A CBO STUDY

Transforming the Navy's Surface Combatant Force

March 2003

The Congress of the United States ■ Congressional Budget Office

Notes

Unless otherwise indicated, the years referred to in this study are fiscal years and the dollar amounts are in 2003 dollars.

Numbers in the text and tables may not add up to totals because of rounding.

The cover shows the *Preble*, an Arleigh Burke class (DDG-51) guided-missile destroyer (top), and an artist's rendering of the DD(X) future destroyer (bottom). (Pictures are courtesy of the Navy and Northrop Grumman, respectively.)

Preface

Today, the U.S. Navy numbers about 300 ships, including a force of 115 surface combatants (cruisers, destroyers, and frigates). For the past six years, the official force goal for surface combatants was 116. But recently, senior Navy officials have argued that the nation needs a larger Navy: 375 ships, including a surface combatant force of 160 ships. That force would comprise 104 large cruisers and destroyers as well as 56 new, much smaller vessels called littoral combat ships—which are expected to be an important element of the Bush Administration's plans for transforming the Navy. Those ships are intended to counter potential threats in the world's coastal regions that, if left unchecked, could inhibit the Navy's freedom of action. At the same time that it hopes to expand the fleet, however, the Navy plans to retire many existing surface combatants early.

Reaching the Navy's new force goal by building more surface combatants would require a substantial investment, which would compete with other demands, including different transformation efforts and ship programs. Are there ways to transform the surface combatant force within today's funding level? This Congressional Budget Office (CBO) study—prepared at the request of the Subcommittee on Seapower of the Senate Committee on Armed Services—examines that question. It looks at the Navy's modernization plans for the surface combatant force and their budgetary implications. The analysis also evaluates three options that would modernize and transform that force at the current funding level. In keeping with CBO's mandate to provide objective, impartial analysis, this study makes no recommendations.

Eric J. Labs of CBO's National Security Division wrote the study under the general supervision of J. Michael Gilmore. Raymond Hall of CBO's Budget Analysis Division prepared the cost estimates and wrote the appendix under the general supervision of Jo Ann Vines. Ian MacLeod of the National Security Division helped review the manuscript for factual accuracy. Lyle Nelson, Arlene Holen, David Moore, Dennis Zimmerman, Tracy Foertsch, and R. William Thomas of CBO provided thoughtful comments on an earlier draft of the study, as did several officials of the Department of the Navy. In addition, numerous Navy officials and analysts answered many requests for information. The author is especially grateful to Robert Work of the Center for Strategic and Budgetary Assessments, whose insights and comments were extremely valuable. (The assistance of such external participants implies no responsibility for the final product, which rests solely with CBO.)

Joseph Foote and Christian Spoor edited the study, and Leah Mazade proofread it. Kathryn Winstead prepared the study for publication. Lenny Skutnik printed the initial copies, and Annette Kalicki prepared the electronic versions for CBO's Web site (www.cbo.gov).

Douglas Holtz-Eakin
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March 2003

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Summary

The Bush Administration came into office with an agenda to transform the military into a more effective and more lethal force. The Navy has numerous transformation efforts under way—some of which were begun before President Bush took office—that Navy officials hope will lead to a better fleet. Such efforts include improvements to the Navy's sensors and information networks, a new and more capable aircraft carrier, new strike and reconnaissance aircraft, and new ways for the Navy and Marine Corps to organize and fight.

Perhaps the most visible effort is the drive to transform the surface combatant force. Representing more than one-third of the fleet, that force comprises the Navy's cruisers, destroyers, and frigates. (It excludes aircraft carriers, amphibious ships, and support ships.) Over the next 10 to 15 years, the Navy plans to retire one class of destroyers, modernize its cruisers and frigates, introduce three new classes of surface combatants, and experiment with different operating concepts. If fully implemented, those plans would produce a surface combatant force of about 160 ships 25 years from now.

This Congressional Budget Office (CBO) study looks at the composition, missions, and modernization programs of the Navy's surface combatant force as well as alternatives to the Navy's current approach to the force. The study focuses on the surface combatant force for two reasons. First, that force is at the heart of the Navy's plans to increase the total size of the fleet from a little more than 300 ships to 375. Although that increase includes an additional amphibious ship and several support ships (and counts some mine-warfare ships not already counted as part of the 300-ship Navy), most of the difference is explained by expanding the surface combatant force from 115 ships today to 160 ships. The resources needed for that expansion are much larger than what the Navy now spends on surface combatants. A CBO projection of the demands on the Navy's shipbuilding budget through 2020 shows that without large budget increases, transforming the surface combatant force could crowd out funding for other ship programs. That situation could pose particular problems for the attack submarine force, which will require substantially greater funding than it now receives if the Navy wants to maintain the existing number of submarines.

Second, the new ships in the surface combatant force are the primary means by which Navy officials expect to defeat threats posed by relatively inexpensive weapon systems that potential opponents might use to inhibit the Navy's freedom of action (a strategy known as area denial). According to the 2001 Quadrennial Defense Review (QDR), defeating those threats should be a central objective of transformation.

As an alternative to the Navy's current plans, this study examines three approaches for structuring surface combatant programs that would produce a larger and more capable force in 2025 than exists today but would limit average annual spending on procurement and direct operation and support costs to roughly the amount spent last year: $6.6 billion (in 2003 dollars). Those different approaches are:

- Retaining and modernizing ships that the Navy now plans to retire and buying a new frigate to provide presence, counter area-denial threats, conduct maritime interception operations, and carry out other missions.

- Retiring more ships earlier than the Navy plans while accelerating the introduction of new classes of surface combatants—but buying them in fewer numbers.

- Buying a much smaller number of new surface combatants than the Navy proposes but operating them with multiple crews to achieve a far higher rate of peacetime availability.

Those options represent three strategies for managing the Navy's transition to a new generation of surface combatants. The first approach emphasizes the modernization of the Navy's "legacy" fleet—the surface combatants that already exist. The other two approaches emphasize the transformation to a new generation of ships. Each of the three approaches would have a very different effect on the force structure and on the capabilities it would provide to the Navy. Using several measures of capability, CBO compares the three options with one another and with the approach that the Navy is taking.

The key conclusion of that analysis is that the Navy could cap spending at today's level and still have a larger and much more capable force of surface combatants 25 years from now. However, the additional money that the Navy would spend under its plan would provide an even bigger and more effective force than any of CBO's options would.

The Surface Combatant Force and Its Missions

As of this writing, the Navy's force of surface combatants comprises 17 Spruance class (DD-963) general-purpose destroyers, 27 Ticonderoga class (CG-47) cruisers, 33 Oliver Hazard Perry class (FFG-7) guided-missile frigates, and 38 Arleigh Burke class (DDG-51) guided-missile destroyers (more DDG-51s are under construction). Those ships constitute the ultimate Cold War generation of surface combatants designed for open-ocean, high-intensity naval warfare against the Soviet Union.

In the past 25 years, surface combatants have seen dramatic improvements in their capabilities. Historically, surface combatants served as escorts for higher-value ships (such as aircraft carriers) or for merchant vessels, protecting them from attack by aircraft, submarines, or small surface craft. Their land-attack capability was restricted to short-range naval guns. New weapon systems—particularly the vertical launch system (VLS) for missiles and the Aegis air-defense combat system—have greatly improved the ability of surface combatants to provide air and missile defense for a naval task force. In addition, the VLS and the Tomahawk cruise missile have enabled surface combatants to attack targets far inland, well beyond the range of traditional naval guns and even naval aviation. Because of those advances, the current generation of U.S. surface combatants is among the best—if not the best—in the world today.

The Resource Implications of Modernizing the Surface Combatant Force

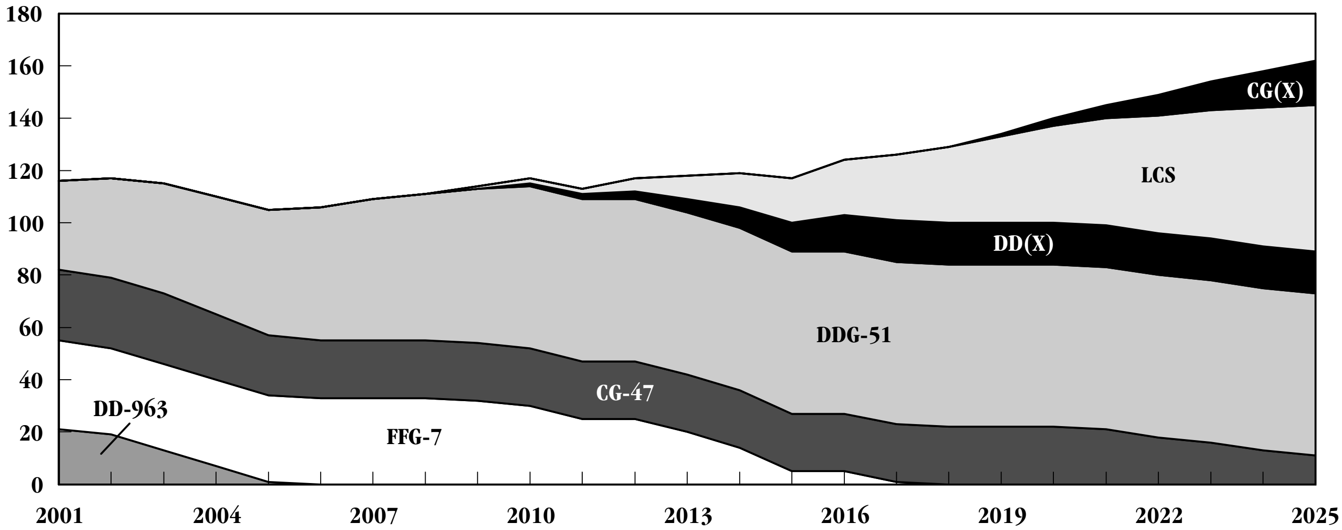
According to statements by Navy leaders and official briefings, the Navy proposes to introduce a new generation of surface combatants designed to confront new threats and perform new missions. With the demise of the Soviet navy, no challenges to U.S. naval supremacy remain on the open ocean. As a result, Navy leaders have refocused their attention on influencing events on land, operating in the crowded coastal regions of the world, and overcoming new antiaccess and area-denial threats to U.S. warships operating closer to shore (within the range of a potential enemy's weapons). The Navy expects the next generation of ships, designed especially for coastal areas, to reduce the risks that U.S. naval forces might face in that new operating environment and to increase the combat effectiveness of those forces.

The Navy's transition, or transformation, plan calls for the early retirement of some current-generation destroyers, the upgrading of other existing ships, and the introduction of a new family of surface combatants. Specifically, the Navy intends to retire all Spruance class destroyers and the first five Ticonderoga class cruisers by the end of 2006 and upgrade the combat and reliability systems of the remaining Ticonderogas and Oliver Hazard Perry class frigates. The Navy's main focus, however, is on buying the DD(X) future destroyer, starting in 2005; the littoral combat ship, also starting in 2005; and the CG(X) future cruiser, beginning around 2014.

The DD(X) is intended to be a multimission ship with an emphasis on land attack. It is expected to carry up to 128 VLS cells and one or two 155-millimeter (mm) ad-

Summary Figure 1.

Inventory of Surface Combatants Under CBO's Estimate of the Navy's 160-Ship Plan, 2001-2025



Source: Congressional Budget Office.

Note: DD-963 = Spruance class general-purpose destroyer; FFG-7 = Oliver Hazard Perry class guided-missile frigate; CG-47 = Ticonderoga class guided-missile cruiser; DDG-51 = Arleigh Burke class guided-missile destroyer; DD(X) = future general-purpose destroyer; LCS = littoral combat ship; CG(X) = future guided-missile cruiser.

vanced gun systems capable of hitting targets 100 nautical miles away. It is also designed to be highly stealthy. Exactly how many DD(X)s the Navy plans to buy is unclear, but as of this writing, 16 appears to be the number.

The littoral combat ship (LCS) is intended to be much smaller than the DD(X). The Navy wants it to be a "focused-mission" ship with a modular design, in which combat systems could be changed relatively easily depending on what mission the ship was assigned to perform. At any given time, the LCS could be configured to carry out only one of three missions: mine countermeasures, antiboat operations, or littoral antisubmarine warfare. As with the DD(X), the Navy has not stated officially how many LCSs it plans to buy, but for this analysis, CBO assumed that the service would purchase 56 of the ships, which is consistent with some statements by Navy officials and with briefings that CBO has received.

The CG(X) future cruiser would also be a multimission ship, sharing many features with the DD(X). It is supposed to emphasize air and ballistic missile defense. Although the Navy has not said how many of the new cruisers it intends to buy, presumably it would eventually want to purchase between 24 and 42 if it pursued its current Global Concept of Operations (or Global CONOPs).

Determining the Navy's Modernization Plans

Estimating the resources necessary to carry out those efforts is difficult because the Navy has not stated exactly how many surface combatants it wants or needs, nor has it laid out a long-term modernization program in any detail. Consequently, CBO developed two long-term procurement plans in an effort to gauge the level of resources that the Navy believes is necessary to modernize the surface combatant force. The first is based on a plan contained in the *Report on Naval Vessel Force Structure Requirements*, released in June 2000 (referred to here as the 30-Year Shipbuilding Report). That report proposed a ship construction plan to maintain a force of 116 large surface combatants, with no new small warships. Officially, it is

Summary Table 1.

Average Annual Spending for Ship Construction, by Category, 1990-2020

(In billions of 2003 dollars)

Category	Force Goal (Number of ships)	Actual Average Annual Spending, 1990-2002	Steady-State Funding Required (Based on 1997 and 2001 QDR force goals)[a]	Cumulative Surplus or Shortfall (-) Relative to Steady-State Funding, 1990-2002	Projected Average Annual Spending[b] 2003-2010	2011-2020
Surface Combatants	116	3.6	3.4[c]	2.0[c]	5.1	6.2
Attack Submarines[d]	58	1.3	3.9	-34.1	4.2	6.3
Ballistic Missile Submarines[e]	14	0.3	0.8	-7.1	0.6	0.4
Aircraft Carriers[e]	12	1.4	1.4	-0.5	2.0	2.1
Amphibious Ships	36	0.9	1.1	-1.8	0.6	0.9
Other	70	0.9	0.7	2.9	1.0[f]	1.0[f]
Total	**306**	**8.5**	**11.3**	**-38.7**	**13.5**	**16.9**

Source: Congressional Budget Office.

Note: QDR = Quadrennial Defense Review.

a. The steady state represents the annual spending required to maintain the fleet at the level of the force goals, which are very close to current levels.
b. CBO projection based on the Navy's proposed 375-ship fleet, including 160 surface combatants.
c. If the requirement for surface combatants was 160 (reflecting the Navy's 160-ship plan including about 60 littoral combat ships), the steady-state budget would be $5.2 billion a year and the cumulative 1990-2002 shortfall would be $19 billion.
d. These numbers represent a slight change from the force goals in the 1997 and 2001 QDRs. They assume 54 attack submarines and four Trident submarines converted to a guided-missile configuration, whereas the 1997 QDR called for 50 attack submarines, and the 2001 QDR seemed to affirm a force goal of 55 attack submarines.
e. Includes funding for refueling overhauls.
f. Includes Maritime Prepositioning Force Future ships.

the only long-term program for Navy ship construction on record that is available to CBO.

The second plan is based on the 2004 Future Years Defense Program, public statements by Navy officials, unofficial sources, and evidence in Navy briefings—outlined most lucidly in the Navy's new Global CONOPs briefing—from the spring and summer of 2002. That plan would upgrade 22 Ticonderoga class cruisers and 33 Oliver Hazard Perry class frigates and would begin procuring 16 DD(X)s and 56 littoral combat ships in 2005. Ten to 15 years from now, the Navy would start replacing the upgraded Ticonderogas with CG(X)s. CBO assumed that the Navy would buy 32 CG(X)s through 2025. Under that approach, the inventory of surface combatants would grow from 115 today to about 160 ships in the next 25 years—88 cruisers and destroyers capable of providing long-range air defense as well as the 16 DD(X) destroyers, and 56 littoral combat ships (*see Summary Figure 1 on page xiii*). Thus, CBO refers to that approach as the Navy's 160-ship plan. Of the two procurement plans, the Navy's 160-ship plan (based heavily on the Global CONOPs briefing) is the more consistent with current Navy thinking on the future of the surface combatant force.

Budgetary Implications of the Navy's Plans

Both the 30-Year Shipbuilding Report plan and the Navy's 160-ship plan would require greater resources than the surface combatant force has received in recent years or expects to receive under the President's budget request for 2004. That request envisions that the Navy will spend $3.2 billion in 2004—or about 28 percent of the shipbuilding budget—to buy surface combatants. The rest of the ship construction budget would go to build aircraft carriers, submarines, amphibious ships, and support ships. In contrast, by CBO's estimate, the Navy would need to spend an average of $5.9 billion a year (in 2003 dollars) on procurement between 2003 and 2025 to implement the 160-ship plan—or more than half of the shipbuilding budget in the President's 2004 request. (The amount required to carry out the 30-Year Shipbuilding Report plan would be similar.)

At the same time, other components of the Navy will need greater resources if Navy leaders are to achieve their overall force goals. CBO estimates that to meet those goals, the budget for ship construction would have to average about $17 billion a year between 2011 and 2020—about $3 billion more than the average required for the 2003-2010 period (*see Summary Table 1*) and twice what the Navy spent between 1990 and 2002. (The Navy's shipbuilding budget in 2003 is about $8 billion.)

Summary Table 1 shows how deep the hole in the Navy's ship construction budget has become, and how building a larger surface combatant force would exacerbate the problem. Before 2002, the Navy's total force goal for ships was still officially about 300. That goal was set by the 1997 QDR, and the 2001 QDR referred to that fleet as being the base on which transformation would be built. Sustaining a 300-ship Navy indefinitely (that is, in steady state) would require spending about $11 billion a year on ship procurement, CBO estimates. But since 1990, the Navy has spent only about $8.5 billion per year, on average. Thus, the total shortfall in ship construction relative to the spending necessary to maintain a steady-state fleet of around 300 ships now stands at almost $39 billion. The lion's share of that shortfall involves attack submarines, of which the Navy bought seven between 1990 and 2002.

In the past year, by contrast, senior Navy admirals have argued that they need 375 ships to perform all of the missions asked of the service. By far the biggest change in force goals is the increase in the desired level of surface combatants from 116 to 160. In short, the Navy is proposing a major expansion of the surface combatant force that will require considerable resources at the same time that other ship programs will need more funding if current force levels are to be maintained.

Structuring the Future Surface Combatant Force at Today's Funding Level

Transforming the surface combatant force need not be as expensive a proposition as the Navy's 160-ship plan would be. CBO examined three different options to structure the force, each of which would require no more than an average of about $6.6 billion a year (in 2003 dollars) for procurement and direct operation and support costs between 2003 and 2025—about what the Navy spent in 2002. The three approaches emphasize different trade-offs between keeping the legacy generation of ships and transforming it over the next two decades. The first option would make maximum use of ships already in the fleet. The second would speed up development and acquisition of new ship classes by retiring many existing ships even faster than the Navy plans. The third would introduce a multiple-crew operating concept for the Navy's new ship classes, allowing the service to buy fewer surface combatants than envisioned in the Global CONOPs but providing more forward presence during peacetime.

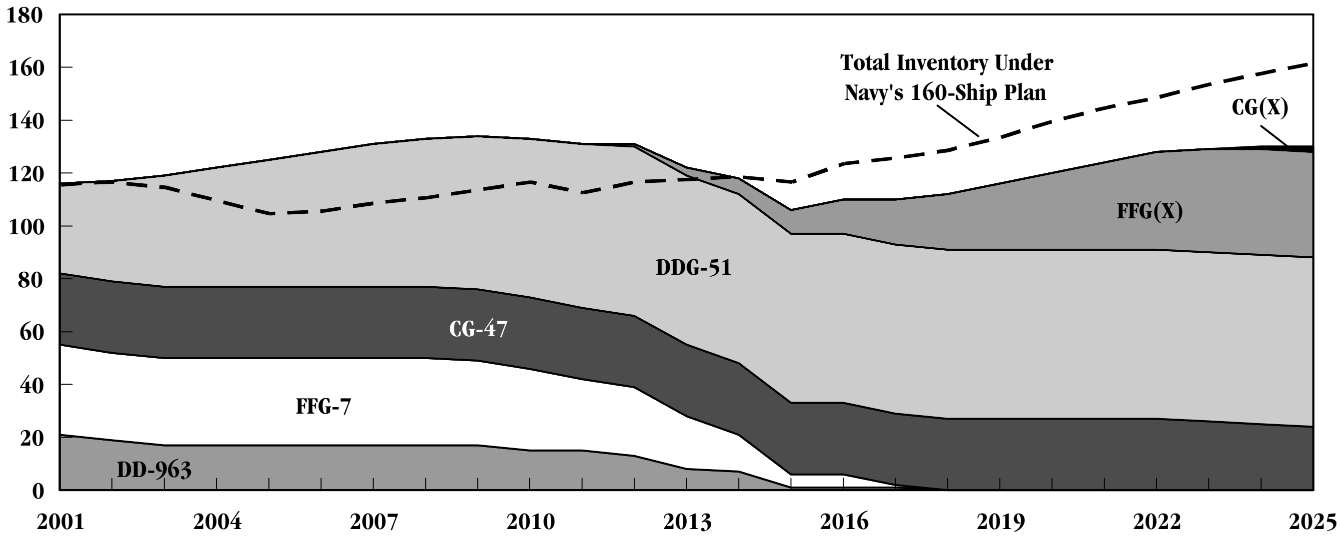
Option I: Delay the Transition to Next-Generation Ships by Making the Most of the Existing Fleet

The ships that make up the legacy generation of Cold War surface combatants remain formidable fighting ships. Recognizing that fact, this approach would keep many of those surface combatants through the end of their notional service lives to ease the shortage of ships that Navy admirals have argued now exists. The Spruance class destroyers would be retained and upgraded, as would the Ticonderoga class cruisers and Oliver Hazard Perry class frigates. With respect to new ship classes, the CG(X) would be delayed for five years, and the DD(X) and littoral combat ship would be canceled. In their place, the Navy would build a next-generation frigate that was more capable than the littoral combat ship but smaller and less costly than the DD(X). That frigate would perform all three LCS missions (mine countermeasures, antiboat operations, and littoral antisubmarine warfare). In addition, it would have robust defensive capabilities to make it more survivable in the littoral environment.

Under this approach, the surface combatant force would grow substantially through 2013 compared with the force in the Navy's 160-ship plan. Indeed, between 2003 and 2012, this option would provide the largest inventory of surface combatants of any approach examined in this study. After 2013, however, as older ships began to be retired in large numbers, the force would fall well below the number of surface combatants that the Navy would have under the 160-ship plan (*see Summary Figure 2*). By 2025, the surface combatant force would number 130 ships under this option, with an average age of a little over 20 years—greater than under any other approach.

Summary Figure 2.

Inventory of Surface Combatants Under Option I, 2001-2025



Source: Congressional Budget Office.

Note: DD-963 = Spruance class general-purpose destroyer; FFG-7 = Oliver Hazard Perry class guided-missile frigate; CG-47 = Ticonderoga class guided-missile cruiser; DDG-51 = Arleigh Burke class guided-missile destroyer; FFG(X) = future guided-missile frigate; CG(X) = future guided-missile cruiser.

Option II: Accelerate the Transition to Next-Generation Ships by Retiring Much of the Existing Fleet Early

In this option, the Navy would more aggressively pursue the new capabilities and ships promised by next-generation technology. To free up the funds for that effort, it would dramatically cut the surface combatant force in the short term. Essentially, this option would fit the Navy's 160-ship plan within the constraints of an average budget of $6.6 billion a year for procurement and operation and support. It would upgrade the combat and reliability systems of 13 of the current 27 Ticonderoga class cruisers; of the other 14, the first five would be retired by 2006 and the rest by 2014, well before the end of their notional 35-year service life. This approach would follow the Navy's plan to retire all Spruances by 2006. In addition, it would retire all Perry class frigates by 2010. It would buy 12 DD(X)s, accelerate the procurement of the CG(X) to 2012, and purchase only 30 littoral combat ships, starting in 2005.

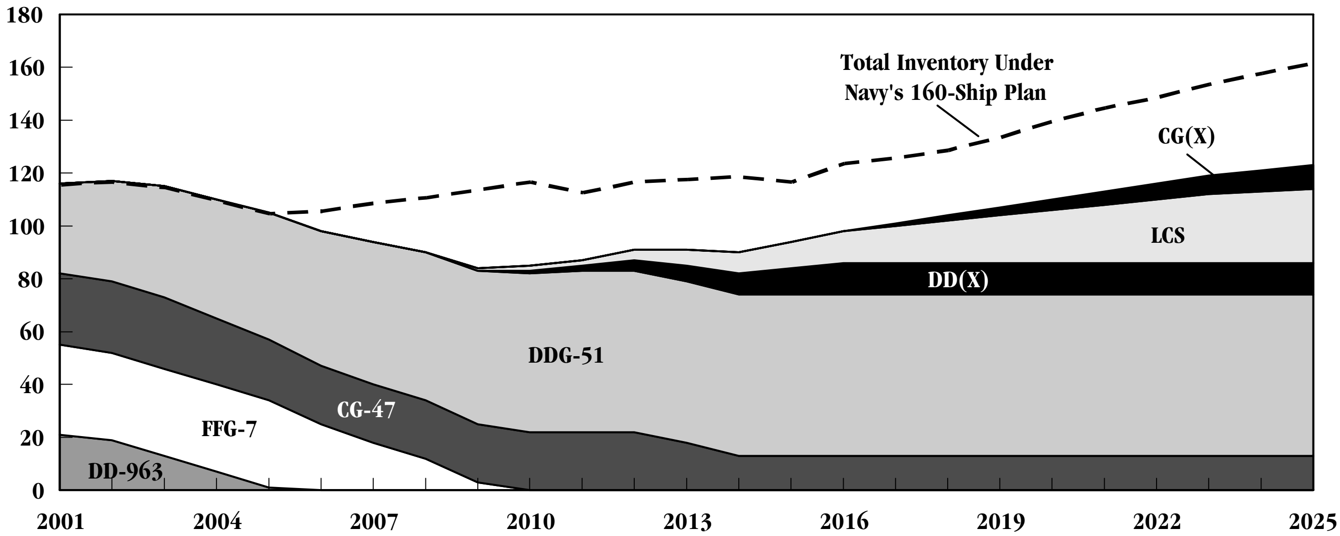
Overall, this approach would give up many older ships in the short run to have more next-generation ships in the long run. The force would immediately and sharply decline, falling to 85 ships by 2010—by far the smallest force of all the approaches that CBO examined (*see Summary Figure 3*). By 2025, however, the purchase of new ships, especially the littoral combat ship, would bring the force up to 123 surface combatants. This option would produce a younger force than CBO's other two options would: the age of surface combatants would average a little over 18 years in 2025.

Option III: Buy Fewer Next-Generation Ships by Assigning Multiple Crews to New Ship Classes

Under this approach, the Navy would transform the surface combatant force through a different operating concept—using three crews to operate two ships. By doing so, the Navy could provide the same forward presence as under its 160-ship plan but with a smaller fleet and for much less money. However, although multiple-crewed ships can provide about twice the peacetime presence of single-crewed ships, they offer no extra benefit during war. (Wartime capability would be based on the number of hulls in the surface combatant force.) This option would restrict the new crewing concept to future ship classes, on

Summary Figure 3.

Inventory of Surface Combatants Under Option II, 2001-2025



Source: Congressional Budget Office.

Note: DD-963 = Spruance class general-purpose destroyer; FFG-7 = Oliver Hazard Perry class guided-missile frigate; CG-47 = Ticonderoga class guided-missile cruiser; DDG-51 = Arleigh Burke class guided-missile destroyer; DD(X) = future general-purpose destroyer; LCS = littoral combat ship; CG(X) = future guided-missile cruiser.

the theory that it would be easier to design new ships to accommodate multiple crews than to modify existing ones.

With respect to ship programs, this approach would follow the Navy's plan in retiring Spruances early and upgrading Ticonderoga cruisers and Perry frigates. It would also buy the same types of next-generation surface combatants as Option II but fewer of them: eight DD(X)s and 28 littoral combat ships. The CG(X) would be delayed until 2018, and only 15 would be purchased. Because those new classes of ships would use multiple crews and spend more time at sea, they would cost more to operate than single-crewed ships would. CBO included those higher costs in its analysis.

Under this option, the surface combatant force would rise to 124 ships by 2025, but the multiple-crewing concept would make that force equivalent to 165 single-crewed ships in peacetime (*see Summary Figure 4*). That force would be the second oldest examined here, with an average age of about 20 years in 2025.

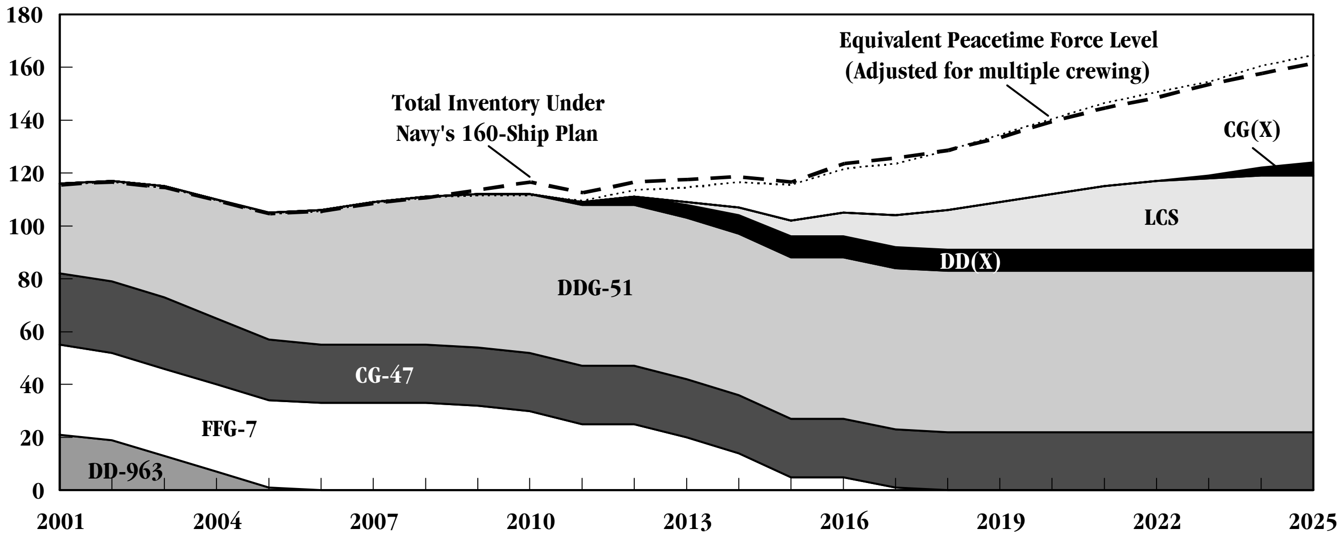
Measures of Capability Under the Various Approaches

To evaluate the different options in this study and compare them with the plan in the 30-Year Shipbuilding Report and the Navy's 160-ship plan, CBO used various measures of peacetime and wartime capability for the surface combatant force. The principal measures were the total number of surface combatants, the total number of VLS cells that those ships carry, the number of ships capable of long-range fleet air defense, the number of helicopter hangars on surface combatants, the number of penetrating littoral antisubmarine warfare suites, the number of guns capable of firing extended-range guided munitions and the number of 155-mm advanced gun systems (to provide long-range fire support to the Marine Corps), the number of next-generation ships, the total crew size of the surface combatant force, and its average age.

Because the Navy's principal peacetime mission is maintaining a combat-credible forward presence, capabilities

Summary Figure 4.

Inventory of Surface Combatants Under Option III, 2001-2025



Source: Congressional Budget Office.

Note: DD-963 = Spruance class general-purpose destroyer; FFG-7 = Oliver Hazard Perry class guided-missile frigate; CG-47 = Ticonderoga class guided-missile cruiser; DDG-51 = Arleigh Burke class guided-missile destroyer; DD(X) = future general-purpose destroyer; LCS = littoral combat ship; CG(X) = future guided-missile cruiser.

on-station (in a ship's theater of operations) are a better measure of how well the surface combatant force performs than fleet totals are. Conversely, in wartime, the critical measure is how much actual firepower can be brought to bear in a given period of time. Thus, CBO calculated the "surge" capacity of each force structure 14 days and 36 days after the beginning of a wartime mobilization. (Chapter 3 provides a detailed assessment of how the different force structures compare using CBO's measures.)[1]

Of the approaches analyzed in this report, the Navy's 160-ship plan would provide the most capable and balanced force of surface combatants—but at a cost that could prove prohibitive. However, all of the alternatives that CBO examined, even those with constrained budgets, would produce a fleet of surface combatants that was much more effective than today's force (*see Summary Table 2*).

Although Option I's force would be the oldest, it would also be the largest and most capable in 2010, according to the majority of measures that CBO used. By 2025, however, it would still be the oldest fleet and would no longer be as capable as the Navy's planned 160-ship force. Option II's strong suit would be its number of next-generation ships, which is a wartime measure. Conversely, Option III would be the best among CBO's options with respect to peacetime presence. The force of the 30-Year Shipbuilding Report would have the most VLS cells and 155-mm guns by 2025 because it would purchase more DD(X)s—in the absence of a littoral combat ship—than would any other approach.

1. Those measures purposely exclude the capabilities that other Navy ships, notably aircraft carriers, could bring to a conflict. Because the analysis focuses on surface combatants, the measures assess only the combat capabilities of those ships, although they would most likely be used in tandem with other Navy ships.

Summary Table 2.

The Surface Combatant Force in 2010 and 2025 Under Alternative Force Structures

Force Structure	Total Number of Ships	Average Age (Years)	Total Crew Size	Number of: Long-Range Air-Defense Ships	Helicopter Hangars	Littoral ASW Suites	Next-Generation Ships	VLS Cells[a]	Guns: ERGM	Guns: 155-mm
2010										
30-Year Shipbuilding Report	120	16.2	38,200	89	174	0	0	8,800	30	0
Navy's 160-Ship Plan	117	15.4	36,400	84	170	2	3	8,600	49	2
Option I	133	18.0	43,100	87	204	0	0	9,700	58	0
Option II	85	11.8	29,100	82	106	2	3	8,400	30	2
Option III[b]	112	15.5	35,400	82	162	0	0	8,300	48	0
2025										
30-Year Shipbuilding Report	122	17.6	33,900	90	186	32	49	14,500	31	64
Navy's 160-Ship Plan	162	15.3	36,600	90	212	34	89	14,000	49	32
Option I	130	20.2	36,000	90	204	40	42	11,200	96	0
Option II	123	18.5	32,200	83	162	21	49	10,600	31	24
Option III										
Peacetime equivalent[c]	165	19.8	36,700	93	218	34	82	13,100	49	32
Actual hulls	124	19.8	36,700	88	164	17	41	10,400	49	16
Memorandum:										
Current Force	115	13.3	36,700	69	168	0	0	7,300	12	0

Source: Congressional Budget Office.

Notes: ASW = antisubmarine warfare; VLS = vertical launch system; ERGM = extended-range guided munition; mm = millimeter.

Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

a. These numbers assume 61 VLS cells for Spruance destroyers, 90 for Flight I/II Arleigh Burke destroyers, 96 for Flight IIA Arleigh Burke destroyers, 64 for the first two modernized Ticonderoga cruisers, 128 for the next three modernized Ticonderoga cruisers, 122 for Improved Ticonderogas, 128 for DD(X) destroyers, 200 for CG(X) cruisers, and 48 for a next-generation frigate.

b. There are no multiple-crewed ships in the fleet by 2010 under this option.

c. The force level and capability numbers for this alternative are the peacetime equivalents of single-crewed ships. That is, the 124 ships of Option III are equivalent to 165 single-crewed ships in their ability to provide forward presence.

CHAPTER

1

Modernizing the Surface Combatant Force and the Implications for the Navy's Budget

Like the rest of the military, the Navy is pursuing a variety of initiatives to transform itself into a more effective and lethal force. Those initiatives include improving sensors and information networks, developing a new and more capable aircraft carrier as well as new strike and reconnaissance aircraft, and changing the way that the Navy and Marine Corps are organized and fight. One of the Navy's highest priorities is transforming the surface combatant force. That force, which represents more than one-third of the fleet, comprises the Navy's cruisers, destroyers, and frigates. Over the next 10 to 15 years, the Navy intends to retire one class of destroyers, modernize its cruisers and frigates, introduce three new types of surface combatants (in particular, a new small warship), and experiment with different operating concepts. If those plans were fully implemented, they would result in a force of around 160 surface combatants in 25 years, compared with 115 ships today.

That transformation effort has serious budgetary implications for the Navy's shipbuilding programs. The resources needed to make those changes would be much greater than what the Navy spends on surface combatants now. The Congressional Budget Office (CBO) projects that in the absence of large increases in the Navy's shipbuilding budget through 2020, transforming the surface combatant force could crowd out funding for other ship construction programs, particularly for attack submarines.

In addition to their budgetary implications, the Navy's plans for surface combatants are important because the new ships represent the primary means by which Navy officials expect to defeat the threat of relatively inexpensive weapon systems that potential opponents might use to inhibit the Navy's freedom of action. According to the 2001 Quadrennial Defense Review (QDR), overcoming that threat should be a key objective of transformation. That objective echoes the Navy's effort in the 1980s to build new surface combatants capable of defeating large-scale attacks by antiship missiles launched from Soviet ships and aircraft.

This CBO study examines the composition, missions, and modernization programs of the Navy's surface combatant force. It also analyzes three alternative approaches to the Navy's transformation plan that highlight key issues and trade-offs associated with transformation. Those approaches were designed to improve the surface combatant force while maintaining roughly the current funding level: an average budget of $6.6 billion a year (in 2003 dollars) for both procurement and operation and support between 2003 and 2025.[1]

Transformation and What It Means for the Navy

No universal agreement exists about what military "transformation" means or why it is necessary. In the past few

1. This analysis treats average spending for research and development as a constant between 2003 and 2025, although CBO's cost estimates for the first DD(X) destroyer and the first littoral combat ship do include the research and development money being spent to build those ships (see the appendix for more details).

years, President Bush has outlined a vision of military transformation in which the number of major combat platforms is much less important than mobility, speed, and the ease of sustaining forces. In his words, the transformed military would rely "heavily on stealth, precision weaponry and information technologies."[2] The President argues that technology is changing the nature of warfare and that if the U.S. armed forces do not embrace those changes, the United States will lose its military superiority and ability to protect its interests, if not its security. Thus, he seeks dramatic improvements in military capability.[3]

The Navy has recently begun to describe what transformation might mean for its forces.[4] But critics complain that the service has been slow to recognize the importance the Bush Administration places on transformation and that its efforts to date have been disorganized and lacking a clear direction or set of priorities.[5] Other observers take a very different view, arguing that the Navy has transformed itself in terms of capabilities and the ability to perform new missions, compared with what it could do 20 years ago. They also argue that the Navy's investment in communications and sensor technology, as well as the way it has operated over the past 30 years, represents a transformation that the Army and Air Force are only now discovering and trying to achieve. The implication is that either the Navy has done a poor job of explaining how it has already transformed itself or it does not recognize itself as already being transformed.[6]

Countering Antiaccess Threats

Although echoing some of the President's themes about transformation, the 2001 Quadrennial Defense Review focused on the need to defend U.S. global interests against regional opponents in the coming decades. The military's fear is that other countries whose interests conflict with the United States' will be able to buy advanced, yet relatively inexpensive, weapons that will make U.S. military action very costly. The weapons that the Navy worries about most are mines; antiship cruise missiles; small, fast attack boats; and diesel-electric submarines (especially those with closed-cycle, air-independent propulsion systems, which can remain underwater for weeks and are extremely quiet.)

If a country had enough of those weapons, it could implement what defense analysts call an asymmetric naval antiaccess or area-denial strategy. Such a strategy would not attempt to challenge and defeat U.S. naval forces directly. Instead, it would seek to inhibit the Navy's operations by strewing coastal areas with mines, putting hundreds of antiship cruise missiles along the shore or on small, fast boats, and having several quiet diesel-electric submarines hide in noisy coastal waters. One official Navy report states: "In future crises and conflicts . . . access-denial weapons could make the projection of U.S. power so costly that the United States might be deterred from acting."[7] Or, if the nation had to act anyway, such weapons could either prevent U.S. forces from prevailing or result in a Pyrrhic victory.

The 2001 QDR was explicit in saying that naval transformation must occur to defeat area-denial threats: "Antiship cruise missiles, advanced diesel submarines, and advanced mines could threaten the ability of U.S. naval and

2. Address by George W. Bush given at the U.S. Naval Academy, May 25, 2001. See also "Remarks by the President to the Troops and Personnel" (speech given at the Norfolk Naval Air Station, February 13, 2001); and "U.S. President George W. Bush Addresses the Corps of Cadets" (speech given at the Citadel, December 11, 2001).

3. Ibid.

4. See Department of the Navy, *Naval Transformation Roadmap: Power and Access . . . From the Sea* (2002).

5. See Gopal Ratnam, "Critics Question Depth of Navy's Sea Power Vision," *Defense News* (June 24, 2002), p. 12; see also Ronald O'Rourke, "Transformation and the Navy's Tough Choices Ahead: What Are the Options for Policy Makers?" *Naval War College Review* (Winter 2001).

6. See Norman Friedman, "Are We Already Transformed?" *Proceedings*, U.S. Naval Institute (January 2002), pp. 34-36; and Colonel Robert O. Work, USMC (ret), *The Challenge of Maritime Transformation: Is Bigger Better?* (Washington, D.C.: Center for Strategic and Budgetary Assessments, 2002).

7. Department of the Navy, *Vision . . . Presence . . . Power* (1999), p. 3.

amphibious forces to operate in littoral waters. New approaches for projecting power must be developed to meet these threats."[8]

Using Forward Presence for Deterrence

The 2001 QDR also stressed the importance of deterring conflict by keeping substantial, powerful U.S. forces deployed around the world. "Transforming the U.S. global military posture begins with the development of new ways to deter conflict. Deterrence in the future will continue to depend heavily upon the capability resident in forward-stationed and forward-deployed combat and expeditionary forces, including forcible entry forces, along with the rapidly employable capabilities that the U.S. military possesses throughout the globe."[9] The implication was that transformation should increase the military capabilities that the United States maintains overseas. That implication was made explicit in the subsequent Defense Planning Guidance, which directed the services to maintain forward presence in four theaters to dissuade potential adversaries from acting against the United States' interests and allies.

Transforming Technology

Another perspective on transformation is more general. It says that advances in technology—particularly communications, sensors, detection equipment, and precision weapons—provide an opportunity to create a smaller force with the same lethality and effectiveness as a much larger force.[10] In today's defense jargon, such advances allow the military to "mass effect, not forces." (For example, a stealthy bomber carrying 16 laser-guided bombs is likely to do more damage to a series of targets than 10 bombers carrying only conventional "dumb" munitions.)

Some advocates of naval transformation want to use developing technologies to better link sensors, computers, communications, and precision weapons into coherent networks so the Navy can engage enemies faster and more efficiently—thus projecting power more effectively, especially on land. Indeed, although the Navy characterizes many of its programs as being part of military "transformation," it emphasizes what it calls FORCEnet (also known as network-centric warfare) as one of the service's most important initiatives. FORCEnet is a technological effort that includes improvements in hardware and software to link all of the communication, sensor, and warfare systems of the Navy's ships so that every ship in a battle force has the same tactical data available. Thus, one ship's sensors might detect a threat, and even if that ship did not have the means to counter it, the threat could still be dealt with quickly because every other Navy ship operating in the area would know about it at the same time. If the FORCEnet effort succeeds, surface combatants, along with other Navy ships, may become more capable and effective than they are today.

Employing New Operating Concepts

Another way of thinking about naval transformation is to include different operating concepts that would allow the Navy either to provide a greater level of overseas presence or to reduce the number of platforms necessary to maintain the current level of presence. One such concept is to base more Navy ships overseas. The 2001 QDR explicitly included home-porting ships overseas as part of naval transformation.[11]

The Navy is pursuing some of those new operating concepts. It plans to base three attack submarines in Guam by early 2004. The Navy is also considering basing a cruiser/destroyer squadron there and possibly additional submarines.[12] Another option would be to use multiple, rotating crews on surface combatants to keep them

8. Department of Defense, *Quadrennial Defense Review Report* (September 30, 2001), p. 31. Other analysts voice the same viewpoint. See, for example, many of the publications issued by the Center for Strategic and Budgetary Assessments in Washington, D.C.

9. Department of Defense, *Quadrennial Defense Review Report*, p. 25.

10. Many Navy officials share that view of transformation. See also Friedman, "Are We Already Transformed?"

11. Department of Defense, *Quadrennial Defense Review Report*, p. 27. See also O'Rourke, "Transformation and the Navy's Tough Choices Ahead," pp. 103-104.

12. Statement of Rear Admiral Miles B. Wachendorf, U.S. Navy, Director, Strategy and Policy Division, before the Subcommittee on Seapower of the Senate Armed Services Committee, March 19, 2002.

deployed overseas for much longer periods than are now the case. As Chapter 2 discusses in more detail, the Navy began an experiment in the fall of 2002 that will rotate three crews from Spruance and Arleigh Burke class destroyers to one ship, with the objective of keeping the ship overseas for about 18 months, substantially increasing the time it spends on-station.

The Budgetary Implications of Transformation

The obvious question is whether the Navy's transformation efforts are expected to be accomplished under existing, smaller, or larger budgets. Some enthusiasts of transformation imply that a smaller, more effective force could also be a cheaper one.[13] Other advocates believe that transforming some parts of the Navy could free up resources to transform or enlarge other parts. Finally, some observers argue that transformation should not be achieved by reducing force structure.[14]

In the wake of the terrorist attacks of September 11, 2001, the idea of spending less money on the military has fallen out of favor. Moreover, the development of and transition to "transformational" technologies is proving expensive. Thus, although the long-term cost implications of military transformation are uncertain, a smaller defense budget may not result.[15]

The Current Surface Combatant Force

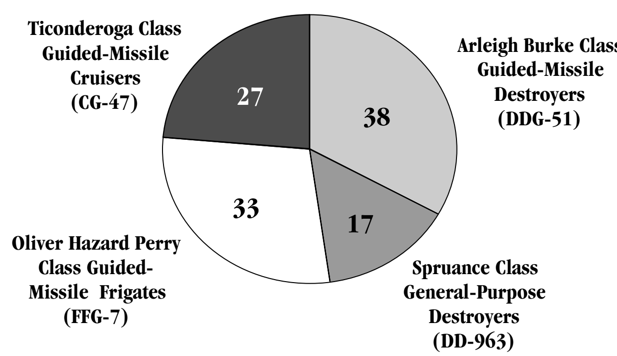
As noted above, the Navy's definition of surface combatants includes cruisers, destroyers, and frigates. (It used to include battleships, but they have been retired.) The service's proposed littoral combat ship, which would be smaller than a frigate, would also be defined as a surface combatant. That definition excludes aircraft carriers and amphibious ships as well as smaller vessels such as mine-warfare ships and patrol craft.

The four classes of surface combatant in active service represent the ultimate development of Cold War-generation ships. Designed for combat against the Soviet Navy in the open ocean, they comprise 17 Spruance class (DD-963) general-purpose destroyers, 33 Oliver Hazard Perry class (FFG-7) guided-missile frigates, 27 Ticonderoga class (CG-47) guided-missile cruisers, and 38 Arleigh Burke class (DDG-51) guided-missile destroyers (*see Figure 1*).

Figure 1.

Composition of the Surface Combatant Force, 2002

(Number of ships)



Source: Congressional Budget Office based on Navy data.

Seventeen Spruance class destroyers remain from an original Cold War production run of 31 ships. Each one carries two 5-inch naval guns, a formidable open-ocean antisubmarine-warfare suite, two helicopters, short-range antiship missiles, and a short-range antimissile system (*see Table 1*).[16] As the first of the final Cold War generation of surface combatants, Spruance destroyers introduced many technologies and systems that have been used on subsequent combatants, including a gas-turbine propul-

13. See, for example, the discussion in O'Rourke, "Transformation and the Navy's Tough Choices Ahead," p. 98.

14. For an overview of those schools of thought, see O'Rourke, "Transformation and the Navy's Tough Choices Ahead." See also James R. Blaker, *Understanding the Revolution in Military Affairs: A Guide to America's 21st Century Defense,* Defense Working Paper No. 3 (Washington, D.C.: Progressive Policy Institute, January 1997).

15. See Congressional Budget Office, *The Long-Term Implications of Current Defense Plans* (January 2003), and *Budgeting for Defense: Maintaining Today's Forces* (September 2000).

16. Most of the information in this and the subsequent paragraphs of this section was taken from Norman Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet* (Annapolis, Md.: Naval Institute Press, 2001).

Table 1.

Characteristics of Current and Proposed Surface Combatants

Ship Class	Type	Displacement (Tons)	Crew Size	Range at 20 Knots (Nautical miles)	Armament	Missions
			Current Ships			
DD-963 Spruance	General-purpose destroyer	9,300	Up to 375	6,000	Two helicopters, two 5-inch guns, eight Harpoon antiship missiles, 61 VLS cells	Land attack, open-ocean antisubmarine warfare
FFG-7 Oliver Hazard Perry	Guided-missile frigate	4,100	221	4,200	Two helicopters, one Mark 13 launcher and magazine with 40 self-defense missiles, one 76-mm gun, six torpedo tubes	Convoy escort, maritime interception, open-ocean antisubmarine warfare
CG-47 Ticonderoga	Guided-missile cruiser	9,500	Up to 410	6,000	Aegis combat system, two helicopters, two 5-inch guns, 122 VLS cells[a]	Long-range air and missile defense, land attack, open-ocean antisubmarine warfare
DDG-51 Arleigh Burke (Flight I/II)	Guided-missile destroyer	8,400	340	4,400	Aegis combat system, one 5-inch gun, eight Harpoon antiship missiles, 90 VLS cells	Long-range air and missile defense, land attack, open-ocean antisubmarine warfare
DDG-51 Arleigh Burke (Flight IIA)	Guided-missile destroyer	9,200	340	4,400	Aegis combat system, two helicopters, one 5-inch gun, 96 VLS cells	Long-range air and missile defense, land attack, open-ocean antisubmarine warfare
			Proposed Ships[b]			
DD(X)	General-purpose destroyer	16,000	95 to 200	N.A.	Two helicopters, two 155-mm advanced gun systems, 128 VLS cells	Land attack, antisubmarine warfare
Littoral Combat Ship	Focused-mission combatant	3,000	N.A.	N.A.	One helicopter, one mission module	Counterboat, countermine, littoral antisubmarine warfare
CG(X)	Guided-missile cruiser	16,000 or more	N.A.	N.A.	Next-generation air and missile defense combat system, 200 VLS cells, two helicopters, possibly other systems	Long-range air and missile defense, land attack

Source: Congressional Budget Office.

Note: VLS = vertical launch system; mm = millimeter; N.A. = not available.

a. The first five ships of the class, CG-47 to CG-51, do not have VLS cells.
b. Many of the characteristics of these ships represent estimates published in media reports or CBO assumptions based on conversations with Navy officials.

sion system and a digital antisubmarine-warfare combat system. The Spruances were later modernized with an antiship missile capability, and 24 of them received the vertical launch system (VLS)—composed of easy-to-maintain groups of launcher "cells" inside a ship's hull—to fire Tomahawk cruise missiles at targets on land. All of the ships still in service are equipped with 61 VLS cells. The oldest Spruance in the active-duty fleet is 27, and the average age of the active ships is 22. Their notional expected service life is 35 years.

The second class of the Cold War family of surface combatants was the Oliver Hazard Perry guided-missile frigate. Thirty-three of those ships remain in commission (out of 51 built for the Navy), including eight assigned to the Naval Reserve.[17] Those ships were designed to help defend sea lines of communication—essentially to serve as convoy escorts—during the Cold War. They carry 40 local air-defense and antiship cruise missiles, fired by two single, above-deck launchers; a rapid-fire cannon; two helicopters and a towed-array sonar system; and a terminal missile-defense gun—all of which provide useful combat capabilities for less stressful naval missions. The age of the oldest Perrys still in commission is 23, and the average age of the class is 19. Their notional expected service life is 35 years. As one reference work puts it, "The soundness of the design has permitted the expansion [of capabilities], and the ships have proven remarkably sturdy."[18]

Ticonderoga class cruisers use the same hull design as Spruance class destroyers, but they carry a much more formidable combat system. They are multimission ships capable of conducting antisubmarine warfare, antiship operations, land attack, and especially long-range air defense for a group of ships. They were the first U.S. surface combatant to be equipped with the Aegis combat system, which was and is the most advanced antiaircraft/antimissile warfare system in the world. The first five Ticonderogas do not have VLS cells. Instead, they carry two above-deck twin-missile launchers fed by below-deck rotary missile magazines, which hold a total of 88 antiair and antisubmarine missiles. The remaining 22 Ticonderoga class ships, sometimes referred to as Improved Ticonderogas, have 122 VLS cells capable of firing a variety of weapons, including Tomahawk land-attack missiles. The first ship of this class was commissioned in 1983, making the oldest Ticonderoga 20 years old. The average age of the class is 14. Its notional expected service life is 35 years.

Arleigh Burke class guided-missile destroyers are the second warship designed to carry the Aegis combat system. They are the newest surface combatants in the fleet. Their hull form differs from that of the Spruances and Ticonderogas, and they have a faceted superstructure that reduces their radar cross section to one-tenth that of a Ticonderoga class cruiser. The 38 Arleigh Burkes now in commission are divided among three groups, or "flights":

- Flight I, the earliest set, comprises 21 ships, each equipped with 90 VLS cells. Although ships of this type have a flight deck on which a helicopter can land, and most are equipped to refuel and rearm a helicopter, they have no hangar and thus would not normally be deployed with a helicopter.

- Flight II comprises seven ships that incorporate several combat system improvements. Flights I and II are sufficiently similar that they are normally grouped together.

- Flight IIA comprises 10 ships. They are somewhat larger than previous Arleigh Burkes to accommodate a hangar for helicopters, which would be deployed with the ships. They also have 96 VLS cells and employ more-sophisticated combat systems and radars than earlier flights do.

As of this writing, another 24 Arleigh Burkes are being built, have been authorized, or may be authorized between now and 2005, for a total planned production run of 62 ships. However, if the Navy experiences problems in developing its proposed DD(X) destroyer, it will almost certainly lengthen production of Arleigh Burkes to support the two shipyards that build surface combatants. The first Arleigh Burke was commissioned in 1991, and the average age of the class is only 5. The ships have a notional expected service life of 35 years.

17. Additional ships were built for foreign navies.

18. A.D. Baker III, *The Naval Institute Guide to Combat Fleets of the World, 2002-2003: Their Ships, Aircraft, and Systems* (Annapolis, Md.: Naval Institute Press, 2000), p. 965.

Evolving Roles and Missions of Surface Combatants

In the past quarter century, surface combatants have already undergone a transformation in their capabilities. Early Cold War cruisers and destroyers generally carried mostly defensive weapons—surface-to-air missiles and antisubmarine rockets—to screen higher-value ships (such as aircraft carriers) and merchant vessels from attack. They also supported amphibious forces with naval gunfire. Today, surface combatants can and still do carry out those missions, but they have also taken on new roles and perform some of their old ones in fundamentally different ways.

Probably the three biggest improvements in the design of surface combatants in recent decades were the Aegis combat system, the vertical launch system, and long-range Tomahawk missiles. The Aegis system—which includes a powerful multifunction, phased-array (fixed-antenna) radar, fire-control directors, computers, displays, and power sources—gives a cruiser or destroyer the capability to defend an entire battle group against aircraft and missiles. The system can track hundreds of air targets up to 200 nautical miles, and because it can update the target data sent to its missiles in flight, it does not have to guide them continuously after launch. As a result, Aegis-capable ships can attack as many as 20 targets simultaneously—a vast improvement over previous antiair-warfare systems. The Aegis system is also less prone than its predecessors to jamming or to electronic countermeasures, and it is effective against sea-skimming antiship missiles. In short, the Aegis system enhances the capabilities not only of the ships that carry it but also of their entire battle group, because it provides for long-range detection, is capable of longer-range interception, and is less susceptible to saturation raids than previous combat systems.

The vertical launch system also created a revolution of sorts in the combat capabilities of surface combatants, for several reasons. First, the system uses space efficiently. The five Ticonderoga class cruisers without VLS cells can carry 88 missiles apiece in their magazines for use by their two twin-missile launchers. Ticonderogas with the VLS can carry 122 missiles in their 122 cells, a nearly 40 percent improvement. Second, the system can be easily converted from an offensive system to a defensive one depending on what type of missile is loaded into the cell. Third, the VLS itself is a relatively low-maintenance weapon system that requires little training to operate. Finally, the VLS cells nestled in the center of a ship below the deck line are less susceptible to battle damage than above-deck launchers are. (Even small hits on those launchers will essentially eliminate a ship's combat effectiveness.)

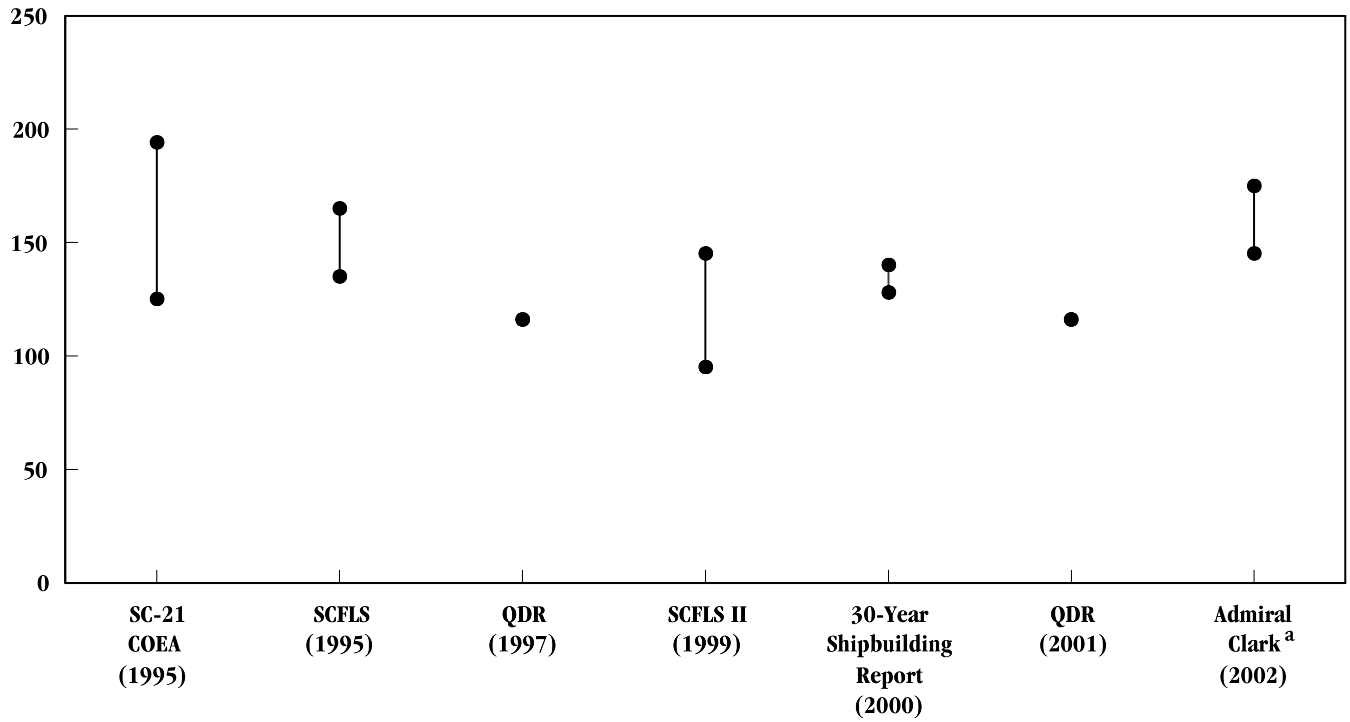
The third major improvement, Tomahawk missiles, have provided surface combatants with the capability to conduct long-range strike (or land-attack) operations. In the past, a surface combatant's ability to hit targets on land was limited to the range of its guns (27 nautical miles for the 16-inch guns of Iowa class battleships and 13 nautical miles for the 5-inch guns on modern warships). The development of Tomahawk missiles and VLS cells has given surface combatants the ability to strike targets 700 miles inland—farther than the range of carrier-based aircraft (unless they are refueled in flight). The VLS/Tomahawk combination also allows ships to launch missiles quickly. A surface combatant armed only with Tomahawks could fire its entire complement within minutes if an operation demanded it. A new version of the Tomahawk missile just beginning production is expected to double the weapon's range and provide additional improvements. (Other land-attack missiles, which would be compatible with the VLS, are also being developed.)

In short, the combination of the VLS and Tomahawk has vastly improved the land-attack capabilities of surface combatants. Into the 1980s, not one of the Navy's cruisers, destroyers, or frigates could strike targets more than 13 miles inland. Today, 82 surface combatants have long-range strike capabilities.

The missions of the surface combatant force may evolve further in the future. With improvements to their radars and missiles, cruisers and destroyers may be able to provide ballistic missile defense within a theater and, possibly, play a role in national missile defense. Such changes could require the development of larger ships to accommodate more-sophisticated radars and larger, faster intercept missiles. Other types of ships, smaller than any in the current force, might also be necessary to fulfill missions that surface combatants already perform and will still be required to carry out 30 years from now.

Figure 2.

The Number of Surface Combatants the Navy Needs, According to Various Sources



Source: Congressional Budget Office.

Note: SC-21 COEA = Surface Combatant 21 cost-effectiveness analysis; SCFLS = Surface Combatant Force Level Study; QDR = Quadrennial Defense Review.

a. Admiral Vernon Clark, Chief of Naval Operations.

Stated Requirements for Surface Combatants

An essential question in this analysis is, How many surface combatants does the Navy need? The service has not answered that question definitively or consistently. Furthermore, the answer depends on responses to other, related questions. What does the Navy want to do with its surface combatants? Does it need larger numbers of smaller, less-capable platforms, or should it buy fewer but more-capable platforms? Finally, will the Navy continue to operate its surface combatants as it has in the recent past—that is, by basing them in the United States and deploying them only about once every two years?

Studies by the Department of Defense and the Navy over the past 10 years have produced various estimates of the required number of surface combatants (*see Figure 2*). One analysis of that issue, the Surface Combatant Force Level Study, published in August 1995, stated that the Navy needed 135 to 165 surface combatants to meet wartime requirements.[19] That conclusion was based on an extensive war game in which U.S. forces fought two major theater wars (in Northeast Asia and the Persian Gulf) at the same time. The figure of 165 represents "peak demand" for surface combatants 30 to 80 days into a conflict, assuming no assistance from allies. If nations friendly to the United States are assumed to contribute 30 ships to the fight, the total wartime requirement falls to 135 surface combatants.

19. Office of the Chief of Naval Operations, Director, Surface Warfare, *Surface Combatant Force Level Study: Requirements for Joint Warfare* (August 1995).

Two years later, however, the 1997 QDR concluded that the Navy should operate only 116 surface combatants. The report did not provide much information about how that figure was determined, but 116 was the number of surface combatants in the fleet at the time. The subsequent QDR, in 2001, did not discuss specific requirements for forces but stated that the current force levels, set by the 1997 QDR, would be the base from which transformation would occur.

In 1999, the Navy completed the Surface Combatant Force Level Study II. It was intended to update the 1995 analysis and provide an authoritative statement of the Navy's requirements for surface combatants. That study was never released (because of the start of the 2001 QDR), but press reports indicate that it concluded that 95 surface combatants would be necessary to meet peacetime requirements in 2015, whereas 145 would be needed to fight simultaneous major theater wars in the Persian Gulf and Northeast Pacific.[20]

In June 2000, the Secretary of Defense released the *Report on Naval Vessel Force Structure Requirements* (also known as the 30-Year Shipbuilding Report), whose completion the Congress had mandated in the 2000 defense authorization act.[21] That report argued that naval forces were in high demand and that the 1997 QDR force was being heavily tasked. To reduce the risks posed by growing operational demands, the report advocated a 10 percent to 15 percent increase in the number of surface combatants, apparently to support a proposed increase in the number of aircraft carriers from 12 to 15.

Today, the Navy is again reevaluating its requirements for surface combatants, primarily because of the war on terrorism, pressure from the Bush Administration to transform the current fleet, and the new forward-presence posture outlined in the most recent Defense Planning Guidance. In the judgment of the Chief of Naval Operations, Admiral Vernon Clark, the Navy would need a fleet of at least 375 ships, including 30 to 60 littoral combat ships, to meet all of its requirements.[22] Under the Navy's evolving future concept of operations, the surface combatant part of that 375-ship Navy would amount to 160 ships. (For a more detailed explanation of what a 375-ship Navy might look like, *see Box 1*.)

The Navy's Plan for Transforming the Surface Combatant Force

The uncertainty about how many surface combatants the Navy needs reflects uncertainty about the proper size and scope of transformation from older to newer generations of ships. How quickly will anticipated antiaccess or area-denial threats evolve? Does the Navy need to transform only a few of its platforms or its entire force structure to counter those threats? More important, to what extent should the focus of transformation be on capabilities or numbers of ships?

Prominent members of the Bush Administration have stated that the emphasis in any modernization program needs to be on capabilities.[23] They appear to be saying that what is required is a set of capabilities to achieve certain tasks. If those capabilities can be provided by a smaller number of platforms, so be it. Others, including Navy officials and Members of Congress, have argued that numbers matter and that the Navy needs to buy more ships and have a larger fleet.

The Navy's plan for transforming the surface combatant force reflects that tension between capabilities and numbers. Over the next five years, the Navy intends to retire some older surface combatants before the end of their notional service life, cutting the fleet in the short term, even though stated requirements and Navy officials have

20. See Robert Holzer, "Requirements Rise May Force Larger U.S. Warship Fleet," *Defense News* (May 24, 1999), p. 1; and Roman Schweizer, "New Surface Ship Force Level Study Evaluates Future Capabilities, Needs," *Inside the Navy* (May 10, 1999), p. 1.

21. Secretary of Defense William Cohen, *Report on Naval Vessel Force Structure Requirements* (June 26, 2000).

22. See Dale Eisman, "Navy Leader Makes Case for New Ships Designed to Speed Quietly to Hot Spots," *Virginian-Pilot* (May 2, 2002); Kerry Gildea, "Clark Estimates Future Naval Fleet at 375 Ships," *Defense Daily* (February 19, 2002), p. 9; and Andrew Koch, "USN Pushes Littoral Combat Ship," *Jane's Defence Weekly* (January 23, 2002).

23. For example, see Ron Laurenzo, "Wolfowitz: U.S. Must Focus on Capabilities," *Defense Week* (February 25, 2002).

Box 1.

Force Structure Under the Navy's New Operational Concept

The Navy recently began to rethink how it will use and deploy its warships. Today, the Navy's principal groups of ships are 12 aircraft carrier battle groups, 12 amphibious ready groups, and seven surface action groups (which are designated for use in the Middle East). Attack submarines deploy either with one of those groups or independently. Amphibious ready groups usually do not operate with surface combatants; thus, they generally are not capable of performing strike operations.

Under its new Global Concept of Operations (or Global CONOPs), the Navy would juggle its surface combatants to create more "strike groups." In the past, six surface combatants were notionally assigned to a carrier battle group. Actual deployments could see four to eight. The Global CONOPs would reduce that number to three. It would also assign three surface combatants to the amphibious ready groups to create 12 "expeditionary strike groups" (the first of which has already been deployed) and create two additional surface action groups. The four Trident submarines that the Navy is converting to perform conventional strike and special-operations missions would each constitute an independent strike force. Thus, the Global CONOPs would produce a total of 37 strike groups.

That operational concept would more evenly balance the Navy's strike capability across the fleet and allow the Navy to have strike presence in all four theaters called for in the Defense Planning Guidance. The new expeditionary strike groups would have the ability to perform missions that in the past could be handled only by a carrier battle group. The defensive capabilities of surface combatants would permit the groups' amphibious ships to operate in more-hostile environments, and the Tomahawk missiles on surface combatants would provide long-range strike capability. New DD(X) destroyers, with their 155-millimeter guns, would be assigned to the expeditionary strike groups, providing a shorter-range strike capability as well as fire support for the Marine Corps.

According to the Navy, implementing that concept would require 375 ships, including 160 surface combatants. The 33 surface-ship strike groups would need three cruisers or destroyers each, plus five more mostly for wartime surge, for a total of 104 cruisers and destroyers. In addition, the Navy plans to buy 56 littoral combat ships, many of which would work with the strike groups, protecting them from mines, submarines, and small boats. The rest of the Navy's fleet would comprise 12 aircraft carriers, 37 amphibious ships, 55 attack submarines, four converted Trident submarines, 14 ballistic missile submarines, and 93 logistics, countermine, and support ships.

Not all observers would agree that the Global CONOPs represents transformation. After all, the Navy has employed surface combatants with amphibious ready groups in the past, albeit not on a regular basis. However, if the Navy does reduce the number of surface combatants associated with carrier battle groups to create more strike groups, it will be organizing the fleet in a way that provides the flexibility and forward presence stressed in the 2001 Quadrennial Defense Review and the Defense Planning Guidance. Such reorganization also provides a justification for buying more ships and creating a larger force structure.

called for more, not fewer, ships. After that, however, it would develop and deploy large numbers of a family of next-generation ships: the big multimission DD(X) class destroyer, a small "focused-mission" ship called the littoral combat ship (LCS), and a large multimission cruiser known as the CG(X). By 2025, the Navy's plan would result in a surface combatant force that was not only 40 percent larger than today's force but much more capable than the current Cold War generation of ships.

Retiring Spruance Class Destroyers Early

The Navy plans to retire its 17 remaining Spruance class destroyers by 2006 rather than keep them in service to the end of their notional life of 35 years. On decommissioning, those ships will average only 24 years of service. The Navy is retiring the still-capable destroyers early to save money: with a crew of 380 and the oldest technology of Cold War-generation ships, Spruances are more expensive to operate and maintain than most of the Navy's other surface combatants (*see Table 2*). Eliminating those ships would save an average of about $600 million per year in operating and support costs.

Table 2.

Annual Operating Costs for Present and Future Classes of Navy Ships

Ship Class	Millions of 2003 Dollars
Current Operating Costs	
DD-963 Spruance Destroyer	34
FFG-7 Oliver Hazard Perry Frigate	19
DDG-51 Arleigh Burke Destroyer	26
CG-47 Ticonderoga Cruiser	35
Estimated Operating Costs Based on Cost Goals	
DD(X) Future Destroyer	20
Littoral Combat Ship	14
CG(X) Future Cruiser	27

Source: Congressional Budget Office using data from the Navy's Visibility and Management of Operating and Support Costs (VAMOSC) database.

Note: Operating costs for ships not yet deployed represent CBO estimates based on the Navy's manning and cost thresholds for those vessels. Operating costs for the CG(X) are based on the same goals as those for the DD(X).

Some Navy officials also regard Spruance class destroyers as unreliable and more prone to unexpected breakdowns than any other surface combatant. Various engineering systems are said to be particularly unreliable. The Navy argues that retaining Spruances for their full service life would require upgrading those systems as well as some of the ships' combat systems, at a cost of $50 million to $100 million per ship. That approach would be similar to the upgrades that the Navy performed on Leahy and Belknap class cruisers in the 1980s, which it retained in the fleet until the early to mid-1990s.

Keeping Spruances running for a total of 35 years would cost an average of $45 million a year per ship for needed upgrades and operations. As a matter of relative cost, that would make keeping Spruances in service cheaper than building new destroyers, and somewhat more expensive than building the as-yet-undesigned littoral combat ship. The equivalent costs are about $60 million a year for a new Arleigh Burke class destroyer and about $30 million a year for the littoral combat ship, CBO estimates.[24]

Clearly, Spruances are much less capable than newly built guided-missile destroyers. They lack the Aegis air-defense system and carry one-third fewer VLS cells. But a better comparison of their capabilities would be with the new littoral combat ship. A modernized Spruance would have two naval guns, 61 cells for land-attack missiles, and two helicopters; as a result, its self-defense and antisubmarine-warfare capabilities could prove equal to those of the smaller LCS. However, Spruances would be larger and much less stealthy than the LCS, so the latter could prove to be more survivable against modern threats in coastal regions, although that is by no means certain.

Improving Ticonderoga Class Cruisers and Oliver Hazard Perry Class Frigates

In contrast to its plan for Spruances, the Navy wants to upgrade the combat systems, habitability, and machinery of Ticonderoga class cruisers and Oliver Hazard Perry class frigates so that those ships will be useful throughout their notional service lives or longer. The cruisers will receive especially extensive improvements that will, in some cases, change their mission.

According to the 2003 Future Years Defense Program (FYDP), the Navy was planning to upgrade all 27 Ticonderoga class cruisers. Fourteen, including the five oldest ships, would be outfitted with improved fire-control systems, radars, and self-defense systems, and their guns would be converted to the 5-inch, 62-caliber design capable of firing extended-range guided munitions. In addition, the first five ships of the class, which have above-deck launchers, would have the VLS installed (the first two would receive 64 cells, and the other three would get 128). The remaining 13 Ticonderogas would receive many of the same improvements in radars, computers, and self-

24. Those cost estimates do not include the normal midlife upgrades to combat and engineering systems that would be necessary to employ ships for their full service life—35 years for destroyers and (CBO assumed) 25 years for littoral combat ships.

protection systems, as well as better missiles and even more advanced radars in order to perform theater ballistic missile defense. In the 2004 FYDP, however, the Navy has altered its conversion plan for Ticonderogas: it proposes canceling the upgrades to the first five ships and retiring them early.[25]

The Navy argues that by updating the combat systems of Ticonderogas, it will extend their useful service life to as much as 40 years. Doing so, however, implies a substantial overlap between that cruiser conversion effort and the program to build a new cruiser, the CG(X) (discussed later). If the Navy upgraded all 27 Ticonderogas, the first one would not retire until 2023, four years after the Navy wants to commission the first CG(X). If the Navy reduced its requirement for cruisers to 22 by retiring the first five Ticonderogas early, all 22 would remain in the fleet until 2026, when the first of them would retire. For this analysis, CBO assumed that under the Navy's 160-ship plan, the upgraded Ticonderogas would serve for 35 years. (CBO's options, however, take advantage of the Navy's estimate of a 40-year service life for upgraded Ticonderogas.)

The Navy also plans to upgrade its Oliver Hazard Perry class guided-missile frigates. To maintain the operational effectiveness of those ships until the last ones retire (in 2018), the Navy wants to improve their engineering, habitability, and combat systems. According to the 2003 FYDP, the Navy plans to spend about $200 million over five years to, among many other things, replace engines, install osmosis units, upgrade the Close-In Weapons System, and incorporate the Nulka decoy system on about half of those ships. (Those last two upgrades would improve the frigate's self-defense capabilities.) The Navy plans to increase spending in later years to upgrade all of the Perrys. CBO estimates that the costs to upgrade all of the frigates would total about $360 million, or slightly more than $10 million per ship.

Developing Future Surface Combatants

Under the Navy's plans, the next generation of surface combatants would comprise three new ships: the DD(X) destroyer, the littoral combat ship, and the CG(X) cruiser. Like the Cold War generation of surface combatants, the new generation would have several different ships to fulfill different missions, but they would share as many technological and design elements as possible to reduce costs.[26] The principal difficulty in evaluating that effort is that the Navy is still unclear about what missions it wants the different ships to perform, how many of each type it needs, or even what their capabilities would be.[27]

The DD(X) Destroyer. At the direction of the Bush Administration, the Navy canceled the DD-21 Land Attack Destroyer program on November 1, 2001. In its place, the DD(X) program was established, which outlined the Navy's vision for a new generation of surface combatants, to include the DD(X) destroyer, the littoral combat ship, and eventually the CG(X) cruiser. Although the DD-21 program consisted of 32 ships, it is not yet clear how many DD(X)s would be bought. As of this writing, the Navy appears to have settled on 16—one each for the 12 planned expeditionary strike groups in the Navy's Global Concept of Operations (see Box 1) and four more for wartime surge capability.

Furthermore, how much the new destroyers might cost is uncertain. The Navy had hoped that by the fifth DD-21 in the production run, that ship would have cost less to procure than an Arleigh Burke class guided-missile destroyer, which costs about $1.2 billion per ship when buying them at a rate of two per year. But if the Navy bought only half as many DD(X)s at a rate of two per year, it would be unlikely to achieve that goal. On the basis of information from the Navy about how much it expects the first DD(X) to cost (excluding nonrecurring design elements), CBO estimates that the new destroyer would have a price tag of about $1.9 billion per ship, on average, for a 16-ship run. In contrast, the Administration esti-

25. David Brown, "Five Ticos in the Trash?" *Navy Times* (July 8, 2002), p. 14.

26. In the Navy's current generation of surface warships, Spruance class destroyers and Ticonderoga class cruisers share the same hull, and the cruisers and Arleigh Burke class destroyers share the same propulsion system and have similar combat systems.

27. For a thorough summary of the program, see Ronald O'Rourke, *Navy DD(X) Future Surface Combatant Program: Background and Issues for Congress*, CRS Report for Congress (Congressional Research Service, May 10, 2002).

mates that the eight DD(X)s included in the 2004 FYDP would cost an average of $1.3 billion apiece. (For a detailed explanation of CBO's cost estimates for future surface combatants, see the appendix.)

Because the DD(X) destroyer would borrow much from the DD-21 program, more is known about it than about the other two ships in the new generation. Like the DD-21, the DD(X) is intended to be a multimission ship, emphasizing land attack. It would carry one or two new 155-millimeter (mm) advanced gun systems developed for the DD-21, each of which can hurl rocket-assisted precision-guided projectiles to ranges of 100 miles. It would also have a VLS battery of up to 128 cells capable of firing various land-attack and self-defense missiles, a large helicopter hangar, and a new integrated undersea-warfare suite. The DD(X) would also be able to operate boats or unmanned vehicles from a special boat ramp.

The DD(X)'s final combat capability would be determined primarily by its size. The DD-21 was supposed to be an extremely large combatant—upward of 16,000 tons—primarily because of two big advanced gun systems and large 600- to 750-round magazines and because of the need to increase its stealthiness. If the Navy decided to reduce the size of the DD(X), it would lose one of the gun systems and decrease the number of VLS cells. However, it is unclear how a smaller number of reduced-capability DD(X)s could meet the operational requirements set forth in the DD-21 program. Producing more DD(X)s would be one option, but that clearly would not be as cost-effective as the current plan.

Much like the role that the Spruance class destroyer played in the current generation of surface combatants, the DD(X) is intended to be the "pathfinder" for technologies that would be used in all subsequent ships of the next generation. Three of those technologies are especially significant.

First, the Navy wants to equip the DD(X) with an all-electric power-distribution and propulsion system instead of the gas-turbine systems on the current generation of surface combatants. That new system would allow a ship to use power far more efficiently. Gas-turbine-powered surface combatants devote most of the power they generate to propulsion, and they cannot easily redirect that power to other purposes. If the technical challenges can be overcome, an all-electric system will be able to divert power effortlessly from propulsion to weapons and back again, paving the way for the development of shipboard, electrically powered weapons, such as lasers or long-range electromagnetic guns.

Second, the DD(X) is intended to incorporate new hull forms, materials, conformal antennas (antennas embedded directly in the skin of a ship), and other design features to give the ship a very small radar cross section, as well as low magnetic, acoustic, and infrared signatures. Those "stealth" features are designed to decrease the ship's detectability and increase its survivability.

Third, the DD(X) is supposed to introduce a host of automatic advances, especially in the area of damage control. The Navy hopes that such advances will eventually allow it to operate the new destroyers with a 70 percent smaller crew than those of today's destroyers.

In addition to expressing skepticism about the Navy's ambitious cost and crewing goals for the DD(X), critics raise other questions about the program. First, it is not apparent why the DD(X) needs to be as stealthy as the Navy wants. Under the new Global Concept of Operations (or Global CONOPs), the smaller littoral combat ship would be the first to penetrate an opposing country's antiaccess network and defeat diesel submarines, mines, and swarms of small missile attack boats that would threaten successive U.S. forces. If that was true, the majority of threats facing the DD(X) would already be dealt with before it moved closer to shore, perhaps eliminating the need to greatly reduce its acoustic and magnetic signatures. Decreasing the DD(X)'s radar cross section would still seem to make sense since an enemy could engage ships close to shore with long-range antiship cruise missiles launched from far inland. But would the DD(X) need to be substantially stealthier than the Arleigh Burke destroyer, which is itself much stealthier than the Ticonderoga cruiser?

A second criticism of the DD(X) program involves its emphasis on land attack. Any surface combatant equipped with the vertical launch system is capable of land attack, and the Navy already has more VLS cells than it can afford to fill with missiles (which is one reason that it feels it can part with Spruance class destroyers). The DD(X)'s new advanced gun system would differ from current guns and have a much greater range and payload, offering the Marines better naval gunfire support. But CBO is unaware of any analysis that explains why the 63-mile extended-range guided munition—which can be fired from upgraded 5-inch, 62-caliber guns and provides five times the range of older 5-inch guns—is not sufficient for naval gunfire requirements, especially since the last large amphibious assault conducted by the United States occurred during the Korean War.

Using a stealthy ship to provide naval gunfire would not seem to make sense because, to get the most out of its range capabilities, the ship would have to operate close to shore, where it would be detectable. (Stealth is discussed in greater detail in Chapter 2.) If the threats that limited the DD(X)'s close-in operations had been eliminated, a less stealthy ship equipped with 155-mm guns, perhaps one based on a commercial design, would serve equally well. (Such a ship would essentially be a gun barge—an off-shore floating platform to provide gunfire support so that Marine Corps units would not have to carry as much artillery with them.)

The Littoral Combat Ship. As noted above, the DD-21 program was intended to consist of 32 ships, for a steady-state surface combatant force of 116 ships. In effect, the DD(X) program and the Global CONOPs modified that plan to include 16 DD(X) destroyers and 56 littoral combat ships, for a steady-state force of 160 surface combatants. Under the 2004 FYDP, the Navy plans to order the first LCS in 2005 and eight more by 2009.

The Navy has yet to answer many questions about the LCS, primarily because the ship is still in the very early stages of design and development. However, Navy officials have stated that the LCS would be much smaller and faster than the DD(X) and would be a focused-mission ship rather than a multimission or single-mission ship. In other words, the LCS would be designed modularly so that it could be reconfigured fairly quickly to perform one of three distinct missions: finding and sinking quiet diesel submarines operating in crowded, noisy, and shallow coastal waters; finding and neutralizing mines; and countering swarm attacks by small, high-speed boats armed with missiles.

Navy officials have begun to characterize the LCS as a kind of "truck" capable of carrying various cargoes. The truck—consisting of the ship's hull, propulsion plant, crew quarters, and basic defensive combat systems—would be developed and acquired separately from its three associated mission packages, or modules. The operators of the truck and the modules would train separately, probably on shore or on designated training vessels. When an LCS was slated to deploy, whichever mission package was called for would be pulled, put on the truck, and sent to sea.

Vice Admiral Phillip Balisle, head of Naval Sea Systems Command and the former head of surface warfare for the Chief of Naval Operations, used the analogy of an aircraft carrier and its air wing to describe that LCS concept, calling the carrier a "hollow" platform until the air wing comes aboard.[28] That analogy seems a bit misplaced, however. Throughout an aircraft carrier's training cycle (which lasts between 12 and 18 months prior to a six-month deployment), the air wing is assigned to the carrier and trains with it. Perhaps a better analogy, which some Navy officials have used in discussions with CBO, is the helicopter detachment routinely assigned to a surface combatant before deployment. Although a helicopter detachment trains with the surface combatant to which it has been assigned, it is more flexible in that it can be assigned to a different ship at the last minute, if necessary. The detachment can even be transferred to another ship during deployment if a mission requires it. Neither of those options is possible with a carrier air wing.

Even that analogy, however, does not quite capture what Navy planners are suggesting for the littoral combat ship. Traditionally, the captain of a surface combatant "fights" the ship, employing all of the weapons and systems at hand. The commander of a helicopter detachment is just another department head on a surface combatant, answering to the ship's captain. But who would "fight" the LCS—the truck driver or the mission-module commander? Which of them would be ultimately responsible for the safety of the ship? The mission commander could be expected to take the lead because only he or she would

28. Vice Admiral Phillip M. Balisle, "Transforming the 21st Century Surface Navy," *Armed Forces Journal International* (September 2002).

Box 2.

The Role of Helicopters in Countering Area-Denial Threats

Helicopters are the essential weapon system on a surface combatant for defeating the threats posed by small, quiet submarines; swarms of small boats; and mines. Unmanned aircraft may perform those missions in the future, but in the next 15 to 20 years—perhaps longer—they are unlikely to replace the vital capability provided by helicopters. Most of the Navy's current surface combatants are capable of embarking a medium-sized helicopter (the H-60 series by Sikorsky). Only the Flight I/II Arleigh Burke destroyers cannot accommodate a permanent helicopter detachment, although they could support one for a few days at a time.

Helicopters use a variety of sensors, including dipping sonar, to detect a submarine. That information is transmitted to the surface combatant for processing. If a target is identified and needs to be engaged, the job can be done either by the helicopter (using antisubmarine torpedoes) or by the surface combatant (using torpedoes or antisubmarine rockets). Even if the helicopter cannot get a precise enough fix on a submarine to target it with a weapon, the helicopter's presence may force the sub to become still and quiet, thereby thwarting its mission. Or the submarine may try to run, in which case the superior dash speed of the helicopter will allow it to keep after the submarine, forcing the sub to run down its batteries. Particularly in shallow water, a helicopter can fight submarines more effectively and with less risk than a surface combatant with its own sonar systems can do by itself.

Helicopters are also effective in countering swarms of small boats by virtue of their speed and armament. As a general rule of thumb, something trying to intercept a small, fast boat needs to be about 50 percent faster than its target. Thus, destroying a boat traveling at 80 knots requires the interceptor to have a speed of at least 120 knots. Only a helicopter, which can travel in excess of 120 knots, provides enough speed to ensure a tactical advantage. Furthermore, helicopters can destroy those targets with their substantial payloads of missiles (such as the Hellfire) and heavy-caliber machine guns. For example, in the Battle of Bubiyan Channel during the Gulf War, two groups of allied helicopters annihilated two convoys of Iraqi fast-attack craft without any loss to themselves or allied shipping.[1]

Helicopters are arguably less essential for mine clearing, the only one of the three missions discussed here for which unmanned underwater and surface vehicles can also be used effectively. However, it will take years for the Navy to finish developing and acquiring such remote mine-hunting systems.

1. Robert Gardiner and Norman Friedman, *Navies in the Nuclear Age: Warships Since 1945* (Annapolis, Md.: Naval Institute Press, 1995), pp. 105-107.

have the expertise to "fight" the ship. But how that would work in actual combat situations is not clear—especially if the truck driver remained responsible for the safety of the ship and its crew.

Another key unknown about the LCS is its ultimate size and configuration. Reports suggest that the Navy is exploring designs that range in size from as little as 300 tons of displacement to as much as 5,000 tons. (By comparison, an Oliver Hazard Perry frigate displaces about 4,000 tons.) Most reports suggest a ship the size of a large corvette, on the order of 3,000 tons. That size ship provides a good balance between payload and endurance. It can deploy reliably overseas while having enough room for acceptable crew facilities, and it is the smallest ship deemed capable of supporting a single medium-sized helicopter. Should the LCS be required to embark (that is, carry, operate, and sustain) a medium-sized helicopter, it would need a displacement of at least 4,000 tons. Smaller vessels can carry helicopters, but the Navy's Helicopter Master Plan calls for only two types of helicopters in the fleet—both variations of the large, multimission SH-60 Blackhawk. Introducing an entirely new class of smaller helicopters to support the littoral combat ship

Box 3.

Providing Logistics Support to a Navy That Has Littoral Combat Ships

Expanding the size of the Navy's fighting force to include littoral combat ships would probably require increasing the number of combat logistics ships (oilers, ammunition ships, and multiple-product vessels) needed to keep that fleet resupplied. The size of that increase, however, would depend heavily on whether those additional logistics ships were operated by the active-duty Navy or the Military Sealift Command and on their capability. (For example, ships that carry three products can do the same supply job as a larger number of dual-product ships, but they are more expensive.)

Today's combat logistics force is composed of 34 ships: 13 oilers, seven ammunition ships, six combat stores ships, and eight triple-product replenishment ships that operate with aircraft carriers. The Navy estimates that a 375-ship fleet would need 42 combat logistics ships, although it says that number is still being studied.

That estimate is consistent with recent experience. In 1995, the Navy had 372 battle force ships, including 41 combat logistics ships, or 11 percent of the fleet. Current numbers are almost the same. If today's fleet was scaled up to 375, the number of combat logistics ships would be about 42—the same as the Navy's estimate.

If, by contrast, the requirement for combat logistics ships was based on the size of the surface combatant force rather than the size of the entire fleet, a larger number of resupply vessels would be necessary. A recent historical average suggests that the Navy needs one logistics ship for every 3.2 surface combatants. Thus, a surface combatant force of 160 ships would require 50 replenishment ships. That measure is misleading, however, because the combat logistics force is responsible for keeping the entire fleet resupplied at sea, not just the surface combatant force.

In this analysis of the Navy's plans for surface combatants and alternative approaches to those plans, the Congressional Budget Office included the costs of additional combat logistics ships in its estimates where appropriate.

would entail considerable costs for training and operation and support.[29] (For more information about the role of helicopters in helping surface combatants counter area-denial threats, *see Box 2 on page 15*.)

Yet another uncertainty surrounding the littoral combat ship is how it would be used. The Global CONOPs suggests that the LCS would be employed in forward-deployed squadrons. However, the size of those squadrons and whether they would be single mission (all carrying the same type of mission module) or multimission (having a mix of mission modules) are unknown. Also unclear is how the LCS would be supported logistically. Some Navy officials have suggested that littoral combat ships could be refueled by the cruisers and destroyer with which they would be operating. But what about food, munitions, and spare parts? Would the squadrons require mother ships? (The Navy does not appear to think so if the ships are in the 3,000-ton range.) If so, how would the mother ships be protected? Under any circumstances, the large numbers of LCSs that the Navy envisions buying would require the service to expand its supporting combat logistics force (for more details, *see Box 3*).

Of the many uncertainties surrounding the LCS, the biggest question is whether the tactical concept of operations for that ship makes sense. The Navy describes the LCS as the "transformational" leg of the DD(X) program because it is designed to provide "assured access" in the face of future naval antiaccess networks. The theory is that the smaller, speedier, and more stealthy LCS would enter an

29. Press reports suggest that the Navy wants the LCS to embark a smaller helicopter but at least support an SH-60-sized aircraft. See Nick Jonson, "Navy Issues Request for Proposals for Littoral Combat Ship Model," *Aerospace Daily* (August 16, 2002), p. 1. In addition, Northrop Grumman Ship Systems unveiled a design for the LCS that would allow it to support a medium-sized helicopter for a few days but not embark one for an entire deployment. See Nick Jonson, "Northrop Grumman Outlines Details of Littoral Combat Ship Proposal," *Defense Daily* (February 11, 2003).

enemy's littoral waters and eliminate mine, submarine, and boat threats, allowing larger and less stealthy ships to move closer to shore at acceptable levels of risk. Yet if an enemy had over-the-horizon targeting capability and antiship cruise missiles effective enough to compel larger combatants to remain far out at sea, could it not engage smaller ships closer to its own shore and overwhelm their small loads of short-range self-defense missiles and guns?

Conversely, if the larger combatants had to move closer to shore to provide longer-range air and missile defense for the LCSs, why could they not perform the antisubmarine warfare, antiboat, and countermine missions themselves? Indeed, the three missions now assigned to the LCS appear heavily dependent on helicopters (and, in the future, unmanned systems); it is not clear why larger combatants could not use those systems to similar effect.

Finally, there is the question of what the LCS will cost. The Navy has provided some information to CBO about the possible price tag of the LCS and its mission modules. But it has not specified whether it plans to buy one mission module of each type for every LCS it buys or a total of 56 mission modules (one for each ship), divided equally among the three missions. CBO estimates the average cost of the LCS, with 1.25 mission modules per ship, at about $350 million apiece (see the appendix for more details). In comparison, the Navy estimates that the first nine ships would cost an average of $200 million and that the mission sets assigned to each ship would cost about $180 million.

The CG(X) Cruiser. In the Navy's plans, the third ship of the DD(X) program will be a large multimission surface combatant, which is expected (although not yet certain) to use the same hull, propulsion plant, and basic combat systems as the DD(X). The key difference is that the CG(X) cruiser would be designed to provide long-range fleet air defense, long-range defense against overland cruise missiles, and theater ballistic missile defense. The CG(X) might be equipped with an upgraded Aegis combat system, but more likely it would introduce an entirely new, advanced-generation combat system, including new radars and more-advanced missiles. Because of its mission, the CG(X) would probably trade the DD(X)'s advanced gun systems for additional VLS cells. CBO assumes that the minimum VLS load for the CG(X) would be 200 cells.

In light of the Navy's plans to modernize Ticonderoga class cruisers, the need to begin building the CG(X) is not pressing. Currently, the Navy thinks it may order the first CG(X) in 2014, with that ship entering the fleet in 2019 or 2020. Such a timetable would cause a large overlap between the first CG(X) and the retirement of the modernized Ticonderogas, which would have an expected service life of 40 years. In fact, the first of the 22 VLS-equipped Improved Ticonderogas, the *Bunker Hill*, would not retire until 2026, and the last, the *Port Royal*, would remain in service until 2034. According to press reports, the CG(X) warships "will *first complement* and eventually replace the 27 Ticonderoga-class Aegis cruisers" [emphasis added], suggesting that the CG(X) production run might be greater than 27 ships.[30]

A larger production run for the new cruiser would be consistent with the Global CONOPs. That operating plan calls for 24 ships—a single cruiser to be assigned to each of 12 carrier strike groups and 12 expeditionary strike groups. However, it also calls for nine surface action groups to provide theater ballistic missile defense, with two dedicated antiballistic-missile shooters and a single antiair "shotgun" for protection. That goal suggests that the Navy would need another 18 CG(X)s, for a total production run of 42. In this analysis, CBO assumed that the additional cruisers would be used to replace the early-flight Arleigh Burke destroyers on a one-for-one basis. (The first of those ships is scheduled to retire in 2026, if it serves its full 35-year expected service life. If midlife upgrades extend that service life to 40 years, the first destroyer will not retire until 2031.) The average price for the CG(X) would be $2.2 billion, CBO estimates (see the appendix for details).

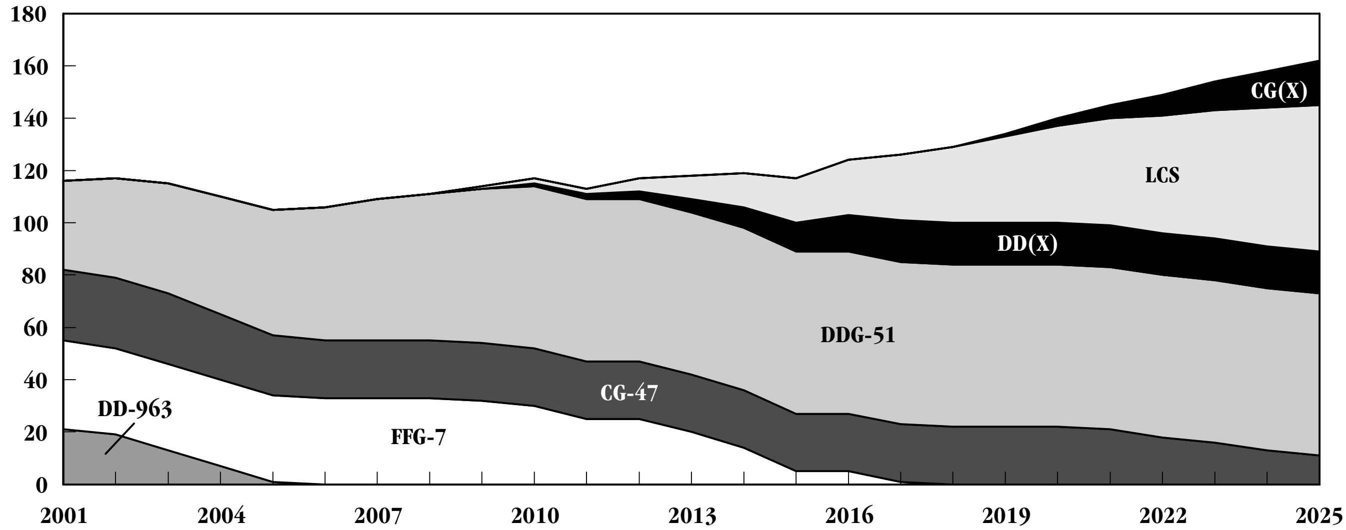
Budgetary Implications of the Navy's Plan

Analyzing the resources necessary to implement the Navy's plan for modernizing its surface combatant force is particularly difficult because the Navy has not specified exactly how many surface combatants it wants or needs, nor has it laid out its long-term modernization program in

30. Scott C. Truver, "U.S. Ship Debate: The Big Question," *Jane's Defence Weekly* (April 24, 2002), p. 25.

Figure 3.

Inventory of Surface Combatants Under CBO's Estimate of the Navy's 160-Ship Plan, 2001-2025



Source: Congressional Budget Office.

Note: DD-963 = Spruance class general-purpose destroyer; FFG-7 = Oliver Hazard Perry class guided-missile frigate; CG-47 = Ticonderoga class guided-missile cruiser; DDG-51 = Arleigh Burke class guided-missile destroyer; DD(X) = future general-purpose destroyer; LCS = littoral combat ship; CG(X) = future guided-missile cruiser.

any detail. The 2004 FYDP provides details only through 2009. As a consequence, CBO developed two long-term procurement plans, based on official information, to determine the level of funding that the Navy thinks it needs to modernize the surface combatant force. Comparing those plans with past and projected funding levels suggests that the Navy could face trade-offs among different parts of its fleet in coming years.

Determining the Navy's Procurement Plans for Surface Combatants Through 2025

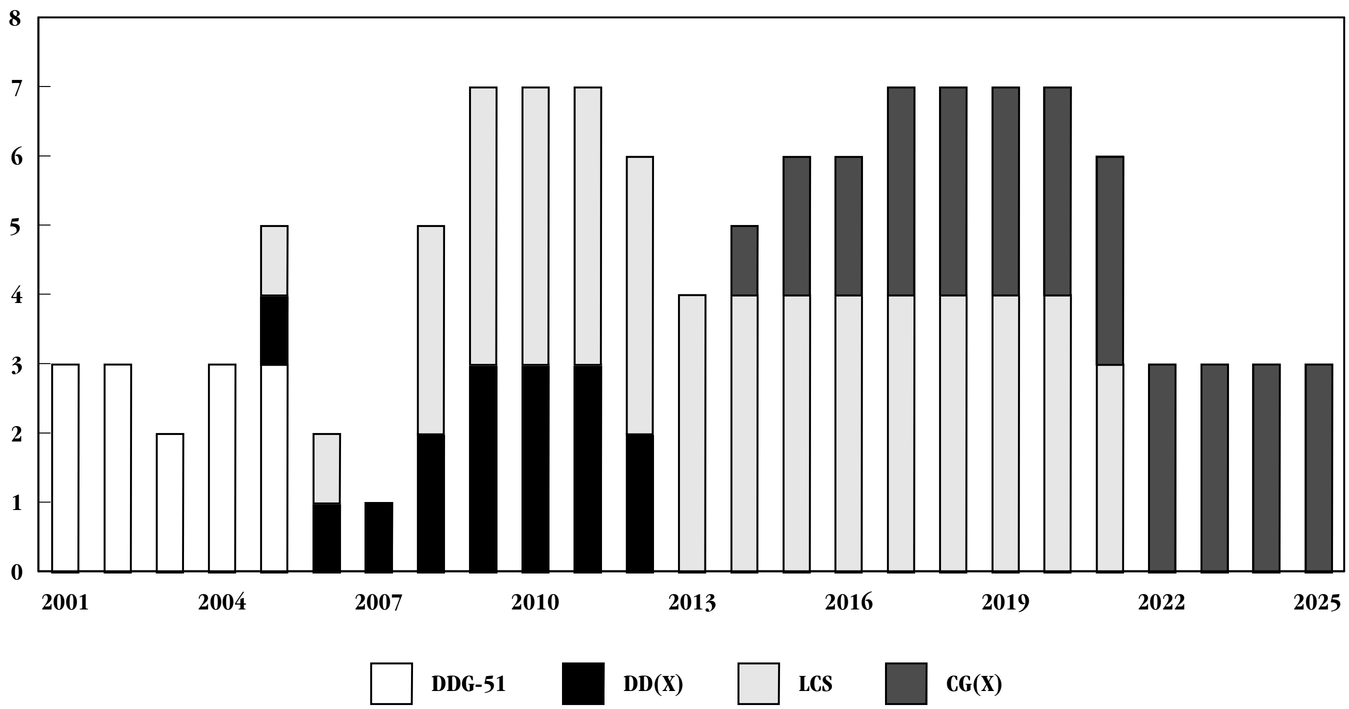
CBO's first procurement plan was based on information contained in the June 2000 *Report on Naval Vessel Force Structure Requirements* (referred to here as the 30-Year Shipbuilding Report), which is the Navy's program of record to the Congress for long-term ship procurement. That report proposed a long-term procurement profile aimed at maintaining a steady-state force of 116 surface combatants, consisting of 27 Ticonderoga class cruisers, 57 Arleigh Burke class guided-missile destroyers, and 32 DD-21 land-attack destroyers. At the end of their service life, the 27 upgraded Ticonderogas would presumably be replaced by 27 CG-21 future cruisers, although that is not certain.

CBO's second shipbuilding plan—which more closely reflects current Navy thinking—is drawn from public statements by Navy officials, the 2004 FYDP, unofficial sources, and the new Global Concept of Operations. CBO assumed that to achieve the force structure goals implied by the Global CONOPs, the Navy would modernize its 22 Improved (VLS-capable) Ticonderoga cruisers and would buy 16 DD(X) destroyers, 32 CG(X) cruisers (with an eventual goal of 42), and 56 littoral combat ships.[31]

31. If the Navy decided to replace the Arleigh Burke destroyer with the CG(X) (which would make far more sense than designing a new ship at that point), the CG(X) production line would need to be extended through at least 2028. CBO assumed that the Navy would continue to buy the CG(X) and thus would purchase a total of 32 between 2014 and 2025.

Figure 4.

Annual Purchases of Surface Combatants Under CBO's Estimate of the Navy's 160-Ship Plan



Source: Congressional Budget Office.

Note: DDG-51 = Arleigh Burke class guided-missile destroyer; DD(X) = future general-purpose destroyer; LCS = littoral combat ship; CG(X) = future guided-missile cruiser.

The Navy would also modernize its frigates and purchase 62 Arleigh Burke destroyers as specified in the 2004 FYDP.[32] Under that approach (referred to here as the Navy's 160-ship plan), the inventory of surface combatants would grow over the next 25 years until it reached a steady-state level of 160 ships (*see Figure 3*).

The Navy's 160-ship plan defines the upper limit of the service's goals for surface combatants, and it conforms most closely to Navy briefings about the Global CONOPs. That concept of operations calls for 88 Aegis ships, 16 DD(X) destroyers, and 56 littoral combat ships. The briefings do not provide a date when such a force would exist, only its general outlines. To derive a procurement plan for surface combatants, CBO used the information in the 30-Year Shipbuilding Report and updated it for recent developments—particularly the intention to buy 16 DD(X)s instead of 32 DD-21s, as well as 56 littoral combat ships. (That procurement plan is shown in *Figure 4*.) CBO then calculated the cost of the two shipbuilding plans using its cost estimates for the various types of surface combatants. (For more details of those estimates, see the appendix.)

The Resource Implications of the Navy's Modernization Program for Surface Combatants

Although the surface combatant force is one of the healthiest parts of the Navy in terms of its share of procurement dollars and its average age, the Navy's 160-ship plan would require greater funding for that force than it

32. Essentially, CBO assumed that the DD(X) would be built on the current schedule, with the lead ship purchased in 2005.

has received in recent years. Between 1990 and 2002, the surface combatant force received an average of $3.6 billion a year (in 2003 dollars) for ship construction, or 42 percent of the Navy's total shipbuilding budget. With that money, the Navy built an average of 3.5 surface combatants a year. That production level is a little more than the 3.4 ships per year required to maintain a force of 116 surface combatants in steady state. (In 2003, the Navy is building only two surface combatants, spending about $2.7 billion.) By contrast, sustaining a 160-ship force in steady state would require substantial increases in construction and funding—to 4.7 ships and about $5.2 billion per year.

Thus, the current level of funding for surface combatants cannot continue much longer if the Navy wishes to achieve its new, higher force goals. CBO estimates that the Navy's 160-ship plan would entail spending an average of about $5 billion annually on surface combatants between 2003 and 2010, for a construction rate of 4.0 ships a year—more than the amount necessary to sustain a force of 116 ships but still less than the amount needed to achieve the 160-ship force goals by 2025. Consequently, after 2010, the surface combatant force would have to consume a far larger share of the Navy's shipbuilding budget. The Navy's 160-ship plan would spend an average of $6.2 billion a year between 2011 and 2020 on surface combatants—or about three-quarters of today's shipbuilding budget. Without a significant rise in the Navy's construction funding, that level of spending would require trade-offs with other shipbuilding programs.

The numbers for surface combatants portray only part of the overall budgetary challenge that the Navy is facing. Other elements of the Navy will also need greater resources if the service is to achieve a total force goal of 375 ships. Although most of the planned increase in the fleet involves surface combatants, reaching a 375-ship Navy would require maintaining at least the current force levels for other types of ships. Between 2011 and 2020, the average ship construction budget needed to build all of the aircraft carriers, submarines, surface combatants, amphibious ships, and support ships now planned would be almost $17 billion a year, CBO estimates (*see Table 3*). That level is roughly double the Navy's average construction spending of $8.5 billion a year over the 1990-2002 period. (The 2003 shipbuilding budget is only slightly more than $8 billion.)[33]

A Trade-Off Between Surface Combatants and Attack Submarines?

What Table 3 shows is that unless the Navy is able to devote significantly more money to ship construction, its leaders will have to decide whether to pursue transformation objectives in the surface combatant force or maintain the attack submarine force near current levels. Over the past 13 years, the Navy has been dramatically underfunding its attack submarine programs relative to the amount needed to maintain that force at the level of 58 subs.[34] The cumulative shortfall over that period in both funding and construction relative to steady-state requirements is about $34 billion and 15 submarines, respectively. Because the Navy did not buy many attack submarines during the 1990s, it must begin to purchase them soon or accept that the force level will decline substantially.[35]

In comparison, the surface combatant force is far healthier, at least with respect to past requirements. Based on the force goal of 116 surface combatants—the requirement that the Navy has operated under for the past six years and that is still official—spending for surface combatants between 1990 and 2002 showed a cumulative surplus of $2 billion and about two ships relative to steady-state needs. Based on the greatly expanded force requirements called for in the Navy's 160-ship plan, however, funding and construction over the 1990-2002 period fell short by $19 billion and 15 ships.

33. That funding level does not include tactical aircraft, which will also place substantial demands on Navy resources over the next 15 years.

34. The 1997 Quadrennial Defense Review set the force goal for attack submarines at 50. That goal was raised to 55 several years later. The current force level is 54, and the Bush Administration is converting four ballistic missile submarines to a guided-missile configuration, which will allow them to perform conventional missions. Thus, for the purposes of this analysis, CBO assumed a force goal of 58 attack submarines.

35. See Congressional Budget Office, *Increasing the Mission Capability of the Attack Submarine Force* (March 2002).

Table 3.

Average Annual Construction Spending and Procurement for Navy Ships, by Category, 1990-2020

Category	Force Goal (Number of ships)	Actual Annual Average, 1990-2002	Steady-State Requirements (Based on 1997 and 2001 QDR force goals)[a]	Cumulative Surplus or Shortfall (-) Relative to Steady-State Requirements, 1990-2002	Projected Annual Average[b] 2003-2010	Projected Annual Average[b] 2011-2020
			Construction Spending (Billions of 2003 dollars)			
Surface Combatants	116	3.6	3.4[c]	2.0[c]	5.1	6.2
Attack Submarines[d]	58	1.3	3.9	-34.1	4.2	6.3
Ballistic Missile Submarines[e]	14	0.3	0.8	-7.1	0.6	0.4
Aircraft Carriers[e]	12	1.4	1.4	-0.5	2.0	2.1
Amphibious Ships	36	0.9	1.1	-1.8	0.6	0.9
Other	70	0.9	0.7	2.9	1.0[f]	1.0[f]
Total	**306**	**8.5**	**11.3**	**-38.7**	**13.5**	**16.9**
			Procurement Quantity			
Surface Combatants	116	3.5	3.4[c]	1.8[c]	4.0	6.2
Attack Submarines[d]	58	0.6	1.8	-15.4	1.8	2.9
Ballistic Missile Submarines	14	0.2	0.3	-2.3	0	0.1
Aircraft Carriers	12	0.2	0.2	-1.1	0.1	0.2
Amphibious Ships	36	0.8	0.9	-0.7	1.1	0.4
Other	70	2.2	2.1	1.7	2.3[f]	3.4[f]
Total	**306**	**7.5**	**8.7**	**-16.0**	**9.2**	**12.7**

Source: Congressional Budget Office.

Note: QDR = Quadrennial Defense Review.

a. The steady state represents the annual spending and purchases required to maintain the fleet at the level of the force goals, which are very close to current levels. To determine steady-state purchases, CBO divided the Navy's inventory of ships by the service life of each type of ship. Those annual purchases were then multiplied by CBO's estimate of the unit (per-item) cost for each type of ship.

b. CBO projection based on the Navy's proposed 375-ship fleet, including 160 surface combatants.

c. If the requirement for surface combatants was 160 (reflecting the Navy's 160-ship plan including about 60 littoral combat ships), the steady-state budget would be $5.2 billion a year and the cumulative 1990-2002 shortfall would be $19 billion. Likewise, the steady-state procurement rate would be 4.7 ships per year, and the cumulative shortfall would be a deficit of 15 ships.

d. These numbers represent a slight change from the force goals in the 1997 and 2001 QDRs. They assume 54 attack submarines and four Trident submarines converted to a guided-missile configuration, whereas the 1997 QDR called for 50 attack submarines, and the 2001 QDR seemed to affirm a force goal of 55 attack submarines.

e. Includes funding for refueling overhauls.

f. Includes Maritime Prepositioning Force Future ships.

Other major components of the Navy are being funded at levels closer to their steady-state requirements. Support ships have actually received a surplus of funding over the past 13 years and will make only modest demands on the Navy's budget relative to what they have been getting. Aircraft carriers and amphibious ships have been underfunded but not dramatically so. Although ballistic missile submarines experienced a large cumulative shortfall between 1990 and 2002, it reflects the relatively young age of those subs (13 years, on average) and their long service life (42 to 44 years). The Navy need not order another ballistic missile submarine until at least 2020.

CHAPTER

2

Options for Managing the Transformation to the Future Surface Combatant Force

Modernizing the surface combatant force need not be as expensive a proposition as the program in the 30-Year Shipbuilding Report or the Navy's 160-ship plan would be. This chapter presents three alternatives for structuring the surface combatant force, each of which would cost no more than what the Navy is spending today on surface combatants. All of the options would result in a larger surface combatant force in 2025 than exists now but a smaller force than the one envisioned in the Navy's 160-ship plan.

Each of these options emphasizes different trade-offs between keeping the current force of surface combatants and transforming it over 25 years. The first option would make maximum use of the still-capable Cold War-generation ships that are in the fleet today. Conversely, the second option would accelerate the process of incorporating next-generation ships into the surface combatant force by retiring many of those Cold War-era ships before the end of their expected service lives and slightly speeding up development of the CG(X) cruiser. The third option would procure smaller numbers of next-generation cruisers, destroyers, and littoral combat ships but would use multiple crews on them, thus significantly increasing the amount of forward presence each individual ship could provide.

In developing the different force structures in these options, the Congressional Budget Office restricted the funding that would be allocated for surface combatants to an average of $6.6 billion a year (in 2003 dollars) for procurement and direct operation and support costs between 2003 and 2025.[1] Both procurement costs and operation and support costs should be considered because they are related and because CBO's force structures make explicit trade-offs between them. Retaining older ships would require higher operation and support costs compared with retiring those ships and speeding up the procurement of new surface combatants. (The discussion in Chapter 1 of the costs of the Navy's 160-ship plan addressed only procurement costs.) CBO chose the $6.6 billion figure because that is what the Congress appropriated to the Navy for its surface combatant force in 2002, expressed in 2003 dollars. It also represents about the amount of money needed to sustain and operate today's surface combatant force in steady state (that is, at the current size indefinitely).

This chapter describes the different force structure options in detail. The next chapter addresses how capable those force structures would be in both peacetime and wartime compared with today's surface combatant force and with the forces implied by the Navy's 160-ship plan and the 30-Year Shipbuilding Report.

Option I: Delay the Transition to Next-Generation Ships by Making the Most of the Existing Fleet

Under this approach, the Navy would emphasize keeping its existing ships through the end of their notional ex-

1. Under Option III, the cost of building additional training facilities is included in the $6.6 billion.

Table 4.

Summary of Program Changes and Assumptions Under Alternative Force Structures Through 2025

Program	Navy's 160-Ship Plan	Option I	Option II	Option III
DD-963	Retires all ships by 2006	Retains all active ships for 35-year service life; upgrades engineering and self-protection systems	Retires all ships by 2006	Retires all ships by 2006
FFG-7	Modernizes all ships; last of the class retires in 2018	Modernizes all ships; last of the class retires in 2018	Cancels modernization program; last of the class retires in 2010	Modernizes all ships; last of the class retires in 2018
CG-47	Retires first five ships by 2006; fully converts the other 22 ships (35-year service life)	Fully converts all 27 ships (40-year service life)	Retires first five ships by 2006; retires nine more by 2014; fully converts the other 13 ships (40-year service life)	Retires first five ships by 2006; fully converts the other 22 ships (40-year service life)
DDG-51	Buys 62 ships (35-year service life, no midlife upgrades)	Buys 64 ships (35-year service life, no midlife upgrades)	Buys 61 ships (35-year service life, no midlife upgrades)	Buys 61 ships (35-year service life, no midlife upgrades)
DD(X)	Buys 16 ships starting in 2005 (35-year service life)	Cancels program	Buys 12 ships starting in 2005 (35-year service life)	Buys eight ships starting in 2006 (35-year service life); uses multiple crews
LCS	Buys 56 ships starting in 2005 (25-year service life)	Cancels program	Buys 30 ships starting in 2005 (25-year service life)	Buys 28 ships starting in 2009 (25-year service life)
CG(X)	Buys 32 ships starting in 2014; total plan of 42 (35-year service life)	Buys 12 ships starting in 2019; total plan of 24 (35-year service life)	Buys 16 ships starting in 2012; total plan of 24 (35-year service life)	Buys 15 ships starting in 2018 (35-year service life)
FFG(X)	n.a.	Buys 40 ships starting in 2008 (30-year service life)	n.a.	n.a.

Source: Congressional Budget Office.

Note: n.a. = not applicable.

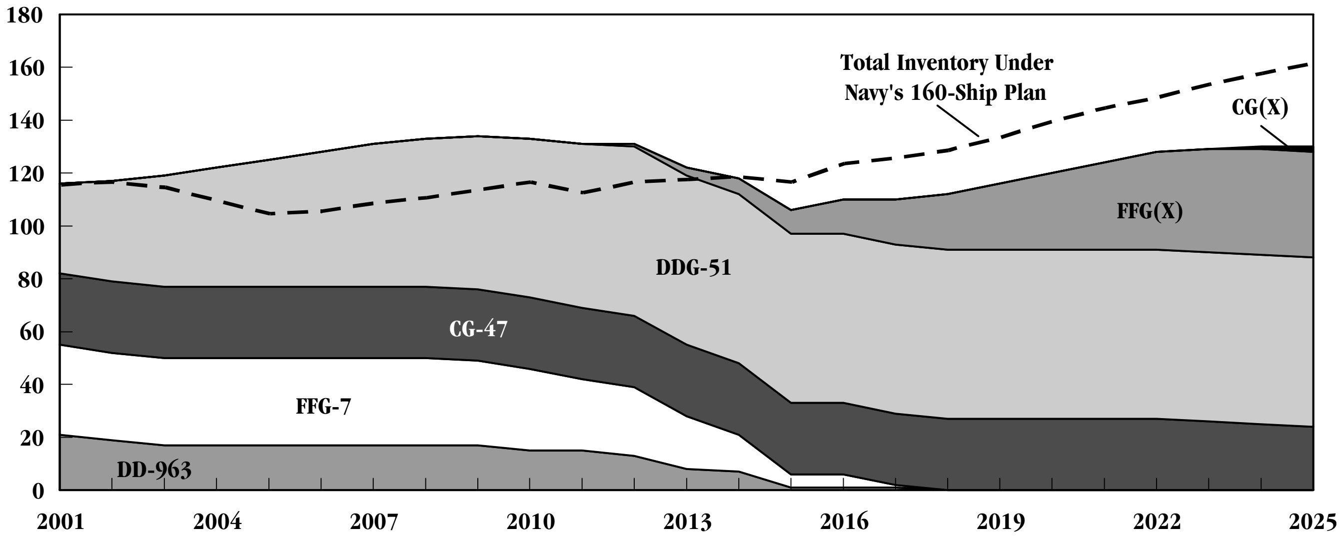
pected service lives rather than retiring some of them early, as under current plans. That approach would make the most of the legacy fleet (capital assets the Navy already has) and would ease the shortage of ships that some admirals argue now exists.[2] At the same time, the Navy would start the transition to the next generation of surface combatants by building a different ship from the ones currently planned.

With respect to specific programs, the Navy would upgrade all 27 Ticonderoga class (CG-47) cruisers and keep them to the end of their extended 40-year service lives (*see Table 4*). It would also retain all 17 Spruance class (DD-963) destroyers and 33 Oliver Hazard Perry class (FFG-7) frigates, upgrading their systems as necessary. It would buy 64 Arleigh Burke class (DDG-51) destroyers

2. See, for example, David Brown, "Fewer Ships: Biggest Problem for SurfLant," *Navy Times* (August 5, 2002), p. 20; Bradley Peniston, "Fleet's Too Small, Say Sixth's Murphy," *Navy Times* (November 1, 1999); and "Mullen: 'Virtual Presence Doesn't Hack It,'" *Defense News* (March 15, 1999), p. 8.

Figure 5.

Inventory of Surface Combatants Under Option I, 2001-2025



Source: Congressional Budget Office.

Note: DD-963 = Spruance class general-purpose destroyer; FFG-7 = Oliver Hazard Perry class guided-missile frigate; CG-47 = Ticonderoga class guided-missile cruiser; DDG-51 = Arleigh Burke class guided-missile destroyer; FFG(X) = future guided-missile frigate; CG(X) = future guided-missile cruiser.

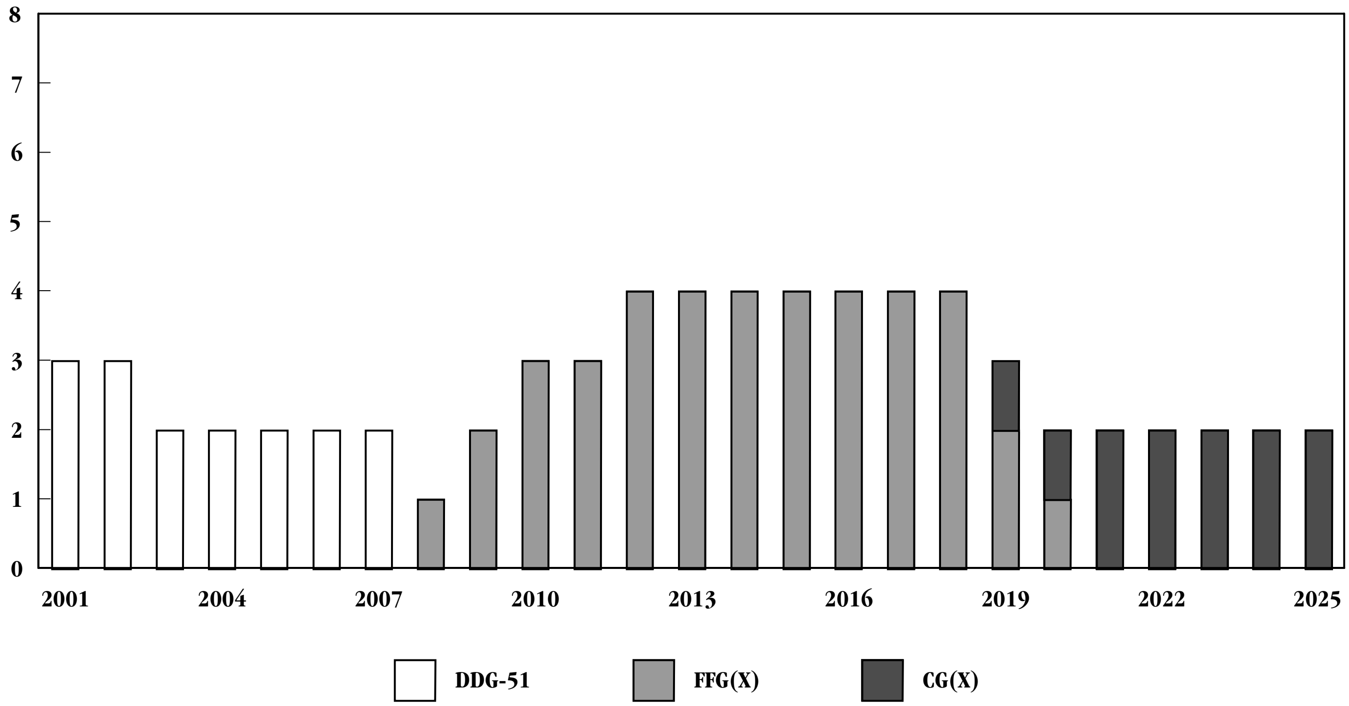
(two more than under the Navy's 160-ship plan) and cancel the DD(X) destroyer and littoral combat ship programs. To replace legacy destroyers and frigates, the Navy would instead build 40 new frigates that were more capable than the littoral combat ship but much smaller and less expensive than the DD(X). (To be consistent with the DD(X)-family terminology, this study refers to the new frigate as the FFG(X).) In addition, because Ticonderoga cruisers would stay in service longer, the CG(X) program would be delayed for five years. With those changes, the steady-state surface combatant force would number 24 cruisers, 64 destroyers, and 40 frigates, for a total of 128 ships.

Under this approach, the surface combatant force would be much larger through 2013 than under the Navy's 160-ship plan (*see Figure 5*). The force would reach 134 surface combatants in 2009 as new Arleigh Burke destroyers were commissioned and older ships were retained. Once the Spruance destroyers and Perry frigates began reaching the end of their full service lives, however, the surface combatant force would shrink before the new frigate began boosting its numbers again. From 2014 on, this option would produce a smaller surface combatant force than the Navy's 160-ship plan would. Moreover, for a few years (between 2015 and 2018), the force would fall below the current size of 115 ships.

Any change in production plans for surface combatants would have implications for the industrial base—the two U.S. shipyards currently capable of building large surface combatants: Bath Iron Works, owned by General Dynamics, and Ingalls Shipbuilding, owned by Northrup Grumman Ship Systems. The 2003 Future Years Defense Program envisioned building no more than two surface combatants a year through 2007. (The 2004 FYDP, in contrast, would produce between one and seven surface combatants a year through 2009.) In general, this option would continue to build two surface combatants a year through 2009 (*see Figure 6*) as well as pursue the full conversion program for Ticonderoga cruisers and substantial upgrades to Spruance destroyers. Those efforts might prove to be just enough work to keep the two shipyards in business, assuming that the amphibious ships called for in the 2004 FYDP were built as well. The period through 2009, while surface combatants were being built at relatively low rates, could prove difficult for Bath Iron Works. After that, when procurement rates for new surface

Figure 6.

Annual Purchases of Surface Combatants Under Option I, 2001-2025



Source: Congressional Budget Office.

Note: DDG-51 = Arleigh Burke class guided-missile destroyer; FFG(X) = future guided-missile frigate; CG(X) = future guided-missile cruiser.

combatants increased to three or four a year, the shipyards would be on a sounder footing. Overall, this option would build an average of 2.7 ships per year between 2003 and 2025.

Average Annual Costs

This approach would cost much less than either the program in the 30-Year Shipbuilding Report or the Navy's 160-ship plan. From 2003 through 2010, the Navy would spend an average of $6.6 billion a year on procurement and operation and support costs (*see Table 5*). That amount would drop slightly, to $6.1 billion a year, between 2011 and 2020. But between 2021 and 2025, when Ticonderoga cruisers would finally begin to retire and have to be replaced, average annual costs would rise to $7.9 billion. Nevertheless, those costs are lower than under the Navy's 160-ship plan, which would require average annual spending of $8.3 billion, $9.5 billion, and $10.3 billion, respectively, for those same periods.

The Navy argues that keeping older ships, particularly Spruance destroyers, around longer is not cost-effective because those ships are more expensive to operate than either an Arleigh Burke destroyer or an Oliver Hazard Perry frigate. If the Navy kept the Spruances and invested $100 million per ship to improve their reliability and self-defense capabilities, the amortized annual cost of retaining those ships in the fleet for a 35-year service life would be about $45 million apiece. That amount compares favorably with the costs of buying and operating a new Arleigh Burke destroyer, which would total about $60 million a year—although the Arleigh Burkes are much more capable ships. A littoral combat ship would cost about $30 million a year to buy and operate, assuming a 25-year service life.

Table 5.

Average Annual Spending for Procurement and Operation and Support, 2003-2025

(In billions of 2003 dollars)

Force Structure	2003-2010	2011-2020	2021-2025	2003-2025
Navy's 160-Ship Plan	8.3	9.5	10.3	9.3
Option I	6.6	6.1	7.9	6.6
Option II	7.1	6.3	6.7	6.6
Option III	7.1	5.6	8.2	6.6

Source: Congressional Budget Office.

Note: Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

Is one Spruance class destroyer worth 1.5 littoral combat ships? That, in effect, is the relative cost-effectiveness decision that the Navy has made in favor of the LCS.[3]

The FFG(X)

The most significant difference between this option and the Navy's plan is that this option would cancel the DD(X) and LCS programs. If spending on the surface combatant force is restricted to existing budget levels, the Navy cannot afford both new ships. Moreover, as discussed in Chapter 1, it is not clear that either the DD(X) or the LCS is what the Navy will need in the future. Rather than replace Cold War-generation destroyers and frigates with 16 DD(X) destroyers and 56 focused-mission but modular littoral combat ships, this option would design and buy 40 multimission frigates.

Those FFG(X)s would be modeled in part on Spain's F-100 guided-missile frigates.[4] The F-100, which went into service last year, is a state-of-the-art frigate that can perform a variety of missions, including antisubmarine, antiship, and antiair warfare. The F-100 is equipped with a single 5-inch, 54-caliber gun and 48 VLS cells, which can carry 96 area air-defense missiles, point air-defense missiles, land-attack missiles, and antisubmarine missiles.[5] The ship is also equipped with the Aegis combat system and can embark two helicopters. It has a range of 5,000 nautical miles at 18 knots and is capable of a sustained speed as high as 27 knots.

The FFG(X) created under this option would not be Aegis-capable; instead, the money saved from not buying the Aegis system would be used to introduce the new all-electric propulsion system, reduce the ship's signature, decrease crew size through improvements in automation, and introduce a littoral antisubmarine warfare (ASW) suite. Those improvements would more than offset the cost of the Aegis system. In addition, the FFG(X) would be incorporated into the Navy's sensor and communication networks.

This kind of frigate would not be nearly as fast as the littoral combat ship is supposed to be, but it would be much more capable and have greater endurance. Moreover, it is not clear that the Navy needs a very high speed ship to perform the missions that the Navy has in mind if the ship is capable of embarking helicopters (see Box 2 on page 15). This frigate could operate effectively as part of a larger group of ships or independently, as long as it was not expected to encounter a particularly intense air threat.[6] The

3. As a point of comparison, the Navy's submarine community has moved in the opposite direction, extending the service lives of most Los Angeles class attack submarines from 30 to 33 years and of Trident ballistic missile submarines from 30 to 42 (or more) years.

4. Germany's Sachsen class (Type 124) guided-missile frigate is another good example. Interestingly, a German industry consortium is testing the feasibility of putting a 155-millimeter gun on the Type 124. See Christopher F. Foss, "Artillery System Targeted for Ships," *Jane's Defence Weekly* (February 12, 2003).

5. An area air-defense missile, such as the Standard Missile, has a range of about 40 nautical miles and thus can reach a wider area to defend a group of ships from attack. A point air-defense missile, such as the Evolved Sea Sparrow, has a much shorter range and is designed to destroy incoming missiles that have "leaked" through outer defenses. Four of those missiles are loaded in "quad packs" in a single VLS cell.

6. For a critique of the littoral combat ship and an argument for more multimission warships, see Lieutenant Commander Richard Brawley, "Streetfighter Cannot Do the Job," *Proceedings*, U.S. Naval Institute (October 2002), pp. 66-69.

average cost of the FFG(X) would be about $700 million, CBO estimates. (For more details about that estimate, see the appendix.) By comparison, Spain's Aegis-capable F-100 frigate reportedly costs about $600 million.[7]

The Risks Posed by Future Threats

This option's approach is based on two premises: that serious area-denial threats will not materialize in the next 10 to 15 years and that a *large* legacy force can handle any near-term threats that do arise. That approach makes sense if one believes, for example, that the nation's principal military problem in the near term will be the war on terrorism, which will require a large number of surface combatants to be in many places at once, performing a variety of missions. An especially important mission may be to conduct more and more maritime interception and escort operations to find terrorists and protect shipping.

In such an environment, the multimission FFG(X) would be more versatile than the LCS and at least as effective, if not more so. Designed to accommodate both helicopters and future unmanned systems as well as a littoral ASW suite, the FFG(X) would represent a good combination of the large DD(X) and the smaller LCS.

Critics might argue that this approach would make more of the surface combatant force vulnerable to threats from diesel-electric submarines, small boats armed with antiship cruise missiles, and mines than under the Navy's 160-ship plan. However, this force would probably be more vulnerable only to antiship cruise missiles; it would be equally as vulnerable to submarines and mines as the currently planned force would be. Diesel-electric submarines find their targets largely through acoustic sonars, and the Spruance class destroyers that this option would retain have a relatively quiet acoustic signature. Mines would pose the same level of threat to a Spruance destroyer as to a DD(X) destroyer. But the much larger radar cross section of today's surface combatants would make it far easier for targeting radars to identify the coordinates of those ships than of much stealthier vessels.

7. A.D. Baker III, *The Naval Institute Guide to Combat Fleets of the World, 2002-2003: Their Ships, Aircraft, and Systems* (Annapolis, Md.: Naval Institute Press, 2002), pp. 737-738.

The central question in regard to that concern is, How capable will potential opponents of the United States be in finding surface ships and targeting them with cruise missiles? So far, potential opponents have yet to demonstrate an operationally effective ability to target U.S. naval forces 150 to 200 miles from shore. Moreover, they would have to overcome many technological hurdles to develop that ability.

A different scenario would be much more challenging for this option's surface combatant force. If, around 2010, a Middle Eastern country blockaded the Persian Gulf and the U.S. Navy needed to force its way into the Strait of Hormuz, cruise missile attacks at relatively short ranges could pose a grave threat. None of this option's new stealthy frigates would be in the fleet yet, and the only way the Navy could ensure the safety of its ships would be to attack the enemy's cruise missile sites and boats first. However, the Navy's 160-ship force would confront the same problem: few of its stealthy ships would be commissioned by 2010, and it would have fewer ships of other types to conduct operations than under this option. If the same scenario occurred in 2020, the odds would improve for both fleets, although the Navy's 160-ship force would have more next-generation ships than the force resulting from this approach.

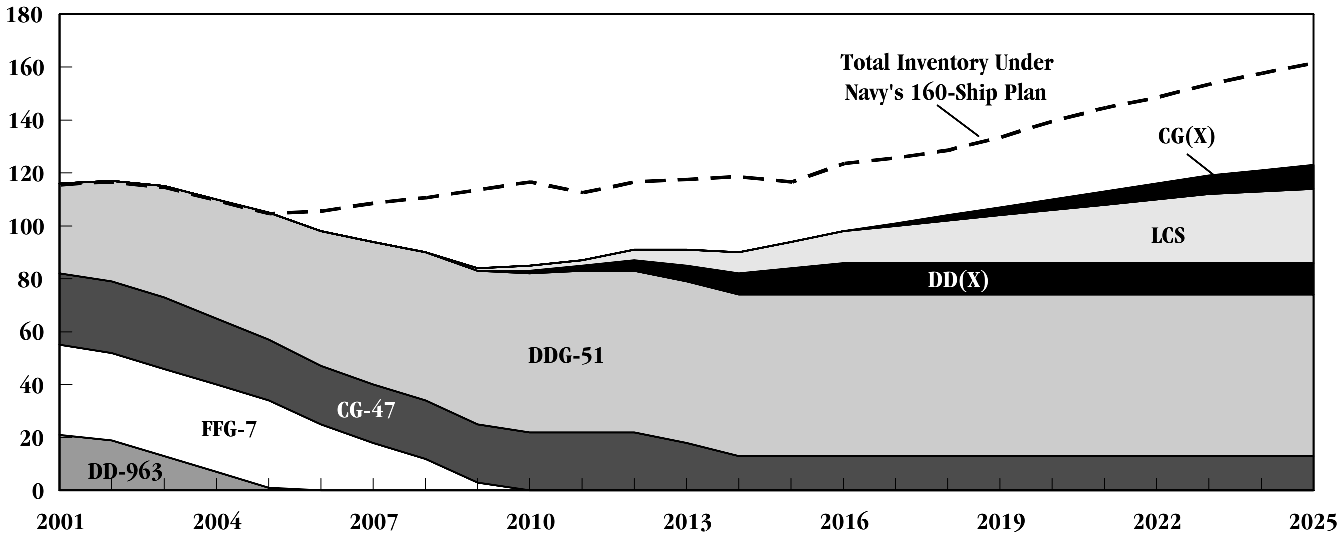
In summary, the risks to the surface combatant force in certain scenarios would arguably be somewhat greater under this option than under alternative approaches that emphasize introducing next-generation surface combatants more quickly. But, as Option II will illustrate, those other approaches risk not having enough ships over the next 10 years for all of the other jobs that the Navy is called on to perform.

Option II: Accelerate the Transition to Next-Generation Ships by Retiring Much of the Existing Force Early

Under this option, the Navy would hasten the introduction of new ships into the fleet—which some admirals say they need—at the cost of reducing the number of legacy surface combatants. This approach would enable the programs of the Navy's 160-ship plan to fit within the budget constraint of $6.6 billion annually, on average, between

Figure 7.

Inventory of Surface Combatants Under Option II, 2001-2025



Source: Congressional Budget Office.

Note: DD-963 = Spruance class general-purpose destroyer; FFG-7 = Oliver Hazard Perry class guided-missile frigate; CG-47 = Ticonderoga class guided-missile cruiser; DDG-51 = Arleigh Burke class guided-missile destroyer; DD(X) = future general-purpose destroyer; LCS = littoral combat ship; CG(X) = future guided-missile cruiser.

2003 and 2025. The result would be a surface combatant force that was substantially smaller than any other force structure discussed in this study. This approach is built on the premise (which CBO assumes for the purposes of this option) that, to the extent that network-centric warfare increases the combat capabilities of a given group of ships, a smaller number of new ships built with such warfare in mind will probably be more capable than a larger number of older ships, all other factors being equal.

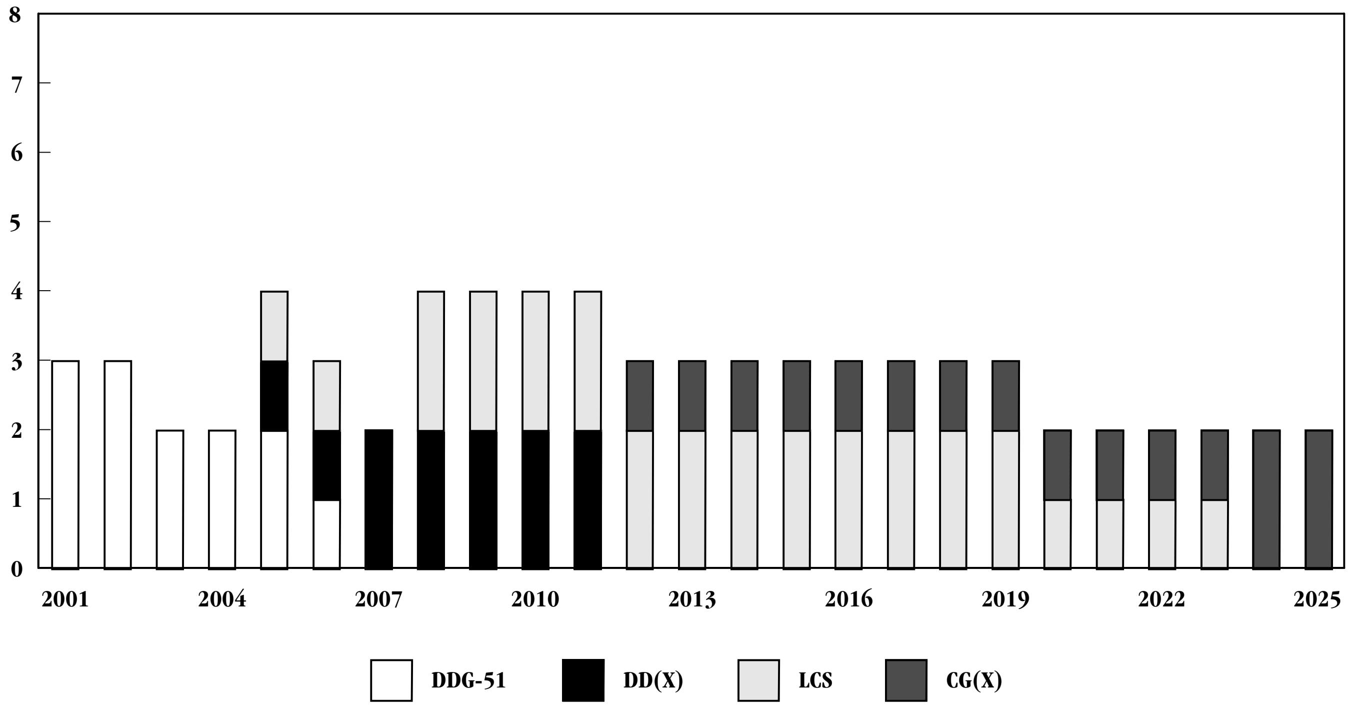
With respect to specific programs, this option would follow the Navy's plan to retire all Spruance class destroyers by 2006 (see Table 4 on page 24). In addition, it would retire all Oliver Hazard Perry class frigates by 2010 and upgrade only 13 of the 27 Ticonderoga class cruisers. The first five cruisers would be retired by 2006, as in the Navy's 160-ship plan, and an additional nine would be retired by 2014 to save money. The 13 upgraded Ticonderogas would have 40-year service lives.[8] This option would also halt the production run of Arleigh Burke destroyers at 61. In regard to next-generation ships, it would accelerate the CG(X) cruiser by two years but would buy only 16 of the total 24 within the 2025 time frame. This option would also purchase only 12 DD(X) destroyers, eliminating the four dedicated to wartime surge. It would begin procuring the littoral combat ship in 2005 but, for affordability reasons, would buy only 30 of them.

Overall, Option II would trade off legacy ships in the near term for a more modern, more capable force in the longer term. It would implicitly accept near-term operational risk in order to reduce operational risk when area-denial threats were likely to be more severe. For example, in the war on terrorism, far fewer ships would be available for maritime interception, escort, or forward presence. By 2009, the surface combatant force would have shrunk to just 84 ships, before new ships, especially the LCS, began to increase the fleet size (*see Figure 7*). By 2025, the surface combatant force would number 123 ships, eight more than today's fleet. Assuming that the Arleigh Burkes were eventually replaced on a one-for-one basis, the steady-state force under this option would ultimately total 125 ships.

8. More-modest upgrades to improve the self-defense capabilities of the ships would still be made.

Figure 8.

Annual Purchases of Surface Combatants Under Option II, 2001-2025



Source: Congressional Budget Office.

Note: DDG-51 = Arleigh Burke class guided-missile destroyer; DD(X) = future general-purpose destroyer; LCS = littoral combat ship; CG(X) = future guided-missile cruiser.

Compared with Option I, this approach would pose fewer risks for the industrial base. It would generally build three or more surface combatants a year starting in 2005, limiting the period of constructing two surface combatants annually to only a few years (*see Figure 8*). Overall, this option would build an average of 2.8 ships per year during the 2003-2025 period.

Average Annual Costs

As with Options I and III, this force structure would fit within the budgetary constraint of an average of $6.6 billion a year for procurement and operation and support costs; therefore, it would cost much less than the Navy's 160-ship plan would. Through 2010, the Navy would spend an average of $7.1 billion a year on procurement and operation and support under this approach (see Table 5 on page 27). That figure would be lower in later years: an average of $6.3 billion annually between 2011 and 2020 (when the Navy will need to invest heavily in attack submarines) and $6.7 billion a year between 2021 and 2025. Because this option would buy more next-generation ships earlier, its average annual costs between 2021 and 2025 would be lower than Option I's.

The Role of Stealth in Navy Warships

This option would yield a more capable next-generation force than the other options analyzed in this chapter, especially with respect to stealth. But do surface ships need to be stealthy? The answer depends on assumptions about what navies should do. In peacetime, the United States keeps about 30 percent of its naval forces forward deployed to exert political influence overseas by reassuring friends and deterring enemies. For the types of missions performed during peacetime—such as conducting maritime interception, enforcing sanctions, or engaging with allies—stealth is of little importance.

Stealth achieves its real value on the rare occasions when the Navy must go to war. That value occurs on two levels: operational and tactical. Operational stealth refers to whether an enemy can locate and track a ship. (Such operational stealth preserves the possibility of tactical sur-prise, making it more difficult for the enemy to focus its defenses.) Tactical stealth refers to the ease with which a ship can be targeted and destroyed, especially in the final antiship engagement.

The Logic of Operational Stealth. Buying operationally stealthy ships is a competitive strategy that seeks to impose costs on potential enemies who want to restrict the Navy's freedom of action. By making its ships difficult to find, the Navy in effect forces adversaries to invest heavily in over-the-horizon detection and targeting systems, such as space-based radars or infrared systems (which might also be put on high-altitude aircraft or unmanned aerial vehicles).

Nevertheless, there are limits on what stealth in surface ships can achieve. For example, a ship with a conventional hull form will always be detectable to an enemy using the appropriate technology. Such a ship leaves a substantial wake (a V-shaped pattern trailing behind it) that an opponent with a sophisticated space-based or aircraft-based synthetic aperture radar can detect. Although different hull forms can substantially reduce the wake of a ship, even in 2030, most of the Navy's large warships—such as aircraft carriers, amphibious ships, destroyers, and logistics support ships—will still have a conventional hull.[9]

Depending on which opponents the United States expects to face over the next 30 years, operational stealth may be either a worthwhile investment or a short-lived, wasting asset. It is doubtful that small, relatively poor adversaries could develop or buy the sophisticated systems needed for a comprehensive over-the-horizon detection and targeting capability. Richer and more technologically sophisticated opponents might decide to make that investment. If so, the question becomes, to what extent is the investment in operational stealth more or less costly to the United States than an opponent's investment in over-the-horizon detection systems is to itself? The answer may hinge in part on future advances in computers and sensor technology. By spending money to make new ships operationally stealthy, the Navy is betting that improvements in sensors and information technology (such as computer processing power) will not come fast enough to degrade the value of stealth fairly early in the life of a ship class.

The Logic of Tactical Stealth. In a wartime environment, a stealthy ship will have a much better chance of surviving antiship engagements than a nonstealthy ship will. The value of that stealth derives from the way in which a ship defends itself against radar-guided antiship cruise missiles. A surface combatant's defenses include a low radar cross section that makes it difficult for a radar-guided antiship missile to find the ship, decoys that provide alternative targets for incoming missiles, medium- and short-range self-defense missiles designed to intercept antiship missiles, and close-in, rapid-fire projectile weapon systems employed as the defense of last resort.

Reducing a ship's radar cross section works in tandem with decoy systems. For example, if a 10,000-ton ship can be made stealthy enough to look like a 3,000-ton ship, it is harder to distinguish from nonmilitary traffic. If the chaff cloud a decoy puts up can look larger than a 3,000-ton ship, the homing radar of an incoming antiship missile will target the "larger" vessel.[10] (For that reason, decoys are not as useful with ships that have very large radar cross sections.) Similarly, reducing a ship's magnetic signature will allow it to thwart many types of mines, and a very low acoustic signature makes the ship less detectable by submarines.

9. Even if the Navy produces new classes of ships with hull forms that reduce their wakes, how will those ships operate? If ships without large wakes are supported by, operate with, or are resupplied by ships that have wakes, they will *all* be detectable. Furthermore, even a ship with a reduced wake may be detectable if an opponent's synthetic aperture radar is powerful enough (down to a one-foot resolution).

10. A chaff cloud is composed of thousands of bits of metal launched adjacent to a ship to make an incoming missile think the cloud is a better target.

New weapon systems could pose problems in the future for ships that were tactically stealthy. Antiship missiles with imaging warheads would not be fooled by the decoy systems that the Navy has now or plans to acquire.[11] Such weapons would aim for targets that matched the images in their on-board computer libraries. Chaff clouds or other decoys would not present an image of a ship to an incoming imaging warhead. The United States is developing and planning to acquire the AIM-9X air-to-air missile. Because that missile will have an imaging warhead, flares will not be a useful defense against it. A similar warhead for an antiship missile has not yet been developed, but it may be only a matter of time before the new technology in air-to-air weapons is applied to antiship weapons.

As is the case with operational stealth, the type of opponents the Navy expects to face over the next 30 years is an important factor in decisions about investing in tactical stealth. Whether many of the United States' potential enemies could afford those new weapon systems in quantity is uncertain. And even if an adversary could afford to buy them, it might not be able to operate them. Still, a rich, technologically sophisticated opponent might eventually find it relatively easy to overcome the tactical stealthiness of future Navy warships.

Unless the threat posed by antiship cruise missiles and diesel-electric submarines is completely eliminated, a ship providing gunfire support to ground forces will be detectable and targetable by the sound of its guns. The new DD(X) destroyer is slated to carry 155-millimeter guns to provide the Marine Corps with naval fire support. An enemy could detect and locate a DD(X) by the firing of its guns, using a series of microphones along the shore and triangulating the ship's position.

This discussion of the value of stealth is not intended to be conclusive. It is meant to raise questions because—as this option illustrates—the cost of a stealthier fleet is high. On the one hand, does it make sense to accelerate the transition to next-generation ships, throwing away many capable ships in the process, when few countries appear to be investing heavily in antiaccess technologies? On the other hand, if the Navy delays that transition too long, will a potential opponent be able to build an antiaccess network far more quickly than the Navy can construct and field highly stealthy, next-generation warships? That trade-off is one of the key issues that the Navy will confront over the next two decades. Clearly, the Bush Administration's choice is to speed up the transition to stealthy, next-generation surface combatants.

Option III: Buy Fewer Next-Generation Ships by Assigning Multiple Crews to New Ship Classes

Under this approach, the Navy would transform the surface combatant force in large part through operating its ships differently. By employing three crews to operate two ships, the Navy could provide as much forward presence as under its 160-ship plan but with a smaller force and for much less money. The Navy is experimenting with a similar crewing concept on some current ships. Nevertheless, for the purposes of this analysis, CBO restricted the new crewing concept to the future ship classes—the DD(X), CG(X), and littoral combat ship—on the premise that designing new ships to accommodate multiple crews would be easier than imposing that change on existing ships.

The 2001 Quadrennial Defense Review implied that transformation should help the U.S. military increase its overseas presence; that increase was mandated by the subsequent Defense Planning Guidance. Some independent analysts have explicitly argued that the Navy should examine different crewing concepts for its ships as part of the overall naval transformation effort.[12]

11. Antiship missiles with imaging warheads are also called coherent seeker warheads or warheads with pattern-matching, automatic target recognition.

12. See Department of Defense, *Quadrennial Defense Review Report* (2001); and Ronald O'Rourke, "Transformation and the Navy's Tough Choices Ahead: What Are the Options for Policy Makers?" *Naval War College Review* (Winter 2001). In addition, the cost and operational effectiveness analysis of the Navy-sponsored Surface Combatant 21 program (the predecessor to the DD(X) program) and the Surface Combatant Force Level Study II both assess, without rejecting, a multiple-crewing concept for future surface combatants.

Table 6.

Estimated Operating Costs for Future Classes of Navy Ships Using Single Crews or Multiple Crews

(In millions of 2003 dollars)

Ship Class	Single-Crewed	Multiple-Crewed
DD(X) Future Destroyer	20	26
Littoral Combat Ship	14	16
CG(X) Future Cruiser	27	34

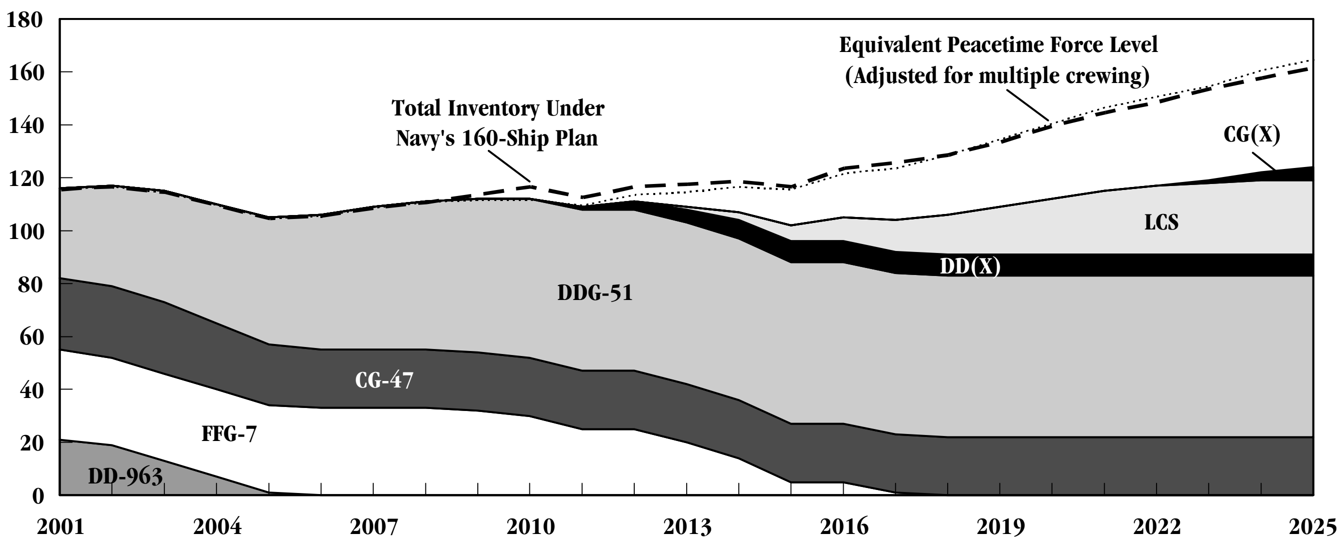
Source: Congressional Budget Office using data from the Navy's Visibility and Management of Operating and Support Costs (VAMOSC) database.

Like the Navy's 160-ship plan, this option would retire all Spruance class destroyers by 2006; modernize all Oliver Hazard Perry class frigates, retiring them by 2018; and convert all but the first five Ticonderoga cruisers, which would be retired by 2006 (see Table 4 on page 24). However, this option would buy 61 Arleigh Burke destroyers instead of 62. More important, it would buy both the DD(X) and the littoral combat ship in reduced numbers: eight and 28, respectively. It would also delay the first purchase of the CG(X) until 2018 and then buy only 15 of them. Because those three classes of next-generation surface combatants would employ three crews for two ships and thus have a higher operating tempo than a single-crewed ship, they would cost more to operate (*see Table 6*). Finally, this option would buy six more combat logistics ships to sustain the large additional forward presence it would provide.

Despite the reduced purchases, this approach would still produce a larger surface combatant force by 2025 than exists today: 124 ships compared with 115 now (*see Figure 9*). Moreover, multiple crewing would make that force equivalent to 165 ships in peacetime—comparable with the Navy's 160-ship plan. Eventually, however, the steady-state force would number 112 ships, slightly smaller than today's force but much more capable. In peacetime presence, that steady-state force would be equivalent to 163 ships. Thus, Option III would achieve a much higher

Figure 9.

Inventory of Surface Combatants Under Option III, 2001-2025

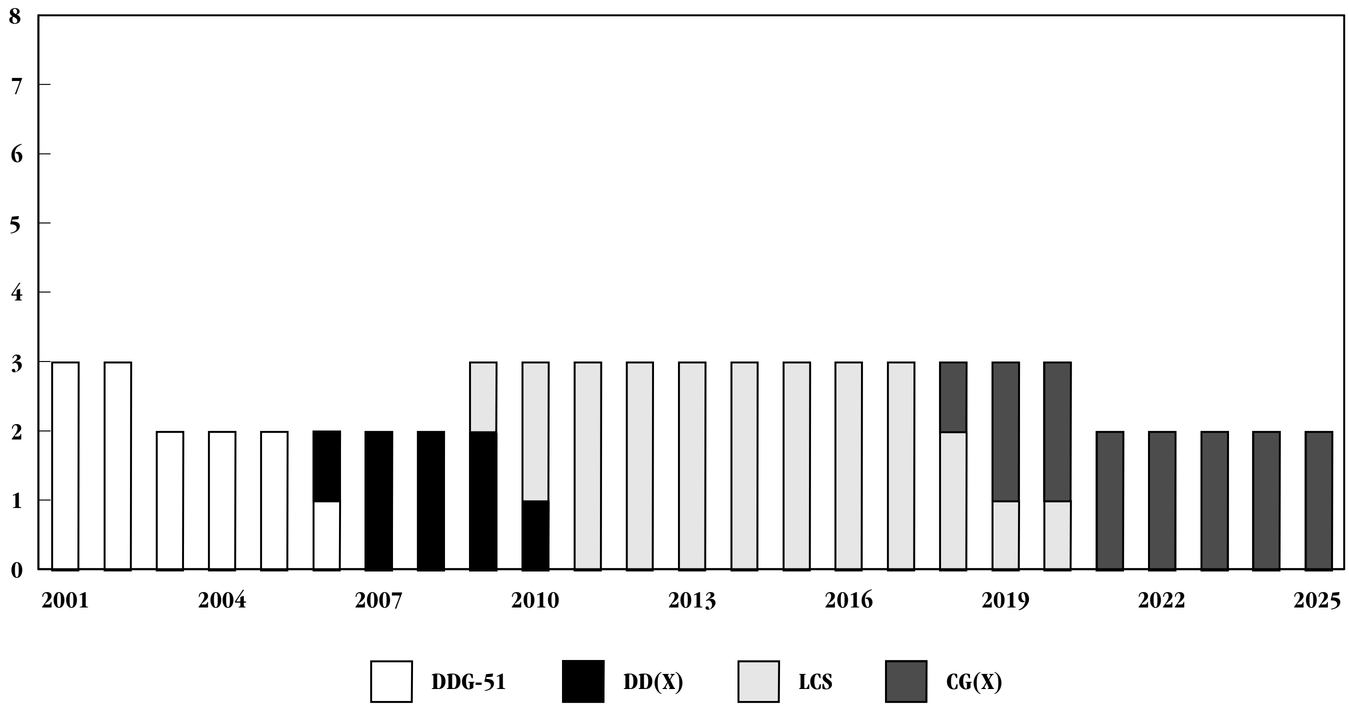


Source: Congressional Budget Office.

Note: DD-963 = Spruance class general-purpose destroyer; FFG-7 = Oliver Hazard Perry class guided-missile frigate; CG-47 = Ticonderoga class guided-missile cruiser; DDG-51 = Arleigh Burke class guided-missile destroyer; DD(X) = future general-purpose destroyer; LCS = littoral combat ship; CG(X) = future guided-missile cruiser.

Figure 10.

Annual Purchases of Surface Combatants Under Option III, 2001-2025



Source: Congressional Budget Office.

Note: DDG-51 = Arleigh Burke class guided-missile destroyer; DD(X) = future general-purpose destroyer; LCS = littoral combat ship; CG(X) = future guided-missile cruiser.

overall level of peacetime capability than the other options but have a lower wartime capability, as multiple crews provide no extra benefit during war. (The number of actual hulls is the wartime force.)

This approach would provide the least amount of shipbuilding work for the industrial base of any of the options analyzed here. Construction rates would increase to a consistent level of three ships a year between 2009 and 2020 (*see Figure 10*), but during that period, one class—the littoral combat ship—would represent most of the annual production. Overall, this option would purchase 58 surface combatants between 2003 and 2025, for an average construction rate of 2.5 ships a year, lower than in Option I.

Average Annual Costs

This approach would do a slightly better job than the other options of conforming to the budgetary constraints of this analysis. Between 2003 and 2010, this option would cost an average of $7.1 billion a year for procurement and operation and support (see Table 5 on page 27). During the succeeding decade, it would cost just $5.6 billion a year, thus imposing the smallest demand on the Navy's budget in the period when the service may want to make major purchases of attack submarines. Between 2021 and 2025, annual costs would rise markedly, to an average of $8.2 billion, reflecting both operating costs for multiple-crewed ships and procurement of large numbers of CG(X) cruisers. (Those costs also include investments in training facilities for the additional crews, which are discussed below.)

How Multiple Crewing Would Work

The Navy is currently experimenting with a new multiple-crewing concept called Sea Swap. Notionally, the crew of a typical surface combatant now spends about 18 months training, performing maintenance, and resting

Figure 11.

Notional Multiple-Crew Deployment Cycle for Future Surface Combatants

Surface Combatant A

On Deployment			At Home		
Crew #1	Crew #2	Crew #3	Crew #2	Crew #3	Crew #1
180 Days	180 Days	180 Days	180 Days (56 at sea)	180 Days (56 at sea)	180 Days (56 at sea)

Surface Combatant B

At Home			On Deployment		
Crew #2	Crew #3	Crew #1	Crew #1	Crew #2	Crew #3
180 Days (56 at sea)	180 Days (56 at sea)	180 Days (56 at sea)	180 Days	180 Days	180 Days

Shore Time

Crew #3	Crew #1	Crew #2	Crew #3	Crew #1	Crew #2
180 Days	180 Days	180 Days	180 Days	180 Days	180 Days

Source: Congressional Budget Office.

before taking its ship on a six-month deployment. In contrast, Sea Swap uses three crews and three ships to keep one surface combatant deployed for 18 months. The first crew takes the ship out on deployment while two other crews continue with their training and maintenance cycles on two other ships. After six months, the second crew flies to an overseas location to meet the deployed ship and relieve the first crew. Six months later, the third crew relieves the second and then brings the ship home for maintenance (or, in the case of Spruance destroyers, retirement) at the end of the 18-month period.

The benefits of Sea Swap are significant. According to the Navy, three ships that each deploy from the United States and return independently after six months will provide a total of 300 days on-station over an 18-month period. By eliminating transit time and allowing time for crews to turn over, the Sea Swap concept increases the amount of presence that each ship provides by 35 percent. Thus, a Sea Swap ship is equivalent to 1.35 ships deploying independently. For simplicity, CBO assumed that none of the surface combatants in any of its options or in the Navy's 160-ship plan would be operated using the Sea Swap concept. To the extent that the concept was used on new ship classes, the relative peacetime advantages of CBO's three options would not be as large as reported here.

To achieve even greater benefits, this option would take the Sea Swap approach one step farther by eliminating one of the two ships that would otherwise remain in the United States. Instead, three crews would take turns operating a pair of surface combatants. When one ship deployed for 18 months, the other would be used for at-sea training by the two crews supporting the forward deployment of the sister ship and its crew.

The schedules of the two surface combatants would be divided into 180-day (six-month) increments (*see Figure 11*):

- The first crew would deploy with the ship for six months, while the second crew trained with the second surface combatant. The third crew would be assigned to shore during that period, where it would conduct more-basic training at shore-based installations. It could also spend a modest amount of time at sea if necessary.

- Near the end of the first six months, the second crew would be flown to the theater of the deployed surface combatant and exchange places with the first crew. The third crew would then assume primary control of the second surface combatant for more-advanced shore training and much more at-sea training. The first crew would fly home and be assigned to shore for rest and to begin the process of basic training all over again. During its first months back in the United States, the first crew would also experience many of its transfers, retirements, and new assignees.

- After the second six-month period, the third crew would rotate out to the deployed surface combatant, eventually bringing it home. The second crew would go ashore and begin the process again. The first crew would assume control of the second surface combatant, eventually taking it on its deployment. When the first surface combatant returned with the third crew, it would become the training ship (or another ship would be substituted for it).

The virtue of that approach, especially when used with newly acquired surface combatants, is that it would save the procurement costs of a third ship. If Sea Swap provides an additional 35 percent of on-station time for each of three surface combatants, this option would provide about a 100 percent increase in on-station time for each of the two surface combatants. In terms of peacetime forward presence, one multiple-crewed surface combatant would be equal to about two single-crewed surface combatants.

Furthermore, over a three-year period, a crew's personnel tempo (the amount of time it spends at sea) would be 44 percent—less than the 48 percent that occurs now with the two-year cycle of a single-crewed surface combatant.[13]

13. Generally, the Navy wants its sailors to spend three years in a sea tour followed by three years in a shore tour.

However, there would be one two-year window during that period in which the crew's personnel tempo was 57 percent. In that period, the Navy (under Department of Defense rules) would have to pay every sailor $100 for each day over 400 days (out of 730) that he or she was deployed or training away from the home port. Even including those costs, multiple crewing is still far more cost-effective than single crewing. The amortized procurement and operating costs for an on-station day for a multiple-crewed DD(X) would be about $800,000, versus $1.8 million for a single-crewed DD(X).[14]

Additional Investments

Making that crewing model work for a large number of surface combatants would require several investments in training and maintenance. First, CBO assumed that the Navy would probably need two new, large training facilities—one on the East Coast of the United States and one on the West Coast—to keep the crews that were not on deployment proficient. Such facilities might require large-scale mock-ups of the ships that would be multiple crewed as well as numerous state-of-the-art training systems and simulators. The Navy does not know how much such facilities might cost, but CBO's cost estimate for this option assumed an average of $100 million per year between 2003 and 2025 to buy and operate those facilities.

Second, because the surface combatant force would have a higher average operating tempo under this option and thus spend more time at sea, CBO assumed that the Navy would need to reactivate a destroyer tender to help provide maintenance overseas and also buy more support ships to keep the surface combatants resupplied. Under this approach, the surface combatant force could have almost 50 percent more ships deployed than today's force does,

14. Although higher maintenance costs may be necessary for a multiple-crewed ship (and CBO included such higher costs in its analysis), CBO assumed that the ship would still have a notional service life of 35 years. Multiple-crewing models for attack submarines assume a reduction in service life because the submarines consume nuclear fuel faster and because their hulls are subject to far more strain than those of surface ships. When that strain becomes too great, it can result in catastrophic hull failure, killing an entire submarine crew. The hull and systems of a surface ship can often last much longer than the ship's notional service life. Surface combatants are usually retired because their combat systems become obsolete and the Navy either is unable to update them or is not willing to spend money to do so for a relatively old ship.

and many of those ships would spend one-third less time in port. Thus, it stands to reason that an additional maintenance ship might be necessary overseas to make this option work. Consequently, CBO assumed that the Navy would return one destroyer tender now in the Reserve to the active-duty force. The costs to operate that ship—about $50 million a year—are included in the costs of this option discussed above, as are the costs to buy and operate six more combat logistics ships to provide additional logistics support.

CHAPTER

3

Measures of Capability Under the Various Options

To evaluate the different force structures described in Chapter 2 and how they compare with the 30-Year Shipbuilding Report and the Navy's 160-ship plan, the Congressional Budget Office used a variety of measures of both peacetime and wartime capability. The principal measures are:

- The total number of surface combatants,
- The number capable of providing long-range fleet air defense,
- The number of helicopter hangars on those surface combatants,
- The total number of vertical launch system cells on those ships,
- The number of penetrating littoral antisubmarine warfare suites that they carry,
- The number of 155-millimeter advanced gun systems and 5-inch guns capable of firing the extended-range guided munition (ERGM) in the surface combatant force to provide long-range fire support for the Marine Corps,
- The total number of next-generation ships,
- The average age of the surface combatant force, and
- The total crew size.

The Navy's principal mission in peacetime is maintaining a combat-credible forward presence, so arguably the most important measure of how well the surface combatant force performs during peacetime is the capabilities it has on-station (in its theaters of operations). In wartime, a better measure is how much actual firepower the force can bring to bear in a particular period. Thus, for each of the measures listed above, CBO calculated a given force structure's capability on-station in peacetime and its surge capacity 14 days and 36 days after the beginning of a wartime mobilization.[1]

The measures that CBO examined offer a fairly reliable guide to a given force's ability to provide ships for peacetime naval presence, wartime surge, air and missile defense, land attack, and operations against small, fast boats. Measuring the ability of a force to conduct antisubmarine warfare in coastal areas or to counter mines is more difficult. Success in performing those missions will depend heavily on the new systems that the Navy plans to develop over the next 10 to 15 years—some or most of which may

1. CBO does not have access to the campaign analysis models that the Navy uses to analyze the demand for ships during wartime. To calculate wartime surge in this analysis, CBO used data from the Surface Combatant Force Level Study II, which reported wartime surge numbers—based on a surface combatant force of 116 ships—for Northeast Asia and the Persian Gulf. The model reported that at the 13- to 14-day point, 22 percent of the surface combatant force could have "surged" (arrived in-theater) to Northeast Asia, and 15 percent could have surged to the Persian Gulf. At 36 days, 66 percent of the force could have surged to Northeast Asia and 50 percent to the Persian Gulf.

be unmanned. For the purposes of this analysis, however, a reasonable proxy for antisubmarine warfare is the number of penetrating littoral ASW suites that will be deployed on DD(X)s and littoral combat ships, as well as the number of helicopter hangars in the surface combatant force. The number of helicopter hangars also provides some insight into a force's ability to defeat mines because surface ships deploy helicopters to carry mine-detection systems.

CBO's measures of capability have limitations, however. If transformation is judged by whether the future surface combatant force is larger, carries more VLS cells, has more land-attack capability, and incorporates more fleet air-defense capability than today's force, the measures that CBO has used will be revealing. But if, as some naval analysts maintain, the test of naval transformation is whether the surface combatant force can defeat diesel-electric submarines, mines, and small, fast boats armed with cruise missiles, these measures will not capture all aspects of those potential missions. As noted above, for those missions, the Navy expects eventually to rely heavily on new unmanned underwater, air, and surface vehicles. Because those vehicles have not yet been developed, their effectiveness cannot be determined or captured by any measure that CBO has available.

Another potential criticism of CBO's measures is that they are simple and ignore potentially significant changes in systems, tactics, and doctrine associated with transformation. The Navy is investing heavily in what it calls FORCEnet—an effort to link all of the communication, sensor, and warfare systems of Navy ships so that every ship in a task force receives the same tactical data. CBO's measures do not quantitatively capture the benefits of that effect or even the benefits of a general improvement in sensors and communications or the potential to upgrade the weapons of a particular platform. If a group of networked ships is more capable and lethal than the same group of unnetworked ships, it may also be true that new ships built with networking in mind will be substantially more capable than existing ships that have been networked together. CBO's measures do not reflect such an effect. Thus, they may underestimate the capabilities offered by Option II (which would speed up the transition to next-generation ships) and, by implication, the Navy's 160-ship plan (which would also retire older surface combatants early and accelerate the development and procurement of new ships). As of this writing, neither the Navy, CBO, nor any studies that CBO is aware of have been able to quantify the operational and tactical benefits of those improvements.[2]

Finally, in choosing its measures, CBO hoped to address the tension between numbers and capabilities that exists in deciding how to alter the size and composition of the surface combatant force. Some Navy officials contend that the service needs more ships, while others argue that the emphasis should be on fleet capabilities. For example, recently departed Secretary of the Navy Gordon England stated that, "it is capabilities, not numbers that matter . . . our 300 ships are far more potent than our 600-ship Navy [was]."[3] At the same time, Admiral Vernon Clark, Chief of Naval Operations, has maintained that the Navy needs 375 ships to do all of the things asked of it, adding, "You can only be in one place at one time with one ship and so numbers do matter. Numbers do have a quality all their own."[4] Although neither man would disagree with the other's viewpoint, those quotations capture the tension in planning future naval force structure. By examining a variety of numerical and qualitative measures in terms of peacetime presence as well as wartime surge, CBO has attempted to address both sides of that issue.

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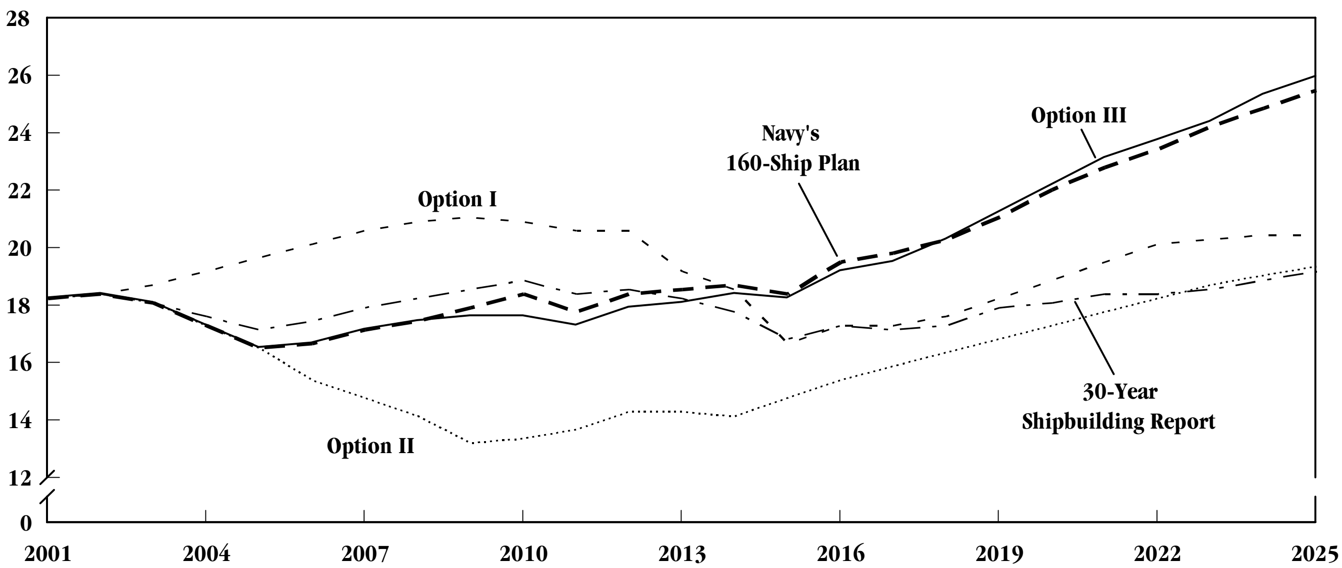
2. Quantifying the effects of such improvements may be impossible until they are developed and deployed. Intuitively, it makes sense that better information will enable naval forces to fight more effectively. For example, the invention of radar and sonar allowed air and naval forces to fight better, but quantifying how much better was impossible when those ideas were still in the technical development stage. For one attempt to solve that problem, see Walter Perry and others, *Measures of Effectiveness for the Information-Age Navy: The Effects of Network-Centric Operations on Combat Outcomes* (Santa Monica, Calif.: RAND, 2002). But as that report states at the outset, "the process reported in this document is deductive—i.e., none of the equations presented in the text was based on experimental or operational data."

3. Gopal Ratnam, "U.S. Navy Wrestles with Fleet Size, Abilities," *Defense News* (July 1, 2002), p. 4.

4. "Interview with Chief of Naval Operations Admiral Vern Clark," *Sea Power* (October 2002). See also Hunter Keeter, "Admiral Foresees Change in Naval Force Structure, Warfighting," *Defense Daily* (September 12, 2002), p. 9; and Ratnam, "U.S. Navy Wrestles with Fleet Size, Abilities."

Figure 12.

Number of Surface Combatants On-Station in Peacetime Under Alternative Force Structures, 2001-2025



Source: Congressional Budget Office.

Note: Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

Number of Surface Combatants

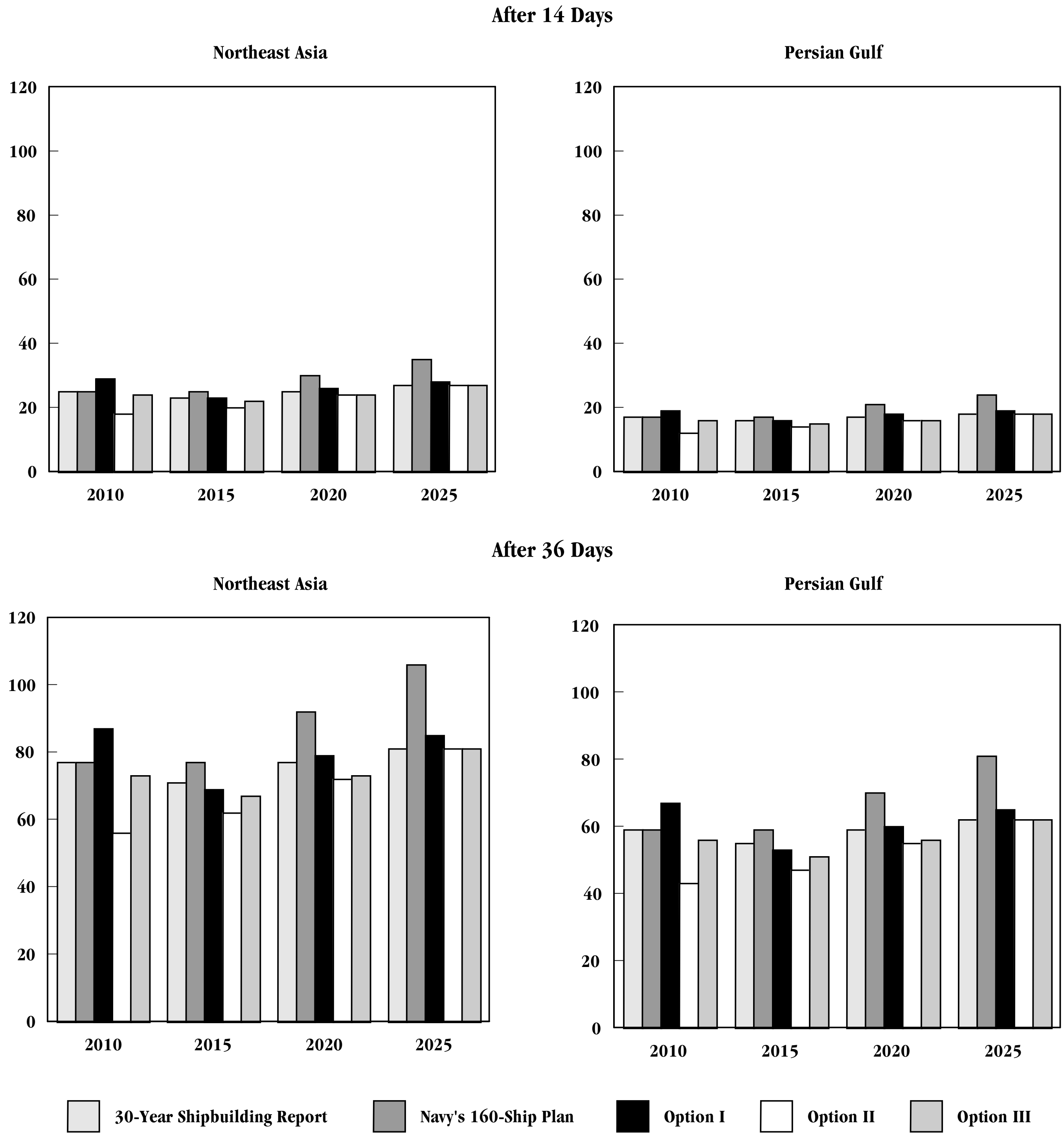
The number of surface combatants in the fleet measures how many ships the Navy can keep on-station in peacetime and how many potential combatants it has in wartime. Although numbers alone do not determine how capable the force is, they are the first measure to which most people turn.

With respect to peacetime, the number of surface combatants on-station around the world varies significantly between the 30-Year Shipbuilding Report and the Navy's 160-ship plan (discussed in Chapter 1) and CBO's three options (discussed in Chapter 2). CBO computed the number of ships on-station using a simple arithmetic model based on data provided by the Navy. On average, it takes about 6.3 single-crewed or 3.2 multiple-crewed surface combatants to keep one of them on-station at any given time. On the basis of those figures, Option I would provide the greatest number of surface combatants on-station over the next 10 years, peaking at about 21 in the 2007-2012 period (*see Figure 12*). By retaining and upgrading the Navy's older ships, that option would maintain a far higher level of overseas presence than any other approach discussed in this study. Conversely, Option II, by retiring more existing ships early, would provide the smallest number of ships on-station: 13 in 2009. After that, however, Option III (which would use multiple crewing on next-generation ships) and the Navy's 160-ship plan would achieve the highest level of overseas presence: 26 ships on-station by 2025.

In the wartime analysis, CBO calculated the number of ships that could be in-theater in Northeast Asia or the Persian Gulf 14 days and 36 days into a wartime surge. As in the peacetime case, the results vary significantly depending on the year being examined. Option I would fare the best in 2010 in wartime as well as peacetime by providing more surface combatants for a conflict in either location (*see Figure 13*). In 2025, all three options discussed in Chapter 2 would perform almost equally well because, by that time, they would have roughly the same size surface combatant force.

Figure 13.

Number of Surface Combatants That Could Be Surged to Northeast Asia and the Persian Gulf in Wartime Under Alternative Force Structures, 2010-2025

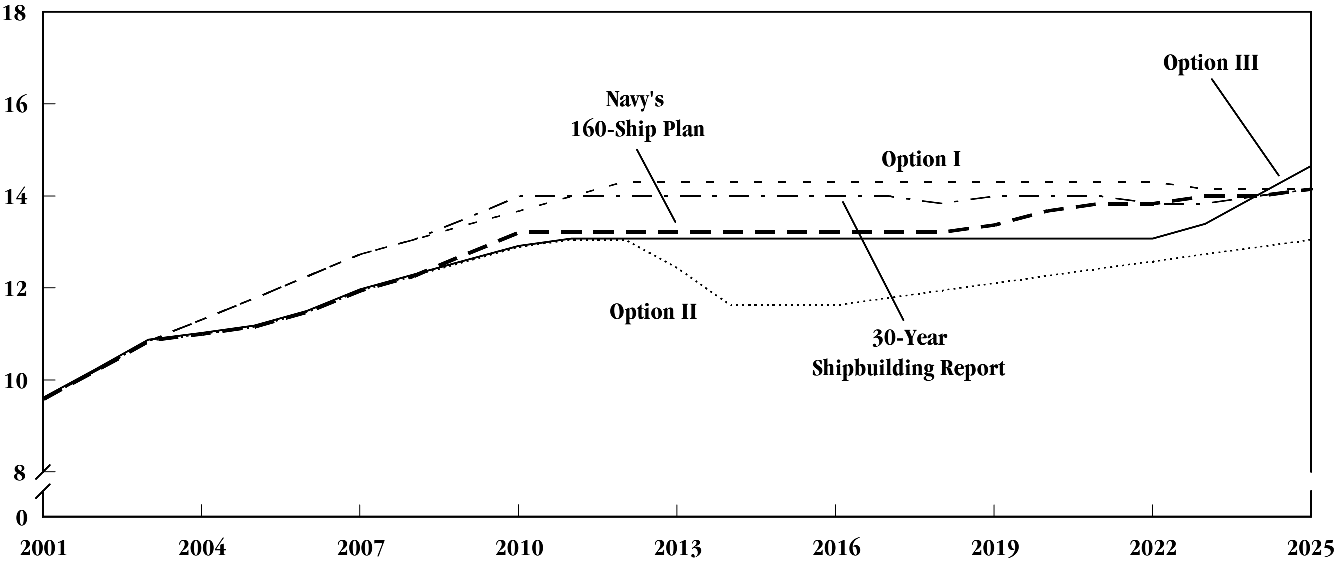


Source: Congressional Budget Office.

Note: Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

Figure 14.

Number of Ships Capable of Long-Range Air and Missile Defense On-Station in Peacetime Under Alternative Force Structures, 2001-2025



Source: Congressional Budget Office.

Note: Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

For example, in a war in the Persian Gulf in 2010, Option I would provide 19 surface combatants after 14 days; Option II, only 12; Option III, 16; and the Navy's 160-ship plan, 17. As the war proceeded, the numbers would jump considerably. After 36 days, Option I would bring 67 surface combatants to the fight; Option II, only 43; and the others, 56 to 59.

If that war occurred in 2025, however, the story would be very different. After 14 days, the Navy would be able to bring 24 surface combatants to the fight under its 160-ship plan, compared with 18 to 19 under the other approaches. By that time, Option I would have lost its advantage, and Option II would fare as well as the other approaches. A similar pattern would be visible 36 days after the start of wartime mobilization.

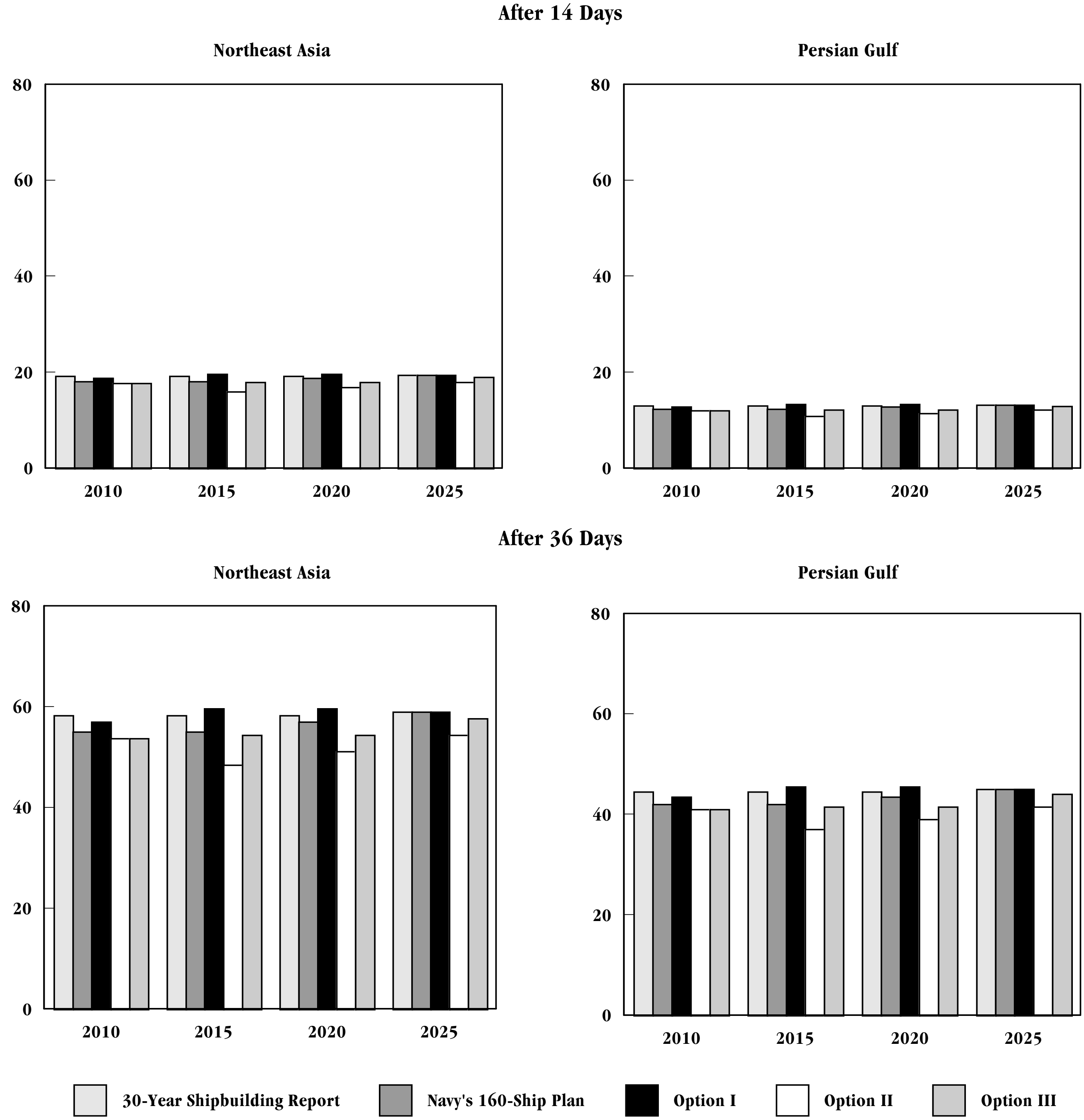
Ships Capable of Long-Range Fleet Air and Missile Defense

Over the past 20 years, the development of the Aegis combat system has introduced a major improvement in fleet air defenses and naval operations. Surface ships can now perform missions in environments that have greater threats from enemy aircraft and missiles without requiring the support of an aircraft carrier. The Navy can therefore provide more presence in more places than it could before the Aegis system was developed. For that reason, the Navy continues to invest in Aegis ships and plans to eventually have more than 80 surface combatants capable of long-range air defense. The importance of that investment was illustrated by a Navy spokesman when he said (somewhat inaccurately), "If it's not Aegis, it simply doesn't have a significant role in our future."[5] For this measure of capability, CBO chose to interpret "Aegis" in that comment to mean ships capable of defending a fleet from long-range air and missile attack. Ships such as the DD(X) and LCS are not counted in this measure, but the CG(X), which is expected to have a next-generation air-defense system, is included.

5. Quoted in Pat Towell, "Navy Caught in Budget Squeeze as Urgency to Build Ships Grows," *Congressional Quarterly Weekly* (February 23, 2002).

Figure 15.

Number of Ships Capable of Long-Range Air and Missile Defense That Could Be Surged to Northeast Asia and the Persian Gulf in Wartime Under Alternative Force Structures, 2010-2025

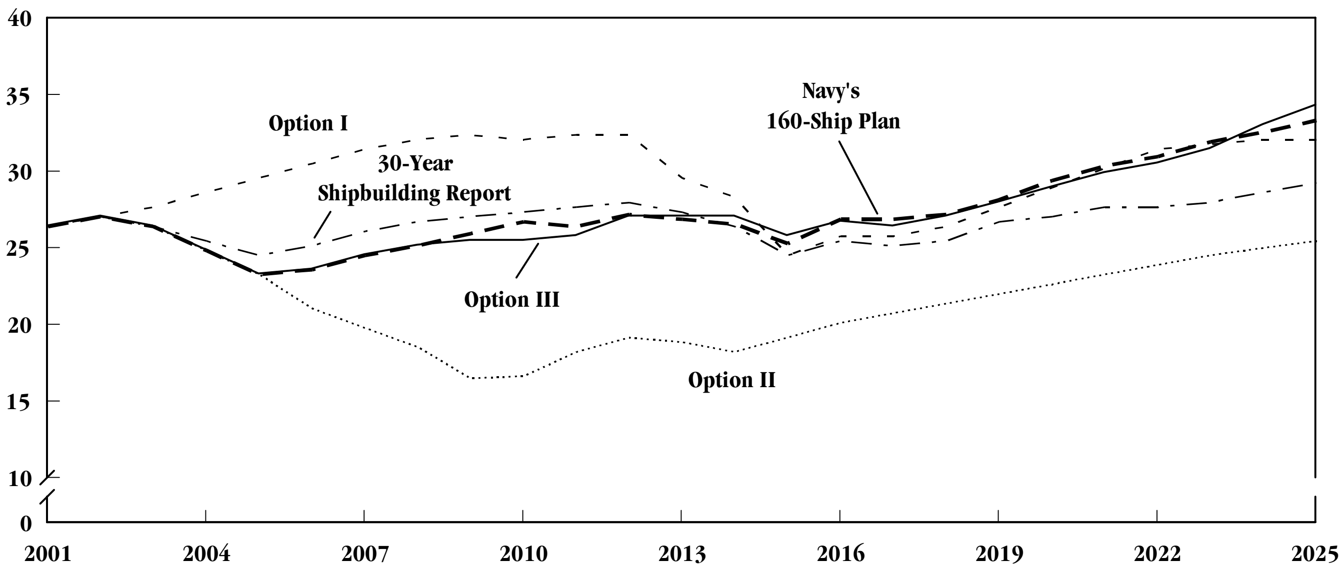


Source: Congressional Budget Office.

Note: Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

Figure 16.

Number of Helicopter Hangars On-Station in Peacetime Under Alternative Force Structures, 2001-2025



Source: Congressional Budget Office.

Note: Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

By this measure, Option I would perform the best in peacetime almost throughout the entire period because it would retain all of the Ticonderoga class cruisers and upgrade them *(see Figure 14 on page 43)*. The 30-Year Shipbuilding Report would perform almost equally well, although cruiser conversions were not included in that plan. The Navy's 160-ship plan would fall slightly short of Option I in peacetime fleet defense, reflecting five fewer cruisers and two fewer Arleigh Burke class destroyers. Option II would fare the worst throughout the 2003-2025 period according to this measure because it would retain and upgrade only 13 Ticonderogas. Significant changes would occur between 2019 and 2025, however. In 2019, the number of fleet air-defense ships in the Navy's 160-ship plan would begin to grow because of the apparent overlap between the cruiser conversion and CG(X) programs. By 2023, Option III would begin to reap the benefits of using multiple crews on the CG(X) cruiser. Despite those differences, all of the approaches that CBO examined would be far more capable than today's surface combatant force with respect to long-range fleet air and missile defense.

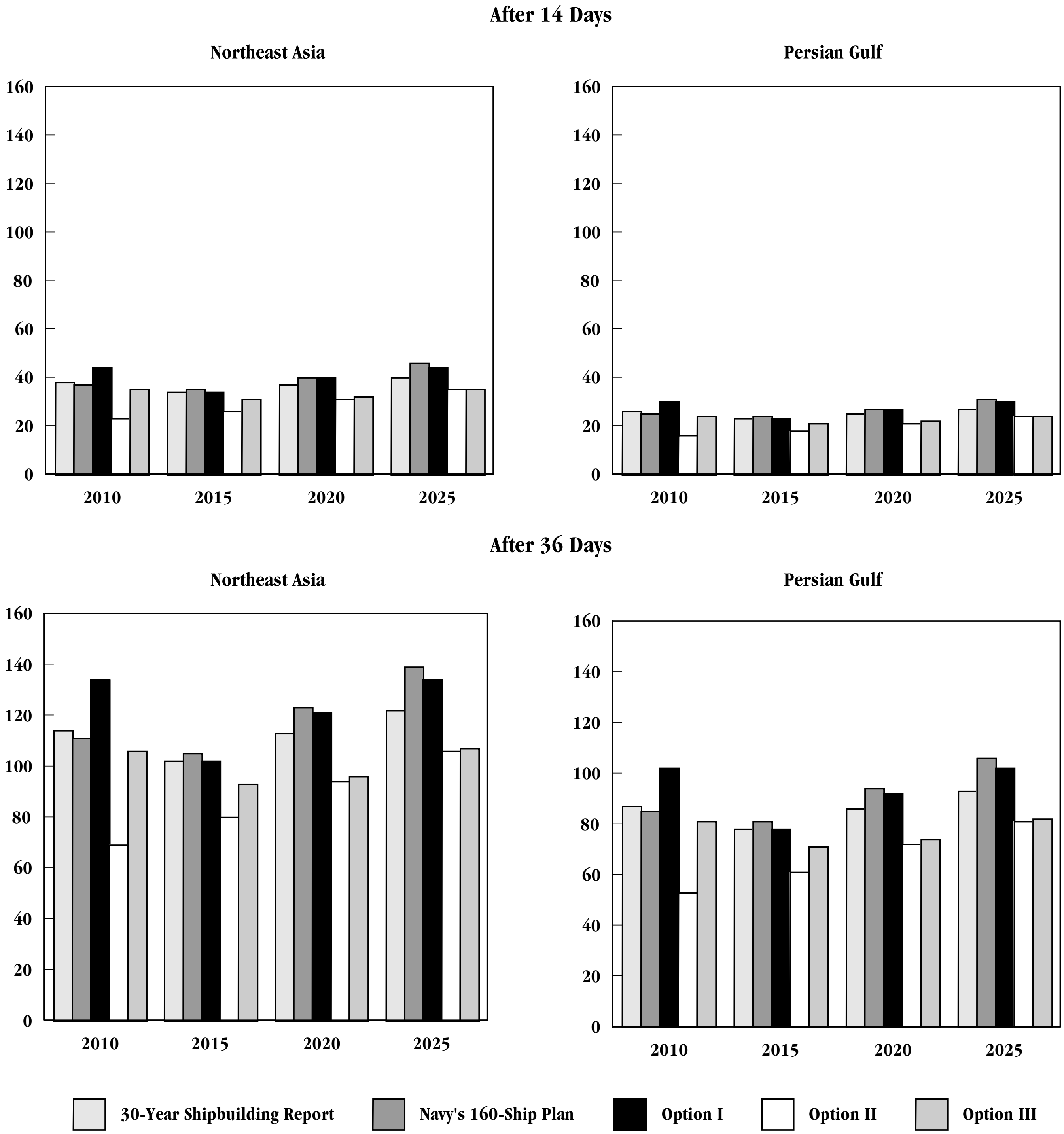
Similar patterns are evident for wartime surge. All of the force structures discussed in this study would provide essentially the same number of ships capable of long-range air and missile defense in Northeast Asia and the Persian Gulf early in a conflict (*see Figure 15*). As a war progressed, however, the 30-Year Shipbuilding Report, the Navy's 160-ship plan, and Option I would put a larger number of ships in-theater than Options II and III would.

Helicopter Hangars

Generally, the most effective weapon against quiet diesel-electric submarines and small, fast boats armed with torpedoes or cruise missiles is a helicopter equipped with missiles. Counting the number of helicopter hangars on surface ships reveals the number of helicopters that the Navy could have available to counter such threats. The more hangars available on-station during peacetime or in-theater during a war, the more flexible the surface combatant force is, and the better equipped it will be to perform its missions, particularly defeating antiaccess threats.

Figure 17.

Number of Helicopter Hangars That Could Be Surged to Northeast Asia and the Persian Gulf in Wartime Under Alternative Force Structures, 2010-2025

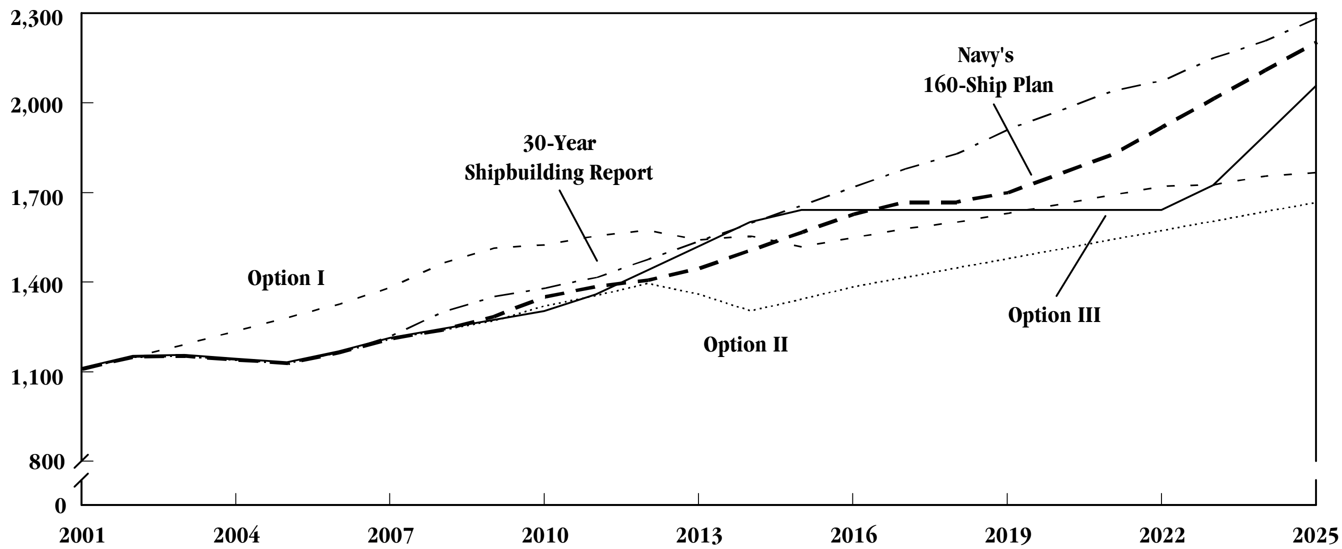


Source: Congressional Budget Office.

Note: Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

Figure 18.

Number of VLS Cells on Surface Combatants On-Station in Peacetime Under Alternative Force Structures, 2001-2025



Source: Congressional Budget Office.

Notes: VLS = vertical launch system.

Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

During both peacetime and wartime, Option I would outperform the other options through 2014 because it would retain Spruance class destroyers, which are capable of embarking two helicopters apiece. In peacetime, Option I would provide a substantially greater number of helicopter hangars on-station between 2003 and 2014 than any other force structure (*see Figure 16 on page 45*). After 2014, the Navy's 160-ship plan and Option III would provide about the same amount of helicopter capability.

In wartime, the results are similar. Option I would provide the most helicopter hangars during a surge to either Northeast Asia or the Persian Gulf in 2010. By 2025, Options II and III would provide about the same amount of capability as each other. Only the Navy's 160-ship plan would be able to surge substantially higher numbers of helicopter hangars: 139 to Northeast Asia and 106 to the Persian Gulf in 36 days (*see Figure 17*). Option I would provide the next highest numbers: 134 and 102, respectively. Options II and III would put the fewest hangars in-theater during that time: about 100 in Northeast Asia and 80 in the Persian Gulf.

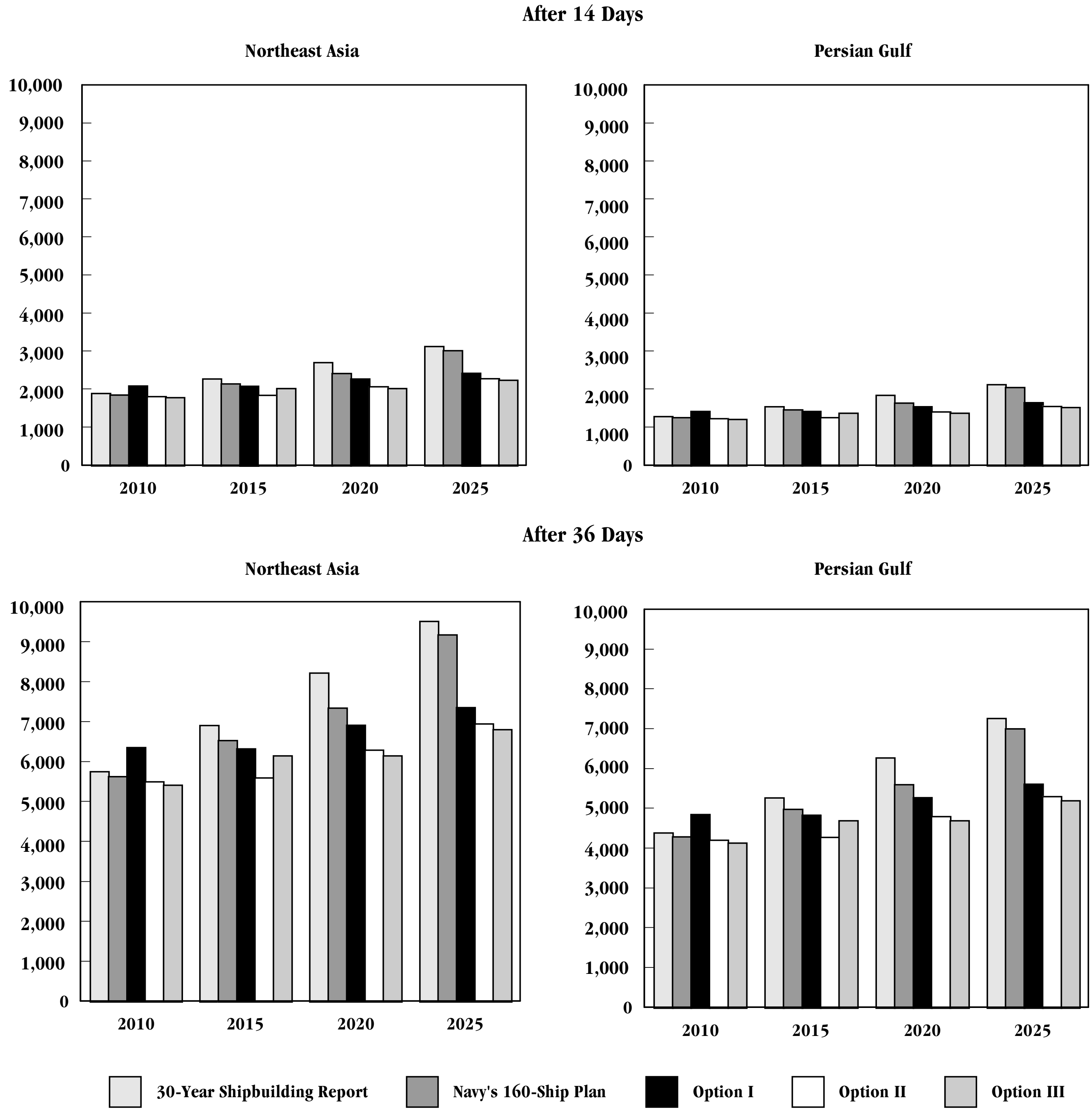
Vertical Launch System Cells

The development and deployment of VLS cells have played an important role in vastly increasing the capability of surface ships. In peacetime, the Navy's regional combatant commanders require a certain number of Tomahawk missiles to be on-station in their respective theaters. Those Tomahawks are usually launched from VLS cells (although not every cell on a surface ship is filled with land-attack missiles). Thus, the number of VLS cells can be used to approximate how well a force structure would meet those peacetime requirements. In addition, given the premium that the Defense Planning Guidance puts on winning wars quickly with forward-stationed forces, this measure can serve as a proxy for combat power on the first day of a war. As the war proceeds, however, the number of VLS cells that can be surged to a theater approximates the ability of the surface combatant force to conduct long-range strike operations in support of military objectives.[6]

6. CBO did not use the actual number of Tomahawks deployed on surface ships as a measure because that number can and will vary depending on the mission that a given ship is assigned to perform.

Figure 19.

Number of VLS Cells on Surface Combatants That Could Be Surged to Northeast Asia and the Persian Gulf in Wartime Under Alternative Force Structures, 2010-2025



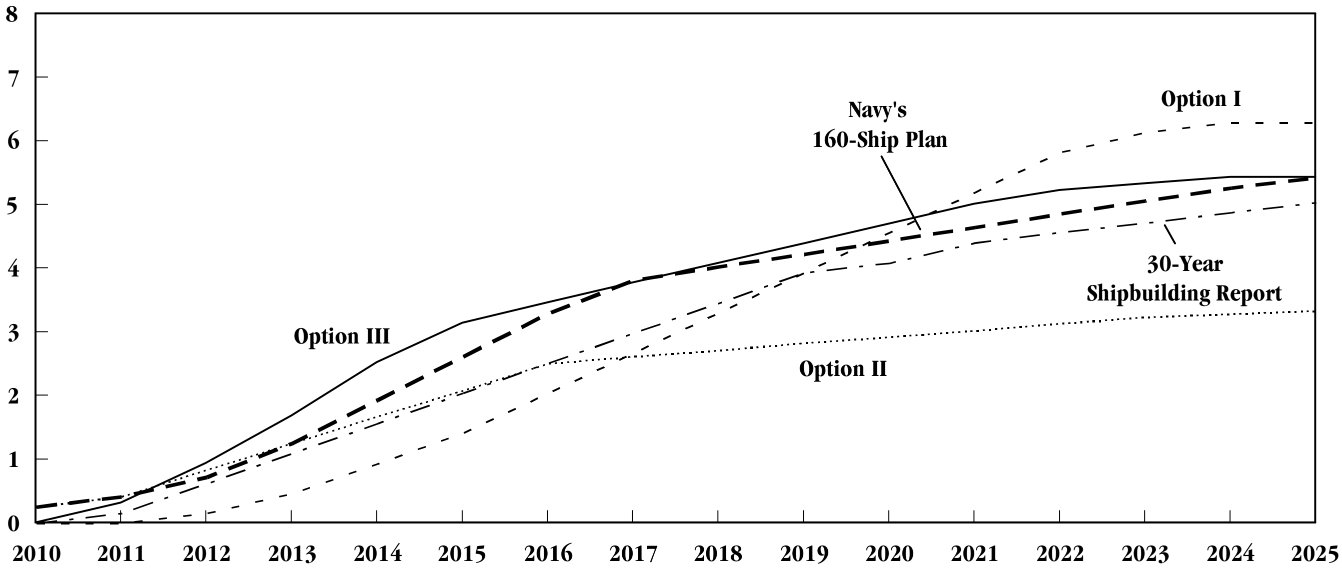
Source: Congressional Budget Office.

Notes: VLS = vertical launch system.

Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

Figure 20.

Number of Ships with Penetrating Littoral ASW Suites On-Station in Peacetime Under Alternative Force Structures, 2010-2025



Source: Congressional Budget Office.

Notes: ASW = antisubmarine warfare.

Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

As with many of the previous measures, Option I holds a significant advantage over the alternatives in the number of VLS cells through about 2012 (*see Figure 18 on page 47*). The reason is that Option I would retain the Spruance class destroyers—which each carry 61 VLS cells (normally armed with Tomahawks)—through their 35-year service life. None of the other force structures would do that. On average, Option I would be able to keep about 140 more VLS cells on-station than any other option would. After the Spruances retired, however, Option I would lose its advantage for the rest of the period of this analysis. After 2012, the plan outlined in the 30-Year Shipbuilding Report would outperform the alternatives because it is the only one that would buy 32 DD(X) destroyers, each carrying 128 VLS cells. By 2025, that force structure would still yield the most cells, although the Navy's 160-ship plan would produce similar results. Options I and II would provide the least cells.

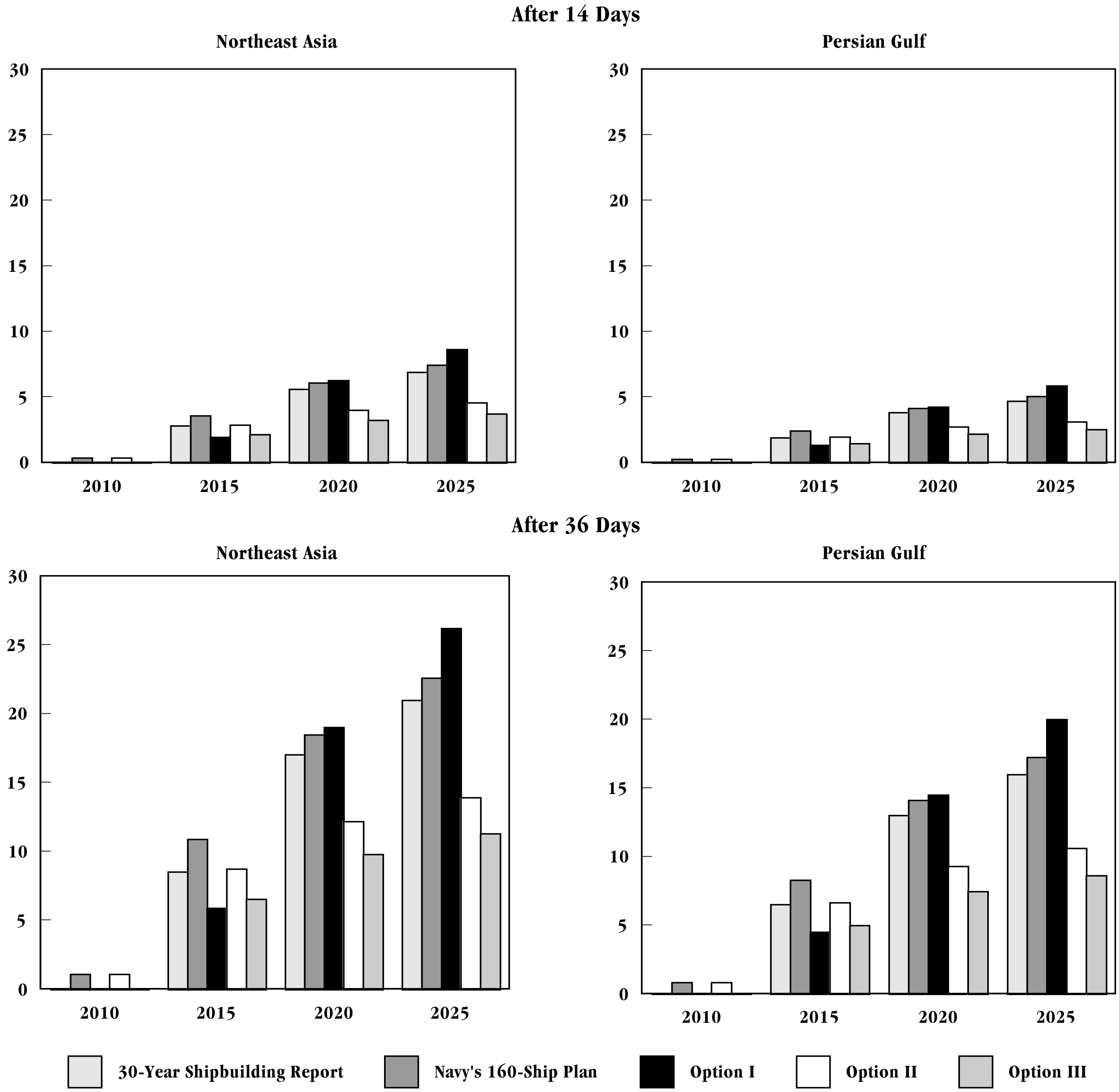
That pattern would also occur in the event of war. During a wartime surge, Option I would put more VLS cells in-theater in 2010 than any other approach, but by 2025, it would fall behind both the 30-Year Shipbuilding Report and the Navy's 160-ship plan (*see Figure 19*). However, in both theaters and in various years, Option I would outperform the other options with limited budgets because all of the new frigates that it would buy would carry 48 VLS cells, unlike the littoral combat ship included in the Navy's 160-ship plan and Options II and III.

Penetrating Littoral Antisubmarine Warfare Suites

The ASW combat system on today's cruisers, destroyers, and frigates (the AN/SQQ89) was designed primarily for open-ocean warfare against Soviet submarines. The AN/SQQ89 has been modernized to give it some shallow-water capabilities. Nevertheless, a better indicator of the ASW prowess of a future surface combatant force might be the number of ships equipped with a new ASW system that was designed from the outset to sweep for submarines in littoral waters.

Figure 21.

Number of Ships with Penetrating Littoral ASW Suites That Could Be Surged to Northeast Asia and the Persian Gulf in Wartime Under Alternative Force Structures, 2010-2025



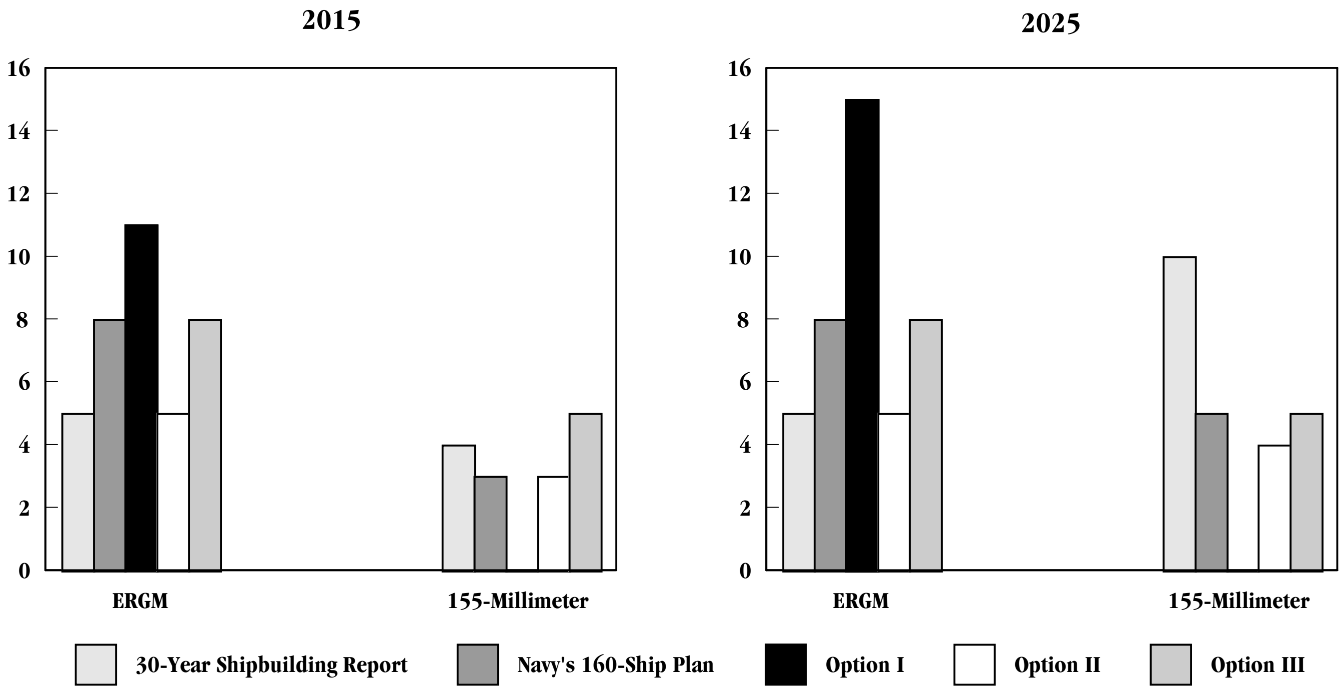
Source: Congressional Budget Office.

Notes: ASW = antisubmarine warfare.

Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

Figure 22.

Amount of Gunfire Support On-Station in Peacetime Under Alternative Force Structures, 2015 and 2025



Source: Congressional Budget Office.

Notes: ERGM = extended-range guided munition.

Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

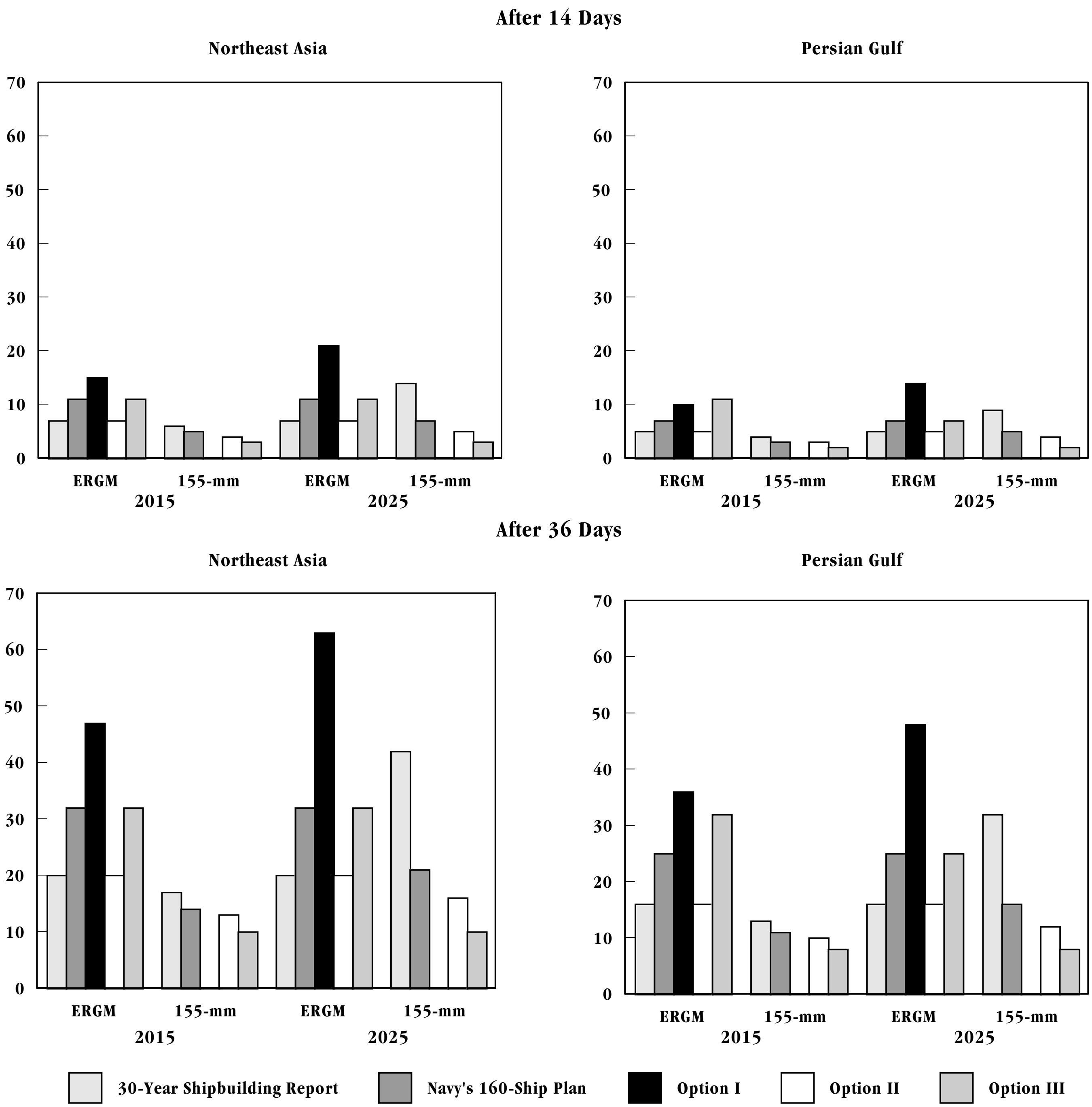
For this analysis, CBO assumed that the littoral combat ship, the DD(X), and the FFG(X) envisioned in Option I would have such littoral ASW systems. Littoral combat ships are intended to be focused-mission ships, however, so CBO assumed that only one-third of them would be equipped with the littoral ASW module at any one time. CBO included the DD(X) in this group because, historically, general-purpose destroyers have been assigned the ASW mission, even though in practice Navy commanders might be reluctant to use such an expensive ship for littoral antisubmarine warfare. The CG(X) could also have a new ASW system, but that ship would probably not be used for early-penetration operations since its primary mission is supposed to be fleet air and missile defense.

With respect to peacetime forward presence, Option III would provide the most new ASW capability through 2020 because of the multiple-crewing concept used for new ship classes (*see Figure 20 on page 49*). After that, however, Option I's new frigates—all of which are assumed to be capable of antisubmarine warfare—would provide the largest forward-deployed force. The Navy's 160-ship plan would be in the middle of the pack. Option II would provide the least new ASW capability because its LCS force is limited to 30 ships, so only 10 are assumed to be configured for antisubmarine warfare.

In wartime, the pattern would be different. The Navy's 160-ship plan would put the most littoral ASW capability in-theater until 2020 (*see Figure 21*). But after that, Option I's frigates would again hold sway. Option III would lose its advantage in these scenarios because multiple crewing provides no extra benefit in wartime, and that option's force structure would have the smallest number of next-generation ASW ships available.

Figure 23.

Amount of Gunfire Support That Could Be Surged to Northeast Asia and the Persian Gulf in Wartime Under Alternative Force Structures, 2015 and 2025



Source: Congressional Budget Office.

Notes: ERGM = extended-range guided munition; mm = millimeter.

Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

ERGM and 155-Millimeter Guns

As noted earlier, one of the principal missions of surface combatants is to provide fire support to Marine amphibious forces. Historically, that support was provided by the conventional guns that surface ships carry. With the final retirement of the Iowa class battleships, however, the largest gun on a Navy ship was 5 inches and 54 caliber, with a range of about 13 nautical miles. Although many Marines have never considered the 5-inch gun adequate for their fire-support needs, it is at least capable of providing gunfire for a Marine landing on a beach.

The Marine Corps's future warfighting doctrine envisions flying over beaches and dropping Marines farther inland to avoid area-denial threats (such as mines and diesel-electric submarines) or troop concentrations close to shore. That doctrine will require much longer range fire support from both guns and missiles. In response, the Navy is developing the extended-range guided munition (ERGM), a rocket-propelled projectile shot from a 5-inch, 62-caliber gun, which is capable of going 63 nautical miles. In addition, as was discussed in Chapter 1, the new DD(X) destroyer will carry one or two 155-mm guns, which are intended to be much more powerful than 5-inch guns and capable of firing rocket-propelled projectiles up to 100 nautical miles. Because few ERGM-capable guns and no 155-mm guns are in the fleet today, CBO used the numbers of those weapons in the surface combatant force as a measure of future fire-support capability.

The number of guns on ships that are forward deployed around the globe in peacetime measures the availability of gun firepower in the event that the Marines need to conduct an operation very quickly. Between now and 2015, the force structures discussed in this study would provide roughly similar amounts of firepower on-station during peacetime—with the exception of Option I, which would have no 155-mm guns because it would cancel the DD(X) destroyer but would have a much larger number of ERGM-capable guns (*see Figure 22 on page 51*). By 2025, there would be notably more variance with respect to the 30-Year Shipbuilding Report, which would have twice as many 155-mm guns as other force structures because it would buy 32 DD(X) destroyers and no littoral combat ships. The only other significant difference is that it and Option II would have fewer ERGM-capable guns since Option II would cancel much of the cruiser conversion program, which proposes putting those weapons on about half of the Ticonderoga class cruisers.

In the event of war in 2015, the surface combatant force of the Navy's 160-ship plan would put the largest total number of guns in the theater of operations after 14 or 36 days (*see Figure 23*). Option I could not put any 155-mm guns in-theater. Option III would surge fewer 155-mm guns than the alternatives would because its dual-crewed DD(X) destroyers would be fewer in number than under either Option II or the Navy's 160-ship plan. In 2025, the force structure of the 30-Year Shipbuilding Report would provide the most firepower. It would put the same total number of guns in-theater as Option I, but two-thirds of them would be 155-mm guns.

Next-Generation Ships

As a final measure of capability, CBO looked at the number of next-generation ships in each surface combatant force. Next-generation ships include the DD(X), the CG(X), the littoral combat ship, and the new frigate included in Option I. This measure captures how effectively the transition to next-generation ships has occurred as well as assessing how stealthy the surface combatant force is. Because stealth in surface ships is not necessary to perform peacetime missions, it should be regarded primarily as a wartime measure.

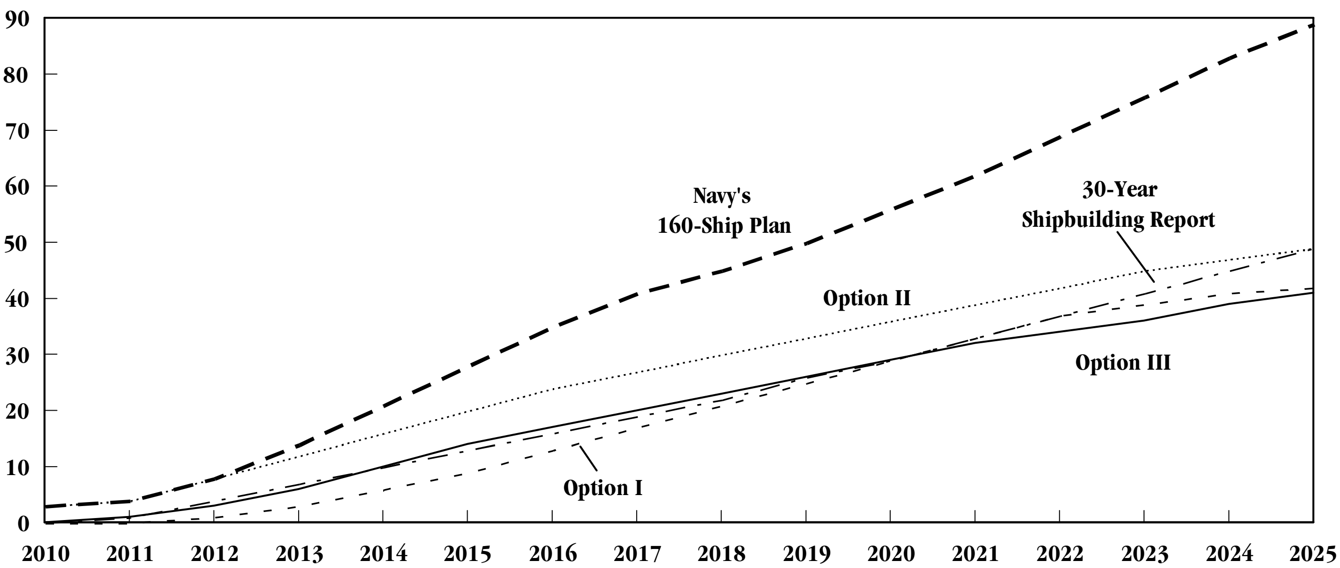
Under this measure, the surface combatant force implied by the Navy's 160-ship plan would have by far the most next-generation ships between 2010 and 2025 (*see Figure 24*). Option II, with its emphasis on a speedy transition, would have the next-largest number of next-generation ships. Options I and III and the 30-Year Shipbuilding Report would be close together at the back of the pack for much of the 2010-2025 period.

Total Crew Size

The total number of sailors serving on surface combatants provides a useful measure of how many sailors could be put at risk in a wartime situation as well as the Navy's potential difficulty in recruiting. Options that required more sailors would obviously pose a greater recruiting challenge. Conversely, if next-generation ships needed fewer sailors to run them, they might require better edu-

Figure 24.

Total Number of Next-Generation Ships Under Alternative Force Structures, 2010-2025



Source: Congressional Budget Office.

Note: Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

cated and more technically trained personnel than older ships do. Thus, options with larger numbers of next-generation ships might necessitate more higher-ranking officers and, especially, enlisted personnel.

Of the approaches in this study, Option I would have the most demanding crew requirements through 2014 (*see Figure 25*). By retaining and operating the legacy fleet, it would not benefit from a smaller force structure and thus from lower personnel requirements. After 2020, the Navy's 160-ship plan would have the largest personnel requirements because it would have by far the biggest force structure. By 2025, Option III (which would use three crews for two ships of each new class) would have the second-highest personnel requirements. Option II would place the least pressure on the Navy's personnel system because its surface combatant force would be smaller than those of Options I and III and the Navy's 160-ship plan. (Option II's force structure would be larger than that of the 30-Year Shipbuilding Report, on average, but the latter's ships would require higher personnel levels than many of the ships in Option II.)

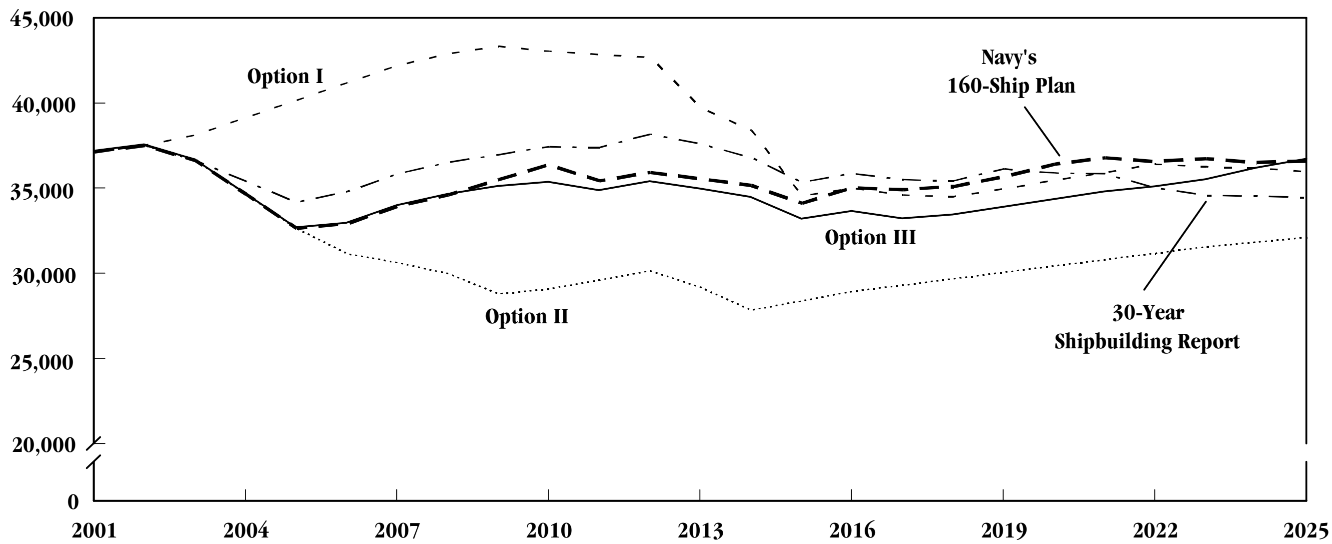
Average Age

The last measure that CBO examined was the average age of the surface combatant force under the various approaches. The service life of a surface combatant can range from 20 to 40 years depending on the kind of ship it is and on whether its combat systems are routinely upgraded to maintain operational effectiveness. CBO estimates that the average service life of the Navy's surface combatants is between 28 and 38 years.[7] (That range reflects the

7. The Navy can and has retired ships younger than 28, often to save money. (For example, most Navy officials would probably agree that Spruance class destroyers could be useful to the fleet through most of their notional service life of 35 years, but the Navy does not find them useful enough to justify their operating costs.) In calculating the service-life range, CBO did not include early retirements for financial reasons.

Figure 25.

Total Crew Size of the Surface Combatant Force Under Alternative Force Structures, 2001-2025



Source: Congressional Budget Office.

Note: Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

Navy's uncertainty about how long a ship will remain useful.)

In general, if the average age of a weapon system is within the range of half its service life, the system can be considered relatively healthy. If, however, its average age exceeds that half-life range, the system is aging overall. Unless that aging is stopped, the military must eventually spend large sums of money for replacements or see the stocks of that weapon system shrink. The same principle holds true for the Navy's surface combatants. By CBO's estimate, their half-life range is 14 to 19 years.

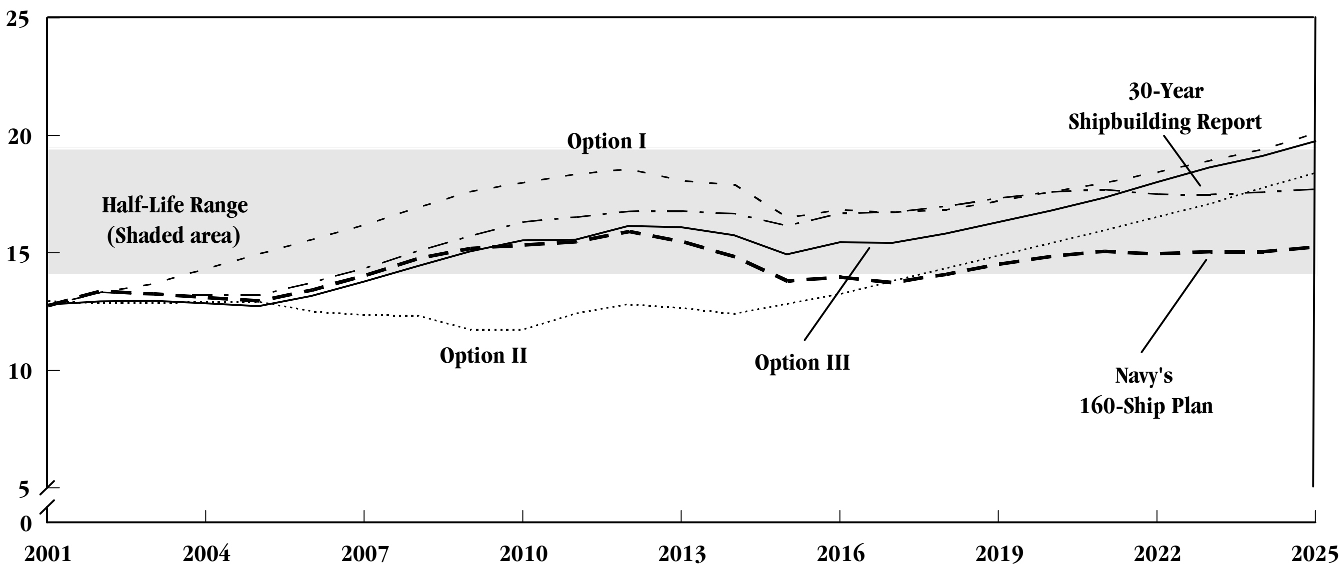
In all the force structures that CBO examined, the average age of the surface combatant force would remain within or below the half-life range through 2022 (*see Figure 26*). The Navy's 160-ship plan would keep that age in the lower part of the half-life range. Option I would produce the oldest force of surface combatants throughout most of the 2003-2025 period, and the average age would exceed the half-life range by 2023. Option II would result in the youngest force, with an average age below that range until 2016. Because it would buy fewer new ships, Option III would see the average age of surface combatants rise after 2014, exceeding the half-life range by 2024.

Implications of the Analysis

The first and most important conclusion that can be drawn from this analysis is that even if the Navy restricted spending on the surface combatant force to today's levels, it could have a larger and more capable group of ships over the course of 25 years than it has today (*see Table 7*). In doing so, the Navy might free up resources to pursue other transformation efforts or buy larger numbers of other types of ships. Of course, if the Navy bought all of the ships implied by the 160-ship plan, it would have an even bigger and more powerful surface combatant force than it could achieve under the current funding level. But as Chapter 1 described, unless the Navy's shipbuilding budget grew significantly, making such an investment would be difficult because of competing priorities and could end up retarding transformation in other areas.

Figure 26.

Average Age of the Surface Combatant Force Under Alternative Force Structures, 2001-2025



Source: Congressional Budget Office.

Notes: Half-life refers to half the expected service life of a surface combatant. However, because actual and expected service lives have varied over time, CBO assumed a range for the half-life to reflect that variation. If the average age for a class of surface combatants remains within the half-life range, that indicates that the force is being replaced relatively steadily. If the average age exceeds or falls short of the half-life range, the force is being replaced either at levels less than or greater than the level required for steady-state replacement.

Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

How effectively would the different options in this analysis transform the surface combatant force? The answer depends on the definition of transformation. The force-structure options outlined in Chapter 2 would all substantially boost the effectiveness of the surface combatant force, but they arguably would not provide the "dramatic" increase in military capability that President Bush referred to in describing transformation.

If naval transformation is measured by the ability to defeat threats from mines, diesel-electric submarines, and small, fast boats, the answer is less clear. Today, mines are an intractable problem that the Navy is not certain it can solve. Diesel-electric submarines, especially those with air-independent propulsion, could prove just as hard to deal with. (Recent history demonstrates that such submarines —even without air-independent propulsion—make Navy commanders very nervous.) No one knows whether the remote systems that the Navy is developing to address both of those threats will be effective, because they are far from complete.[8] In the case of the small-boat threat, the helicopters that surface combatants carry should be able to overcome it, so long as the number of boats is not great enough to saturate a task force's defenses. Those problems afflict all of the force structures examined in this study, not just the three CBO options.

What happens after 2025? The answer will be determined largely by what the Navy decides to do with its Arleigh Burke class destroyers. CBO assumed for this analysis that

8. See Roxana Tiron, "Unmanned Underwater Vehicles Not Quite There Yet, Navy Says," *National Defense* (April 2002), pp. 44-45.

Table 7.

The Surface Combatant Force in 2025 Under Alternative Force Structures

Force Structure	Total Number of Ships	Average Age (Years)	Total Crew Size	Number of: Long-Range Air-Defense Ships	Helicopter Hangars	Littoral ASW Suites	Next-Generation Ships	VLS Cells[a]	Guns: ERGM	Guns: 155-mm
30-Year Shipbuilding Report	122	17.6	33,900	90	186	32	49	14,500	31	64
Navy's 160-Ship Plan	162	15.3	36,600	90	212	34	89	14,000	49	32
Option I	130	20.2	36,000	90	204	40	42	11,200	96	0
Option II	123	18.5	32,200	83	162	21	49	10,600	31	24
Option III										
Peacetime equivalent[b]	165	19.8	36,700	93	218	34	82	13,100	49	32
Actual hulls	124	19.8	36,700	88	164	17	41	10,400	49	16
Memorandum:										
Current Force	115	13.3	36,700	69	168	0	0	7,300	12	0

Source: Congressional Budget Office.

Notes: ASW = antisubmarine warfare; VLS = vertical launch system; ERGM = extended-range guided munition; mm = millimeter.

Option I would delay the transition to next-generation surface combatants by making the most of the existing fleet. Option II would accelerate the transition to next-generation ships by retiring much of the existing force early. Option III would buy fewer next-generation ships by assigning multiple crews to new ship classes.

a. These numbers assume 61 VLS cells for Spruance destroyers, 90 for Flight I/II Arleigh Burke destroyers, 96 for Flight IIA Arleigh Burke destroyers, 64 for the first two modernized Ticonderoga cruisers, 128 for the next three modernized Ticonderoga cruisers, 122 for Improved Ticonderogas, 128 for DD(X) destroyers, 200 for CG(X) cruisers, and 48 for a next-generation frigate.

b. The force level and capability numbers for this alternative are the peacetime equivalents of single-crewed ships. That is, the 124 ships of Option III are equivalent to 165 single-crewed ships in their ability to provide forward presence.

those ships would not receive any midlife upgrades and would serve for 35 years. That assumption may not be a reasonable one, however. Historically, surface combatants become less effective in wartime operational environments well before the end of their notional 35-year service lives in the absence of midlife improvements to their combat systems. If the Arleigh Burkes do not receive such upgrades, they may be retired after only 25 years, beginning around 2016. That would leave all of the force structures in this study much smaller by 2025 than reported here. If, by contrast, those ships receive midlife improvements, they may be able to serve for 40 years—the estimated service life of a converted Ticonderoga class cruiser. In that case, the first Arleigh Burke would not leave the fleet until 2036, which means that the surface combatant forces in this analysis would look fairly robust for the next three decades.

Upgrading Arleigh Burke destroyers, however, would require funding that has not been accounted for in this analysis. CBO has no way of knowing what midlife improvements the Arleigh Burkes might need in 10 to 15 years or how much the upgrades might cost, which is why it did not address that important issue. But those destroyers will eventually represent about one-third to one-half of the surface combatant force, so how the Navy ultimately deals with them will have far-reaching implications for both the size of that force and the resources needed to sustain it.

If the Arleigh Burkes stayed in the fleet throughout their 35-year service lives and no additional money was spent to improve their combat systems, the surface combatant force would begin to shrink after 2025 under all three CBO options. That decline would occur because the force structures in Options I and II cannot be sustained and operated indefinitely on an average annual budget of $6.6 billion. Option I would require $7.3 billion a year to sustain and operate a steady-state force of 64 Arleigh Burke destroyers, 24 cruisers, and 40 FFG(X)s. Option II would need \$7.5 billion annually to sustain a steady-state force of 61 Arleigh Burkes, 12 DD(X)s, 24 CG(X)s, and 30 littoral combat ships. By contrast, Option III's steady-state force of 112 ships, including 51 multiple-crewed ones, could be sustained and operated for \$6.6 billion year. (In 2025, Option III's force structure is actually about 10 ships larger than its steady-state size.)

The three options described in this study represent effective ways to defer significantly higher spending on surface combatants for the next 20 years. In the meantime, the Navy could use the money that was not spent on surface combatants to pay for different transformation efforts or other ship programs. Of course, whether the Navy should do that is a matter for defense officials and lawmakers to decide. It is beyond the scope of this analysis and of CBO's mandate.

APPENDIX

Cost Estimates for New Ships in the Navy's 160-Ship Plan and CBO's Option I

When this study was being written, the Navy's force of surface combatants included 17 Spruance class destroyers, 27 Ticonderoga class cruisers, 33 Oliver Hazard Perry class frigates, and 38 Arleigh Burke class destroyers. According to published plans, the Navy will retire all of the Spruance class destroyers and the first five Ticonderoga class cruisers by 2006, upgrade the remaining cruisers and all of the Oliver Hazard Perry class frigates over the next 10 years, and deploy 24 more Arleigh Burke class destroyers by 2010. However, the Navy's main focus in transforming the surface combatant force is not those ships but the three new classes of ship—the DD(X) destroyer, the littoral combat ship (LCS), and the CG(X) cruiser—that it plans to buy starting as early as 2005.

In estimating costs for this study, the Congressional Budget Office assumed that the Navy would buy 16 DD(X)s, 56 LCSs, and 32 CG(X)s between 2005 and 2025 under its 160-ship plan. CBO estimates that purchasing those 104 ships would cost a total of about $120 billion (in 2003 dollars). Production costs for the CG(X) cruiser make up roughly 60 percent of that amount, or about $70 billion. Production costs for the DD(X) and LCS account for about $30 billion and $20 billion, respectively. This appendix gives the basis for those estimates as well as information about CBO's cost estimate for the 40 FFG(X) frigates envisioned in Option I.

The Navy has provided some details about the acquisition schedules for the DD(X) and LCS programs but little information on the schedule of the CG(X) program. The Navy has requested funds to buy the first DD(X) destroyer in 2005 and plans to buy a total of eight ships by 2009. It estimates that those eight ships will cost a total of about $10 billion (in 2003 dollars). The Navy also plans to purchase the first LCS in 2005 and a total of nine ships over the same period, at a total cost of about $2.5 billion, it estimates (including the cost of mission modules for those ships). However, the Navy has not yet determined the total production run for either the DD(X) or the LCS.[1]

In the absence of detailed information from the Pentagon, CBO developed cost estimates for the DD(X), LCS, and CG(X) on the basis of top-level descriptions of those ships contained in Navy briefings and press reports. (The characteristics that CBO assumed in estimating production costs of those new ships are summarized in Table 1 on page 5.) It also postulated procurement schedules for the three ships consistent with the information in those documents (*see Table A-1*). Similarly, CBO developed its cost estimate and procurement schedule for the FFG(X) on the assumption that the ship's general characteristics would be consistent with those of the FFG-7 frigate.

Significant uncertainty exists about the capabilities, technologies, and schedules for those new surface combatants. CBO's cost estimates represent one possible outcome, calculated under the assumptions described above. But programs (such as the ones for those ships) that are in the early stages of the development cycle and at the cutting edge of technology have a greater risk of cost and schedule growth than do programs that are better defined and based on proven technologies. Although current cost estimates for those ships account for such risks to some extent, CBO expects that its estimates will change, perhaps significantly, as each ship's design and acquisition plans are more fully defined.

1. The funds for the first ship of the DD(X) and LCS classes are included in the research and development budget line for those programs in the President's budget plan for 2004 through 2009.

Table A-1.

Estimated Production Schedule for New Surface Combatants, 2005-2025

Ship Class	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
DD(X)[a]	1	1	1	2	3	3	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0
LCS[a]	1	1	0	3	4	4	4	4	4	4	4	4	4	4	4	4	3	0	0	0	0
CG(X)[a]	0	0	0	0	0	0	0	0	0	1	2	2	3	3	3	3	3	3	3	3	3
FFG(X)[b]	0	0	0	1	2	3	3	4	4	4	4	4	4	4	2	1	0	0	0	0	0

Source: Congressional Budget Office.

Note: DD(X) = future general-purpose destroyer; LCS = littoral combat ship; CG(X) = future guided-missile cruiser; FFG(X) = future guided-missile frigate.

a. For the Navy's 160-ship plan.
b. For Option I only.

Production Cost of the DD(X) Destroyer

CBO estimates that the DD(X) would cost about $1.9 billion apiece to build, or a total of about $30 billion for 16 (assuming that the new destroyer has the characteristics and capabilities described in Table 1). Although the Navy currently plans to buy the first ship with research, development, test, and evaluation funds, CBO included those costs in its estimate to measure the total costs of production more accurately.

CBO used two methods to calculate the total costs of the initial DD(X). In the first method, it started with the Navy's estimate of the costs for detail design and construction of the initial ship (roughly $2.4 billion) and increased construction costs by 17 percent to account for the average cost growth that has occurred in past ship construction programs.[2] That approach yielded an estimate of about $2.7 billion for the first ship. In the second method, CBO used the actual cost of the first Arleigh Burke class (DDG-51) destroyer as an analogy and adjusted that cost for differences in weight and armament systems between the DD(X) and the DDG-51. That approach also produced an estimate of about $2.7 billion for the first DD(X). Both of those estimates include about $500 million for nonrecurring detail design work. CBO used the Navy's figure for that work because it has no basis from which to develop an independent estimate at this time. The way in which CBO estimated the remaining $2.2 billion in recurring production costs under the second method is described below.

CBO estimated the recurring costs for six elements of the DD(X)—basic construction; electronics; hull, mechanical, and electrical (HM&E) systems; ordnance; other costs; and change orders (*see Table A-2*). Basic construction includes labor and material costs for assembling the hull structure as well as the shipbuilder's profit and other fees. Electronics includes the costs of government-furnished hardware such as radars, sonars, navigation, and communications equipment. The HM&E category includes

Table A-2.

CBO's Cost Estimate for the First DD(X) Destroyer

(In billions of 2003 dollars)

	Estimated Cost	Primary Basis of Estimate
Detail Design	0.5	Navy estimate
Production		
Basic construction	0.7	DDG-51 analogy
Electronics	0.6	Navy estimate
Hull, mechanical, and electrical systems	0.1	DDG-51 analogy
Ordnance	0.3	DDG-51 analogy
Other costs	0.2	Navy estimate
Subtotal	1.9	
Change orders	0.3	DDG-51 analogy
Total Production Cost	2.2	
Total DD(X) Cost	2.7	

Source: Congressional Budget Office.

2. See J. A. Drezner, *An Analysis of Weapon System Cost Growth* (Santa Monica, Calif.: RAND, 1993); and Karen W. Tyson and others, *The Effects of Management Initiatives on the Costs and Schedules of Defense Acquisition Programs* (Alexandria, Va.: Institute for Defense Analyses, November 1992).

the costs of pumps, motors, cooling systems, piping, and electrical wiring. Ordnance includes the costs of combat systems, guns, missile launchers, and other systems related to the ship's weapons. Other costs include the costs of system integration and engineering, equipment testing, and management support. Finally, the category of change orders includes costs that result from government-imposed modifications to the design of the ship.

CBO based its estimate of the costs of basic construction, HM&E systems, and ordnance on similar costs for the first DDG-51 and adjusted those costs for the differences in weight and ordnance between the two ships (as shown in Table 1). For the categories of electronics and other costs, CBO did not have enough information about the DD(X) to make similar adjustments to the DDG-51's costs, so CBO used Navy cost estimates for those two categories. (Those estimates are significantly higher than the equivalent costs for the first DDG-51.) For the category of change orders, CBO based its estimate on the relationship between actual change-order costs and total costs for the first DDG-51. Those change orders amounted to about 16 percent of total recurring construction costs.

CBO estimated the costs of the other 15 DD(X)s by analyzing the actual costs of the DDG-51s that were bought during the 1985-1992 period. That analysis indicated that doubling the annual purchase rate reduced unit costs by about 15 percent. Thus, CBO estimated that the cost of the second DD(X) would total about \$2.2 billion (the same amount as the first ship minus the nonrecurring detail design) and that the unit cost of the remaining ships would fall to \$1.7 billion when the production rate rose to three a year.

Production Cost of the Littoral Combat Ship

CBO estimates that building 56 littoral combat ships would cost a total of about \$20 billion, or about \$350 million per ship (assuming that the Navy buys the LCS with the characteristics described in Table 1 and on the schedule shown in Table A-1). To estimate the cost of the first LCS, CBO used the actual costs of buying Oliver Hazard Perry class (FFG-7) frigates as an analogy and adjusted those costs for technical differences between the two ships. That approach produced an estimate of about \$700 million for the initial LCS, including about \$200 million for nonrecurring detail design efforts. The basis for that \$700 million estimate is outlined below.

DoD reports actual budgeted costs for weapon systems in its Selected Acquisition Reports (SARs). CBO analyzed the final SAR for the FFG-7 program and determined that the cost to build the first FFG-7 totaled about \$600 million (in 2003 dollars). CBO increased that amount by about \$100 million to account for differences between the existing FFG-7 frigates and the planned LCS in three areas.

First, CBO decreased the estimate by about \$150 million to reflect the difference in weight between the LCS (3,000 tons) and the FFG-7 (4,100 tons).

Second, CBO increased the estimate by about \$50 million to cover the cost of the additional equipment (called mission modules) that is likely to be required for each littoral combat ship. Although the Navy has provided few details about the LCS program, it has stated that it wants a ship that will be able to quickly swap out mission equipment to tackle rapidly changing jobs. CBO assumes that the Navy would need to purchase 70 mission modules for the force of 56 LCSs. The extra 14 modules (beyond the one included in the cost of each LCS) would cost about \$2.5 billion in all, CBO estimates, or about \$50 million per LCS when amortized across the 56 ships.

Third, CBO increased the estimate by about \$200 million to account for the cost of detail design. In the 1970s, when the FFG-7 was being built, the Navy did not pay for detail design work with production funds, as it does now. All of the expenses of that work for the FFG-7 program were included in research and development funds, which totaled about \$100 million in today's dollars. CBO assumes that the \$200 million for the LCS is appropriate because it falls within the range of the detail design costs for the FFG-7 and the equivalent costs for the DD(X). The Navy has not indicated what the cost would be for detail design work for the LCS.

CBO estimated the costs of the succeeding 55 littoral combat ships using statistical analyses of the costs of the FFG-7s bought during the 1970s. Those analyses show

Table A-3.

CBO's Cost Estimate for the First CG(X) Cruiser

(In billions of 2003 dollars)

	Estimated Cost	Primary Basis of Estimate
Detail Design	0.5	DD(X) estimate
Production		
Basic construction	0.8	Adjusted DD(X) estimate
Electronics	0.6	Adjusted DD(X) estimate
Hull, mechanical, and electrical systems	0.1	DD(X) estimate
Ordnance	0.6	Adjusted DD(X) estimate
Other	0.2	DD(X) estimate
Subtotal	2.3	
Change orders	0.4	Percentage of production costs
Total Production Cost	2.7	
Total CG(X) Cost	3.2	

Source: Congressional Budget Office.

that costs decline as production rates increase. The unit cost for the FFG-7 fell by 20 percent when the annual purchase rate doubled. On the basis of that relationship, CBO estimated that the remaining LCSs would cost an average of $350 million apiece.

Production Cost of the CG(X) Cruiser

The future CG(X) cruiser is even less well defined than the littoral combat ship. The Navy suggests that it would share many features with the DD(X) destroyer. It would be a large, multimission surface combatant and use the same hull form, propulsion plant, and basic combat systems as the DD(X). A key difference between the DD(X) and CG(X) is that the new cruiser would probably be equipped with a next-generation air and missile defense combat system that included advanced radars. Also, the CG(X) would be expected to trade the advanced gun systems on the DD(X) for additional vertical launch system (VLS) cells. Building 32 CG(X) cruisers would cost a total of about $70 billion, or an average of about $2.2 billion per ship, CBO estimates (assuming that the Navy bought the CG(X) with the characteristics described in Table 1 and on the schedule shown in Table A-1). The initial ship of that class would cost about $3.2 billion (*see Table A-3*).

To calculate the cost of the first CG(X), CBO started with its estimate of $2.7 billion for the initial DD(X) destroyer, since the two ships will be roughly the same size and share many of the same features. CBO then raised that amount by about $500 million to account for differences between the ships in four areas. First, CBO increased the estimate for ordnance by $250 million to capture the increased cost of the state-of-the-art weapon system that would probably be installed on the new cruiser. (CBO used the cost of the existing Aegis system as the basis for the cost of that next-generation weapon system.) Second, CBO boosted the estimate for basic construction by about $100 million to account for the increase in construction costs from installing the new weapon system. Third, CBO raised the estimate for ordnance by another $75 million because it assumed that each CG(X) would have 200 VLS cells instead of the 128 cells planned for the DD(X). Fourth, CBO increased the estimate for change orders by $75 million so that the cost of those orders would equal about 16 percent of total recurring construction costs.

To estimate the costs of the remaining 31 CG(X)s, CBO derived a cost-estimating relationship using the same analysis it used for the DD(X). That analysis indicates that a doubling of the annual purchase rate reduces unit costs by about 15 percent. Thus, CBO estimated that the average cost of the other new cruisers would be about $2.2 billion.

Production Cost of the FFG(X) Frigate

For the new frigate envisioned in Option I of this study, CBO estimated an average cost of $700 million per ship (assuming that the FFG(X) followed the production schedule in Table A-1).[3] Building 40 FFG(X) frigates would cost about $28 billion in all, CBO estimates.

Much as it did in calculating the cost of the first littoral combat ship, CBO estimated the cost of the initial FFG(X) by starting with the actual cost to build the first FFG-7 (about $600 million). CBO increased that amount by about $500 million to account for three major differences between the FFG-7 and the FFG(X). First, CBO increased the estimate by about $250 million to reflect the difference in weight between the new frigate (6,000 tons) and the existing one (4,100 tons). Second, CBO raised the estimate by about $50 million to cover the costs of the additional VLS cells that the FFG(X) is assumed to have. Third, CBO included an estimated $200 million for detail design to account for the cost of such work not included in the cost of the first FFG-7. (That figure is the same amount that was included in the cost estimate for the first LCS.)

The cost estimate for the other 39 FFG(X)s is based on an analysis similar to the one used to derive LCS costs. That analysis suggests that doubling the annual purchase rate reduces unit costs by about 20 percent. Thus, CBO estimated that the other new frigates would cost about $700 million apiece, on average.

3. It also assumed that the FFG(X) had the following characteristics: a displacement of 6,000 tons, a crew of about 120, a modern combat system suite, 48 VLS cells, two helicopters, and one 5-inch gun capable of firing the extended-range guided munition.