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Cover: SH-60B Sea Hawk helicopter and helicopters from US Army 35th Combat Aviation Brigade fly in formation over guided-missile destroyer USS Jason Dunham (DDG 109) after US Army-Navy interoperability training. (Smith Collection/Gado/Getty Images).

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EXECUTIVE SUMMARY

The US fleet is at an important crossroads. Nearly twenty years after the drive for transformation led to costly and problematic programs such as the littoral combat ship (LCS), Gerald R. Ford-class aircraft carrier, and Zumwalt-class destroyer, the Navy is again starting work on new ships in every vessel category. It is essential to make smart decisions on the design of these ships, and of the fleet as a whole, to create a force that affordably supports future defense strategy and avoids mistakes of the past.

The Navy is arguably facing a once-in-a-century combination of challenges and opportunities as it embarks on its new family of ships. Today its leaders, like their predecessors in the years after World War I, are reconsidering the relevance and survivability of the fleet's premier capital ship. In addition, emerging technologies are enabling new platforms and tactics that could disrupt the design of today's fleet; rising adversaries are threatening US allies and the international order; and budget constraints prevent the Navy from countering revisionist powers by simply growing the fleet with better versions of today's ships and aircraft. Today's Navy, however, unlike its interwar predecessor, sustains a global presence to underpin a network of alliances and protect vital sea lanes and does not have the luxury of bringing the fleet home to retool for the emerging competition.

The Navy will need a new fleet design to affordably address its challenges and exploit its opportunities while maintaining today's operational tempo. Unfortunately, its current plans fail to deliver on these goals. The force structure reflected in the PB 2020 Shipbuilding Plan and FY 2021 budget, by continuing to emphasize large multimission combatant ships, includes too few ships to distribute the fleet or create sufficient complexity to slow or confuse an enemy's attacks. Moreover, the fleet's weighting toward large manned platforms creates unsustainable O&S costs that the Navy is even now struggling to pay.[1]

The Navy Needs a Theory of Victory

Navy force structure requirements rest on an implicit or explicit concept for how the Navy will deter aggressors or win if deterrence is unsuccessful. The last two decades of Navy assessments assembled requirements from the bottom up, building campaign plans to fight in canonical scenarios and determining the forces needed to succeed using modeling and simulation. These needs, combined with the day-to-day naval presence needed by combatant commanders, resulted in a force structure requirement.[2] The bottom-up method of force structure planning, however, tends to rely on attrition-centric tactics that defeat an enemy in detail, rather than implementing operational concepts that prevent the opponent from succeeding.

Bottom-up force planning may not be appropriate for the emerging strategic environment. The home field advantage enjoyed by potential adversaries like China, Russia, North Korea, or Iran has allowed each to establish a robust network of sensors and weapons designed to raise the bar for US intervention in its region. Under the protective umbrella of these systems, these rivals pursue a wide range of military and paramilitary actions below the threshold of violence that may provide a pretext for large-scale US or allied retaliation. As a result, US commanders are forced to accept significant risk with a proportional response or deploy large, well-defended force packages that could be costly to maintain forward. And if confrontation turns to conflict, the sensor and weapons networks of adversaries could rapidly overwhelm the defenses of US and allied naval forces.

Overcoming these threats in the face of technology proliferation and fiscal constraints will require more than simple attrition. The new joint warfighting concept that the Department of Defense (DoD) is pursuing, and the Navy's concepts for Distributed Maritime Operations (DMO) and Littoral Operations in a Contested Environment (LOCE), would suggest the Navy's theory of victory should instead rest on establishing a decision-making advantage over adversaries.[3] This approach, drawn from maneuver warfare, would combine defensive operations to foreclose enemy attack options with a diversity of offensive capabilities and complex force presentations to degrade adversary decision-making.[4]

Employing a decision-centric approach, US naval forces could implement a theory of victory appropriate to the US position as a status quo power that seeks primarily to deter aggression or prevent it from being successful. As described in the chapters that follow, US naval forces would pursue deterrence by deploying in a resilient posture capable of promptly transitioning to wartime combat.

If deterrence fails, using a combination of distribution, defensive capabilities, and complex presentations, the fleet would slow enemy efforts to neutralize or destroy US naval forces in the region. While the opponent attempts to defeat Navy and Marine Corps units in detail, the fleet would exploit its diversity of weapons platforms and operating locations to attack enemy forces in ways that will impose dilemmas and reduce the enemy's ability to achieve its objectives in time. The focus on specific targets, consistent with the principles of maneuver warfare, is essential, because US forces will likely be at a numerical disadvantage as the "away team" in future conflicts.[5]

Decision-centric Warfare Requires New Operational Concepts

The Navy's fleet design should prioritize a new set of characteristics to implement decision-centric warfare in the emerging strategic and fiscal environment:[6]

- defensive capacity in each platform or force package to defeat a prompt adversary attack and enable US forces to effectively fire their offensive weapons;
- offensive weapons capacity distributed across numerous platforms and able to sustain strike and counter-maritime operations;
- force package diversity at various scales to enable proportional and sustainable responses to aggression;
- force package complexity to counter adversary decision-making, based on the number of different ways a force package can deliver a warfighting effect; and
- affordable procurement and sustainment costs.

Improving the Navy's performance in these metrics will require new approaches to important naval missions, as described below. A foundational element of these tactics is the distribution of naval forces as described in the concepts for DMO and LOCE.[7]

Context-centric Command, Control, and Communications (C3)

Today the Navy manages operations at a theater level and attempts to build resilient wide-area communication networks to support this preferred command and control (C2) structure. Despite sizable investments in backup and redundant systems, these networks are likely to be degraded during conflict with a great power competitor.[8] Navy and joint service doctrine direct that when communication with superiors is lost, subordinate leaders should use "mission command," in which junior commanders take the initiative to continue pursuing the senior commander's intent.[9]

However, future US naval forces will likely be unable to execute mission command. Distributed operations and the growing number of unmanned systems and small combatants will probably be too complex for junior commanders to manage without a planning staff. Junior naval commanders will need automated planning tools to execute mission command while imposing complexity on adversaries using deception and sensor countermeasures.[10] Decision-support tools would enable C2 relationships to be established based on the availability of communications, rather than building networks that support desired C2 structures.

Intelligence, Surveillance, Reconnaissance, and Targeting (ISRT) and Counter-ISRT

For US naval forces, the continued proliferation of passive RF, electro-optical/infrared (EO/IR), and acoustic sensors, as well as the expanding number of commercial and military satellite constellations, creates a detection challenge. Naval forces are unlikely to be successful if they attempt to hide at sea. Instead, US naval forces operating inside an enemy's weapons range should focus on degrading enemy sensors, increasing the number of targets presented to the enemy by deploying RF, IR, and acoustic decoys, and modestly obscuring the signatures of both real and decoy naval units above and below the water. This approach will present an opponent with numerous equally plausible targets. The enemy will either have to attack all the potential targets, using more weapons and potentially escalating beyond what was planned, or wait to analyze US operations and potentially lose the initiative.

To reduce the likelihood of being detected by an opponent's passive sensors, naval formations will also need to employ more passive and multistatic electromagnetic (EM) sensing. Large active radars like the SPY-1 and SPY-6 should be employed around high-value targets such as airbases ashore or aircraft carriers that will suffer large-scale attacks and are likely to be located using other means. For self-defense, surface and amphibious forces should rely on cueing from passive RF or EO/IR sensors on unmanned airborne aircraft or balloons, vessels, and LEO (low earth orbit) satellites; they should use radars in ways that reduce their likelihood of detection and only for final targeting and engagement.

Air and Missile Defense (AMD)

More distributed formations will dilute adversary attack salvos, reducing the number of weapons each ship or force package may face. The proposed fleet architecture will combine disaggregated operations with air defense tactics that focus on shorter ranges, allowing greater reliance on electronic warfare, directed energy weapons, and smaller surface-to-air interceptors that can be carried in larger numbers. The Navy's current layered air defense approach, including long-range interceptors like the SM-2 and SM-6, will be employed to protect larger platforms such as amphibious assault ships (LHA/LHD) and aircraft carriers.

Anti-submarine Warfare (ASW)

Today, submarines and surface combatants contribute to ASW, but they will need to devote more of their effort to strike and air defense in the future fleet. The Navy will therefore need to increase its reliance on unmanned vessels and sensors to conduct ASW sensing, supported by unmanned and manned aircraft to pounce on targets with affordable suppression weapons, rather than large, expensive torpedoes.

Land and Maritime Strike

The limited reach of today's carrier-based tactical aircraft and small number of refueling tankers planned by the Navy will constrain carriers' offensive capacity from ranges where carrier strike group (CSG) defenses can defeat enemy weapons salvos. Although aircraft with standoff missiles can conduct strikes 1,000 nm from a carrier with minimal refueling, these weapons are the same price as their surface-launched counterparts and carry the additional cost of the air wing and carrier escorts. A growing proportion of strike operations will therefore be conducted by surface combatants, complemented by submarines for strike or anti-surface warfare (ASUW) attacks from inside highly contested areas.

Amphibious Operations

Today's fleet is designed to support amphibious assaults from short range, but these operations are too challenging in the face of anti-ship threats from great or regional powers. Instead, marines will increasingly be used to conduct widely distributed missions ashore as part of the EABO concept. For example, even small Marine F-35 detachments with short-range air defenses could compel opponents to shift tactical aircraft to suppression or escort operations; similarly, Marine anti-ship missile launchers could impact an opponent's maritime freedom of action. The Navy's amphibious fleet will need some ships designed to support these littoral operations and others for open ocean movement of marines and equipment.

Mining and Mine Clearance

Mining will be an important component of naval maneuver warfare, as it inherently imposes dilemmas on an enemy. Mine clearing was a rising priority for the Navy during the last decade and is a primary mission for the LCS. Although the LCS mine warfare mission package is delayed by performance shortfalls, its emphasis on unmanned systems reflects the future of offensive and defensive mine warfare. The portability and scaling possible with unmanned systems suggest the Navy should decouple mine warfare from the LCS and deploy these packages on a range of vessels to support minelaying and clearing.

A New Fleet Design Is Achievable

The Navy can evolve to improve its distribution, offensive and defensive capacity, complexity, and cost while better supporting new concepts for decision-centric warfare. Hudson Institute developed a fleet architecture that prioritizes these metrics by rebalancing from a small number of large platforms to a larger number of small platforms. The proposed fleet also prioritizes

Table 1: Hudson Institute Fleet and 2045 Fleet Compared to Current Navy Fleet

CATEGORIES	VESSEL TYPE	NAVY FLEET IN FY 2020	PROPOSED HUDSON REQUIREMENT	PROPOSED HUDSON FLEET IN FY 2045
Carriers	Nuclear Carrier (CVN)	11	9	9
Surface	Large Surface Combatant (CG/DDG)	89	64	74
	Small Surface Combatant (FFG/LCS/FSSC)	32	52	52
	Small Surface Combatant (DDC)	0	80	80
	Unmanned Support (MUSV)	0	99	99
Subsurface	Ballistic Missile Submarine (SSBN)	14	12	12
	Attack/Strike Submarine (SSN/SSGN)	54	60	54
	Unmanned Subsurface (XLUUV)	0	40	40
Amphibious	Amphibious Assault (LHD/LHA)	10	8	9
	Dock Landing/Amphibious Transport (LSD/LPD)	23	22	24
	Small Amphibious (LAW)	0	26	27
Logistics	Large CLF (T-AO/T-AOE/T-AKE/T-AKM)	29	38	38
	Small CLF (T-AOL)	0	18	18
Command & Support	AS, T-ATS, LCC, T-AGOS, T-EPF, ESD/ESB, MPS T-AKE	35	53	45
Battle Force Fleet Size	Manned Classes Only	297	442	442
	Manned and Unmanned Classes	297	581	581
Non-Battle Force Ships	CONSOL Tankers (T-AOT)	5	20	20
	Medical Ships	2	5	5

SOURCE: AUTHORS

Figure 1: Proposed Hudson Institute Shipbuilding Plan Procurement Costs

Billions of FY2020 dollars

SOURCE: AUTHORS

logistics and sealift with a larger, more affordable force that leverages the commercial maritime industry. The resulting fleet architecture is shown in table 1.

The shipbuilding plan to construct this fleet, depicted in appendix 1, is estimated to fall within the ship construction funding in the Navy's proposed President's Budget for FY 2021 (PB21), adjusted for inflation. The plan takes into account the capacity of the shipbuilding industrial base as well as the need to sustain both shipbuilders and the thousands of suppliers who support them.

The proposed architecture rebalances from larger, more expensive ships toward smaller, less expensive ones. However, its more numerous ships overall will raise operations and support (O&S) costs by an average of 4.9 percent above costs budgeted in PB21, adjusted for inflation. The effort to control O&S costs is also driven by the need to increase fleet maintenance capacity, especially in private repair yards that are responsible for most surface combatant maintenance. The Navy may need to spend more in O&S costs than projected in this report to improve repair yard infrastructure or give private yards a more predictable workload. The challenge of managing sustainment costs suggests the Navy should incorporate O&S expenses more explicitly into its fleet design analysis.

The proposed fleet, like that which the Navy is considering, incorporates several new ship classes. The proposed shipbuilding plan mitigates the risk associated with new platforms by using derivative vessel designs where appropriate and providing, on average, more than seven years between initial ship concept and construction. This allows technologies to mature and provides sufficient time for detailed design work. During this time, the Navy should implement a technology development roadmap for each new ship to enable the development of essential hull, mechanical, and electrical systems or the evolution of the vessel's concept to accommodate expected technological limitations. Specific changes for each Navy ship category are described below:

Figure 2: Proposed Hudson Institute Fleet Architecture O&S Costs

Billions of FY2020 dollars

SOURCE: AUTHORS

Aircraft Carriers

The architecture continues to build Ford-class nuclear-powered aircraft carriers (CVNs) but adjusts their construction frequency to once every six years, allowing the number of carriers to gradually decrease to nine. This reduces the fleet's overall O&S costs and reflects the change in the role of carriers, from the primary naval strike platform to a platform complemented by surface combatants for the naval strike mission.

Surface Combatants

The architecture rebalances US surface forces away from large combatants and toward smaller ships. It does so by slightly reducing procurement of new guided-missile destroyers (DDGs); retiring aging guided-missile cruisers (CGs) and DDGs at their end of service life; and building new guided-missile frigates (FFGs) to replace DDGs in ASW and escort surface action groups (SAGs). To manage costs, the architecture succeeds the DDG-51 class with a DDG(X) that is similar in capacity, rather than with the larger, more expensive, future large surface combatant planned by the Navy. To further distribute the fleet, increase the complexity of force packages, and enable sustainable fires, the architecture also constructs corvettes (DDCs) instead of the Navy's planned large unmanned surface vessel (LUSV). DDCs, as part of strike-oriented SAGs, would carry offensive missiles and rotate through remote reload stations to sustain fires. Because they would be manned, however, DDCs could also conduct maritime security and other missions that LUSVs would be ill suited to perform.

Submarines

The architecture continues production of Virginia-class nuclear-powered attack submarines (SSNs) with the Virginia Payload Module (VPM) before transitioning to an SSN(X) focused on ASW and ASUW. As adversary ASW capabilities improve, VPM payload capacity would likely evolve from carrying missiles to deploying unmanned undersea vehicles and systems. Because of financial constraints during construction of the Columbia-class SSBN, the SSN fleet increases in numbers during the 2030s and 2040s but does not reach sixty ships until 2051. The architecture follows the Navy's plan to build a fleet of twelve Columbia-class SSBNs.

Amphibious vessels: The architecture rebalances today's amphibious fleet to better align with the Marine Corps' *Commandant's Planning Guidance*, *Force Design 2030*, and EABO concept.[11] Although the implications of these directives are still being assessed, it is clear the future amphibious force will require two main components: a fleet of small amphibious warships and logistics ships to support marines distributed across littoral areas to conduct EABO; and a fleet of larger amphibious vessels with the endurance and survivability to maneuver across open ocean and deliver marines to littoral areas, conduct raids or small-scale assaults, and support surface forces conducting sea control.

To provide longer-range fires to widely distributed marines and support air operations from austere forward bases, amphibious assault ships (LHAs/LHDs) are employed primarily as Marine F-35B carriers. Amphibious transport docks (LPDs) and dock landing ships (LSDs) would support establishment of expeditionary bases and larger amphibious operations, such as noncombatant evacuation, humanitarian assistance, and disaster response. To meet the LSD/LPD requirement and sustain the amphibious ship industrial base, the architecture maintains LPD Flt II in production by procuring one every other year until a follow-on ship is developed. To move troops and equipment to and between distributed Marine bases, the architecture builds a new light amphibious warship.

Logistics and Support Vessels

The architecture expands logistics forces with new classes of vessels to enable more distributed sustainment concepts and increase the resilience of deployed naval formations. In addition to the cargo ships and oilers of today's Combat Logistics Force, the proposed logistics fleet includes small oilers, large tankers, dedicated weapon reload ships, additional medical vessels and towing and salvage vessels, and more tenders to support the larger surface fleet and increasing numbers of deployed unmanned vessels. The fleet also provides sufficient funding for a new, flexible approach to strategic sealift.

A Closing Window of Opportunity

Navy leaders need to establish force structure requirements and plans that address the US military's operational challenges by exploiting conceptual and technological opportunities within the Navy's likely resources. The past two decades of Navy force designs failed to create a larger, more sustainable fleet because of their overly optimistic assumptions regarding budget constraints and technology maturation. Going forward, the Navy will need to emphasize affordability and executability in its plans to gain the confidence of industry, Congress, and allies abroad.

There is still time for the Navy to change course and develop a force better suited than today's fleet to long-term competitions with great and regional powers. The long-term changes to Navy fleet architecture proposed above would be significant. However, by acting now, Navy leaders could begin an evolutionary approach that brings on new platforms after reasonable concept and design development, while continuing to produce proven ships to sustain the industrial base and recapitalize some of today's multimission vessels as they retire.

But the window for the Navy to start this evolution is closing. Adversaries may intensify their efforts against America's allies if they perceive US leaders are focused on domestic concerns and unwilling to sustain operations abroad. Fiscal constraints will also begin to foreclose options for the Navy to adopt a new fleet design. As shown above, O&S costs for the fleet grow faster than inflation even with the proposed Hudson fleet architecture. Every year that the Navy delays rebalancing the force to smaller, less-sophisticated, and less-manpower-intensive platforms means higher sustainment costs that will crowd out research and development or procurement of next-generation ships, aircraft, and mission systems.

Today's Navy leaders, like their predecessors between the world wars, have an opportunity to establish an enduring advantage against US competitors. Without significant change, however, the fleet could enter a spiral of rising costs, shrinking numbers, and technological irrelevance. The Navy and Congress should act now to ensure this does not happen.

CHAPTER 1: A FAMILIAR CROSSROADS

The US Navy is at an important crossroads. Nearly twenty years after its drive for transformation led to costly and problematic programs such as the LCS, Gerald R. Ford-class aircraft carrier, and Zumwalt-class destroyer, the Navy is again starting new ships in every vessel category. It is essential for the Navy to make smart decisions on the design of these ships, and of the fleet as a whole, to create a force that affordably supports future defense strategy and avoids the mistakes of the past.

In its efforts to evolve the fleet, the Navy is arguably facing a once-in-a-century combination of challenges and opportunities. Its leaders, like their predecessors in the years following World War I, are reconsidering the relevance and survivability of the fleet's premier capital ship. Moreover, emerging technologies are enabling new platforms and tactics that could disrupt today's predominant fleet design; rising peer competitors are threatening US allies and the international order; and budget constraints prevent the Navy from checking revisionist powers by simply growing the fleet with better versions of today's ships and aircraft. Today's Navy, however, unlike its interwar predecessor, faces global responsibilities to support a network of alliances and protect sea lanes that prevent the fleet from coming home to experiment and transform.

The Navy will need a new fleet design to sustainably counter adversaries and advance US and allied interests. Unfortunately, its current plans fail to deliver on this goal. The force structure reflected in the PB 2020 shipbuilding plan and FY 2021

Photo Caption: US Navy aviation boatswain's mates transport F/A-18E Super Hornet aircraft to the hangar bay aboard the aircraft carrier USS George Washington (CVN 73) in the Pacific Ocean Sept. 10, 2012. (US Navy photo by Mass Communication Specialist Seaman Apprentice Brian H. Abel/Released) budget continues to emphasize large multimission combatant ships. As a result, it includes insufficient vessels to distribute the fleet or create enough complexity to slow or confuse an enemy's attacks. Perhaps of greater concern during a period of constrained budgets, the fleet's weighting toward large manned platforms creates rising O&S costs that the Navy is even now struggling to pay.[12]

This study develops a fleet design for the US Navy that affordably responds to the challenges posed by great power or regional competitors and exploits the opportunities created by emerging technologies. This requires, first, assessing the political conditions and interests of the United States and the Navy's role in addressing them. Therefore, this chapter will examine the strategic context facing the US Navy today, how it is likely to evolve during the coming decades, and how a decision-centric approach to military operations could provide US naval forces an advantage. Subsequent chapters will describe the operational concepts the Navy should use to support a decision-centric operational strategy and propose a fleet design and shipbuilding plan to implement them.

An Intensifying Strategic Competition

In 2018, the DoD published a National Defense Strategy (NDS) that continues to guide US military force development efforts, albeit imperfectly.[13] The NDS recognized that a series of strategic shifts were poised to revolutionize the global balance of power. Gone is the unipolar order of the 1990s; a new system has replaced it, centered on the strategic competition between the United States and China and involving the critical contributions of allies and partners. As revisionist powers grow in strength and ambition, so must American policy be reconfigured. The sea services, and the US military more broadly, must assess the shifting strategic situation and construct a fleet capable of deterring US adversaries, supporting US allies, and winning a multi-theater great power war.

The United States is not the first maritime power to face shifting geostrategic circumstances while bearing global responsibilities. Britain in the nineteenth and twentieth centuries encountered a similar situation, when rising powers and technological changes undercut the United Kingdom's grand strategy and necessitated a new approach undergirded by a redesigned military. Examining British policy choices, and their failures, serves as a useful starting point for any assessment of US naval force structure.

British Naval Power, 1795–1945

At the turn of the nineteenth century, Britain was reeling, embroiled in a war with France shortly after losing its economically important American colonies to independence. By 1820, however, Britain had gained global naval mastery, defeated the French Empire, constructed a European political system to forestall future continental conflagrations, and gained control of India. The second British Empire seemed even more powerful—and eternal—than its eighteenth-century predecessor.

From 1822 onward, three assumptions undergirded British foreign policy and grand strategy.[14] First, European sea control was equivalent to global sea control. Thus, the Royal Navy could concentrate its main battle force in the European Atlantic and Mediterranean, while stationing smaller ships in outposts around the globe and controlling specific choke points like the Suez Canal and Strait of Malacca. Second, the balance of power in continental Europe would correct itself without too much British prodding. Enough statesmen had an interest in maintaining the European system to ensure that European conflicts would remain regional. Third, any threat to European stability would be apparent enough to enable the United Kingdom to build a coalition against it. British naval mastery was thought to be decisive, which would ensure diverse diplomatic options if any crisis threatened to escalate to war.

These three assumptions combined to create the British policy of "splendid isolation," which saw the United Kingdom avoiding permanent alliances and continental engagements, instead leveraging its naval power to ensure continuous economic prosperity. This policy remained strategically reasonable until the 1880s. At that time, Germany, France, the United States, and a recently unified Japan expanded their coal and steel production, leveraging their large populations and exploiting the United Kingdom's free trade policies to undercut British prices and develop national industrial bases.[15] These structural economic effects were translated into strategic terms by the 1890s.[16]

Within Europe, Germany, France, Russia, and Italy expanded and modernized their combat fleets. Between 1895 and 1905, it became apparent that a continental naval coalition would have quantitative and qualitative parity with the Royal Navy in European waters. Britain could have sustained its overall strategy by expanding the European fleet while maintaining second-tier forces deployed at the colonies and choke points. But Japan and the United States also posed a maritime threat; combined, they fielded by 1906 only three fewer battleships than France and five fewer than Germany.[17]

Officially, Britain maintained global sea control through the "two power standard" established by the Naval Defence Act of 1889. This committed the Royal Navy to maintaining a battleship fleet numerically equal to the combined fleets of the world's second- and third-ranked naval powers. The United Kingdom slipped below this mark between 1895 and 1905, but by 1906 its sixty-one-strong battleship force equaled a combined Franco-German fleet of sixty ships. However, Japanese and US naval expansion undercut the two-power standard, since both rising powers fielded fleets large enough to outclass the Royal Navy's colonial cruisers and frigates.

British policymakers were therefore faced with a choice. Either expand the fleet by a third, building enough ships to maintain European naval superiority and at minimum, Asian and Atlantic naval parity; or abdicate global sea control, negotiate settlements with Japan and the United States, and focus on Euro-Atlantic naval superiority.

Two factors made the former choice less likely. First, the United Kingdom's land commitments had grown concurrently with its imperial expansion. While maritime power protected the empire's sinews, land power was necessary to defend British India from Russia's Asian expansionism and protect Canada in a war with the United States. Second, Britain's fiscal situation deteriorated throughout the late nineteenth century, making military spending increases politically unfeasible. By 1905, both British Army and Royal Navy budgets were declining, and British leaders concluded separate agreements with the United States and Japan that functionally abdicated non-European sea control.

Budgetary restrictions demanded a cheaper fleet, but the growing German naval and military threat required commensurate action. In response to these pressures, the Royal Navy transformed its force structure, based upon "the scheme," conceived by First Sea Lord Jacky Fisher. Known for his iconoclasm and opposition to the stultifying classism and conservatism that defined the nineteenth-century Royal Navy, Fisher had established a reputation as a firebrand reformer, particularly through his transformation of the Royal Navy's officer cadet selection and training system—a direct challenge to the service's traditionalist establishment.

Fisher's scheme linked British strategy to force structure within budgetary restrictions, leveraging technological advances to transform the capital ships that defined great power navies.[18] Fisher identified Germany as the primary threat and reasoned that the decisive theater of confrontation would be the North Sea. However, the Royal Navy was still charged with protecting British and dominion shipping internationally, and Germany deployed cruiser squadrons for commerce raiding during wartime. Considering budgetary restrictions and German economic power, simply constructing more standard battleships was a risky choice. Germany had between eight and twelve battleships under construction in any given year from 1896 onward, while British battleship construction declined from fifteen in 1903 to six in 1906.

Fisher's solution identified three critical advances in naval technology—long-range gunnery, improved propulsion, and the torpedo. Fisher combined cutting-edge propulsion technology with a revolutionary all-big-gun armament to enable HMS *Dreadnought* to outclass any battleship in the world at the time. Concurrently, Fisher developed the battlecruiser, a dedicated cruiser-killer and fleet scout that combined a battleship's armament and a fast cruiser's speed by sacrificing armor. Beginning with the Invincible class, the battlecruiser was superior in speed and firepower to any armored or protected cruiser that had preceded it. While dreadnought battleships would form the core of the fleet's striking power, battlecruisers could protect British shipping by defeating commerce raiders and legacy German armored cruisers. Finally, Fisher identified the threat and opportunity created by torpedo-armed destroyers and submarines. He spearheaded British undersea warfare development in response, creating torpedo tactics and authorizing an increase in destroyer construction.[19]

The longevity of Fisher's navy is a testament to the scheme's strategic coherence. Big-gun battleships formed the Royal Navy's core combat formations during both world wars, while three of Fisher's battlecruisers were converted into aircraft carriers and saw service into the 1940s. But after World War I, the Royal Navy could not meet the requirements of being a world power, particularly following cuts imposed by the post-war Washington and London naval treaties. When World War II broadened to the Pacific in 1941, the Imperial Japanese Navy overwhelmed its British counterpart.[20] Although the United States ultimately proved more powerful than Japan, Britain, by abdicating global sea control, ceded political leverage outside of the Euro-Atlantic and Mediterranean. Fisher's scheme created a clear connection between British strategy and force structure. In this respect, it stands as a model for modern defense planners. But it also serves as a warning. When budgets alone drive policy, grand strategy evaporates.

American Naval Force Structure, 1950–2010

Just as twentieth-century British fleet architecture stemmed from late-nineteenth-century strategic choices, today's US strategy and force structure stem from the policy decisions of the late Cold War and early twenty-first-century. And much as in pre-war Britain, the United States is experiencing a growing gap between its naval force structure and grand strategy.

Throughout the Cold War, the US naval force structure matched the requirements of a unique strategic situation, as the United States and Soviet Union became the only powers capable of strategic competition following the economic and political devastation of World War II.[21] This structural bipolarity also differed qualitatively from its historical antecedents. Previously, each great power fielded distinct capabilities. Britain's land power could never match that of its continental rivals, while Russia, Germany, and France could not independently eclipse Britain at sea. But each great power fielded roughly similar military forces—armies comprised infantry, cavalry, and artillery, while battleships formed the core of naval forces.

By contrast, the United States and Soviet Union fielded qualitatively *and* quantitatively distinct military forces. On land, the United States hoped to offset Soviet advantages in tank divisions with tactical airpower and mobile anti-tank units. At sea, the differences were even more stark. Like the Russian Empire that preceded it, the Soviet Union lacked warm-water ports with unrestricted access to the sea. Moreover, the Soviets lacked capital ships in sufficient numbers to create standard naval combat formations. The United States, however, fielded the world's largest navy, optimized for fleet combat and amphibious operations after four years of Pacific warfare.

As mentioned above, Soviet policy was predicated upon gaining a decisive conventional victory in Europe before the United States employed nuclear forces. Land power and land-based airpower were central to this strategy, according to which Warsaw Pact armored divisions and tactical air forces would create and exploit gaps in NATO defensive positions, overwhelming exhausted Allied units and racing to the Rhine River in under a week.[22] But Soviet naval inferiority threatened to cripple this strategy—US sea control allowed the United States to redeploy ground troops in Europe and pressure the Soviets' northern and southern flanks.

The Soviet Navy, to address its overall inferiority, emphasized submarines, which became the fleet's premier warfighting arm. Quiet SSNs like the Victor III and Akula classes were designed to hunt naval battle groups and nuclear ballistic missile submarines, while fast, deep-diving SSNs like the Alfa class were intended to attack NATO naval forces reinforcing Europe during a broader conflict. Soviet nuclear ballistic missile submarines benefitted from improved missiles during the Cold War, which allowed later Delta- and Typhoon-class submarines to operate in the Arctic, whereas older Yankee--class submarines needed to patrol in the Atlantic or Pacific Oceans to reach their US targets.

The Soviets used surface warships and land-based aviation to create naval bastions, particularly in the Barents Sea and Sea of Okhotsk, from which Soviet submarines could sortie and to which they could return during wartime.[23] This approach to naval warfare stemmed from Soviet strategic realities and budgetary priorities. The Soviets lacked unrestricted maritime access and needed to prioritize continental superiority in a broader NATO–Warsaw Pact confrontation. The Soviet emphasis on undersea capabilities can therefore be understood as an asymmetric solution to the USSR's maritime and grand strategic requirements.

Similarly, the force structure of the United States derived from its strategic goals. The core US strategic objective remained denying any power or coalition hegemony on the Eurasian landmass. The insular position of the United States, therefore, necessitated a robust, forward deployed Navy throughout the Cold War, which linked together the US alliance network.

Although the fleet's architecture was modified throughout the Cold War, US strategy was most coherent during the 1980s. In Europe, the AirLand Battle concept leveraged US and allied technological advantages to blunt a possible Soviet offensive. At sea, the new US maritime strategy employed naval power to pressure the Soviet Union's flanks in the High North, Mediterranean, and Far East. This required operating close to the Soviet coastline, directly pressuring the naval bastions that undergirded Soviet maritime power. US and NATO naval forces would strike inland at advancing Soviet ground forces *and* jeopardize Soviet nuclear second-strike capabilities, placing the Warsaw Pact at a simultaneous conventional and nuclear disadvantage.[24]

This strategy dictated a force structure centered upon the carrier battle group (CVBG), the core of US naval forces since the Second World War. The reliance on CVBGs stemmed from the Navy's role in both sea control and power projection. Depending on the combination of aircraft in its carrier air wing (CVW), a carrier could conduct nearly any naval mission. By the 1980s, US CVWs included six distinct airframes and nine variants of combat-related aircraft to support their varied roles.[25]

The maritime strategy also guided American surface combatant development, which was divided between high-end ships like the Kidd- and Adams-class DDGs and a class of lower-end ships, the Perry-class FFG. While the former operated with CVBGs, the latter were intended to provide ASW and surface warfare in less-contested regions or protect friendly shipping during a global war. Finally, US amphibious assault ships operated alongside the CVBG and independently in amphibious ready groups, positioned to deploy marines along the Soviet periphery.

The US Navy's Cold War force structure jeopardized the Soviet Union's bastion strategy and increased the likelihood that Soviet aggression would fail. The maritime strategy and resulting fleet may well have hastened the end of the Cold War.

The Soviet Union's collapse transformed the international environment—and arguably left the sea services without a clear mission. Global US sea control remained important absent a great power threat, but the Navy perceived that it had no need to prepare for a global peer-to-peer conflict. The overwhelming US victory during Operation Desert Storm in 1991 established the primacy of land power and airpower in US post–Cold War operations. It also heralded a shift in US military strategy—from planning to thwart the efforts of a great power aggressor by creating multiple insoluble dilemmas, to defeating opponents primarily through attrition of their forces, followed potentially by regime change.[26]

The Navy compensated by redefining itself as a crisis-response force: CSGs and expeditionary strike groups (ESGs) could support combatant commanders in regional contingencies while reducing stress on other military forces based largely in the continental United States (CONUS). The fleet's mission contracted to focus on precision ground attack. Other operations, such as ASW, surface warfare, and air defense were deemphasized, resulting in the gradual retirement of specialized ships and aircraft. Overall, the fleet's size shrank from 594 ships in 1987 to 318 in 2000.[27]

The Navy's flexibility became apparent again during the early 2000s, when naval aviation was integral to the US campaigns in Afghanistan and Iraq. Particularly in the former, the carrier's adaptability was central to US success because of the lack of available nearby air bases early in the conflict. The USS *Enterprise* took up station in the Arabian Sea immediately following the September 11 attacks, providing air support to special operations forces throughout their campaign against al-Qaeda and the Taliban. The Air Force's 160th Special Operations Aviation Regiment also used the conventionally powered USS *Kitty Hawk* as an afloat staging base. The Marine Corps proved similarly useful as a manpower reserve, providing surge capacity to the Army throughout Operation Iraqi Freedom.

Despite the Navy's utility in the post–Cold War period, the fleet's overall size dropped below 300 in 2003 and reached a low of 279 in 2007. The number of Navy CVWs also shrank, as the Navy phased out the F-14 *Tomcat*, S-3 *Viking*, and A-6 *Intruder*, with variants of the latter remaining in service as electronic warfare platforms until 2015.

Great Power Competition, 2010–Present

The People's Republic of China (PRC) poses the greatest nation-state challenge to US and global security. The scale and sophistication of the People's Liberation Army (PLA), coupled with the PRC's comprehensive national power, collectively rival those of the United States and pose a peer threat that could overcome US and allied attempts to stop PRC aggression.[28]

General Secretary Xi Jinping has made clear his vision of "national rejuvenation" and "building a community with a shared future for humanity," in which the PRC establishes global hegemony and once more becomes the Middle Kingdom of a world that bows to China's authority.[29] Rejecting Deng Xiaoping's earlier strategy that aimed to "hide your strength and bide your time," Xi aggressively pursued becoming "the most active and positive force in global governance" and in totalitarian fashion, recommitted the PRC to eliminating any "opportunity or outlets for incorrect thinking or viewpoints to spread" worldwide.[30]

Under Xi, the PRC intensified its efforts to enforce China's influence and territorial control in East Asia, killing soldiers and fishermen in border disputes, constructing fortifications on artificial features that Xi Jinping had promised not to militarize, and attacking US and allied forces with non-kinetic weapons.[31] Through these gray-zone tactics, the PRC government uses military and paramilitary forces to achieve its political objectives. It does so in a manner that aims to stay below the level of violence that may trigger a broader or more committed international response. Conventional and nuclear forces capable of threatening US and allied militaries help establish the PLA's escalation dominance during gray-zone operations and can be employed in larger-scale conflicts.[32]

The capability development and operations of the PLA are guided by its concept for systems destruction warfare, which intends to “disrupt, paralyze, or destroy the operational capability of the enemy’s operational system.”[33] To implement this approach, the PLA assesses US and allied operational systems of systems in detail to identify potential vulnerabilities, and it builds organizational and operational structures to exploit the most advantageous shortfalls.

Applying the concept of systems destruction warfare, PLA modernization during the last two decades has created a military capable of wielding force to coerce its neighbors and counter intervening US forces. In a major conflict, the PLA could use its long-range missile arsenal and diverse ground-, sea-, and air-based delivery platforms to saturate nearby US and allied positions.[34] Naval forces could restrict access to contested areas while amphibious, ground, or airborne forces could assault desired territory.

PLA capabilities are currently most powerful near the PRC, and it has expressed a willingness to use force or demonstrated the use of force against US allies and partners in the region, such as India, Japan, Korea, Taiwan, and Vietnam. The PLA, however, is also developing forces and bases to support global operations. Accordingly, US planning scenarios should focus on the threat the PRC poses to allies in the region but should also plan for the need to counter worldwide PRC aggression.

Contemporary Russia, like China, is heir to a dual Marxist-imperial tradition that conditions its strategic viewpoint. Both strands of Russian identity contain within them deep-rooted suspicion and paranoia toward Europe and Asia, stemming from the invasions that define Russian political history. Thrice in history has a single power neared continental hegemony. Two of these powers—Napoleonic France and Nazi Germany—mounted invasions that nearly broke Russia. The third, Imperial Germany, waged a war so brutal that it destroyed the Russian Empire. Even a European power or coalition without continental hegemony can threaten Russian survival, as Russia’s wars with Poland and Sweden attest.

NATO poses the greatest contemporary challenge to Russian ambitions. The Russian government cannot tolerate an extra-European power with a major stake in European security or a Europe united under a hegemon or in a defensive alliance. By erasing the US role in European security, the Russian government hopes to dominate a divided continent, replacing NATO’s security system with a Kremlin-managed European balance of power.

Achieving Russian objectives requires “cracking” NATO, rather than overcoming it in a conventional conflict. In addition to Russia’s invasion of Georgia, Moscow used a mix of gray-zone and conventional approaches to occupy Crimea and other parts of Ukraine. A similar strategy is imaginable in the Baltic States or Poland. The Kremlin’s intelligence services could stoke ethnic tensions to enable a tacit or open Russian intervention against the legitimate government.[35] If the crisis escalates and NATO responds, Russia could threaten limited nuclear use to attempt to force NATO to deescalate.

The Russian military continues to develop new capabilities that could contest the forces of NATO and other countries across domains. Although the strategic aims of Russian aggression in a possible scenario are likely ashore, naval forces are integral to Russia’s strategy in three ways. First, by exerting sea denial or sea control in the Mediterranean, Russia can pressure NATO allies in the Mediterranean and potentially draw a disproportionate number of NATO forces away from the primary area of operations. Second, in the Baltic, Russian naval forces could restrict the maritime corridor through which NATO can reinforce its eastern members. Third, naval power provides and protects Russian nuclear second-strike capability and affords options for unwarned conventional or nuclear cruise missile attack against the US homeland.

To fulfill these three missions, the Russian fleet is designed to reflect priorities similar to those of its Soviet predecessor.[36] Submarines remain the backbone of Russian naval power, with improved Kilo-class SS and Akula-, Sierra-, and Yasen-class SSNs forming the core of Russia's attack submarine fleet. Russian Federation Navy (RFN) surface forces are increasingly centered on modern small surface combatants, such as the Grigorovich-, Steregushchiy, and Gorshkov-class frigates and Bykov-class corvettes, that are designed for operations in European littoral waters.[37]

Great powers like China and Russia are not the full extent of the challenges facing the United States and the US Navy. Regional powers such as Iran and North Korea exploit a combination of strategically beneficial geography and smart military modernization to threaten US and allied interests.

North Korea is more concerning than Iran because of its demonstrated nuclear weapon and ballistic missile capabilities, which it has tested and threatened to employ against US allies and the United States itself. Moreover, Kim Jong-un's regime continues to be in a technical state of war with the Republic of Korea (RoK), and it has employed force against RoK military units and civilians since the establishment of the armistice. The risk of North Korean nuclear or conventional ballistic missile attack creates a demand for sea-based ballistic missile defense (BMD) from the US Navy to help protect the RoK, Japan, and Guam.

Although financial sanctions constrain North Korean weapons development and procurement, Pyongyang continues to selectively modernize the North Korean People's Navy, fielding new submarines and corvettes.[38] These ships do not possess the same level of capability or capacity to contest access as Chinese or Russian platforms, but North Korea's ballistic missile and midget submarines are capable enough to require significant US and allied ASW operations during a conflict.

Among Iranian forces, the irregular units garner the most attention. Because Tehran lacks sufficient traditional ground and air forces to achieve its strategic objectives, the regime created a robust proxy network that it supports technically, financially, and militarily through the Quds Force of the Islamic Revolutionary Guard Corps (IRGC).[39] Quds Force activities are largely oriented toward gaining Iranian influence and undermining competitors in the Levant and Arabian Peninsula.

Iran's irregular forces have a wider geopolitical impact through their maritime operations. The Quds Force armed Hezbollah and Houthi rebels with anti-ship missiles—in both cases likely providing technical and operational assistance, and possibly directing targeting as well.[40] The IRGC operates a fleet of fast attack boats and midget submarines in the Strait of Hormuz and Persian Gulf that are intended to counter Saudi and US naval forces with the threat of cheap missile barrages.[41] Ground-launched anti-ship and anti-air missiles support this irregular fleet from the Iranian coast.

Iran's regular military also has a capable maritime component. The Islamic Republic of Iran Navy (IRIN) generally operates outside the Persian Gulf, where its three Kilo-class submarines, coastal submarines, and small surface combatants defend Iran's maritime approaches or threaten sea lanes in the Arabian Sea and Indian Ocean.[42]

Iran's maritime capabilities further its interests by jeopardizing oil transit from the Near East and more broadly undermining US and allied sea control in the Levantine basin. By controlling the Strait of Hormuz and placing forces along the Bab el-Mandeb in Yemen, Iran can contest energy flows to US allies as well as to China.

Implications for Concepts and Forces

Current US force structure is unable to meet the multiple interrelated challenges described above. The US military is optimized for limited regional contingencies such as those it fought in Iraq, Afghanistan, and Kosovo during the 1990s and 2000s. Ground forces and land-based air forces are the most common tools used to mitigate military flashpoints, with the Navy and Marine Corps usually employed in support. Naval combat power is concentrated in CSGs and ESGs designed to support ground forces, with short-range air wings carrying precision-guided munitions, while the Marine Corps functions essentially as a reserve source of aircraft and armor to supplement Army and Air Force combat power.

The sea services must become more distributed, more flexible, and more lethal. But like the Royal Navy at the turn of the last century, the US Navy has global responsibilities. The demands on today's US fleet challenge the ability of Navy leaders to transform the force. The Navy will need a plan that affordably evolves the fleet for the future while continuing important contemporary operations.

CHAPTER 2: STRATEGIC AND OPERATIONAL CONCEPTS OF THE FUTURE FLEET

Navy force structure requirements rest on an implicit or explicit concept for how the Navy will deter aggressors or win if deterrence is unsuccessful. As described in chapter 1, the US Navy has lacked a clear theory of victory for potential warfighting scenarios since the Cold War's maritime strategy.

Without a guiding approach to naval operations, the Navy in the last two decades made assessments that assembled requirements from the bottom up: it built campaign plans for naval forces to support joint operations in canonical scenarios and determined the forces needed to succeed using modeling and simulation. These needs, combined with the day-to-day naval presence requested by combatant commanders, resulted in a force structure requirement.[43] The bottom-up method, because it is not framed by an overall approach and associated metrics, tends to rely on attrition-centric tactics that defeat an enemy in detail.

Bottom-up force planning may not be appropriate for the emerging strategic environment. The home field advantage enjoyed by adversaries like China, Russia, and Iran has allowed each to establish a robust network of sensors and weapons designed to raise the bar for US intervention in support of allies

Photo Caption: An anti-submarine warfare unmanned surface vehicle performs strategic maneuvers during the unveiling ceremony of the littoral combat ship anti-submarine warfare mission package held at the Naval Mine and Anti-Submarine Command Complex of Naval Base Point Loma, Calif., Sept. 19, 2008. (US Navy photo by Seaman Omar A. Dominquez/Released) and partners. Under the protective umbrella of these systems, the great power and regional competitors of the United States pursue a wide range of military and paramilitary actions that are below the threshold of violence that would provide a pretext for large-scale US or allied retaliation. As a result, US commanders are forced to accept significant risk if they respond proportionally or deploy large, well-defended force packages that could be difficult to sustain forward over a protracted period. And if confrontation turns to conflict, the sensor and weapons networks of these adversaries could rapidly overwhelm the defenses of US and allied naval forces.

Overcoming these threats in the face of technology proliferation and fiscal constraints will require more than simply growing the fleet's size and sophistication to better attrite enemy forces. The new approaches described in DoD's emerging joint warfighting concept, and in the Navy's concepts for DMO and LOCE, suggest the Navy's theory of victory should instead rest on establishing a decision-making advantage over adversaries.[44] This approach, drawn from maneuver warfare, would combine defensive operations to foreclose enemy attack options with a diversity of offensive capabilities and complex force presentations to degrade adversary decision-making.

Employing a decision-centric approach, US naval forces could implement a theory of victory appropriate to the US position as a status quo power that seeks primarily to deter aggression or prevent it from being successful. US naval forces would deter aggression by deploying in a resilient posture capable of promptly transitioning to wartime combat from operations associated with peacetime competition.

If deterrence fails, US naval forces would prevent enemies from accomplishing their aims and, if necessary, sustain a protracted campaign that imposes costs and decreases enemy combat power. Using a combination of distribution, defensive capabilities, and complex presentations, the fleet would slow enemy efforts to neutralize or destroy US naval forces in the region. While the opponent attempts to defeat Navy and Marine Corps units in detail, the fleet would exploit its diversity of weapons platforms and operating locations to attack enemy forces in ways that impose dilemmas and reduce the enemy's ability to achieve its objectives in time. The focus on specific targets, consistent with the principles of maneuver warfare, is essential because US forces will likely be at a numerical disadvantage as the "away team" in future conflicts.[45]

The Emerging Era of Decision-centric Warfare

Current US defense strategy pursues deterrence by denial, which depends on creating uncertainty for an adversary regarding its likelihood of success.[46] As noted above, US forces effectively deterred post–Cold War opponents by threatening overwhelming attrition of enemy forces and potential removal of the opposing government. These threats are not likely to be credible against Chinese or Russian leaders and may fall short of deterring a geographically well-positioned Iranian regime or nuclear-armed North Korean dictator.

The US military could more effectively create uncertainty and deter aggression by employing decision-centric approaches, such as maneuver warfare, which attempt to create a set of insoluble dilemmas for the enemy that dissuade it from aggression or compel it to seek an exit from an ongoing conflict.

The US military is beginning to make the shift toward decision-centric warfare with DoD's establishment of the strategy for operations in the information environment, and in its pursuit of new concepts that emphasize distributed operations.[47] The emphasis on decision superiority is more explicit in DoD's emerging concept for joint all-domain C2 (JADC2). Although it is primarily focused on establishing interoperability and communications connectivity across the force, JADC2 is also intended to afford US forces the ability to make faster and more effective decisions than adversaries.[48]

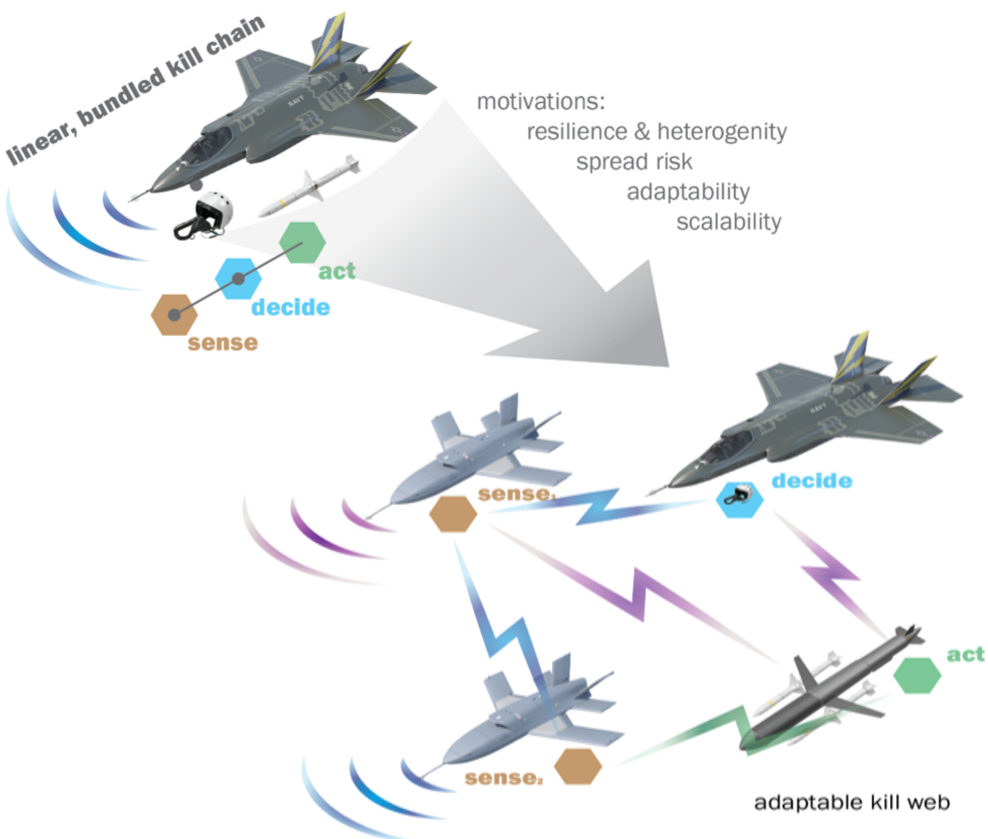
JADC2's main limitation is that it does not acknowledge the challenges and opportunities arising from the presence of a capable adversary. US forces will have to contend with enemy attacks on US and allied networks and sensor and communication platforms, which will need to be mitigated by new C2 concepts and capabilities. But decision advantage can also be obtained by US operations that degrade an opponent's decision-making. The Mosaic Warfare concept of the Defense Advanced Research Projects Agency (DARPA) fully embraces these aspects of the decision-centric approach and is in many ways the basis for the strategic concept advanced in this study.[49]

Implications for Force Design

Mosaic Warfare and other decision-centric concepts derive in large part from maneuver warfare, which is often employed by powers that are attempting, from a position of localized military inferiority, to prevent an opponent from succeeding. Two fundamental applications of maneuver warfare are *dislocation*, preventing the enemy from reaching its objective at the intended

Figure 3: Representation of Disaggregated Force Operations

A more disaggregated force exchanges a small number of multimission units for a larger number of units with fewer functions, creating a more adaptable and complex force.



SOURCE: AUTHORS

time, and *disruption*, attacking the enemy's center of gravity, such as the C2 systems, networks, and logistics that provide cohesion to the enemy force.[50]

A disaggregated force incorporating many small units with a focused set of functions and a few large, multimission units would be better able than today's US military to cause dislocation of enemy aggression. The disaggregated force would have fewer readily identifiable nodes and would be more capable of reorganizing to confuse enemy sensing and compensate for losses. The adversary would therefore need to attack most or all of the US units or take more time to understand the US force disposition and tactics. Either approach would put the adversary at a disadvantage. Furthermore, the disaggregated US force would enable a wide range of possible effects chains, creating adaptability and accelerating decision-making in offensive operations to slow or stop enemy aggression.

Disaggregated forces would also be better able than today's US military to disrupt an enemy's centers of gravity. The capability and capacity of a force package comprising a large number of small units would afford more options to commanders and be more easily calibrated to the task than is today's US military. This would enable commanders to formulate courses of action (COAs) faster and spread a given force over more simultaneous tasks. The resulting tempo and scale of military actions could overwhelm an adversary's decision-making and defenses, improving the likelihood that US forces would reach enemy centers of gravity. Moreover, a more disaggregated force that includes a large number of attritable or expendable unmanned systems and smaller units could conduct more effective feints and probing operations, something rendered almost impossible by the need to protect today's manned multimission platforms.

A decision-centric approach to warfare would combine disaggregated forces with decision-support tools to manage the larger number of units and enable US forces to make faster and more effective decisions than adversaries. The core metrics of decision-centric operations, as with maneuver warfare, would be the number of distinct dilemmas presented to the enemy and the speed with which they are imposed. Ideally, US forces would impose multiple dilemmas so that an opponent attempting to counteract one must become more vulnerable to another. To compound the challenge, US forces would seek to fight at a rate that does not permit the adversary to regroup or concentrate.

Military theorist John Boyd advocated a decision-centric approach to military operations in his writings and presentations. He broke down the military decision-making process into observation of adversary and friendly forces; orientation to assess what the enemy is doing and why; the decision to develop and choose a COA; and implementation of the COA. Boyd called this the observe-orient-decide-act (OODA) loop and proposed that military operations should focus on defeating the enemy's orientation to slow and eventually collapse its decision cycle.[51]

The proliferation and improvement of military and commercial airborne, satellite, and third-party sensors make observation almost impossible to prevent. Using deception, decoys, camouflage, and jammers, decision-centric warfare enables a US force to confuse the enemy regarding the most advantageous targets to attack, the force's intended objectives, and the approach it will take to achieve them.

Operational Concepts for Decision-centric Warfare

The Navy's operational concepts and fleet design should prioritize a new set of characteristics to affordably implement decision-centric warfare:[52]

- defensive capacity in each platform or force package to defeat a prompt adversary attack and enable US forces to effectively fire their offensive weapons;
- offensive weapons capacity distributed across numerous platforms that is able to sustain strike and counter-maritime operations;

- force package diversity at various scales to enable proportional and sustainable responses to aggression;
- force package complexity to counter adversary decision-making based on the number of different ways a force package can deliver a warfighting effect; and
- sustainable costs for procurement and O&S.

Improving the Navy's performance in these metrics will require new approaches to important naval missions, as described below. A foundational element of these tactics is to distribute naval forces as described in the DMO and LOCE concepts.[53]

Context-centric C3

Today the Navy manages operations at a theater level and attempts to build resilient wide-area communication networks to support this preferred C2 structure. Despite sizable investments in backup and redundant systems, these networks are likely to be degraded during conflict with a great power competitor.[54] When communication with superiors is lost, Navy and joint service doctrine direct subordinate leaders to use "mission command," in which junior commanders take the initiative to continue pursuing the senior commander's intent.[55]

It is likely, however, that future US naval forces will not be able to execute mission command. The Navy plans to introduce a growing number of unmanned systems and small combatants into the fleet, which this study proposes to expand further. The larger number of naval units, combined with the distributed operations envisioned under DMO and EABO, along with the need to operate in a cross-domain manner, will likely be too complex for junior naval commanders without a planning staff to manage.

Junior commanders will need automated planning tools to execute mission command of the Navy's planned and proposed force. Decision support systems such as the Aegis Combat System, Air Battle Management System (ABMS), or DARPA's Adapting Cross-Domain Kill Chains (ACK) could help commanders identify the forces in communication with them, develop COAs to employ the available units to pursue prescribed tasks, and impose complexity on adversaries using deception and sensor countermeasures. [56]

Decision-support tools would enable C2 relationships to be established based on the availability of communications, rather than building networks that support desired C2 structures. When connectivity is lost to higher command, this context-centric approach to C3 would enable a more graceful and intentional devolution of command to junior leaders who can take charge of the forces with which they are in communication.

ISRT and Counter-ISRT

The continued proliferation of passive RF, EO/IR, and acoustic sensors, and the expanding number of commercial and military satellite constellations, creates a detection challenge for US naval forces. As the "away team" in potential Eurasian confrontations, US naval forces are less able to exploit terrain to hide and more dependent on active sensors like radar to rapidly find and localize threats such as anti-ship missiles (ASMs).

Naval forces are unlikely to be successful if they attempt to hide at sea. There are too many overlapping commercial and military sensors covering most relevant areas in an increasing span of acoustic and EM frequencies, from RF to EO/IR to ultraviolet (UV).[57] Instead, US naval forces operating inside an enemy's weapons range should focus on degrading enemy sensors; increasing the number of targets presented to the enemy by deploying RF, IR, and acoustic decoys; and modestly obscuring the signatures of both real and decoy naval units above and below the water. This approach will present an opponent with numerous equally plausible targets. The enemy will either have to attack all potential targets, using more weapons and potentially escalating beyond what was planned, or wait to analyze US operations and potentially lose the initiative.

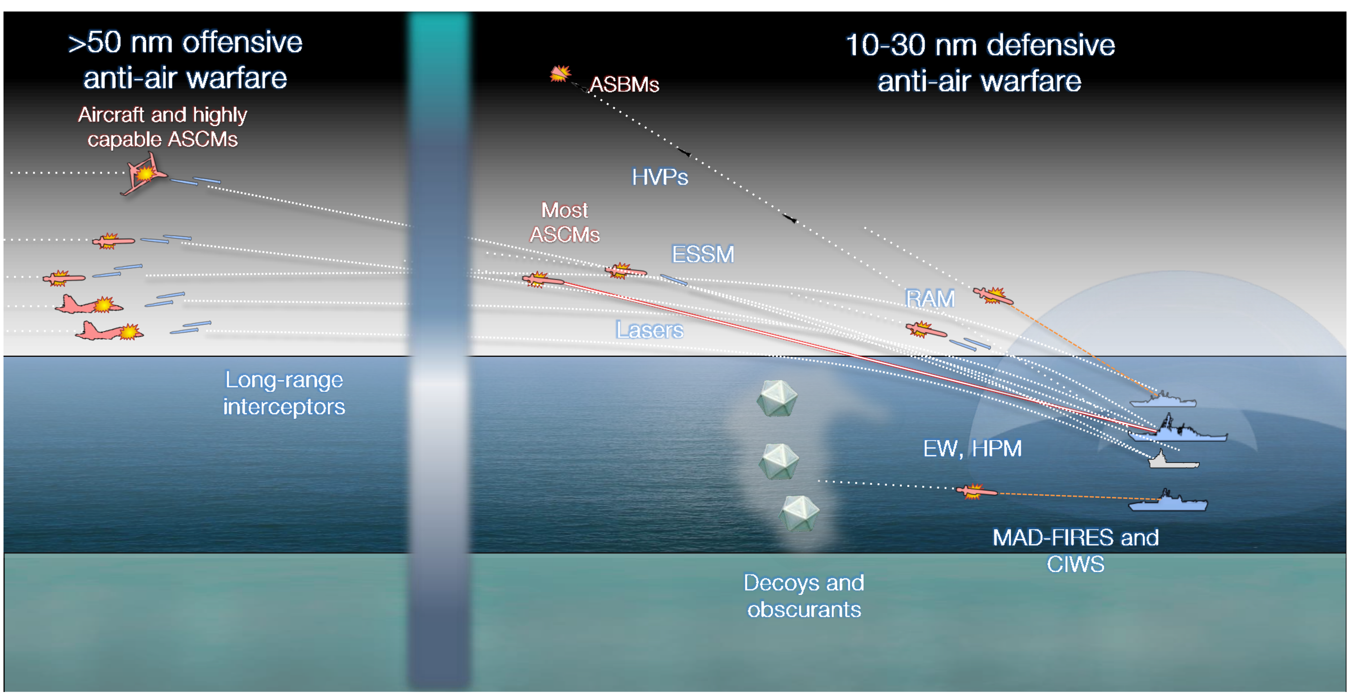
Naval formations, to reduce their likelihood of detection by an opponent's passive sensors, will also need to employ more passive and multistatic EM sensing. A challenge with passive sensing is that the opponent can impact the strength of its signatures, and this often requires passive sensors to approach the target more closely for detection. Naval forces can use unmanned systems to help address this constraint. For example, they can employ unmanned surface vessels (USVs) as emitters for passive receivers on manned surface combatants or rely on space and airborne unmanned EO/IR sensors to locate enemy ships and other potential threats and targets.

The need to shift to passive sensors will also result in changes to naval missile defense architectures, because the responsiveness and accuracy of radar will still be needed for missile intercepts. Large active radars like the SPY-1 and SPY-6 should be employed around high-value targets, such as airbases ashore or aircraft carriers, that will suffer large-scale attacks and are likely to be located using other means. For self-defense, surface and amphibious forces should rely on cueing from passive RF or EO/IR sensors on unmanned airborne aircraft or balloons, vessels, and LEO satellites. Smaller self-defense radars would only be used for final targeting and engagement.

Air and Missile Defense

Today's AMD tactics use multiple long-range surface-to-air interceptors such as the SM-2 and SM-6 against each incoming missile, combined with electronic warfare (EW) and short-range point defense weapons against weapons that leak through longer-range defenses.[58] This approach essentially guarantees that US surface combatants will use their best and most-expensive defenses first, and will eventually be left with only self-defense systems and EW to address later salvos. The Navy will need to break from this paradigm to achieve more

Figure 4: Proposed AMD Concept



SOURCE: AUTHORS

advantageous cost-exchange ratios and increase the AMD capacity of naval formations.

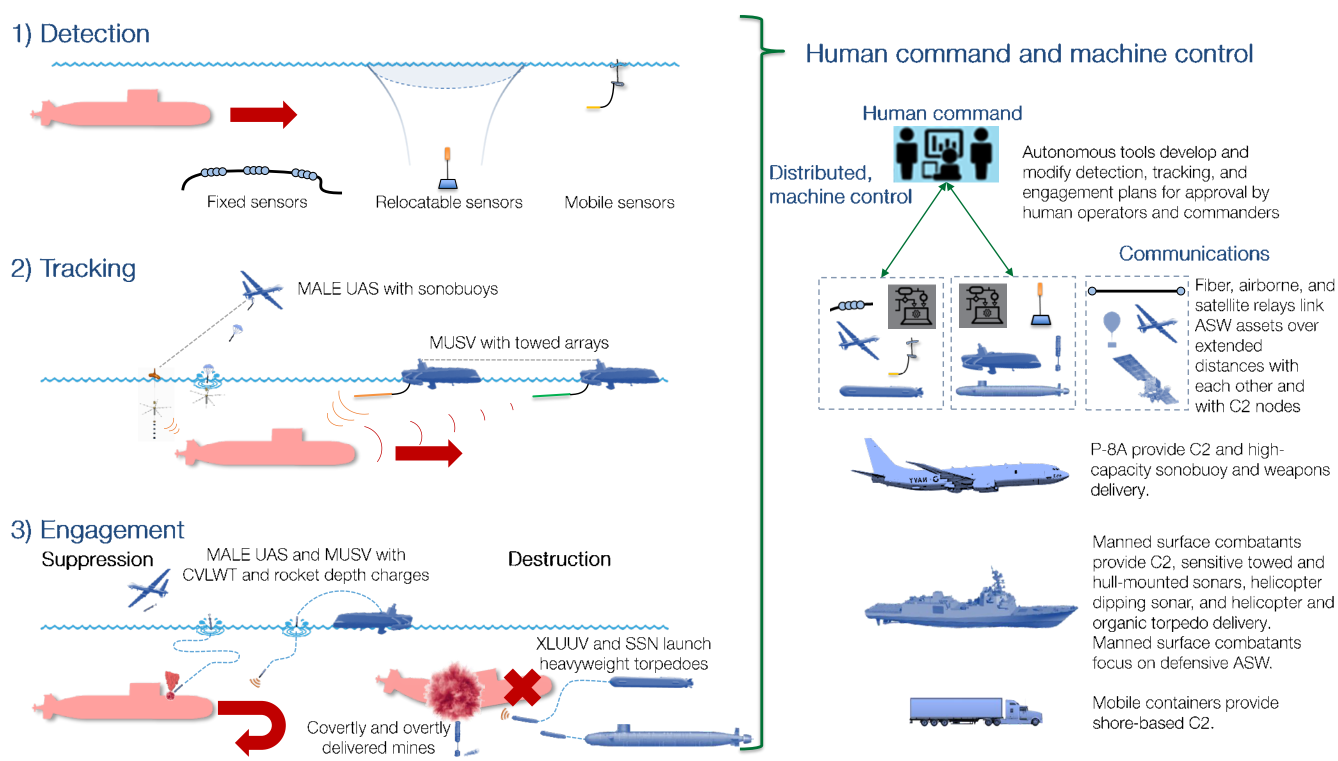
Distributed naval forces such as SAGs would shift to using primarily short- and medium-range defenses for AMD that engage incoming missiles or aircraft 10–30 nm from the protected ship. These include EW systems and directed energy weapons that are limited by the horizon; the Rolling Airframe Missile Block II, which is deployed from a dedicated launcher; and the Evolved Sea Sparrow Missile (ESSM) Block II, which fits four to a standard vertical launching system (VLS) cell. These shorter-range systems are less expensive than SM-2 or SM-6 interceptors and can be carried in much greater capacity. Distribution will further extend the AMD capacity of SAGs by diluting adversary attack salvos and reducing the number of weapons each force package may face.

The Navy will continue to employ its current layered air defense approach, including long-range interceptors like the SM-2 and SM-6, to protect larger platforms such as LHA/LHDs and aircraft carriers, as well as bases ashore like those in Guam or Okinawa. As described above, surface combatants conducting these defensive operations would continue to rely on high-power active radars like the SPY-1 and SPY-6.

ASW

The Navy generally conducts ASW with a combination of seabed sensors such as the Sound Surveillance System (SOSUS); P-8A

Figure 5: Proposed Unmanned ASW Concept



Source: Authors

maritime patrol aircraft; and submarine or surface combatants.[59] This approach is platform- and manpower-intensive, costly in terms of O&S, and unlikely to scale during wartime or periods of heightened tensions when adversaries could deploy large numbers of submarines to overwhelm US ASW forces. Moreover, US submarines and surface combatants will need to devote more of their effort to strike, ASUW, and AMD in the future fleet.

A particular weakness of the current US ASW approach is tracking or trailing of enemy submarines after they pass through choke points such as the Greenland-Iceland-United Kingdom (GIUK) gap or Ryukyu Straits, where US and allied ASW sensors will be concentrated. Although US SSNs or DDGs could trail high-priority submarines for their deployment, other submarines would eventually become unlocated and pose a potential threat to US or allied forces and territory.

To create a scalable and more affordable ASW approach, the Navy should increase its reliance on unmanned vessels and fixed or relocatable sensors to conduct ASW sensing; land-based unmanned aircraft and USVs to track submarines in the open ocean; and land-based unmanned and manned aircraft to pounce on targets. ASW is uniquely suited among naval missions to the use of unmanned systems. Search and track can be highly automated using highly identifiable sound signatures and target motion analysis algorithms. In addition, ASW prosecutions unfold slowly enough for commanders and operators to be “in the loop” and decide when to launch weapons against the target.[60]

This new concept would also exploit the inherent vulnerabilities of submarines: they are relatively slow, and unlike an aircraft, cannot outmaneuver or outrun a nearby torpedo; they lack robust defenses like those on surface ships; and their sensors cannot rapidly determine if an incoming attack is unlikely to be successful. These shortcomings would allow ASW forces with torpedoes or depth bombs to keep submarines evading and unable to conduct their primary mission.

Today’s Mk-54 air- and surface-launched torpedo, however, was assessed in the mid-2010s to have relatively low lethality, although modifications made since then may have improved performance.[61] Low lethality would be acceptable because the proposed ASW approach focuses on suppressing, rather than sinking, submarines, but the Mk-54 costs more than $1 million per unit. In the proposed architecture, therefore, ASW forces would complement the Mk-54 with smaller, more affordable weapons like the compact very lightweight torpedo (CVLWT), or depth bombs like the Hedgehog for suppression operations. Smaller weapons would also enable UAVs to conduct pouncer operations and carry enough weapons to remain on station for an operationally relevant period of time.

The Navy would employ SSNs for ASW only when US naval forces needed to destroy, rather than suppress, an enemy submarine, such as an SSBN or an SSGN threatening the US homeland. The Mk-48 heavyweight torpedo carried by US SSNs and SSGNs is more lethal than the Mk-54, has a longer range, and can be placed in closer proximity to the enemy submarine to improve the probability of a hit.

Land and Maritime Strike

The growing range and numbers of Chinese, Russian, and Iranian ASMs will increase the risk to CVNs, amphibious warships, and surface combatants operating in proximity to enemy territory or force concentrations. Although a CVN may be able to survive within weapons range of these opponents, the operations needed to defeat enemy sensors and weapons will largely negate its ability to generate significant numbers of sorties. Surface combatants, however, should still be able to launch missiles.

US submarines, including SSNs and the Ohio-class SSGN, have been considered the Navy’s best platforms for strike operations in the face of improving adversary ASMs.[62] Because submarines can penetrate inside contested areas, they can reach deeper inland with strikes than surface combatants or aircraft can, and do so with less warning. However, US adversaries are improving their ASW capabilities, and enemy mines could challenge the ability of US SSNs to penetrate into highly contested areas. Submarines conducting strikes will likely be detected, and although they will probably evade attacks, US SSNs and SSGNs will be unavailable for other operations until they regain their stealth. Therefore, the proposed architecture assumes submarines will conduct strikes or ASUW only in areas where other platforms are unable to operate at acceptable risk, and when the importance of the target outweighs the risk that the submarine will become unavailable.

Using China as the most stressing case, CSGs operating about 1,000 to 1,200 nm from significant air and missile threats should be able to defeat the salvos possible at that range while still launching and recovering aircraft.[63] Aircraft with standoff missiles, such as the joint air-to-surface strike missile (JASSM), could attack targets 1,000 nm from a carrier with minimal refueling. However, these weapons are the same price as their surface-launched counterparts, and they bring with them the additional cost of the air wing and carrier escorts. Surface combatants will therefore conduct a growing portion of strike and ASUW operations, complemented by submarines for high-priority missile strikes or attacks from inside highly contested areas.[64]

A benefit of CVW-delivered strikes is that the aircraft can reload and attack multiple times during an operation. Surface combatants are more cumbersome to reload and reloading often must be conducted from distant stations. Surface forces will sustain missile strikes in the new ASUW/strike concept by rotating VLS-equipped combatants out of the fight to sheltered reloading locations ashore and afloat and then back to SAGs.

Given their relative strengths and weaknesses, the proposed architecture assumes submarines and surface combatants will conduct the majority of initial strike and ASUW operations into highly contested areas, protected by CVWs performing sea control by conducting AMD, ASW, and ASUW. As the conflict progresses and threats are reduced through attrition or expenditure, carriers will be able to operate closer to enemy forces, allowing CVWs to conduct more strike and ASUW operations and shifting most sea control responsibilities to surface forces and submarines.

Amphibious Operations

Today's amphibious fleet is designed primarily to support amphibious assaults from short range, although it has been repurposed for other amphibious operations, including disaster response and humanitarian assistance. Large-scale assaults will only grow more challenging in the future, while marines are increasingly needed to conduct widely distributed missions ashore as part of the EABO concept.

Although the Marine Corps is still refining its EABO concept and associated force design, these efforts suggest the amphibious operations will fall into two main categories: expeditionary operations ashore in island or archipelagic environments within a theater to deploy sensors, countermeasures, air defenses, and anti-ship missiles; and larger amphibious operations from the sea such as raids or armed reconnaissance. The force supporting marines conducting EABO would likely include smaller amphibious ships with a lower signature that could operate out of austere locations. The force supporting sea-based Marine operations would consist of larger ships similar to those in today's amphibious fleet.

Long-range fires from aircraft will be essential for marines in both parts of the amphibious force. Marines in expeditionary advance bases (EABs) would prioritize anti-ship or anti-air missiles to enable them to impact enemy freedom of movement around or over the island hosting the EAB. This would limit the amount of organic self-defense they can carry. Marine forces at sea conducting raids will need to deploy from long range to protect their ships, preventing rotary wing and ground-based fires from supporting their operations. To protect Marine expeditionary missions in both cases, the amphibious fleet will transition all LHAs and LHDs to carry F-35B *Lightning* strike-fighters.[65]

Mining and Mine Clearance

Mining will be an important component of naval maneuver warfare, as it inherently imposes dilemmas on an enemy. Mine clearing has been a rising priority for the Navy during the last decade and is a primary mission for the LCS. Although the LCS mine warfare mission package is delayed by performance shortfalls, its emphasis on unmanned systems reflects the future of offensive and defensive mine warfare. The portability and scaling possible with unmanned systems suggest the Navy should decouple mine warfare from the LCS and deploy these packages on a range of vessels to support minelaying and clearing.

Summary

The new operational concepts proposed above support the metrics associated with a decision-centric approach to warfare and will drive the Navy's fleet architecture toward a design better suited for an era of great power competition. Perhaps the most important of these metrics is O&S costs. Today's US Navy is struggling under the weight of manning, maintenance, and logistics expenses created by fleet designers of the early twenty-first century who focused on introducing transformational technologies at the expense of fielding a sustainable fleet.

The strategic concept of decision-centric warfare and operational concepts for important naval missions are translated into a fleet architecture in the following two chapters. This architecture and associated shipbuilding plan will enable the future Navy to conduct its missions more effectively, while remaining affordable in an era of more-constrained defense budgets.

CHAPTER 3: PROPOSED FLEET ARCHITECTURE AND PERFORMANCE

The fleet proposed by the Navy in its FY 2020 annual long-range plan for construction of naval vessels lacks the distribution, lethality, and logistical support necessary to implement US defense strategy using the operational concepts described in chapter 2.[66] The planned Navy fleet is also fiscally unsustainable due to the rising procurement and O&S costs of its highly integrated, manpower-intensive warships. The Navy will need a new fleet architecture to address the challenges and opportunities posed by the emerging strategic environment.

This study proposes that to develop a new fleet design, the Navy adopt an analytic approach that shifts focus from the attributes of individual ships to the performance of force packages and the fleet as a whole. Eventually, requirements do need to be developed for specific platforms. However, rather than determining a ship's or aircraft's characteristics in isolation and then designing the fleet around the resulting collection of platforms, Navy planners should allow requirements to emerge or be refined using insights from analysis of the overall fleet.

The fleet architecture described below reflects this more holistic design approach and is assessed using relatively simple metrics applied to the overall fleet and its force packages. This methodology is arguably superior to the Navy's "bottom-up"

Photo Caption: An MV-22B Osprey assigned to the 31st Marine Expeditionary Unit, Marine Medium Tiltrotor Squadron 265 prepares to take off from the flight deck of the forward-deployed amphibious assault ship USS America (LHA 6). (US Navy photo by Mass Communication Specialist Seaman Matthew Cavenaile) planning approach, which relies on modeling and simulation of platforms in specific scenarios to assess the utility of planned ships, aircraft, and other force structure elements. Modeling and simulation depend on numerous assumptions regarding the future environment, threats, and US capabilities that can drive analysis toward point solutions that may not be robust or resilient across the range of potential future situations.

This chapter describes the ship types and force packages in the proposed fleet and advances a posture for deploying naval forces using a combination of existing operating models. It then assesses the fleet through metrics associated with decision-centric warfare, such as distribution, offensive and defensive capacity, and complexity.

Future Family of Fleet Units

To execute the new operating concepts described in chapter 2, the Navy will need force packages that employ a combination of current and proposed platforms and payloads and enable proportional, tailored activities to support and train with partners and allies, deter and counter gray-zone aggression, and win in a conflict through decision-centric warfare. The proposed force packages for each mission described in chapter 2 are detailed below. In addition to supporting new operational approaches, the force packages are designed to meet procurement and sustainment cost limitations that this study treated as a constraint. Although the platforms in each force package are designed around a primary combat mission, they could also be used to conduct day-to-day maritime missions during peacetime competition.

The 2018 US National Defense Strategy organizes deployed US forces into a "contact" layer of units that engages allies and adversaries below the level of conflict and forms the first line of defense against adversary aggression. Contact layer forces are backed up by a "blunt" layer of deployed forces operating elsewhere in the theater or other theaters that will act to delay, degrade, or deny aggression. Contact and blunt layer forces rely on surge forces in port, or operating around CONUS, that will mobilize to reinforce or replace contact or blunt layer forces lost in combat.[67]

Carrier Strike Groups

Large CVNs and their embarked CVWs will continue to play an important role in the future fleet. CVWs currently provide the majority of the Navy's ASUW, strike, and counter-air capacity. As noted in chapter 2, however, the growing ability of adversaries to threaten carriers will cause more ASUW and strike operations to shift to surface combatants. The role of CVWs will increasingly be sea control, operating from the periphery of the combat area to protect bases and ships inside while complementing offensive ASUW/strike attacks with aircraft-delivered weapons.

CSGs consist of a CVN and its CVW, four DDGs, three DDCs, and seven MUSVs.[68] This construct enables CSGs to exert sea control across wide ocean areas and conduct ASUW and strikes from their surface combatants. The CSG's design also allows it to be a self-contained package for offensive and defensive operations in more permissive environments.[69]

In this proposed fleet architecture, CSGs are intended to operate in pairs as a single carrier strike force (CSF). The CSF would be the core of naval blunt layer forces and would operate across the Indo-Pacific littoral, where carrier operations are most likely to be needed. If a contingency developed in Europe requiring CSG operations, a CVN from the surge force based in CONUS would be mobilized.

Surface Combatant Force Packages

Surface forces play an increasingly important role in the proposed fleet compared to the Navy's current force structure.[70] Within surface force packages, DDGs provide large sensors and high-capacity kinetic and non-kinetic defensive fires. FFGs specialize in ASW and can conduct local AMD. The LCS and the future small surface combatant (FSSC) perform ASW and maritime security operations in less-contested environments. DDCs provide additional missile capacity in combat and enable maritime security and training activities in peacetime, while MUSVs provide intelligence, surveillance, and reconnaissance (ISR), counter-ISR, and ASW capabilities.

Three ASUW/strike SAGs of two DDGs, six DDCs, and five MUSVs, distributed across the Indo-Pacific, provide prompt, high-capacity offensive fires in contested areas. During combat, DDCs carry offensive missiles and rotationally reload in remote locations to sustain fires. In peacetime, DDCs would operate as part of the ASUW/strike warfare (STW) SAGs, and some can perform maritime security, training, and cooperation operations with allied and partner navies.

ASW groups of two FFGs and five MUSVs collaborate with a network of unmanned sensors and manned and unmanned land-based aircraft to detect, track, and suppress or destroy adversary submarines and large UUVs in contested and moderately contested areas.[71] Two ASW SAGs operate in the Indo-Pacific and one in the Atlantic.

ASW patrols consist of two LCSs or FSSCs and two MUSVs.[72] These ASW patrols are similar in concept to ASW SAGs but are intended for less-contested or uncontested areas, such as near the coasts of less-contested US allies or partners or the coasts of the continental United States. The proposed posture deploys one ASW patrol in the Pacific and one in the Atlantic.

Escort groups consist of one DDG, two FFGs, and four MUSVs.[73] They are employed to protect high-value maritime units, such as logistics groups, strategic sealift ships, or other critical unarmed or lightly-armed naval units. The proposed posture has two escort groups in the Indo-Pacific and one in the Atlantic.

AMD SAGs for locations ashore consist of two DDGs and four DDCs.[74] In these force packages, DDCs would provide additional missile capacity to increase the number and diversity of attacks against which the SAG can defend. Two of these SAGs operate in the Indo-Pacific.

Mine warfare (MIW) groups consist of four LCSs or FSSCs, four MUSVs, and associated explosive ordnance disposal personnel and equipment. Their mission would include both mine countermeasures (MCM) and defensive or offensive minelaying.[75] Because the Navy's MCM capabilities are being modularized and shifted to unmanned systems that operate from the LCS, MIW groups could be complemented by Expeditionary Sea Bases (ESBs) or other vessels of opportunity capable of carrying mines or MCM systems.[76] One MIW group is forward stationed in the Pacific and another in the Arabian Gulf.

Maritime security operations (MSO) units consist of a single LCS or FSSC that engages allies and partners and conducts low-intensity MSO activities, such as counter-smuggling or counter-narcotics operations, during the competition phase.[77] During a conflict, MSO units can be tasked to focus on higher-intensity MSO operations, such as blockade enforcement. One MSO unit operates throughout the Americas and West Africa.

Expeditionary Strike Groups

The architecture rebalances today's amphibious fleet to better align with the Marine Corps *Commandant's Planning Guidance*, *Force Design 2030*, and the EABO concept by dividing it into two main components.[78] These are: 1) a fleet of small amphibious warships and logistics ships to support marines distributed across littoral areas in conducting EABO as part of the defense strategy's contact layer; and 2) a fleet of larger amphibious vessels with the endurance and survivability to maneuver across open ocean and deliver marines to littoral areas, conduct raids or small-scale assaults, and support surface forces conducting sea control as part of the defense strategy's blunt layer.

Operationally, deployed amphibious forces in the architecture are organized into ESGs consisting of one LHA or LHD, four LSDs or LPDs, and four light amphibious warships (LAWs). For additional long-range fires and air defense, ESGs would include at least one DDG and one DDC. Depending on the threat environment, ESGs could be augmented with an additional DDG, an FFG for ASW, up to three DDCs for missile capacity or to support maritime security, and seven MUSVs for ASW, ISRT, and counter-ISRT.

ESGs would normally disaggregate; the LAWs would operate in littoral areas to support a Marine Littoral Regiment ashore, and larger amphibious ships would move between littoral areas to move Marine forces in support of exercises or other operations.[79] The proposed posture includes two ESGs operating throughout the Indo-Pacific, one of which is forward-based in Japan.

Within ESGs, LHAs and LHDs would provide long-range fires in support of marines distributed across littoral areas, using an air component consisting predominantly of F-35B *Lightning* strike fighters.[80] With the exception of LHA-6 and LHA-7, large-deck amphibious ships would use their well deck for logistics operations, to carry surface connectors, and to transfer equipment and troops within an ESG.[81] LSDs and LPDs would carry surface connectors and MV-22 tilt-rotor transport aircraft to augment LAWs in delivering marines to widely distributed operational areas and support larger amphibious operations such as conducting raids, establishing lodgments, evacuating noncombatants, humanitarian assistance, and disaster response. LAWs would move troops and equipment to and between distributed Marine littoral outposts.[82]

Undersea Vessels

The proposed architecture fields a mix of manned and unmanned undersea vessels. SSNs focus on ASW, ASUW, and strike, while XLUUVs focus on ASW, MIW, and ISR. As described above, most ASUW and strike missions would be conducted by a combination of surface combatants and CVW aircraft. SSNs and SSGNs would conduct land or maritime strikes from inside highly contested areas, or when enemy alertment needs to be minimized.

The architecture, in keeping with the Navy's plans, builds Virginia-class SSNs equipped with the Virginia Payload Module (VPM) in Blocks V through VII of the class. This enables each SSN to carry up to forty missiles, or twenty-four missiles and four large-diameter UUVs (LDUUVs). After Virginia Block VII, the architecture transitions to a new SSN(X), which is optimized for ASW and ASUW, rather than strike. Following the retirement of Ohio-class SSGNs during the mid-2020s, undersea strike would be conducted by SSNs, including those with VPM.[83]

The proposed architecture postures groups of undersea forces in the Indo-Pacific and European theaters. In addition to SSNs, undersea groups include XLUUVs that would be forward stationed in Europe and East Asia. The architecture also follows the Navy's plan to build a fleet of twelve Columbia-class SSBNs that would be homeported in CONUS.

Logistics and Support Vessels

The proposed fleet expands logistics and support forces with new classes of vessels to enable more distributed sustainment concepts and increase the resilience and lethality of deployed naval formations.[84] As a result, the architecture includes more consolidated logistics tankers (T-AOTs), T-AOLs, weapon reload ships (T-AKMs), tenders (AS), and towing and salvage vessels (T-ATS) than are called for in the Navy's FY 2020 thirty-year shipbuilding plan.

Support Ships

The proposed fleet accounts for the naval and Joint Force requirements of non-battle force support ships, including strategic sealift, oceanographic survey ships (T-AGS and AGS), auxiliary general oceanographic research (AGOR) vessels, cable ships (T-ARC), and a new class of expeditionary medical ships, or medium hospital ships (AHM).[85]

Other Naval Forces

Factors including the direction of naval aviation, enabling capabilities and systems, and opportunities to integrate with allies and partners play a critical role in shaping the proposed fleet design.

This study assumed that due to cost constraints, the CVW would gradually evolve to an air wing that incorporates the MQ-25 *Stingray* refueling tanker in larger numbers and introduces a new fighter/attack aircraft derived from the F-35C or F/A-18E/F. If sufficient funding were available, an improved CVW would provide greater CSG performance than that modeled in this study. However, the fundamental constraints on carrier space and the ability of enemies to build longer-range missiles would prevent a change in the trend of CVWs toward a greater emphasis on sea control and of surface combatants toward power projection.[86]

To be effective, a fleet requires a range of enablers, such as munitions and other expendable payloads, ISRT and communications systems, and shore-based infrastructure and equipment. Without continued investment and improvements in these areas, the proposed force packages and fleet may be incapable of fighting effectively, especially for a prolonged period.

Lastly, the proposed fleet is designed to better integrate with allies and partners. The readiness cycle of force packages allows them to focus on specific regions for deployment, enabling them to gain familiarity with local allies and partners, adversaries, and geography. It also provides sufficient time for experimentation and exercises with other countries. The proposed architecture leverages the unique capabilities of allies and partners, such as maritime security operations, mining, or regional ASW, which allows US forces to deploy ships to other theaters.

Proposed Force Posture, Readiness Operating Model, and Fleet Composition

The proposed fleet organizes most battle force ships into force packages and postures them according to the operations needed in each region. Proposed force packages are listed in table 2. Because cost was considered a significant constraint that should shape force design, the number of deployed force packages was limited to ensure the fleet would be affordable in terms of procurement and sustainment.

Force packages are postured in locations where their capabilities would most likely be needed, as shown in figure 6. The proposed architecture assumes ships currently homeported overseas in the forward deployed naval force (FDNF) will remain, and it adds new ship classes in support of the deployed force packages of table 2. The proposed architecture assumes the following overseas homeporting:

- FDNF Yokosuka, Japan: 1 CVN, 11 DDGs, 6 DDCs, 14 MUSVs
- FDNF Sasebo, Japan: 1 LHA/LHD, 3 LPDs/LSDs, 4 LCSs/FSSCs, 5 LAWs, 4 MUSVs
- FDNF Bahrain: 4 LCSs/FSSCs, 3 LAWs, 4 DDCs, 4 MUSVs
- FDNF Rota, Spain: 6 DDGs

The FDNF plan would provide forces for a CSG and ESG, MIW groups, AMD SAGs, and ASUW/strike SAGs. These forces would be complemented by ships deploying from CONUS.

US naval forces operate in rotational cycles consisting of deployments, maintenance, training, and certification for the next deployment. The number of each type of vessel needed in the fleet is based on the number deployed at any given time, and the rotational readiness cycle that prepares force packages for deployment to support the National Defense Strategy.[87]

In the proposed fleet, surface force packages that contribute to the contact layer, including those homeported in CONUS, follow a higher operational-tempo readiness cycle, like that used today by FDNF units. In this readiness model, ships are available for operations 50 percent of each year and spend the other 50 percent conducting training or maintenance.

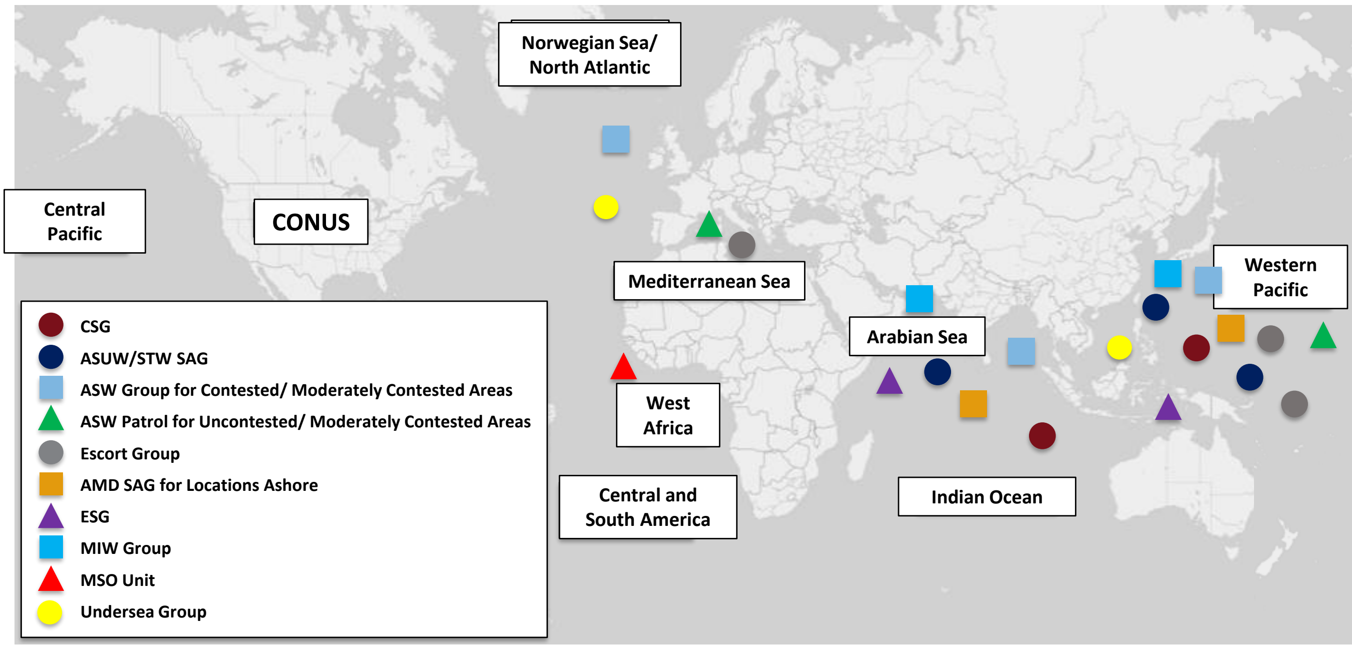
Force packages contributing to the blunt layer, such as CONUS-based ESGs and CSGs and submarines, would follow the Optimized Fleet Response Plan (OFRP) readiness cycle, in which they would be available for operations approximately 19–25 percent of the time.[88] The FDNF-based CSG and ESG would follow the FDNF readiness model and be available 50 percent

Table 2: Proposed Force Packages

FORCE PACKAGES			CVN	LHD/ LHA	LPD	LAW	DDG	LCS / FSSC	FFG	DDC	MUSV	SSN-774V	SSN(X)	XLUUV
CSG	Number of Force Packages	2	1				4			3	7			
	Total Vessels		2				8			6	14			
ASUW/STW SAG	Number of Force Packages	3					2			6	5			
	Total Vessels						6			18	15			
ASW Group for Moderately Contested / Contested Areas	Number of Force Packages	3							2		5			
	Total Vessels								6		15			
ASW Patrol for Uncontested / Mod. Contested Areas	Number of Force Packages	2						2			2			
	Total Vessels							4			4			
Escort Group	Number of Force Packages	3					1		2		4			
	Total Vessels						3		6		12			
AMD SAG for Locations Ashore	Number of Force Packages	2					2			4				
	Total Vessels						4			8				
ESG	Number of Force Packages	2		1	3	4	1		1	3	7			
	Total Vessels			2	6	8	2		1	3	7			
MIW Group	Number of Force Packages	2						4			4			
	Total Vessels							8			8			
MSO Unit	Number of Force Packages	1						1						
	Total Vessels							1						
Undersea Group	Number of Force Packages	2										3	4	17
	Total Vessels											6	8	34
Number of Deployed Vessels by Type			2	2	6	8	23	13	13	35	75	6	8	34
Total Deployed Vessels														**225**

SOURCE: AUTHORS

Figure 6: Global Laydown of Force Packages



SOURCE: BASED ON A FIGURE IN BRYAN CLARK AND TIMOTHY WALTON, "TAKING BACK THE SEAS: TRANSFORMING THE U.S. SURFACE FLEET FOR DECISION-CENTRIC WARFARE," P.74, CENTER FOR STRATEGIC AND BUDGETARY ASSESSMENTS, DECEMBER 31, 2019.

of the time, because the CVN and LHA/LHD would return to CONUS periodically for deep maintenance.

Overall, the proposed approach to readiness generation provides more time and greater stability for force packages to train, experiment, adapt, and conduct maintenance between deployments. Contact layer forces could specialize to a greater degree in facing challenges in their operating areas, while blunt layer forces would have sufficient time in their cycle to prepare for high-end conflict, experiment with new concepts and tactics, and participate in large-scale exercises.

Composition of the Proposed Fleet

The force packages and posture described above are designed to implement the strategic approach of decision-centric warfare and associated operational concepts. The naval posture can be translated into a required number of ships and unmanned vehicles by accounting for the aforementioned readiness cycles, time ships are in transit, and long-term maintenance.[89]

Table 3 compares the Navy's current inventory with the required number of platforms to maintain the posture of figure 6 and the proposed fleet's composition in FY 2045, based on the shipbuilding plan described in chapter 4.

Compared to the Navy's current inventory, the proposed fleet decreases the number of CVNs to reduce overall O&S costs and reflect the changing role of carriers: from the Navy's primary strike and air defense platform, to one that is complemented by surface combatants and submarines in these missions. It also rebalances US surface combatants away from large combatants and toward smaller manned and unmanned ships. The number

Table 3: Hudson Institute Fleet and 2045 Fleet Compared to Current Navy Fleet

CATEGORIES	VESSEL TYPE	NAVY FLEET IN FY 2020	PROPOSED HUDSON REQUIREMENT	PROPOSED HUDSON FLEET IN FY 2045
Carriers	Nuclear Carrier (CVN)	11	9	9
Surface	Large Surface Combatant (CG/DDG)	89	64	74
	Small Surface Combatant (FFG/LCS/FSSC)	32	52	52
	Small Surface Combatant (DDC)	0	80	80
	Unmanned Support (MUSV)	0	99	99
Subsurface	Ballistic Missile Submarine (SSBN)	14	12	12
	Attack/Strike Submarine (SSN/SSGN)	54	60	54
	Unmanned Subsurface (XLUUV)	0	40	40
Amphibious	Amphibious Assault (LHD/LHA)	10	8	9
	Dock Landing/Amphibious Transport (LSD/LPD)	23	22	24
	Small Amphibious (LAW)	0	26	27
Logistics	Large CLF (T-AO/T-AOE/T-AKE/T-AKM)	29	38	38
	Small CLF (T-AOL)	0	18	18
Command & Support	AS, T-ATS, LCC, T-AGOS, T-EPF, ESD/ESB, MPS T-AKE	35	53	45
Battle Force Fleet Size	Manned Classes Only	297	442	442
	Manned and Unmanned Classes	297	581	581
Non-Battle Force Ships	CONSOL Tankers (T-AOT)	5	20	20
	Medical Ships	2	5	5

SOURCE: AUTHOR

of submarines in the FY 2045 fleet equals the current fleet (and increases thereafter), and it is complemented by XLUUVs. The amphibious fleet consists of a comparable number of traditional amphibious ships and introduces LAWs to support EABO and distributed operations. The architecture significantly expands the logistics and command and support force with new classes of vessels to enable more distributed sustainment concepts and increase the resilience of deployed naval formations. The proposed fleet also procures and secures access to important non–battle force ships, such as strategic sealift ships, CONSOL tankers, oceanographic research ships, and medical ships. It also incorporates a larger number of unmanned undersea sensors and air vehicles than the Navy's planned fleet.

Assessment of the Proposed Fleet

The proposed fleet is designed to deliver improved performance compared to the Navy's current and planned force. This study assessed the architecture's performance using four directly measurable parameters that will influence the ability of the fleet and its force packages to deter or defeat aggression through decision-centric operations. Those metrics are: complexity of US force presentation, defensive capacity, offensive capacity, and amphibious and strategic sealift capacity.

Simple numerical measures, like those chosen for this assessment, can provide an effective measure of the capability and capacity in the force and avoid the point solutions that can result from assessments based on modeling and simulation alone. Metrics for the 2045 force requirement were assessed in terms of individual ships, force packages, and the fleet overall. In general, the proposed fleet outperforms the current Navy fleet in all categories. The proposed architecture was not compared to the Navy's projected 2045 fleet because the Navy's future plans and associated operational concepts are not yet well defined.

Complexity Imposed

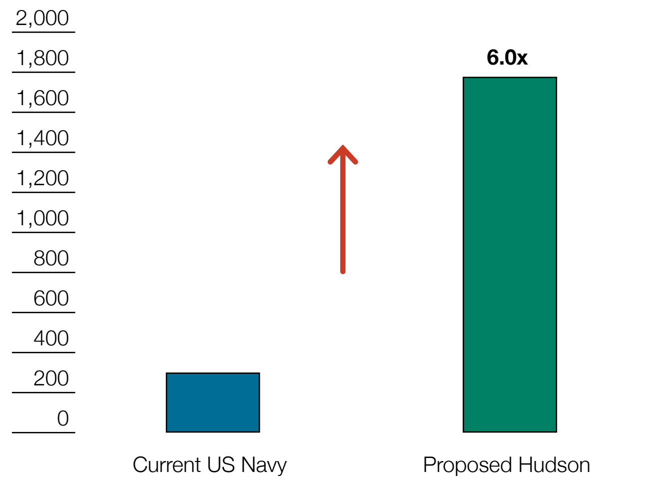
The proposed fleet generates a significantly more complex force presentation for adversaries. Increased complexity can degrade an adversary's decision-making or increase the salvo size needed for an enemy to conduct a successful rapid attack. Deployed force packages in the proposed fleet are able to generate six times as many effects chains compared to today's fleet, as shown in figure 7, and can distribute their operations across and within theaters.[90]

The fleet's ability to generate numerous, dynamic effects chains also enables the fleet to be more adaptable. As a result, the proposed fleet's combat potential would degrade more gracefully, since it may be difficult for an adversary to negate all key nodes capable of executing effects chains. The complexity of force presentation is enhanced through decoy, deception, and sensor countermeasure operations conducted by MUSVs, shipboard UAVs, and small and medium UUVs deployed by ships.

Complexity and distributed operations, however, impose an increased sustainment cost. The proposed fleet includes

Figure 7: Complexity Imposed by Deployed Forces

Number of Effects Chain



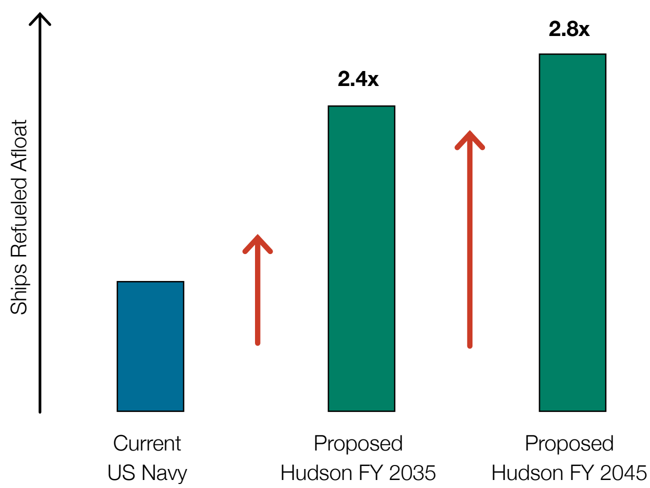
The complexity imposed by deployed forces is shown in terms of the number of different effects chains each force package can potentially execute.

SOURCE: AUTHORS

a robust logistics and support force to enable protracted operations. Complemented by shore-based infrastructure and teams, the logistics and support fleet consists of larger cargo and fuel ships such as CONSOL tankers that operate between depots and intermediate transfer points at sea; traditional combat logistics force ships that operate between intermediate transfer points and deployed forces; and small logistics vessels, such as the new T-AOL, that distribute fuel and supplies from combat logistics force vessels to deployed forces. As shown in figure 8, the proposed fleet's oilers increase the number of ships that can be refueled afloat in distributed high-tempo operations if forward bases are contested.[91]

Efforts to distribute operations, degrade or deceive adversary ISRT, and improve AMD capacity are mutually reinforcing and increase the salvo size required by an enemy to defeat a naval force. The proposed force packages incorporate significantly

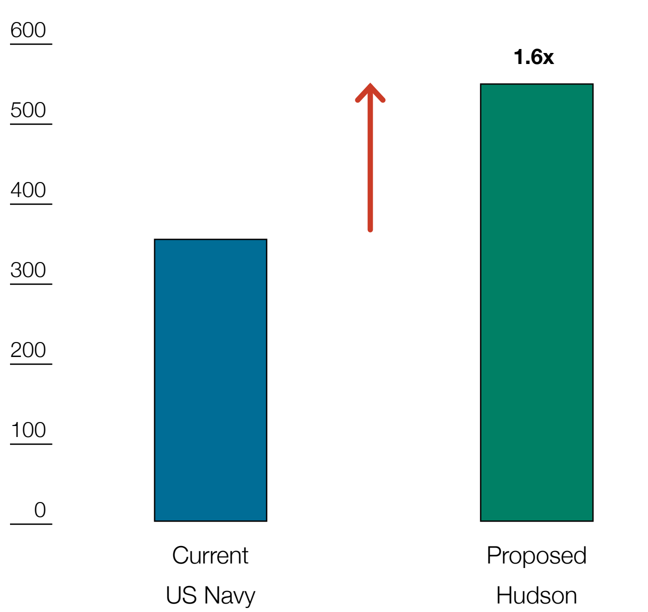
Figure 8: Number of Combatants Refueled Afloat



SOURCE: AUTHORS

Figure 9: ASUW/Strike SAG AMD Capacity

Number of engagements >10 nm in 2 min



SOURCE: AUTHORS

more AMD capacity than those in today's fleet. For example, as shown in figure 9, each ASUW/strike SAG is capable of approximately 60 percent more defensive engagements at greater than 10 nm in two minutes compared to a current SAG.[92] Figure 10 depicts the defensive engagement capacity for the proposed fleet that is possible in each type of force package.

Better-protected force packages will require an aggressor to mount a larger attack. This could escalate a confrontation beyond the level to which an attacker is willing to go, such as in gray-zone tactics used by Chinese or Russian forces. Alternatively, an attacker could be more efficient if it takes the time to target key nodes or platforms in US and allied naval forces at the cost of ceding the initiative. Decoy capabilities on manned and unmanned vessels and offboard expendables could increase the difficulty of deciding how and when to attack US and allied force packages.

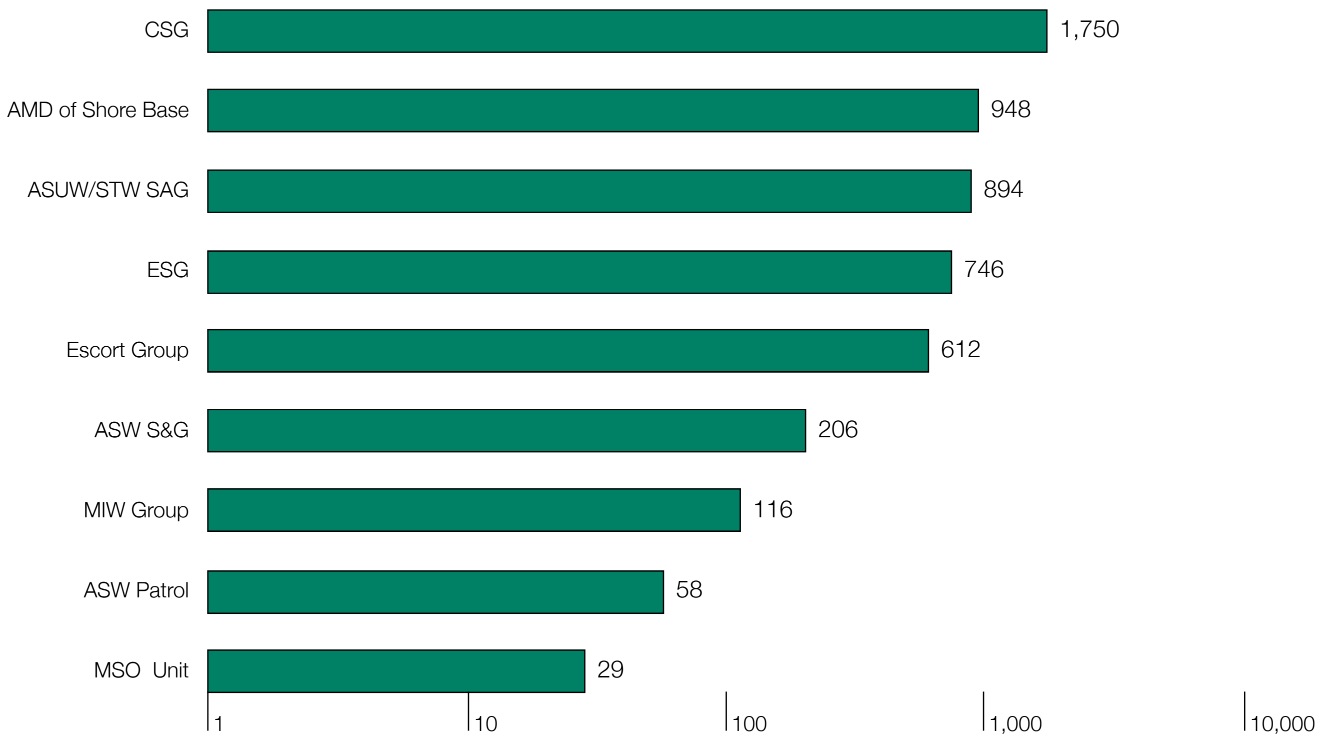
Offensive Capacity

The proposed fleet enables a significant increase in offensive capacity. It also leverages the best attributes of aircraft and ship-delivered fires by using CVW aircraft to generate episodic mass fires, and surface ships and submarines for prompt fires. During a conflict, CVWs would play a critical role providing counter-air capabilities in contested areas; surface and undersea forces would provide a greater proportion of ASUW and strike fires.

As shown in figure 11, deployed force packages in the proposed architecture could generate a sustained firing rate of approximately 500 1,000-lb warhead equivalents per day, or 34 percent more than estimated for the current fleet.[93] Of that capacity, about 56 percent would be generated by CVWs and LHD/LHA air wings, compared to 76 percent today, with surface combatants and submarines playing a greater ASUW and strike role. CVWs would also play a critical role providing offensive and defensive counter-air capabilities, independently and in conjunction with other naval and joint forces.

Figure 10: AMD Capacity by Force Package

Number of engagements possible in two minutes



SOURCE: AUTHORS

The proposed architecture also distributes fires across a wider number and variety of platforms than the Navy's current fleet, to increase complexity and compel adversaries into larger attacks or longer decision cycles. In terms of total missile cells dedicated to ASUW/strike, the proposed fleet generates a 75 percent increase over the current fleet by FY 2045, primarily by introducing DDCs that carry 44 percent of offensive missile capacity. The distribution of fires improves the fleet's resilience by enabling incremental diminishment of offensive capacity as ships are lost.

In addition to introduction of DDCs, the distribution of strike capacity is enabled by heavy investment in munitions, logistics munitions reload ships (T-AKM and AS), and other shore-based infrastructure and support.

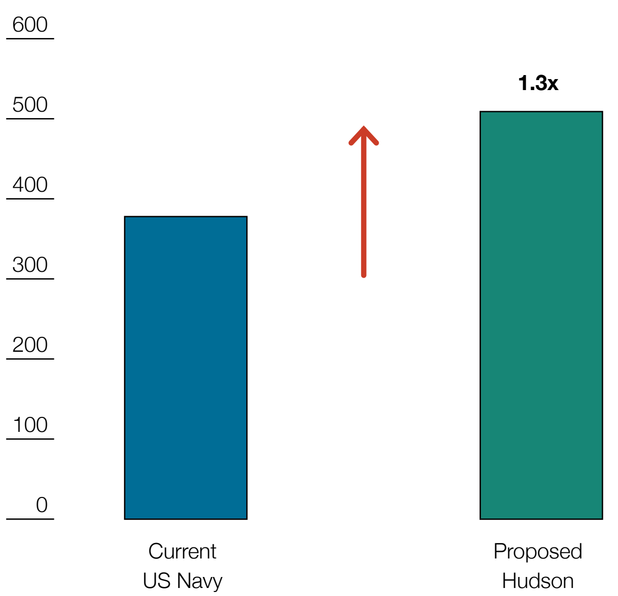
Amphibious and Strategic Sealift Capacity

The proposed fleet evolves the Navy's amphibious and strategic sealift forces to align with the emerging force design and operational concepts of the Marine Corps. It does so by distributing troops, vehicles, and equipment across more platforms through introduction of the LAW. Distribution will also improve the resilience of amphibious forces, which is similar to the increase in strike/ASW resilience achieved by fielding the DDC.

The proposed architecture increases troop berthing and embarked aircraft on larger amphibious ships and, with the LAW, grows vehicle capacity, although fleet well deck capacity shrinks. This reduction should not significantly impact the ability of marines to get ashore, since the LAW is intended to be beachable.

Figure 11: Deployed Force Packages: Sustained Offensive Strike Capacity

1,000-lb warhead equivalents per day



SOURCE: AUTHORS

Today's US strategic sealift fleet of sixty-one government-owned cargo, tanker, and support ships is aging, is in need of recapitalization, and falls far short of the tanker capacity needed to support a military contingency. The proposed fleet adopts a new, flexible approach to strategic sealift that combines twenty-six newly built government-owned and operated ships with chartered US flagships and an expanded Maritime Security Program of commercial US flagships.[94]

The proposed plan, by relying more heavily on the commercial Merchant Marine, would likely outperform the Navy's current or planned sealift fleet in meeting cargo requirements established by the US Transportation Command's *Mobility Capabilities and Requirements Study 2018*, as shown in figure 14. In addition, if Congress's proposed Tanker Security Fleet were expanded and reforms were made to overseas fuel purchases, the proposed fleet would be better able to meet tanker requirements more quickly and reliably than the fleet envisioned in the current Navy plan, depicted in figure 15.

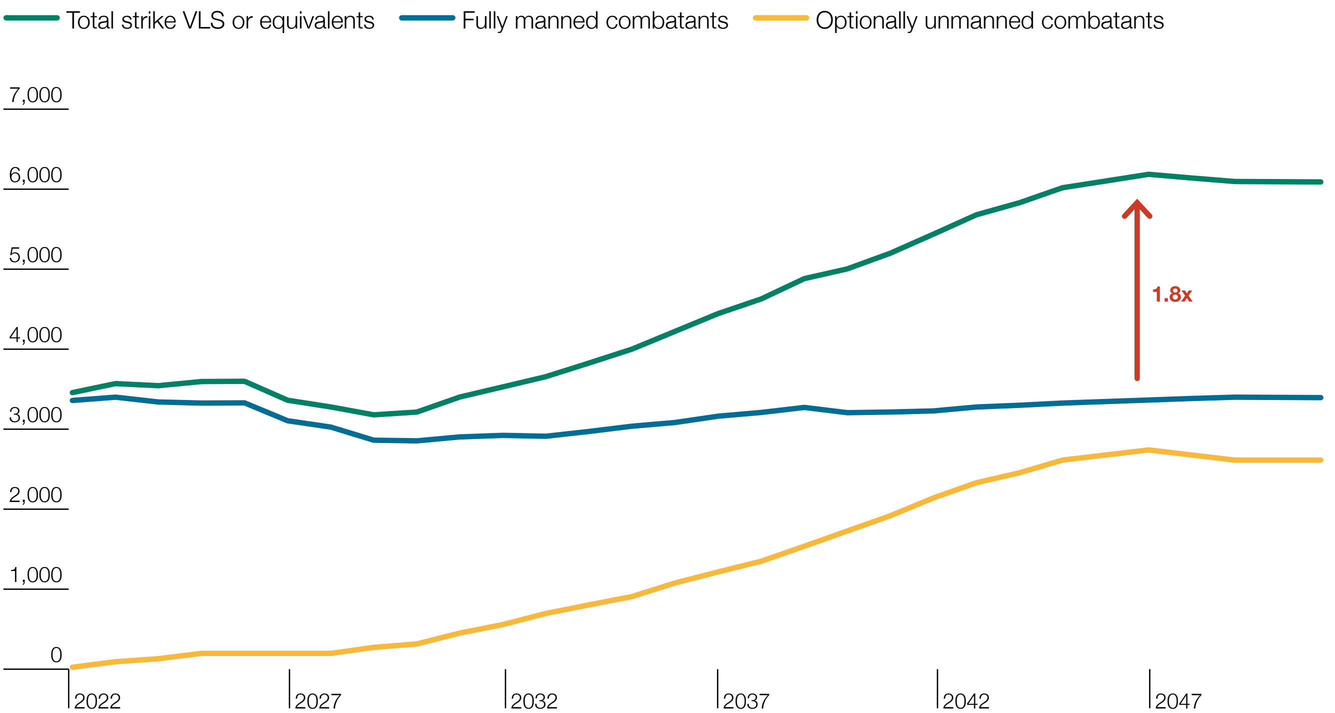
Summary

The emergence of decision-centric operations will require a fleet that can impose complexity on an adversary's decision-making, increase the size and escalation of attacks needed to defeat it, and grow and gain resilience by distributing offensive fires and amphibious capacity. The proposed fleet would significantly outperform the Navy's current and planned force in these metrics. Perhaps more importantly, it would also be more affordable and sustainable than the Navy's planned fleet, as will be detailed in the next chapter.

Using new operating concepts, the proposed architecture would improve the Navy's performance and better support US defense strategy during peacetime competition and conflict. Leveraging existing technologies or ones that could be matured over the next decade, all of the ship designs and force packages described above could be fielded as detailed in the following chapter's shipbuilding and technology development plan.

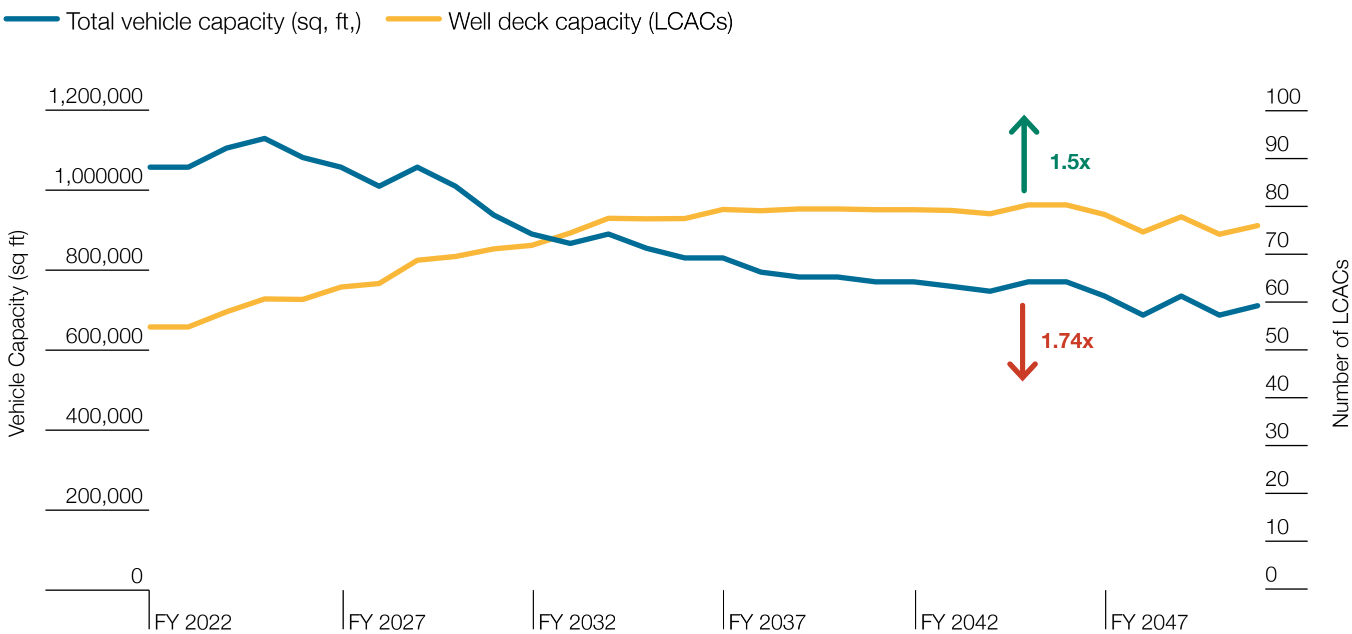
Figure 12: Strike Missile VLS Cells or Equivalents in Fleet

Strike VLS or Equivalents



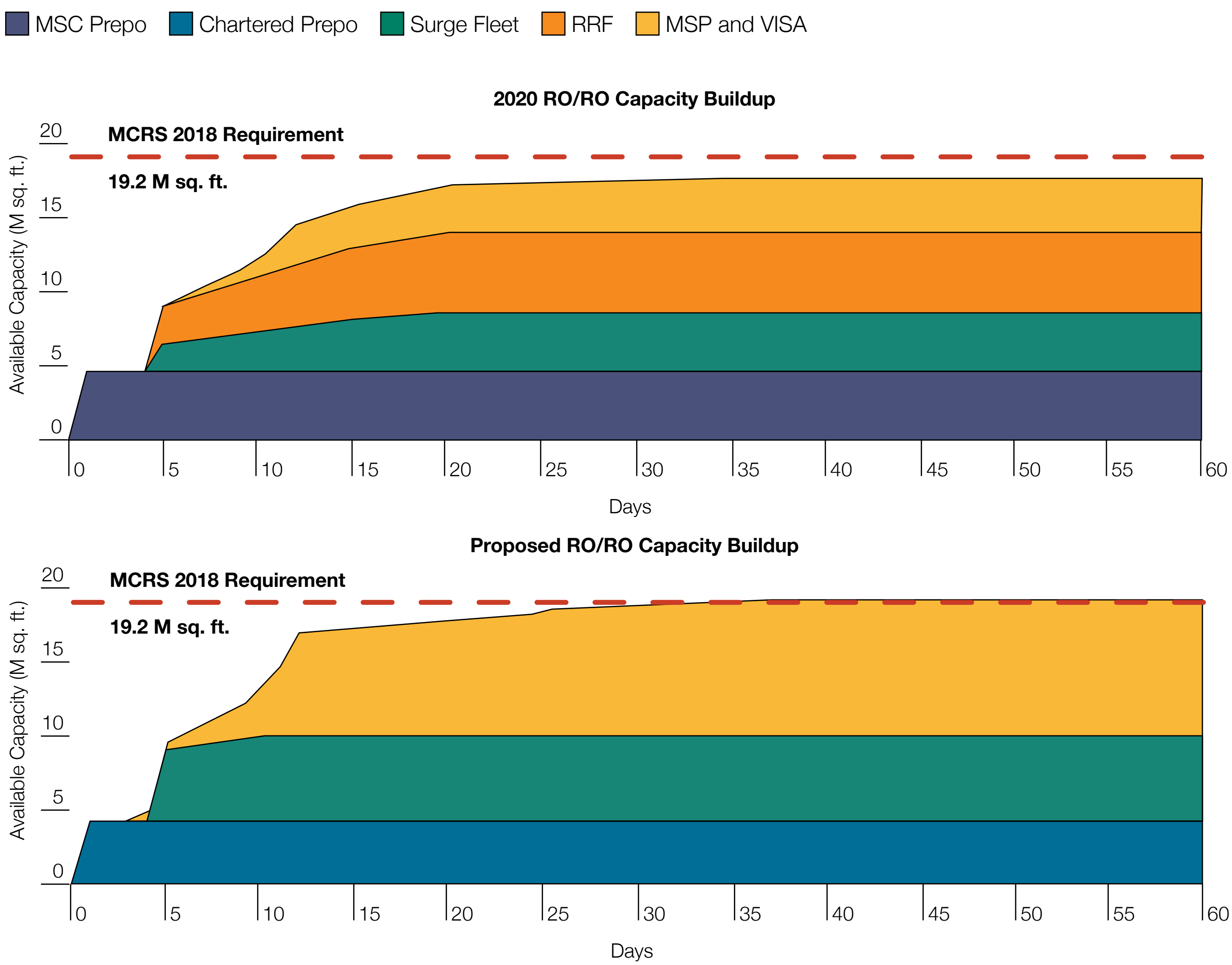
SOURCE: AUTHORS

Figure 13: Amphibious Ship Vehicle and Well Deck Capacity



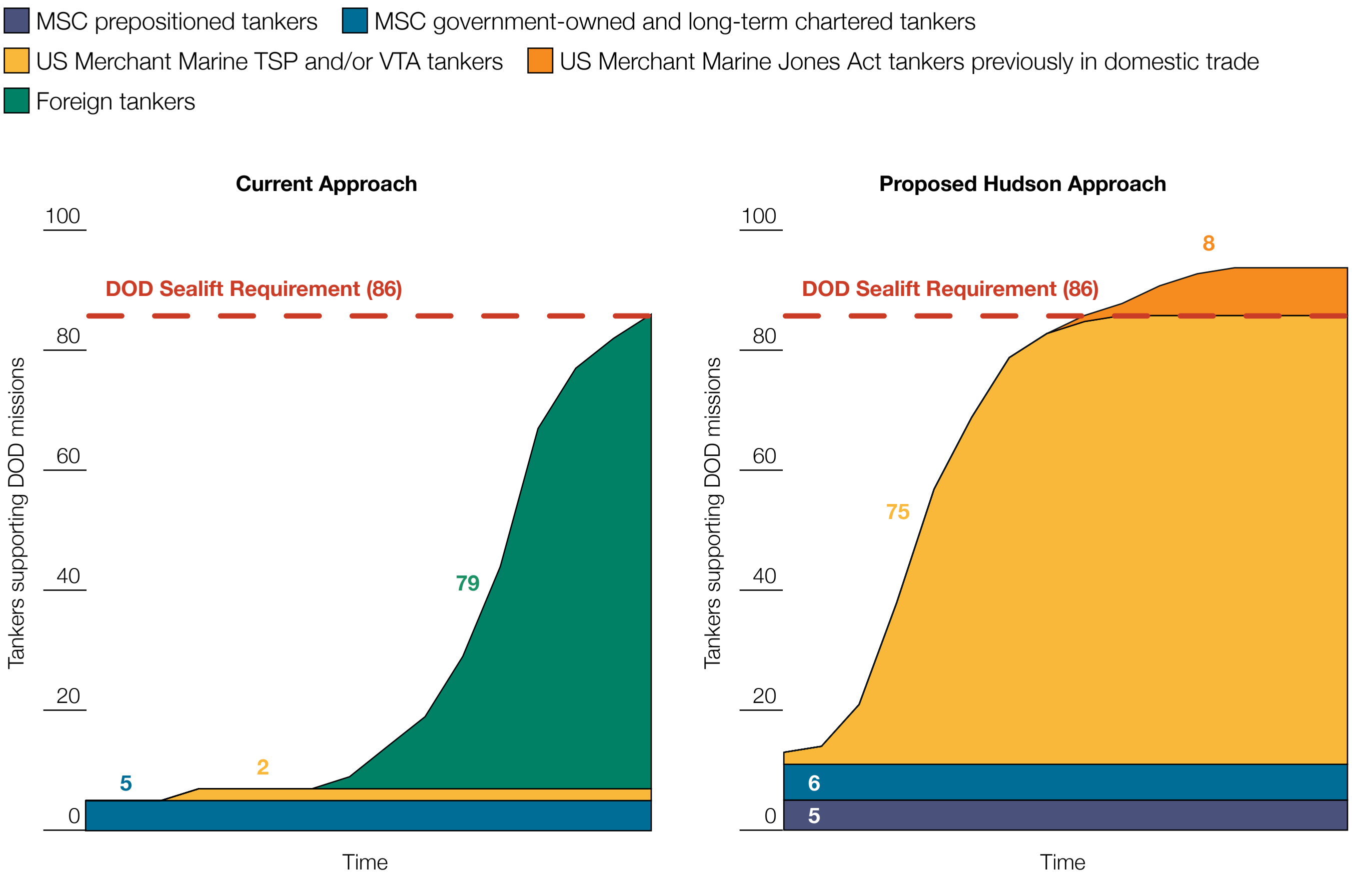
SOURCE: AUTHORS

Figure 14: Strategic Sealift Roll-on/Roll-off (RO/RO) Capacity



SOURCE: CLARK, WALTON, AND LEMON, STRENGTHENING THE U.S. DEFENSE MARITIME INDUSTRIAL BASE, 64.

Figure 15: Tanker Capacity



SOURCE: CLARK, WALTON, AND LEMON, STRENGTHENING THE U.S. DEFENSE MARITIME INDUSTRIAL BASE, 61.

CHAPTER 4: FIELDING THE FUTURE FLEET

It will take more than a decade to evolve today's fleet into an architecture better suited for decision-centric operations and great power competition due to the lifespan of warships and the need to mature underlying technologies. To assess the executability of the proposed fleet architecture, this study generated a shipbuilding and retirement plan described in appendix 1 and assessed the O&S costs of the resulting fleet over the next thirty years.

Four principles guide the plan. First, shipbuilding costs stay below a Shipbuilding and Conversion, Navy (SCN) budget constraint, consisting of the amount proposed for PB21 in FY 2021–2025, adjusted for inflation in subsequent years.[95]

Second, the fleet follows a realistic transition time that allows for technology maturation, ship design and construction, concept experimentation and development, and fleetwide adoption. The plan purposefully provides time for technology maturation and detailed design work before procuring ships. During the years between fleet design and platform introduction, the Navy should implement a technology development roadmap for each new platform that enables essential hull, mechanical, and electrical systems to be developed, or the platform's concept evolved, to accommodate expected technological limitations. For example, the proposed plan procures the first DDG(X) in 2030, rather than the Navy's initial plan to replace the DDG-51 in the mid-2020s.[96] This deliberate approach reduces technical risk and is likely to result in working systems faster than an approach that attempts to rush the delivery of poorly designed or incomplete ships. In

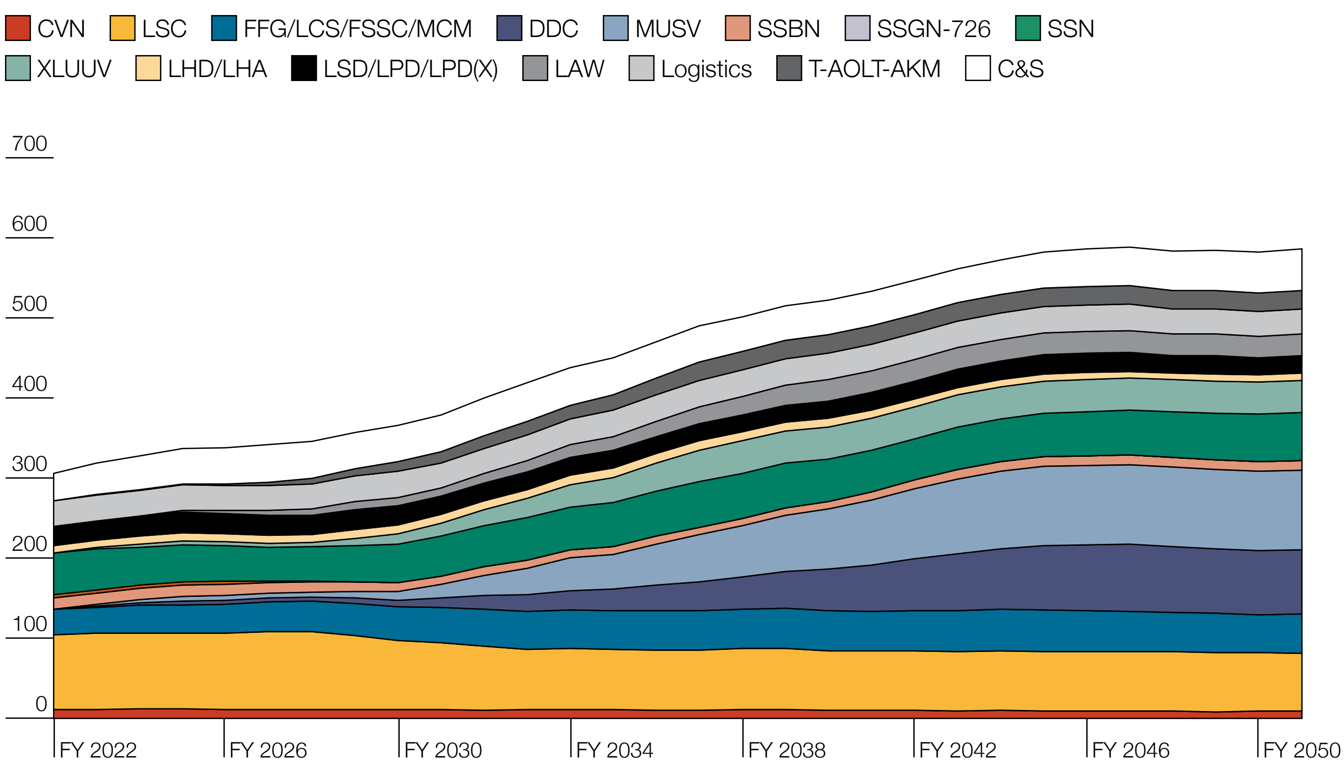
Photo Caption: The fleet replenishment oiler USNS Tippecanoe (T-AO 199) steams alongside the forward-deployed aircraft carrier USS Ronald Reagan (CVN 76) during an underway replenishment. (US Navy photo by Christopher Bosch) the case of new ship classes such as corvettes and unmanned vessels, the proposed fleet architecture introduces a four- to five-year pause between procurement of prototypes and serial production.

Third, the plan provides stability and opportunity to the shipbuilding industrial base, which is a critical national asset. In contrast to the significant variability in some previous Navy shipbuilding plans, the proposed plan lowers costs and increases the likelihood of on-time delivery by establishing a predictable demand, repetition in construction, and appropriate procurement intervals to achieve efficiencies. The plan's inclusion of battle force and non–battle force ships and new smaller ships types such as DDC and LAW provides more opportunities to coordinate shipbuilding needs from multiple government agencies and stabilize the workload for large and small shipyards.

Fourth, the plan pursues sustainability by accounting for the O&S costs of ships, and it constrains fleet size to attempt to stay under a limit of PB21 plus inflation. The actions it proposes to achieve this include retiring ships when they reach the end of their originally-planned service lives; adopting smaller ship classes that require fewer personnel; introducing automation to a greater degree throughout the fleet; and reducing the number of large combatants such as CGs, DDGs, CVNs, and LHAs/

Figure 16: Proposed Battle Force Inventory for a Hudson Institute Shipbuilding Plan

Number of Ships



SOURCE: AUTHORS

LHDs. The effort to control O&S costs is also driven by the need to increase fleet maintenance capacity, especially in private repair yards that are responsible for most surface combatant maintenance. The Navy may need to spend more in O&S costs than projected in this report to improve repair yard infrastructure or give private yards a more predictable workload.

The proposed shipbuilding plan depicted in figure 16 and in appendix 1 yields a battle force capable of executing new operational concepts within fifteen years.[97] By FY 2045, it meets all of its requirements. The lag in fully meeting force structure requirements is a result of industrial base dynamics, SCN and O&S cost constraints, and the organizational changes needed to field new platform types. Specific actions are described below by ship class.

Aircraft Carriers

The shipbuilding plan continues to build Ford-class CVNs but adjusts their construction frequency to six years. This allows the number of carriers to be gradually lowered from eleven in FY 2020, to nine in FY 2046, and to eight or nine CVNs in subsequent years.[98] The shift from four- to six-year construction cycles is estimated to increase CVN procurement costs from approximately $12.8 billion to $14.3 billion each; however, over the period of the shipbuilding plan, the increased cost is offset by the decreased frequency of procurement. The procurement and O&S costs savings generated by this shift enable the fleet to invest in more surface combatants, submarines, and amphibious ships and reflect the changing role of carriers, from the primary strike and air defense platform to a platform complemented by surface combatants in these missions.

Surface Combatants

The shipbuilding plan rebalances US surface forces away from large combatants and toward smaller ships by slightly reducing procurement of new DDGs, retiring aging CGs and DDGs at their end of service life, and building new FFGs. DDG-51 Flt IIIs are procured until FY 2030, when they are replaced by the new DDG(X), at the same rate of two per year. Unlike the Navy's planned future large surface combatant, the DDG(X) would be similar in size and VLS magazine capacity to DDG-51, to avoid reversing the desired trend toward more distributed fires.[99] The architecture, in addition to procuring thirty-one FFGs to replace DDGs in ASW and escort operations, builds a new FSSC that replaces the LCS starting in the late 2030s.

To further distribute the fleet, increase the complexity of force packages, and enable sustainable fires, the architecture constructs DDCs with twenty-four- to thirty-two-cell VLS magazines, instead of the similarly armed LUSV planned by the Navy.[100] In addition to providing manned missile capacity to SAGs, DDCs could support MSO during peacetime competition and train with partner navies deploying comparable ships. The ability of the small DDC crew to oversee and protect the ship's weapons and perform limited maritime operations makes it a more useful platform than the LUSV across the competition-conflict spectrum.

The proposed shipbuilding plan procures MUSVs to conduct ISRT, counter-ISRT, and ASW operations in support of most force packages. The proposed MUSV is fully unmanned and capable of carrying a forty-foot shipping container.[101] Both the MUSV and DDC are procured initially in prototype form; following a four- to five-year period of technology and concept of operations maturation, both platforms are transitioned into serial production.

Amphibious Vessels

The shipbuilding plan maintains LHA-8 procurement at a rate of one every five years and an LPD construction rate of one every two years throughout the build plan. LPD-17 Flt II procurement continues until the sixth and final hull, LPD-35, which provides an opportunity to incorporate new features, such as missile launchers that would better enable LPDs to support other missions, including ASUW and strike. LPD production then transitions to a new LPD design, LPD(X) or L(X), with a slightly lower procurement cost. LAW procurement starts in FY 2023 at a steady procurement rate of two per year generally, for a total of twenty-seven ships.

Undersea Vessels

The proposed shipbuilding plan builds twenty-five Virginia-class SSNs equipped with the VPM, then transitions to procurement of SSN(X), which is designed primarily for ASUW and ASW and therefore would not have a large vertical launch missile magazine like the VPM. The architecture follows the Navy's plan to build a fleet of twelve Columbia-class SSBNs. Although the plan accounts for industrial base limits during construction of the Columbia class, it still addresses the growing gap in SSN capacity. By FY 2033, the plan fields more SSNs than today, reaching sixty by FY 2051. The proposed plan also builds forty XLUUVs that start serial production after experimentation with XLUUV prototypes during the early 2020s. As the technologies and employment of XLUUVs mature, they may be able to relieve submarines of some relatively simple missions, as described in chapter 2.

Logistics and Support Vessels

The shipbuilding plan procures John Lewis–class oilers at a rate of two per year generally. After a period of experimentation with a prototype, the fleet procures nineteen light oilers (T-AOLs), generally at a rate of two per year. The plan also procures five missile reload ships (T-AKMs) and nine tenders (AS), generally at a rate of one per year each. Navajo-class towing and salvage vessel procurement continues at a rate of generally two per year, for a total of fourteen. Seven T-AGOS(X) ocean surveillance ships are procured starting in FY 2022 at a rate of one per year.

The proposed plan secures access to 20 CONSOL tankers (T-AOT) to support sequential refueling operations with T-AOs and T-AOLs to distributed naval forces. Seven T-AOTs are obtained via long-term charter, and the remaining thirteen are secured through an expanded version of the proposed Tanker Security Fleet.[102] Other important logistics and support vessels, such as float-on/float-off ships, could be secured in a similar manner.

Support Ships

The proposed shipbuilding plan explicitly accounts for non–battle force support ships to gain efficiencies across government and commercial shipbuilding plans. The proposed architecture includes a new, flexible approach to strategic sealift, procuring new vessels at a rate of generally one per year throughout the plan, starting with eight specialty ships and then eighteen roll-on/roll-off (RO/RO) ships.[103] Simultaneously, the plan expands the Maritime Security Program and charters prepositioning ships. The plan relies on the proposed Tanker Security Fleet, and reforms to overseas fuel purchases, to create sufficient tanker capacity for joint force requirements.[104]

The shipbuilding plan includes other important ships, such as oceanographic survey ships (T-AGS and AGS), auxiliary general oceanographic research vessels (AGORs), cable ships (T-ARCs), and a new class of expeditionary medical ships, or medium hospital ships (AHMs), for which procurement would start in FY 2023.

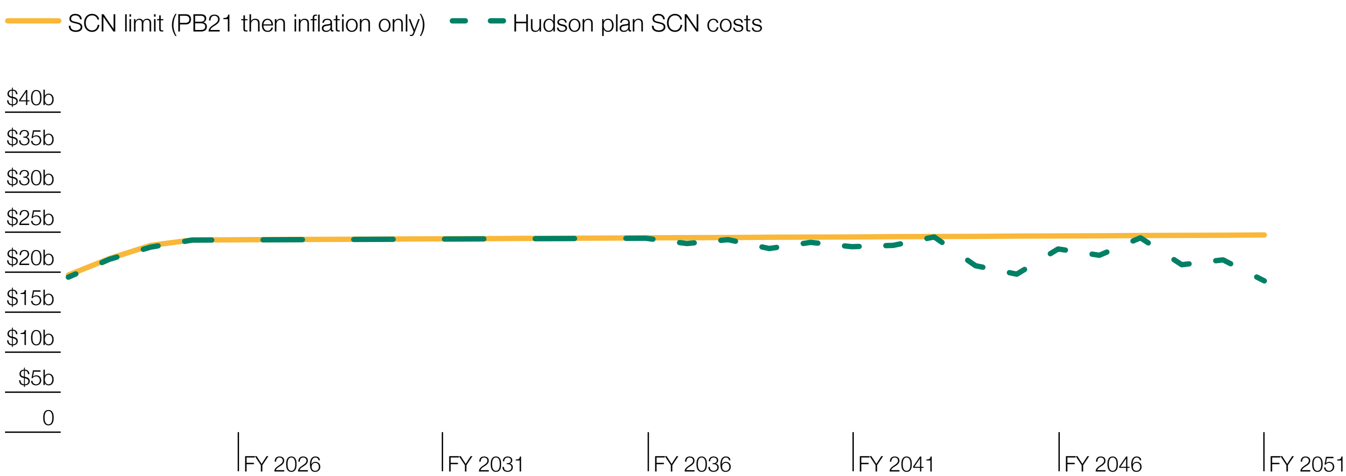
Procurement Costs

The shipbuilding plan supports the deployed posture of chapter 4 with a fleet that is larger, more operationally effective, and significantly less expensive to procure and sustain than the Navy's planned force. The proposed plan balances the need for a new fleet architecture with the imperative to manage costs and takes an evolutionary approach to developing and fielding new platforms and associated technologies.

Over thirty years, the shipbuilding plan costs $31.7 billion less to buy in FY 2020 dollars than the PB21 SCN budget plus inflation.[105] It includes an affordable mix of platforms, such as a $2.3 billion DDG(X) that has the same VLS capacity as a current DDG, rather than the Navy's planned cruiser-like $3.3 billion future large surface combatant. The plan also includes a $4

Figure 17: Proposed Shipbuilding Plan Procurement Costs

Billions of FY 2020 dollars



SOURCE: AUTHORS

billion SSN(X) that is designed for stealth, survivability, and speed rather than a large, undersea mothership with significant missile and UUV capacity that could cost more than $5.5 billion.[106] By keeping total shipbuilding costs lower than the PB21-plus-inflation limit throughout the plan, the Navy can preserve funding for research, development, testing, and evaluation of future technologies and procurement of key enablers, without having SCN costs crowd out necessary investments in these areas.

Over the next decade, the plan features new starts in nearly every ship class. To navigate this challenging period and reduce cost and schedule risks, the Navy will need to establish and fund technology development roadmaps to mature systems and refine designs before starting construction of new ship classes. In some cases, to avoid budget bottlenecks in years when multiple expensive ships are procured, the Navy will need to procure ships ahead of schedule or use multiyear procurement (MYP), block buy contracting (BBC), or other contractual mechanisms to accelerate procurement while keeping construction rates stable. This study suggests that over the next ten years, there is just enough funding to execute the proposed plan—provided the Navy has the intiative to plan ahead, the authority to move funding slightly ahead of need when appropriate, and the ability to keep programs at or under predicted costs. To do so, the Navy will need to gain the confidence and buy-in of Congress.

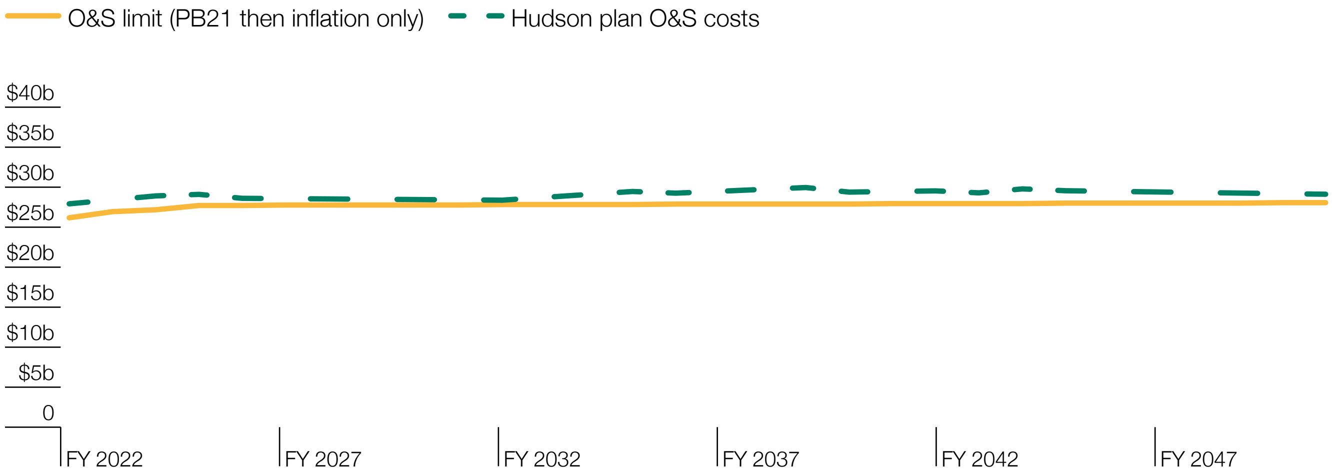
Another significant factor shaping shipbuilding costs is non–battle force ships. New strategic sealift, T-ARC, AGOR, and AHM vessels will require considerable construction funding during the 2020s. Consequently, the Navy should formally incorporate non–battle force ship procurement into its 30-year shipbuilding plan.[107] Integrating these ships into the plan would provide industry with more visibility into planned procurement, aid Congressional oversight of this area, and facilitate the coordination of Navy, other government, and commercial shipbuilding plans.

Sustainment Costs

The proposed fleet architecture costs, on average, approximately $1.3 billion more per year —4.9 percent—than the PB21-plus-

Figure 18: Proposed Fleet Architecture O&S Costs

Billions of FY 2020 dollars



SOURCE: AUTHORS

inflation O&S limit.[108] By slightly reducing the number of CVNs in the fleet, fielding fewer large surface combatants with fewer personnel, and not extending ships past their original service lives, it would be possible to lower O&S costs for existing ship classes. However, introducing small surface combatants, unmanned vessels, and auxiliaries to create a fleet with more than twice the number of ships as today's force leads to a net increase in O&S costs.[109]

The above O&S estimates do not address the Navy's existing shortfall in public and private shipyard capacity. Improving public shipyard infrastructure through the Shipyard Infrastructure Optimization Plan and similar investments at private repair yards may require additional O&S spending—another reason for adopting a fleet design that controls O&S costs as much as possible.[110]

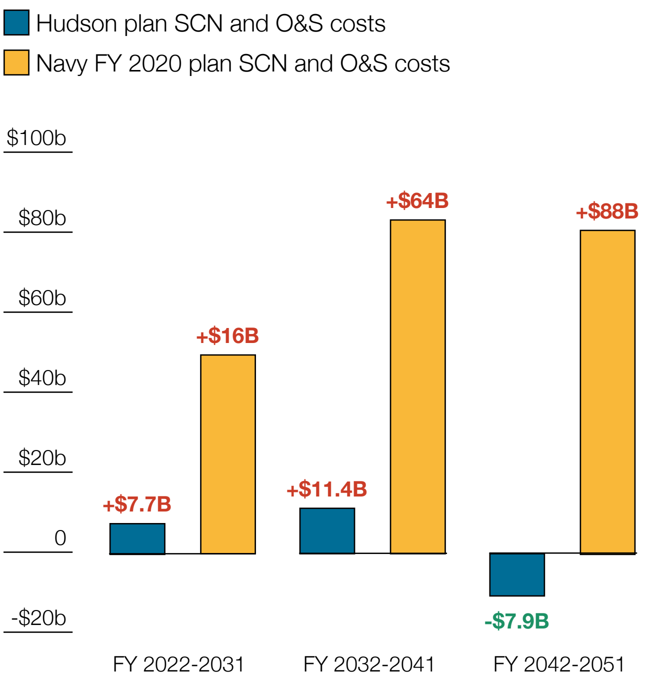
Over the next thirty years, Hudson's proposed fleet would cost a total of $8.6 billion more to procure, operate, and sustain than the sum of the SCN and O&S PB21-plus-inflation limits. The Hudson fleet would cost $165 billion less to procure, operate, and sustain than the fleet proposed by the Navy in its FY 2020 thirty-year shipbuilding plan, as shown in figure 19. This is true even though the Hudson plan has nearly twice as many vessels.[111] The Navy plan would require $174 billion more than the established limit.

In terms of personnel, even when the proposed plan robustly crews each vessel, it would require 27 percent fewer personnel to crew the fleet by FY 2045 than the Navy's FY 2020 thirty-year shipbuilding plan, as shown in figure 20. This is mostly a result of shifting to smaller designs and adopting greater automation.

To maximize operational availability of the proposed fleet, the proposed architecture and posture provides adequate time in readiness cycles and appropriate levels of funding to conduct ship maintenance. In a larger fleet that has a significant portion of its vessels operating forward, including unmanned ones, it will be essential to institute new approaches to increase vessel availability. The proposed plan and its posture allow

Figure 19: Difference with Total SCN and O&S Limit

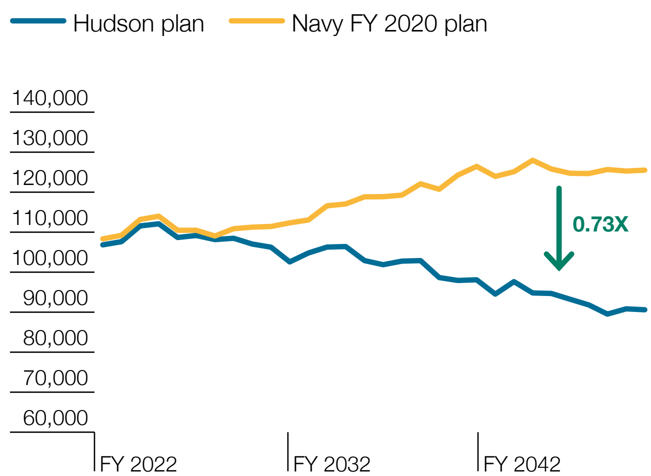
Billions of FY 2020 dollars



SOURCE: AUTHORS

Figure 20: Personnel Required to Crew Fleets

Personnel



SOURCE: AUTHORS

for the following best practices that can maximize operational availability:[112]

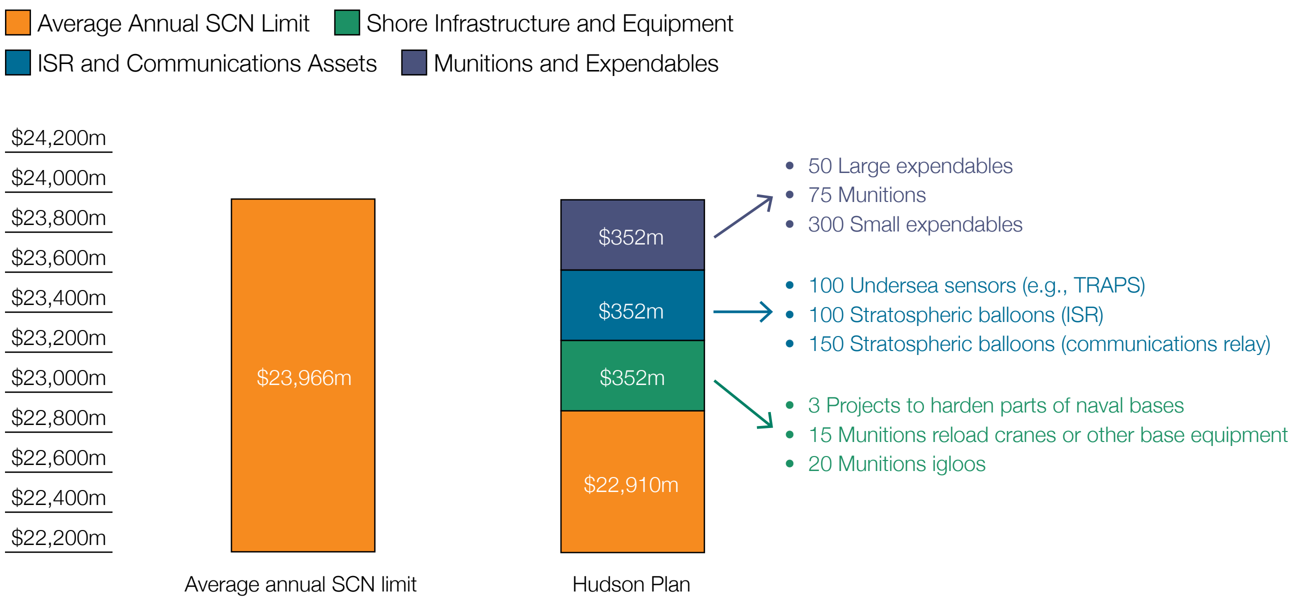
- purchasing technical data and sufficient spare parts used in maintenance
- providing adequate ship construction timelines and not accepting ships with defects
- adopting realistic sustainment assumptions
- robustly crewing ships to allow for maintenance during operations
- investing in shore infrastructure to modernize maintenance facilities and equipment
- following deployment schedules and not deferring maintenance
- fielding more tenders and other logistics and support vessels that would support the operations and maintenance of forward operating vessels

For a fleet to be effective, it requires a range of enablers, such as munitions and other expendable payloads, broad-area ISRT and communications systems, and resilient shore-based infrastructure and equipment. The current approach to fleet design prioritizes procurement of ships and then allocates funding to these systems, if available. This results in chronic gaps in key enablers, such as preferred munitions, and risks having the Navy field a hollow force that would not deter or defeat aggression, since adversaries would know it could not fight for an operationally relevant period.

A new approach to fleet design, by focusing on the fleet's desired performance in metrics such as complexity imposed, defensive capacity, and offensive capacity, can assess the requisite contributions of fleet enablers and prioritize funding for them. Furthermore, a more affordable fleet, in addition to allocating dedicated funding for enablers, yields savings from SCN and

Figure 21: Opportunities to Invest Plan Savings into Critical Enablers

Millions of FY 2020 dollars



SOURCE: AUTHORS

O&S accounts that can be invested in these and other enablers. Figure 21 depicts a representative selection of investments that could be annually made from SCN savings. Overall, a balanced approach to fleet design prioritizes investments in these enablers, given their outsized effect on force performance—even if they come at the cost of some ship hulls.

CHAPTER 5: CONCLUSION

Navy leaders need to establish force structure requirements and plans that address the US military's operational challenges by exploiting conceptual and technological opportunities within the Navy's likely resources. The past two decades of Navy force designs failed to meet these objectives because they made overly optimistic assumptions regarding budget constraints and technology maturation. Going forward, the Navy will need to emphasize affordability and executability in its plans to gain the confidence of industry, the Congress, and allies abroad.

There is still time for the Navy to change course and develop a force better suited than today's fleet to long-term competitions with great and regional powers. The long-term changes proposed above to Navy fleet architecture would be significant. However, by acting now, Navy leaders could begin an evolutionary approach that introduces new platforms after reasonable concept and design development, while continuing production of proven ships to sustain the industrial base and recapitalize some of today's multimission vessels as they retire.

But the window for the Navy to start this evolution is closing. Adversaries of the United States may intensify their efforts against US allies if they perceive US leaders are focused on domestic concerns and unwilling to sustain engagement and operations abroad. Fiscal constraints will also begin to foreclose options for the Navy to adopt a new fleet design.

Photo Caption: Sailors assigned to the Virginia-class attack submarine USS California (SSN 781) salute during the commissioning ceremony for the Virginia-class attack submarine USS California (SSN 781) at Naval Station Norfolk. California is the eighth Virginia-class submarine and will be homeported in Groton, Conn. (US Navy photo by Eric Tretter)

As shown above, O&S costs for the fleet grow faster than inflation, even with the proposed fleet architecture. Every year that the Navy delays rebalancing the force to smaller, less-sophisticated, and less-manpower-intensive platforms results in higher sustainment costs that will crowd out research and development or procurement of next-generation ships, aircraft, and mission systems.

Today's Navy leaders, like their predecessors in the early-twentieth-century Royal Navy, have an opportunity to establish an enduring advantage over US competitors. Without significant change, however, the fleet could enter a spiral of rising costs, shrinking numbers, and technological irrelevance. The Navy and Congress should act now to ensure this does not happen.

APPENDIX 1: SHIPBUILDING PLAN AND INVENTORY

Table A1: Proposed Hudson Procurement Profile

FISCAL YEARS	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
CVN-78	2									1						1						1						1				
DDG-51 III	3	2	2	3	2	1																										
DDG-51 IIIA						1	2	1	2	1	1																					
DDG(X) Flt I											1	2	2	2	1	2	2	2	2	1	1	1										
DDG(X) Flt II																				1	1	2	1	2	2	2	2	2	2	2	2	2
FFG	1	1	1	3	2	2	2	2		1	2	1		1	1	2	2	2	2	2	1											
FSSC Flt I																			1	1	2	2	2	2	1							
FSSC Flt II																									1	2	2	2	2	2	1	1
DDC		2	1	2				2	1	4	5	4	6		6	3	4	6	6	6	7	6	6	6	4	4	4	4	4	4	4	4
MUSV		2	2	2				2	3	6	10	6	8	2	8	8	7	8	7	6	6	6	6	6	6	6	6	6	6	6	6	6
SSBN-826		1			1		1	1	1	1	1	1	1	1	1	1																
SSN-774 VPM	2	1	2	2	2	2	2	2	1	2	1	2	1	2																		1
SSN(X)															1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
XLUUV								4	4	3	4	5	4	3	4	4	4	1									2	2	1			
LHA-8	1							1					1					1					1					1				
LPD-17 Flt II		1		1	1	1			1																							
LPD(X)										1			1		1		1		1		1		1		1		1		1		1	
LAW				2	2	2	2	2			2	2	2	1	2	2	2	2	2										1	2	2	2
T-AO-205	2		2	2	2	2	1	2		1	1																					
T-AKE(X)																									1		1	2	2	2	2	2
T-AKM				1	2	1	1																									
T-AOL			1				1	2	1	2	2	2	2		2	2	2													1	2	2
T-ATS(X)	2	2	2	2	2	1																										
AS(X)					1	1	1	1			1				1							1	1	1								
T-AGOS(X)			1	1	1	1	1	1	1																							
LCC(X)															1	1																
T-EPF Flt II												1		1	1	1		1	1	1	1	1	1	1	1	1	1	1				
T-AK(X)				1	1	1	1	1	1		1	1																				
T-AR(X)																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
T-ARC					1																											
T-AGS																				1												
AGOR						1	1	1											1													
AGS							1	1	1		1	1	1																			
AHM				1	2	1	1																									

Table A2: Proposed Hudson Procurement Profile Depicting Industrial Base Workload

Individual ships. Colors distinguish changes in ship classes, e.g., DDG-51 Flt III, DDG-51 Flt IIIA, DDG(X) Flt I, and DDG(X) Flt II.

Cells with vertical lines indicate the procurement of additional ships beyond the normal construction rate that year to help stabilize workload for the industrial base. This was done because the following year's shipbuilding budget could not accommodate continued production at the established rate.

Cells with horizontal lines indicate the impact of the previous years' procurement of additional ships (in vertical line cells) in sustaining a level industrial base workload. For example, in the case of DDC Flt I, from FYs 2029 to 2032 a total of four additional ships are procured (as denoted in the vertical line cells). The additional procurement in these years keeps the workload stable through FY 2033.

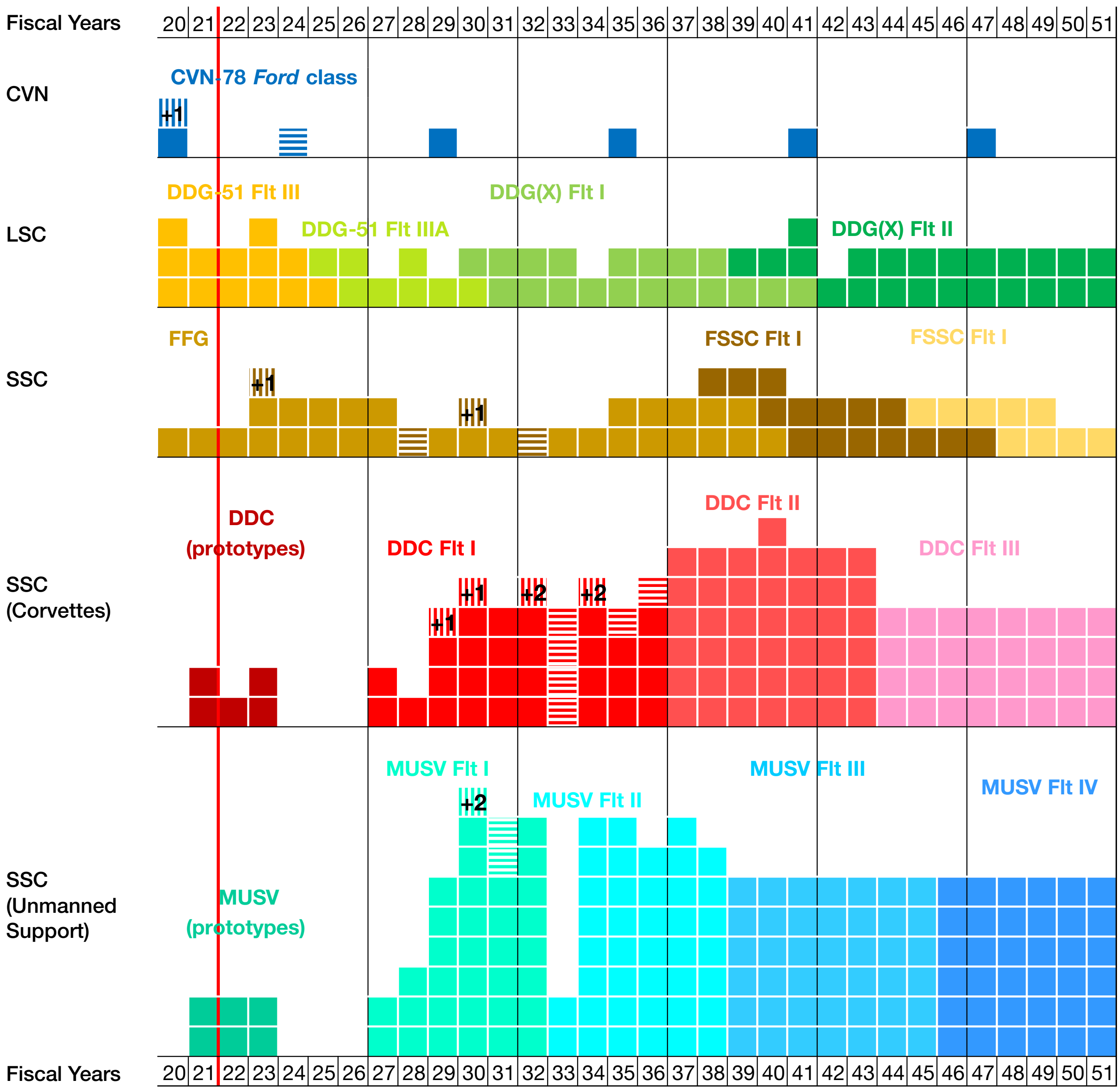


Table A2 Continued

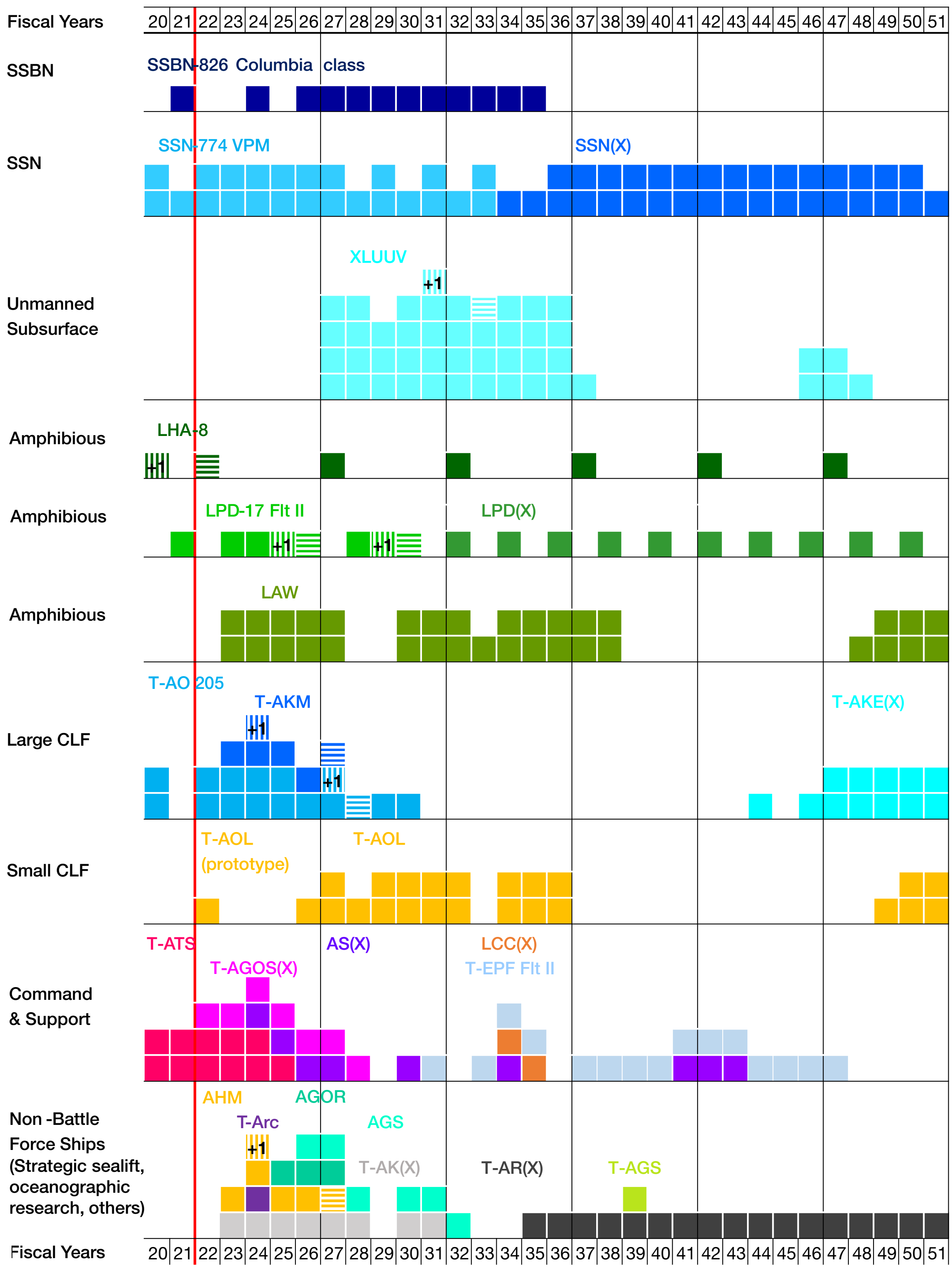


Table A3: Proposed Hudson Battle Force Inventory

FISCAL YEARS	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
CVN-68	10	10	10	10	10	10	9	9	8	8	8	8	7	7	7	7	6	6	6	6	5	5	5	4	4	3	3	3	3	2	2	2
CVN-78	1	1	1	1	2	2	2	2	3	3	3	3	3	4	4	4	4	4	5	5	5	5	5	5	6	6	6	6	6	6	7	7
CVN	**11**	**11**	**11**	**11**	**12**	**12**	**11**	**11**	**11**	**11**	**11**	**11**	**10**	**11**	**11**	**11**	**10**	**10**	**11**	**11**	**10**	**10**	**10**	**9**	**10**	**9**	**9**	**9**	**9**	**8**	**9**	**9**
CG-47	22	18	16	16	14	12	10	10	8	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DDG-51 Flt I	21	21	21	21	21	21	21	21	21	19	14	10	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DDG-51 Flt II	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DDG-51 Flt IIA	41	43	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	44	40	38	36	34	32	30	28	26	24	22	19	16
DDG-51 III	0	0	0	2	3	5	8	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
DDG-51 IIIA	0	0	0	0	0	0	0	0	1	3	4	6	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
DDG(X) Flt I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	5	7	8	10	12	14	16	17	18	19	19	19	19	19	19	19
DDG(X) Flt II	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	5	7	9	11	13	15
DDG-1000	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
LSC	**94**	**92**	**93**	**95**	**94**	**94**	**95**	**97**	**97**	**92**	**86**	**83**	**80**	**75**	**76**	**75**	**75**	**75**	**76**	**76**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**73**	**72**
LCS	0	25	27	31	35	35	35	35	35	35	35	35	35	34	34	33	33	32	31	31	30	27	24	21	18	15	12	9	6	4	0	0
FFG	0	0	0	0	0	0	1	2	3	5	7	9	11	13	14	15	16	17	18	19	20	22	25	28	30	31	31	31	31	31	31	31
FSSC Flt I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	6	8	10	11	11	11	11
FSSC Flt II	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	5	7
Ghost Fleet LUSV	0	2	4	4	4	4	4	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DDC	0	0	0	2	3	5	5	5	5	7	8	12	17	21	24	27	32	36	40	46	52	58	65	71	75	80	82	84	82	80	80	80
MUSV	0	0	0	2	4	6	6	6	6	8	11	17	25	33	41	43	51	59	64	70	75	81	87	93	97	99	99	99	99	99	99	99
MCM	8	8	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SSC	**30**	**35**	**36**	**40**	**46**	**50**	**51**	**52**	**53**	**59**	**65**	**77**	**88**	**101**	**113**	**118**	**132**	**144**	**153**	**166**	**177**	**188**	**202**	**215**	**224**	**231**	**232**	**233**	**230**	**228**	**226**	**228**
SSBN-726	14	14	14	14	14	14	14	13	12	11	10	9	9	8	7	6	5	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0
SSBN-826	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3	4	5	6	7	8	9	10	11	12	12	12	12	12	12	12	12	12
SSGN-726	4	4	4	4	4	4	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SSN-688	8	6	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SSN-688I	23	23	22	21	18	15	12	9	8	7	7	7	7	7	6	6	6	5	4	3	1	0	0	0	0	0	0	0	0	0	0	0
SSN-21	3	3	3	3	3	3	3	3	3	3	3	2	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SSN-774	17	20	22	24	26	28	29	29	29	29	29	29	29	29	29	29	29	29	28	28	27	26	24	24	22	21	20	19	18	17	16	15
SSN-774 VPM	0	0	0	0	0	0	0	1	3	6	9	12	14	16	17	19	20	22	23	25	25	25	25	25	25	25	25	25	25	25	25	25
SSN(X)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	6	8	10	12	14	16	18	20
XLUUV	0	0	0	2	4	5	5	5	5	9	13	16	20	24	28	31	35	39	41	40	40	40	40	40	40	40	40	40	40	40	40	40
SSN	**51**	**52**	**52**	**51**	**47**	**46**	**44**	**42**	**43**	**45**	**48**	**50**	**51**	**53**	**53**	**55**	**56**	**57**	**56**	**56**	**53**	**52**	**51**	**53**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
LSD-41	8	8	8	8	8	8	7	6	5	5	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LSD-49	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
LPD-17	11	12	12	12	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	12	10	10	8	8
LPD-17 Flt II	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
LPD(X)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8
LHD-1	8	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	6	5	5	4	4	3	2	2	2	1	1	1	1	1
LHA-6/8	2	2	2	2	3	3	3	3	3	4	4	4	4	4	5	5	5	5	5	6	6	6	6	6	7	7	7	7	7	8	8	8
LAW	0	0	0	0	0	2	4	6	8	10	10	10	12	14	16	17	19	21	23	25	27	27	27	27	27	27	27	27	27	27	27	27
Amphibious	**33**	**33**	**33**	**33**	**35**	**38**	**39**	**41**	**42**	**46**	**45**	**44**	**45**	**47**	**50**	**51**	**52**	**54**	**55**	**57**	**59**	**59**	**59**	**59**	**59**	**60**	**60**	**59**	**57**	**59**	**57**	**58**
T-AOE	2	2	2	2	2	2	2	2	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T-AO 187	15	15	14	12	11	10	9	7	5	4	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T-AO 205	0	1	2	4	5	6	6	8	10	12	14	15	16	17	18	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
T-AKE 1	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	13	10	8	6	4
T-AKE(X)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	6	8
T-AKM	0	0	0	0	0	0	1	2	3	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
T-AOL	0	0	0	1	1	1	1	2	4	5	7	9	11	12	12	14	16	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
CLF	**31**	**32**	**32**	**33**	**33**	**33**	**33**	**35**	**38**	**41**	**45**	**45**	**47**	**49**	**49**	**52**	**54**	**56**	**56**	**56**	**56**	**56**	**56**	**56**	**56**	**56**	**56**	**56**	**54**	**54**	**54**	**54**
T-ATF	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T-ARS	2	2	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T-ATS	0	1	4	7	9	11	13	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
AS	2	2	2	2	2	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AS(X)	0	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5	6	6	6	6	6	6	6	7	8	9	9	9	9	9	9
T-AGOS	5	5	5	5	5	5	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T-AGOS(X)	0	0	0	0	0	0	0	1	2	3	4	5	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7

Table A3 Continued

FISCAL YEARS	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
LCC	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LCC(X)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
T-HST	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T-EPF	12	12	12	14	15	15	15	15	15	15	15	15	15	14	13	11	10	8	6	5	4	3	3	1	0	0	0	0	0	0	0	0
T-EPF Flt II	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4	4	5	6	7	8	9	10	11	12	13
T-ESD	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
T-ESB	3	3	3	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C&S	**29**	**31**	**34**	**39**	**42**	**44**	**45**	**47**	**46**	**45**	**45**	**46**	**47**	**48**	**47**	**46**	**45**	**45**	**43**	**43**	**43**	**43**	**43**	**42**	**43**	**45**	**47**	**48**	**49**	**50**	**51**	**52**
Battle force fleet total (manned ships only)	**297**	**302**	**305**	**314**	**319**	**325**	**326**	**330**	**334**	**339**	**341**	**345**	**354**	**361**	**368**	**375**	**383**	**391**	**395**	**404**	**406**	**411**	**419**	**427**	**434**	**442**	**446**	**448**	**443**	**444**	**442**	**446**
Battle force fleet total (manned and unmanned ships)	**297**	**304**	**309**	**322**	**331**	**340**	**341**	**345**	**349**	**360**	**369**	**382**	**399**	**418**	**437**	**449**	**469**	**489**	**500**	**514**	**521**	**532**	**546**	**560**	**571**	**581**	**585**	**587**	**582**	**583**	**581**	**585**

GLOSSARY OF TERMS

air and missile defense (AMD)
AirLand Battle
amphibious assault ships (LHAs/LHDs)
amphibious transport docks (LPDs)
anti-ship missiles (ASM)
anti-submarine warfare (ASW)
anti-surface warfare (ASUW)
AS, T-ATS, LCC, T-AGOS, T-EPF, ESD/ESB, MPS T-AKE
attack/strike submarine (SSN/SSGN)
auxiliary general oceanographic research vessels (AGOR)
ballistic missile capabilities
ballistic missile defense (BMD)
ballistic missile submarine (SSBN)
block buy contracting (BBC)
cable ships (T-ARCs)
carrier air wing (CVW)
carrier battle group (CVBG)
carrier strike force (CSF)
carrier strike group (CSG)
coastal submarines (SSCs)
combat logistics force (CLF)
compact rapid attack weapons (CRAW)
compact very lightweight torpedo (CVLWT)
CONSOL tankers (T-AOTs)
continental United States (CONUS)
corvettes (DDCs)
cruise missile attack
decision-support tools
Defense Advanced Research Projects Agency (DARPA)
Department of Defense (DoD)
Distributed Maritime Operations (DMO)
dock landing ships (LSD)
dock landing ships (LSDs)
dock landing/amphibious transport (LSD/LPD)
electromagnetic (EM)
electronic warfare (EW)
electro-optical/infrared (EO/IR)
Evolved Sea Sparrow Missile (ESSM) Block II
expeditionary advance base operations (EABO)
expeditionary advance bases (EABs)
Expeditionary Sea Base (ESB)
expeditionary strike groups (ESGs)
extra-large unmanned underwater vehicles (XLUUVs)
forward deployed naval force (FDNF)
future small surface combatant (FSSC)
guided-missile cruisers (CGs)
guided-missile destroyers (DDGs)
guided-missile frigates (FFGs)
High North
intelligence, surveillance, and reconnaissance (ISR)
Intelligence, surveillance, reconnaissance, and targeting (ISRT)
Islamic Republic of Iran Navy (IRIN)
Islamic Revolutionary Guard Corps (IRGC)
joint air-to-surface strike missile (JASSM)
joint all-domain C2 (JADC2)
large CLF (T-AO/T-AOE/T-AKE/T-AKM)
large surface combatant (CG/DDG)
large-diameter UUVs (LDUUVs)
LEO (low earth orbit)
light amphibious warships (LAWs)
littoral combat ship (LCS)
Littoral Operations in a Contested Environment (LOCE)
logistics tankers (T-AOT)
manned classes only
maritime patrol unmanned aircraft system (UAS)
maritime security operations (MSO)
medium altitude long endurance (MALE)
medium hospital ships (AHMs)
mine countermeasures (MCMs)
mine warfare (MIW)
multiyear procurement (MYP)
National Defense Strategy (NDS)
nuclear-powered aircraft carriers (CVNs)
nuclear-powered attack submarines (SSNs)
observe-orient-decide-act (OODA)
oceanographic survey ships (T-AGS and AGS)

operations and support (O&S)
Optimized Fleet Response Plan (OFRP)
President's Budget for FY 2021 (PB21)
refueling complex overhaul (RCOH)
Republic of Korea (RoK)
Rolling Airframe Missile Block II
Russian Federation Navy (RFN)
Small amphibious (LAW)
Small CLF (T-AOL)
small surface combatant (DDC)
small surface combatant (FFG/LCS/FSSC)
Sound Surveillance System (SOSUS)
surface action groups (SAG)
surface action groups (SAGs)
surface action groups (SAGs)
tenders (AS)
towing and salvage vessels (T-ATS)
unmanned aircraft system (UAS)
unmanned subsurface (XLUUV)
unmanned support (MUSV)
unmanned surface vessel (LUSV)
unmanned surface vessels (USV)
US Department of Defense (DoD)
vertical launching system (VLS)
vertical-launch ASW missile (VLA)
Virginia Payload Module (VPM)
weapon reload ships (T-AKMs)

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9 *Mission Command: Command and Control of Army Forces*, US Department of the Army, 2020, https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/ARN19189_ADP_6-0_FINAL_WEB_v2.pdf.

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11 *Force Design 2030*, Department of the Navy, US Marine Corps, March 2020, https://www.hqmc.marines.mil/Portals/142/Docs/CMC38%20Force%20Design%202030%20Report%20Phase%20I%20and%20II.pdf?ver=2020-03-26-121328-460 and *Commandant's Planning Guidance: 38th Commandant of the Marine Corps*, Department of the Navy, US Marine Corps, https://www.hqmc.marines.mil/Portals/142/Docs/%2038th%20Commandant%27s%20Planning%20Guidance_2019.pdf?ver=2019-07-16-200152-700.

12 David Larter, "Despite Record Budgets the U.S. Navy Is Short Hundreds of Millions for Maintenance," *Defense News,* https://www.defensenews.com/naval/2019/08/19/despite-record-budgets-the-us-navy-is-short-hundreds-of-millions-for-maintenance/.

13 *Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military's Competitive Edge*, US Department of Defense, 2018, https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf.

14 Henry Kissinger, *Diplomacy* (New York: Simon and Schuster, 1994), 121.

15 Paul K. MacDonald and Joseph M. Parent, *Twilight of the Titans* (Ithaca: Cornell University Press, 2018), 80–81. MacDonald and Parent articulate a useful, if ultimately imprecise, appraisal of British foreign policy in the 1870s.

16 Aaron L. Friedberg, *The Weary Titan: Britain and the Experience of Relative Decline, 1895–1905* (Princeton, NJ: Princeton University Press, 2010), 274.

17 All fleet numbers are taken from Friedberg, *The Weary Titan*, 274.

18 Harry Halem, "Strategy and Ship Design – History's Lessons for Future Warship Concepts," Center for International Maritime Security, July 11, 2017, http://cimsec.org/strategy-and-ship-design-historys-lessons-for-future-warship-concepts/33251.

19 Fisher's scheme also included an aggressive operational and strategic concept, under which the Royal Navy would mount an amphibious assault against Germany's North Sea coastline. While this never came to fruition, in part because First Lord Winston Churchill identified this policy as operationally impossible, the ships produced to fulfill this mission were used to screen the Grand Fleet in combat and police the channel throughout the Great War.

20 And, one should note, every European navy stationed in the Pacific at the time.

21 Samuel P. Huntington, "National Policy and the Transoceanic Navy," *Proceedings* 80, no. 5 (May 1954), https://blog.usni.org/posts/2009/03/09/from-our-archive-national-policy-and-the-transoceanic-navy-by-samuel-p-huntington.

22 Michael Sadykiewicz, *Soviet-Warsaw Pact Western Theater of Military Operations: Organization and Missions*, RAND Corporation, August 1987 (Unclassified), 60–75.

23 James Lacey, "Battle of the Bastions," War on the Rocks, January 9, 2020, https://warontherocks.com/2020/01/battle-of-the-bastions/.

24 The historical record invalidates the complaints of "neo-realists" like John Mearsheimer, who argue that the maritime strategy's focus on Soviet nuclear forces undermined European stability. The ability of the United States to use its maritime power to jeopardize the entire Soviet political-military system played in NATO's favor. Without a US threat to Soviet SSBNs, the Soviet General Staff might have remained committed to fighting a general war, assuming that the United States lacked the stomach for even a limited nuclear exchange that eliminated 10–15 percent of its population. As a point of reference, the Soviet Union lost 13 percent of its population during the Second World War. To bring about equivalent Soviet losses during a nuclear exchange would have required the saturation of at least the USSR's three largest cities, along with several other population centers.

25 F-14 *Tomcat*s provided the carrier with long-range intercept and strike capabilities. F/A-18 *Hornet*s bolstered the CVBG's air defenses and could conduct shorter-range strike missions. A-6 *Intruder*s provided long-range and extended-time-on-station ground and maritime strike capabilities, and the A-6 platform was also used for electronic warfare (EA-6B *Growler*) and a tanker/range extender. The S-3 *Viking* served as a dedicated anti-submarine and surface warfare platform (and as a range extender). The A-7 *Corsair* II fulfilled a low-end attack requirement. Finally, the E-2 *Hawkeye* provided the CVBG with airborne early warning.

26 Hal Brands, "Choosing Primacy: U.S. Strategy and Global Order at the Dawn of the Post-Cold War Era," *Texas National Security Review* 1, no. 2 (February 2018), https://tnsr.org/2018/02/choosing-primacy-u-s-strategy-global-order-dawn-post-cold-war-era-2/.

27 "U.S. Ship Force Levels, 1886-Present," Naval History and Heritage Command, last updated November 17, 2017, https://www.history.navy.mil/research/histories/ship-histories/us-ship-force-levels.html.

28 Timothy A. Walton, "Securing the Third Offset Strategy: Priorities for the Next Secretary of Defense," *Joint Force Quarterly* 82 (July 2016), https://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-82/jfq-82_6-15_Walton.pdf.

29 "Xi Focus: Xi Stresses Racing against Time to Reach Chinese Dream," *Xinhua*, January 23, 2020, http://www.xinhuanet.com/english/2020-01/23/c_138729706.htm.

30 Charles Clover, "Xi Jinping Signals Departure from Low-profile Policy," *Financial Times*, October 20, 2017, https://www.ft.com/content/05cd86a6-b552-11e7-a398-73d59db9e399; "Document 9: A ChinaFile Translation," China File, November 8, 2013, https://www.chinafile.com/document-9-chinafile-translation; and Robert O'Brien, "The Chinese Communist Party's Ideology and Global Ambitions," White House, June 26, 2020, https://www.whitehouse.gov/briefings-statements/chinese-communist-partys-ideology-global-ambitions/.

31 Pia Krishnankutty, "Not Just India, Tibet—China Has 17 Territorial Disputes with Its Neighbours, on Land and Sea," The Print, July 15, 2020, https://theprint.in/theprint-essential/not-just-india-tibet-china-has-17-territorial-disputes-with-its-neighbours-on-land-sea/461115/; "China's Xi Jinping Broke Promise on South China Sea, Says Top US General," *Straits Times*, May 30, 2019, https://www.straitstimes.com/asia/east-asia/chinas-president-xi-broke-promise-on-south-china-sea-says-top-us-general; and Kyle Mizokami, "A Chinese Destroyer Fired a Laser at a U.S. Navy Patrol Aircraft," *Popular Mechanics*, February 29, 2020, https://www.popularmechanics.com/military/navy-ships/a31159120/chinese-destroyer-laser/.

32 Bryan Clark, Mark Gunzinger, and Jesse Sloman, *Winning in the Gray Zone Using Electromagnetic Warfare to Regain Escalation Dominance*, Center for Strategic and Budgetary Assessments, 2017, 4, https://csbaonline.org/uploads/documents/CSBA6305_(EMS2_Report)Final7-web.pdf.

33 Jeffrey Engstrom, *Systems Confrontation and System Destruction Warfare: How the Chinese People's Liberation Army Seeks to Wage Modern Warfare* (RAND: Santa Monica, CA, 2018), iii, https://www.rand.org/pubs/research_reports/RR1708.html.

34 *China Military Power: Modernizing a Force to Fight and Win*, Defense Intelligence Agency, 2019, 23–26, https://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/China_Military_Power_FINAL_5MB_20190103.pdf.

35 Andrew Radin, *Hybrid Warfare in the Baltics: Threats and Potential Responses* (Santa Monica, CA: RAND Corporation, 2017), 14–30.

36 Keith Crane, Olga Oliker, and Brian Nichiporuk, *Trends in Russia's Armed Forces: An Overview of Budgets and Capabilities* (Santa Monica, CA: RAND Corporation, 2019), https://www.rand.org/content/dam/rand/pubs/research_reports/RR2500/RR2573/RAND_RR2573.pdf.

37 *The Russian Navy: A Historic Transition*, Office of Naval Intelligence, December 2015, 32–34, https://www.oni.navy.mil/Portals/12/Intel%20agencies/russia/Russia%202015screen.pdf?ver=2015-12-14-082028-313.

38 Mark Episkopos, "How North Korea's Navy Keeps Getting Better," *National Interest*, July 22, 2020, https://nationalinterest.org/blog/buzz/how-north-koreas-navy-keeps-getting-better-165306.

39 J. Matthew McInnis, *Iranian Concepts of Warfare: Understanding Tehran's Evolving Military Doctrine*, American Enterprise Institute, February 16, 2017, 21–25, https://www.aei.org/wp-content/uploads/2017/02/Iranian-Concepts-of-Warfare.pdf.

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41 "Missiles of Iran," CSIS Missile Defense Project, June 14, 2018, last updated 12 April 12, 2020, https://missilethreat.csis.org/country/iran/.

42 *Iranian Naval Forces: A Tale of Two Navies*, Office of Naval Intelligence, February 2017, https://www.oni.navy.mil/Portals/12/Intel%20agencies/iran/Iran%20022217SP.pdf.

43 Barber, “Redesign the Fleet,” https://www.usni.org/magazines/proceedings/2019/january/redesign-fleet.

44 Davidson, “Transforming the Joint Force, https://www.pacom.mil/Media/Speeches-Testimony/Article/2101115/transforming-the-joint-force-a-warfighting-concept-for-great-power-competition/.

45 Leonhard, *Art of Maneuver*, 66–74.

46 *Summary of the 2018 National Defense Strategy of the United States*, https://www.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf.

47 See *Strategy for Operations in the Information Environment*, US Department of Defense, June 2016, https://dod.defense.gov/Portals/1/Documents/pubs/DoD-Strategy-for-Operations-in-the-IE-Signed-20160613.pdf.

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51 Frans Osinga, *Science, Strategy, and War: The Strategic Theory of John Boyd* (New York: Routledge, 2007).

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55 *Mission Command: Command and Control of Army Forces*, Headquarters, US Department of the Army, July 2019, https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/ARN19189_ADP_6-0_FINAL_WEB_v2.pdf.

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61 Director of Operational Test and Evaluation, “MK 54 Lightweight Torpedo and Its Upgrades Including High Altitude Anti-Submarine Warfare Capability,” September 26, 2016, US Department of Defense, https://www.dote.osd.mil/Portals/97/pub/reports/FY2016/navy/2016mk54.pdf?ver=2019-08-22-105304-587.

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63 This rationale is detailed in Bryan Clark et al., *Regaining the High Ground at Sea: Transforming the U.S. Navy’s Carrier Air Wing for Great Power Competition*, Center for Strategic and Budgetary Assessments, 2018, https://csbaonline.org/uploads/documents/CVW_Report_Web_1.pdf.

64 For more details on this approach, see Clark and Walton, *Taking Back the Seas*.

65 See Bryan Clark and Jesse Sloman, *Advancing Beyond the Beach*, Center for Strategic and Budgetary Assessments, 2016, https://csbaonline.org/research/publications/advancing-beyond-the-beach-amphibious-operations-in-an-era-of-precision-wea.

66 Deputy Chief of Naval Operations (Warfare System Requirements – OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, Office of the Chief of Naval Operations, March 2019, https://assets.documentcloud.org/documents/5777236/PB20-30-Year-Shipbuilding-Plan-Final.pdf.

67 *Summary of the 2018 National Defense Strategy of the United States*, 2018, 7, https://www.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf.

68 In CSGs, DDGs focus on providing high-capacity kinetic and non-kinetic defenses for the CVN, while DDCs provide long-range

offensive missile fires that complement and can be integrated with CVW strikes. Four MUSVs conduct counter-ISR with electronic spoofing and jamming systems, and three MUSVs conduct ASW with low-frequency active sonars and passive towed arrays. Other ASW, ISR, and counter-ISR assets support the CSG.

69 If the CVN and CVW can operate around 500 nm from targets, CVW aircraft will not require extensive refueling and can maximize the offensive and defensive capacity of the CSG.

70 For more information on the conceptual approach to the surface combatant fleet adopted by this study and the methodology undergirding it, see Clark and Walton, *Taking Back the Seas*.

71 In the ASW SAGs, FFGs provide local command and control over the MUSVs and deploy passive towed arrays. FFGs are also equipped with a longer-range version of today's vertical-launch ASW missile (VLA). Each FFG also embarks a manned helicopter to conduct ASW and other missions, and a medium altitude long endurance (MALE) UAV to conduct ASW and communications relay. MALE UAVs are capable of delivering short-range ASW weapons like compact rapid attack weapons (CRAW). Three MUSVs focus on ASW, using active low-frequency sonar and passive towed arrays. Some MUSVs are also capable of attacking, with human direction, submarine contacts with short-range CRAW or Hedgehog-like weapons. The use of MUSVs to actively transmit expands the search area available to the SAG and reduces the counter-detection risk posed to the manned FFGs. Two other MUSVs focus on counter-ISR operations with electronic spoofing and jamming systems. Additional assets of these ASW SAGs are distributed acoustic sensors, such as the transportable reliable acoustic path system (TRAPS); gliders or extra-large unmanned underwater vehicles (XLUUVs) with passive towed arrays; and MALE unmanned aircraft systems (UAS) and P-8As to episodically deploy sonobuoys and pounce to engage tracked submarines with lightweight torpedoes.

72 In the ASW patrols, LCSes or FSSCs provide local command and control over the MUSVs and deploy passive or active towed arrays. They embark a manned helicopter and MALE UAV, as well as other small recoverable and expendable UAVs. MUSVs use active low-frequency sonar and passive towed arrays. Distributed acoustic sensors, UAS, and P-8As are employed to detect, track, and engage targets.

73 Within the escort group, the DDG provides advanced sensing and high-capacity kinetic and non-kinetic defensive fires. FFGs specialize in ASW and can also provide local AMD. Both DDGs and FFGs can provide limited ASUW/strike fires and deploy embarked medium and small UAVs to conduct ISR, counter-ISR, and communications relay. MUSVs focus on counter-ISR or ASW, with the proportion of each depending on the anticipated threat environment.

74 In the AMD SAGs for locations ashore, DDGs provide broad-area sensing (with support from inorganic land-based radars, other ships, satellites, and airborne assets) and kinetic and non-kinetic engagement capability. DDGs are complemented by four DDCs armed with AMD missiles. DDGs provide DDCs with tracks to engage. This robust package supports multi-axial coverage of defended assets.

75 In the MIW groups, LCSs operate CUSVs equipped with towed synthetic aperture sonar and single pass neutralization systems, and CUSVs with the Unmanned Influence Sweep System. LCSes also embark a manned helicopter and small UAVs to conduct MCM with laser and EO/IR sensors, ISR, and communications relay. MUSVs in the group, controlled by the LCSes, are capable of towing MCM systems or laying smart mines, with a focus on minelaying. Smart mines can be laid defensively to protect friendly areas of interests, such as straits or near ports. Alternatively, MUSV can be employed a long distance from the LCS to deploy mines offensively in contested areas to deny operating areas to enemy forces.

76 Megan Eckstein, "ExMCM Companies, LCS Mission Package: Will Both Contribute to New Mine Countermeasures Triad," *USNI News,* November 6, 2019, https://news.usni.org/2019/11/06/exmcm-companies-lcs-mission-package-will-both-contribute-to-new-mine-countermeasures-triad.

77 For the MSO unit, the LCS is equipped with the Surface Warfare Mission Module, a manned helicopter capable of conducting ASUW, visit, board, search and seizure, and search and rescue, as well as small recoverable and expendable UAVs capable of conducting ISR and communications relay.

78 *Force Design 2030*, Department of the Navy, US Marine Corps, March 2020, https://www.hqmc.marines.mil/Portals/142/Docs/CMC38%20Force%20Design%202030%20Report%20Phase%20I%20and%20II.pdf?ver=2020-03-26-121328-460 and *Commandant's Planning Guidance: 38th Commandant of the Marine Corps*, Department of the Navy, US Marine Corps, https://www.hqmc.marines.mil/Portals/142/Docs/%2038th%20Commandant%27s%20Planning%20Guidance_2019.pdf?ver=2019-07-16-200152-700.

79 Shawn Snow, "New Marine Littoral Regiment, Designed to Fight in Contested Maritime Environment, Coming to Hawaii," *Marine Corps Times*, May 14, 2020, https://www.marinecorpstimes.com/news/your-marine-corps/2020/05/14/new-marine-littoral-regiment-designed-to-fight-in-contested-maritime-environment-coming-to-hawaii/.

80 During the competition phase, the mix of embarked aircraft on LHAs/LHDs would be balanced to support a range of contingencies. During a crisis or conflict, LHAs or LHDs would usually be employed primarily as Marine F-35B carriers. They could also be incorporated into a CSG or CSF, providing defensive counter-air sorties that enable a larger proportion of the CVWs to be used for ASUW or strike.

81 This study team considered the utility of a light carrier (CVL) that would be derived from the LHA-8 class, as well as alternative designs that could displace up to 60,000 tons and be equipped with catapults and arresting gear. It found that the significant increases in procurement and O&S costs to field these CVLs, compared to the LHA-8, considerably exceeded their modest increase in aviation capacity. Given the cost constraints of this study, continued procurement of an LHA-8 design was deemed preferable to adopting a new CVL.

82 LAWs are envisioned as beachable vessels with 10,500 square feet of vehicle capacity (equivalent to Besson-class logistics support vessels), a displacement of 6,000 tons, and the ability to berth 75–100 marines, in addition to the ship's crew of around 30 personnel.

83 SSN(X) is envisioned as a new design with improved speed, stealth, and survivability compared to the Virginia class, but it does not have the VPM. SSN(X) would have a larger torpedo payload than Virginia and possibly two vertical-launch payload tubes that can carry six twenty-one-inch missiles each.

84 For more information on the conceptual approach to the logistics and support fleet adopted by this study and the methodology undergirding it, see Timothy A. Walton, Ryan Boone, and Harrison Schramm, *Sustaining the Fight: Resilient Maritime Logistics for a New Era*, Center for Strategic and Budgetary Assessments, 2019, https://csbaonline.org/uploads/documents/Resilient_Maritime_Logistics.pdf.

85 For more information on battle force counting rules, see Ray Mabus, "Secretary of the Navy Instruction 5030.8C," Department of the Navy, June 14, 2016, https://news.usni.org/wp-content/uploads/2016/07/SECNAVINST-5030.8C.pdf#viewer.action=download.

86 For a discussion of possible approaches to future CVW design, see Bryan Clark et al., *Regaining the High Ground*, https://csbaonline.org/uploads/documents/CVW_Report_Web_1.pdf.

87 For additional information on readiness cycles, see Bryan Clark et al., *Restoring American Seapower: A New Fleet Architecture for the United States Navy*, Center for Strategic and Budgetary Assessments, 2017, 101–7, and Clark and Walton, *Taking Back the Seas*, 79–81.

88 Chief of Naval Operations, "OPNAV INSTRUCTION 3000.15A: Optimized Fleet Response Plan," US Department of the Navy, November 10, 2014, https://www.secnav.navy.mil/doni/Directives/03000%20Naval%20Operations%20and%20Readiness/03-00%20General%20Operations%20and%20Readiness%20Support/3000.15A.pdf. Of note, CONUS-based submarines would follow a readiness cycle in which they would be available for operations approximately 25 percent of the time.

89 This study assumes that the rotation base of non-deployed ships is sufficient for wartime surge requirements. For some classes, the number of ships in the fleet slightly exceeds the number required to maintain a rotation base. This modest surplus provides spare capacity if events disrupt the rotation base, and it provides additional crisis or conflict surge and attrition reserve capacity.

90 To gauge complexity, this study calculates the different ways in which the fleet could be composed into effects chains of multimission or command and control elements, sensor or counter-sensor elements (including decoys), and effectors. The study assessed the contributions of combatants. The incorporation of auxiliaries and other platforms into an assessment would further increase the complexity imposed on adversaries.

91 For the FY 2020 current US Navy force, this assessment assumes the use of five Military Sealift Command– chartered CONSOL T-AOTs, in addition to combat logistics force (CLF) ships. For more information on the logistics methodology informing this study, see Walton, Boone, and Schramm, *Sustaining the Fight*.

92 The air and missile defense capacity employed in this study also includes the number of Rolling Airframe Missile (RAM) engagements possible in two minutes. RAM is assumed to have a range of less than 10 nm. ("RIM-116 Rolling Airframe Missile," US Navy, https://www.navy.mil/navydata/fact_display.asp?cid=2200&tid=800&ct=2.) Figure 9 is based on a figure in Clark and Walton, *Taking Back the Seas*, iv.

93 This assessment assumes strikes against targets 1,000 nm away using 1,000-lb warhead equivalent weapons. CVW aircraft use air-delivered standoff weapons at approximately 500 nm. In the proposed fleet, ships and submarines use weapons like Tomahawk and reload from locations 1,250 nm away, from T-AKM missile reload ships afloat or shore sites. In the current fleet, ships and submarines are assumed to reload from locations approximately 4,000 nm away, given the lack of afloat missile reload ships or resilient shore sites. Of note, this comparison assumes forces have sufficient standoff weapons to sustain operations, and to ensure the lethality of the proposed fleet, this study prioritizes weapon procurement. This assessment also assumes perfect reloading efficiency and no attrition or damage to weapons, launch platforms, or reloading assets/locations.

94 For more information on the approach this study adopts to the strategic sealift fleet, see Bryan Clark, Timothy A. Walton, and Adam Lemon, *Strengthening the U.S. Defense Maritime Industrial Base: A Plan to Improve Maritime Industry's Contribution to National Security*, Center for Strategic and Budgetary Assessments, 2020, https://csbaonline.org/uploads/documents/CSBA8199_Maritime_Industrial_FINAL.pdf.

95 Inflation was assumed to grow at a rate of 2.1 percent per year.

96 Megan Eckstein, "Future Large Surface Combatant Pushed to Late 2020s, Navy Takes 'Measured' Development Approach," *USNI News,* January 14, 2020, https://news.usni.org/2020/01/14/future-large-surface-combatant-pushed-to-late-2020s-navy-takes-measured-development-approach.

97 For the proposed thirty-year shipbuilding plan and resulting battle force inventory, please see appendix 1.?

98 CVN design is unlikely to remain static over the next thirty years. Continued construction of the Ford class enables learning curve and other construction efficiencies that can lower costs. Moreover, it ensures commonality of systems and parts throughout the carrier fleet, which aids supportability and lowers O&S costs. However, at a certain point it will likely be prudent to evolve to a future CVN design, even when accounting for the non-recurring costs required to do so. A follow-on large CVN design could be right sized for future airwings, which could slightly reduce its follow-on procurement cost. It could also harness automation and other technologies to an even greater degree to further reduce O&S costs, similar to how the O&S costs of the Ford class are anticipated to

be approximately 19 percent less than the Nimitz class, which preceded it. A CVN-83 procured in FY 2036 could potentially be the first of a follow-on CVN design. Such an approach would procure five Ford-class CVNs before evolving to a new design. However, for purposes of costing, this study assumed all CVNs to be Ford-class ships procured on six-year centers.

99 David Larter, "Congress Aims to Strip Funding for the US Navy's Next-gen Large Surface Combatant," *Defense News*, June 25, 2020, https://www.defensenews.com/naval/2020/06/25/congress-aims-to-strip-funding-for-the-us-navys-next-generation-large-surface-combatant/.

100 Paul McLeary, "Congress Pumps the Brakes on Navy, Demands Answers from OSD," *Breaking Defense*, July 2, 2020, https://breakingdefense.com/2020/07/congress-pumps-the-brakes-on-navy-demands-answers-from-osd/.

101 Sam Lagrone, "Navy Awards Contract for First Vessel in Its Family of Unmanned Surface Vehicles," *USNI News*, July 14, 2020, https://news.usni.org/2020/07/14/navy-awards-contract-for-first-vessel-in-its-family-of-unmanned-surface-vehicles.

102 CONSOL tankers (T-AOTs) are arguably the most important element of the proposed naval logistics fleet. They provide intermediate nodes where oilers and other refueling vessels can refuel without having to transit to rear area ports when forward ports are highly contested. Additionally, if some are equipped with modular fuel delivery systems, they can refuel combatants and thus provide an attrition reserve for oiler losses. However, T-AOTs do not count as battle-force ships. Under a new Tanker Security Fleet Program, similar to the Maritime Security Program, the US government could provide a stipend to commercial tankers that operate under the US flag with American crews, in exchange for their commitment to be available during a crisis or conflict. See Charlie Papavizas, "U.S. Congress Again Proposes U.S.-Flag Tanker Program," Casetext, June 15, 2020, https://casetext.com/analysis/us-congress-again-proposes-us-flag-tanker-program.

103 For more information on this study's approach to the strategic sealift fleet, see Clark, Walton, and Lemon, *Strengthening the U.S. Defense Maritime Industrial Base*.

104 Another option to grow the US tanker fleet, which complements the proposed Tanker Security Fleet, is for the US military to buy more of its fuel from US refineries. If the US government bought about half of its overseas fuel from US refineries, this change would cost less than $30 million annually, or less than half a cent per gallon, and would generate sufficient business transporting the fuel to yield up to seven more US-flagged tankers.

105 Procurement costs for current and planned vessels were established in consultation with Navy and Office of Cost Assessment and Program Evaluation (CAPE) staffs, and were informed by government data, Eric Labs's Congressional Budget Office cost estimation methodology and reports, and consultations with industry. Unless otherwise noted, all costs in this report are expressed in FY 2020 dollars. Moreover, SCN costs include CVN RCOHes.

106 Megan Eckstein, "CBO: Navy's Next Nuclear Attack Submarine Could Cost $5.5B a Hull," *USNI News,* October 10, 2019, https://news.usni.org/2019/10/10/cbo-navys-next-nuclear-attack-submarine-could-cost-5-5b-a-hull.

107 This would expound on the high-level Auxiliary and Sealift Vessel Plan Appendix to the thirty-year shipbuilding plan.

108 O&S costs for current and planned vessels were established in consultation with Navy and CAPE staffs and informed by ship database information from the Navy's Visibility and Management of Operating and Support Costs system. Figures do not include CVW or Aviation Combat Element (ACE) costs. A comprehensive assessment of Department of the Navy operations and maintenance costs would account for aviation costs and other direct and indirect ship and non-ship costs.

109 As discussed in the subsequent paragraph, the proposed fleet costs significantly less than the sum of the SCN and O&S limits in most years, and certainly over the course of thirty years. If, however, there were a desire to further reduce O&S costs due to hard budget limits that could not be exceeded in any year, the greatest factor that would generate an immediate reduction in O&S costs would be cancellation of CVN RCOHes, which would lead to their premature retirement. Retiring other ships early and refraining from introducing as many small vessels (manned and unmanned) into the fleet would also significantly reduce O&S costs. Premature retirements would likely lead to force-capacity reductions.

110 Steve Lagana, "Shipyard Infrastructure Optimization Plan (SIOP)" (Presentation to Sea-Air-Space Exposition, May 7, 2019), https://www.navsea.navy.mil/Portals/103/Documents/Exhibits/SAS2019/SteveLagana-SAS-05072019.pdf?ver=2019-05-07-144653-417; and *Naval Shipyards: Key Actions Remain to Improve Infrastructure to Better Support Navy Operations*, Report to Congressional Committees, US Government Accountability Office, November 2019, 5, https://www.gao.gov/assets/710/702883.pdf.

111 The latest thirty-year shipbuilding plan that the Navy delivered to Congress was for FY 2020. This comparison takes the Navy's choices in that plan, then continues them in FY 2050–51 to create an extrapolation of the plan. The cost comparison includes battle force and support-type ship procurement. Of note, the Navy FY 2030 thirty-year shipbuilding plan did not include DDC, LAW, LUSV, MUSV, T-AOL, T-AKM, or XLUUV ship classes, which are included in the Hudson plan.

112 Ibid., i.

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