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**HEARING ON DD(X)**  
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Mr. Chairman, distinguished members of the subcommittee, thank you for the opportunity to appear before you to discuss the Navy's DD(X) Program. As requested, my testimony will focus on the requirement for the DD(X); the program's status and cost; the Navy's overall acquisition strategy; and its impact on the industrial base. It will frame these issues within the context of the global naval competition.

### **The US Fleet Within the Context of the Global Naval Competition**

I would just like to make a few observations that will help frame my comments on the DD(X). The first is that despite its small relative size in comparison with some past US fleets, the US Navy is the most powerful naval force in the world by an astounding margin. To support this statement, I'll use three simple metrics. The first is aggregate fleet tonnage. As naval analyst Geoffrey Till explains, "[t]here is a rough correlation between the ambitions of a navy and the size and individual fighting capacity of its main units, provided they are properly maintained and manned."

Considering aviation power projection platforms that can operate fixed wing tactical aircraft, surface combatants with greater than 2,000 tons full load displacement, and submarines with submerged displacements greater than 450 tons, the Navy operates a fleet of fighting warships with an aggregate displacement of some 2.85 million tons. The next largest fleet is the Russian Navy, with an aggregate displacement of only 630,600 tons. Indeed, only seven countries other than the US operate war fleets that displace more than 100,000 aggregate tons; an additional ten operate fleets that displace between 50,000 and 100,000 tons.

In other words, at this point in time, the US faces 17 credible competitors in the global naval race. In order of aggregate tonnage, these competitors are: Russia; Japan; the United Kingdom; the People's Republic of China (PRC); India; France; Taiwan; Turkey; Brazil; Canada; Spain; Italy; Germany; Australia; South Korea; Greece; and the Netherlands. Together, these 17 navies account for 2.66 million tons of the entire rest of the world's (ROW) warship displacement of 3.03 million tons (88 percent).

At the height of its naval dominance, the British Royal Navy strove to achieve at least a "two-navy standard." That is, British naval planners aimed to maintain a navy that was as large as the combined fleets of the closest two naval powers. In terms of aggregate warship tonnage, then, the US enjoys a "17-navy standard." Indeed, at 94 percent of the total aggregate ROW tonnage, *the US war fleet displaces nearly as much as all other warships in the world's navies, combined.*

The next metric I'll use for comparison is the number of surface warships. At the end of 2004, there were a total of 574 surface combatants in the world with full load displacement greater than 2,000 tons. Of these, the US operated 101. Of the remaining 473 ROW combatants, the top 17 naval competitors operated 366. The Japanese Navy operated the second largest combatant fleet with 51 ships. None of the other competitors operated more than 35 surface combatants: the Chinese People Liberation Army Navy (PLAN) operated 35; the British Royal Navy, 31; the Russian Federation, 30; Taiwan, 29; France, 23; India, 22; and Turkey, 20. The remaining nine navies all operated 17 or fewer

surface combatants. In pure numerical terms, then, the US thus enjoys slightly more than a “two-navy standard” in major surface combatants.

However, the third metric—number of vertical launch system (VLS) cells and surface combatant striking power—reveals an even more impressive US edge. Of the 101 US surface combatants larger than 2,000 tons full load displacement, 30 are relatively small FFG-7 guided missile frigates and 71 are large, multi-purpose surface warships. The latter ships—the fleet’s “surface battle line”—are the focus of my testimony today. The battle line performs four key fleet, Joint, and national roles: it protects the sea base from air, cruise and ballistic missile, and submarine attack with heavy, multi-layered defensive fires; it protects Joint forces operating ashore from air and cruise and ballistic missile attacks by providing extended-range defensive fires; it augments the offensive punch provided by fleet aircraft carrier with both sustained offensive missile and gun fire; and it protects the US homeland from ballistic missile attack by providing extended-range radar cueing and defensive fires. In other words, the ultimate purpose of a surface combatant is to put “ordnance on target”—be it on an inbound missile or aircraft, a submarine, or a land target. And in this regard, the development of the vertical launch missile system (VLS) revolutionized the way the US surface battle line accomplished this purpose.

The VLS was introduced during the height of the intense Cold War naval competition between the Soviet and US Navies. The Soviets opted for a below deck, cylindrical VLS that rotated like the chamber of a revolver, slotting long-range surface-to-air missiles (SAMs) into a single missile firing chamber. In contrast, the US adopted a far more flexible and versatile system, referred to as the Mk41 VLS. Unlike the Soviet VLS, which fired only long-range SAMs, the Mk41 VLS consisted of missile “modules” containing eight individual missile “cells,” each of which could flexibly store and fire either one 21-inch diameter Tomahawk land attack missile or ballistic missile interceptor; one 13-inch diameter standard SAM or ASW rocket; or four, “quad-packed” 10-inch diameter local air or terminal defense SAMs. Moreover, the US VLS made very efficient use of space in a ship’s hull, allowing a ship so equipped to carry over 40 percent more missiles than a legacy ship of equal size equipped with above deck-trainable, “rail” launchers.

The introduction of the Mk41 VLS changed the surface combatant design regime as profoundly as did the HMS *Dreadnought* in 1906; the former pointed the way toward an “all-VLS missile combatant” just as the latter pointed the way toward an “all-big gun battleship.” However, the speed in which navies adjusted to the disruptive design change was much different. More than ten nations immediately started pursuing *Dreadnought*-type battleships, pressing the British Royal Navy’s standing as the number one naval power. In contrast, only the US had the economic wherewithal to aggressively pursue large VLS-equipped combatants. As a result, it has built a spectacular lead in the global VLS competition, even if they lag in fielding munitions for them.

Indeed, by December 31, 2004, only two of 71 ships in the current US battle line were equipped with legacy rail launchers; the rest all had VLS main batteries. As a result, the US surface battle line had a formidable punch, as measured by its fleet battle force

missile capacity: together, the 71 ships could carry no less than 7,566 large battle force missiles, with over 90 percent of the missiles being carried in 6,958 VLS cells. In comparison, only 47 of the 366 surface combatants operated by the next largest 17 naval competitors were equipped with VLS, and they carried among them only 1,552 VLS cells capable of firing either a battle force or local air defense missile. The combined magazine capacity for the 366 ships was 5,262 battle force missiles with an additional 2,978 local air defense missiles.

In other words, the US battle line had nearly one-and-a-half times the number of VLS-equipped warships than the next 17 navies combined, and it enjoyed a greater than four-to-one advantage in battle force/local air defense VLS cells. This disparity in VLS cells gave the US surface battle line an enormous advantage in fleet striking power. *Indeed, since a single Mk41 VLS missile cell can carry four local air defense missiles, the 71 ships in the US battle line could carry more battle force and local air defense missiles than the 366 ships in the 17 next largest navies, combined.*

Moreover, 68 of the 71 US ships were equipped with the superb AEGIS combat system, which was closely tied to the introduction of the VLS. The fleet introduction of AEGIS combat system in 1983 resulted in an impressive increase in fleet defensive firepower. In earlier missile ships, SAMs had to be guided from the time of launch to the time of target impact. The number of missiles a ship could fire and control was limited by the number of separate guidance radars carried by the ship. In contrast, the AEGIS was designed to work with missiles with “commandable autopilots.” Once a missile’s autopilot was set at launch, the AEGIS system would upgrade it periodically during flight. Specific radar guidance would not be required until the last seconds before a target intercept. This allows an AEGIS equipped ship to control up to five missiles per guidance channel—four more than previous missile defense ships. Although the system has been in fleet service for over two decades, successive upgrades still allow the AEGIS combat system to claim the title as “the most advanced anti-air system in existence, land-based or naval.”

The individual power of each shipboard AEGIS system is being linked together through a new cooperative engagement capability (CEC). The CEC will integrate the data of all SPY-1 radars—as well as fleet airborne radars such as those carried on E-2C air battle management aircraft—into a “single, real-time, fire-control-quality composite track picture.” Operating under a single designated commander, CEC will thus allow a naval task force to operate as a single, integrated, defensive combat network. This network extends the range at which any given ship can engage a target to well beyond its own radar horizon, thereby improving fleet area, local, and terminal self-defense missile coverage.

The Mk41 VLS system, AEGIS, and CEC have converted the US surface battle line into a *mobile, densely packed, modular and networked missile battery* that can be easily scaled and tailored to accommodate any threat or mission, and that carries more striking power than the next 17 naval competitors combined.

Incredibly, the number of ships in the US battle line is actually *growing*—as is the fleet VLS cell count and striking power. In 2005 and 2006, the Navy was to decommission its last two non-VLS combatants and last three non-AEGIS equipped ships. However, the loss of these four ships will be more than offset by the addition of 18 guided missile destroyers either under construction or authorized. When the last major surface combatant now authorized enters the fleet in 2011, the fleet battle line will consist of 84 ships:

- 22 VLS-equipped *Ticonderoga*-class guided missile cruisers. These ships, referred to hereafter as the CG-52 class, have an average full load displacement (FLD) of 9,877 tons. They carry the AEGIS combat system, and are armed with two, 61-cell VLS batteries, two 5-inch naval guns, eight *Harpoon* anti-ship cruise missiles (ASCMs), two *Phalanx* Close-in Weapons Systems (CIWS) for terminal missile defense, and two MH-60 helicopters.
- 28 “Flight I/II” *Arleigh Burke*-class guided missile destroyers, referred to hereafter as the DDG-51 class. These ships have average full load displacements of approximately 8,900 tons. These ships are equipped with the AEGIS air combat system, 90 VLS cells, eight ASCMs, one 5-inch gun, and two *Phalanx* CIWSs. They carry only three missile directors, rather than the four carried on the guided missile cruisers. They have a landing pad for helicopters, but have no hanger.
- 34 “Flight IIA” *Arleigh Burke*-class guided missile destroyers, referred to hereafter as the DDG-79 class. Although a variation of the DDG-51s, these ships represent a major upgrade in combat capabilities, and deserved a separate class designator. These ships have average full load displacements of 9,203 tons. Among other things, they differ from the DDG-51 class in that trade eight ASCMs for six more VLS cells and have a helicopter hanger and facilities to support two MH-60 helicopters.

The total missile capacity for this 84-ship battle line will rise to 8,868 battle force missiles, with 95 percent being carried in VLS cells (8,486 cells). This represents a healthy 18 percent expansion of battle line missile capacity. In addition, the ships will boast a total of 106, 5-inch naval guns, and be able to hanger and operate 112 MH-60 helicopters. Moreover, the fleet will be quite young, having been built over a period of 25 years at an average build rate of 3.36 ships per year, or approximately ten ships every three years. Indeed, the average age of the fleet will be only 12.5 years—which is below the average age of the naval aircraft fleet.

Given the change in strategic circumstances, the sheer size of this programmed fleet is quite astonishing. The 600-ship Navy, designed to fight a global war against a naval near-peer, had a target of 100 guided missile cruisers and destroyers, 90 with AEGIS/VLS. The programmed 2011 surface combatant fleet will thus represent 84 percent of the 600-ship Navy requirement for guided missile cruisers and destroyers, and 93 percent of its requirement for AEGIS/VLS ships. Even when expanding the comparison to all types of “battle force capable combatants,” the relative size of the 2011 fleet continues to impress. Altogether, the total 600-ship Navy requirement for battle force capable combatants

included six nuclear-powered guided missile cruisers, 27 guided missile cruisers, 67 guided missile destroyers, and 37 general purpose destroyers, for a total of 137 combatants. Seventeen of these ships were dedicated escorts for convoys and underway replenishment groups, a requirement that ended with the Garrison Era. The 84 ships in the 2011 battle line thus represent 70 percent of the 600-ship Navy's comparative requirement for battle force capable ships (84 of 120).

Looked at in another way, the 600-ship Navy included 15 deployable carriers and four refurbished World War II battleships, resulting in a ratio of "high value units" (19) to battle force escorts (120) of one-to-6.31. In contrast, according to current DoN plans, the 2011 battle fleet will include 10 deployable carriers. With 84 major combatants, this will result in a comparative ratio of 8.4 major surface warships for every high value unit—a relative improvement of 33 percent. In a world in which the US will likely be able to concentrate its strength in a single theater in support of one major Joint power projection operation, these numbers appear to be more than sufficient.

The size and strength of the US battle line appears even more impressive in comparison with the other world's navies and in light of the surface combatant design competition. At one time, such comparisons would involve matching the numbers of "battleships," "battlecruisers," "cruisers," "destroyers," "frigates," and "corvettes" in the US fleet with those in competing navies. Today, however, one navy's "guided missile frigate" is another navy's "guided missile destroyer." Such designators are simply no longer helpful in distinguishing relative warship capabilities. A different method of comparison is needed.

One such method involves using a contemporary combatant "rating system" modeled after the one developed by the Royal Navy during the age of sail and gun. However, instead of being based on the number of guns a warship carries, it is based first on the number of vertical launch cells a combatant carries, and second by the total number and types of missiles in its magazines (which allows a comparison between VLS-equipped and non-VLS equipped "legacy" warships). Using these criteria, one modern combatant rating system might include seven distinct ship classes. These classes are:

- ***First-rate Battle Force ships (battleships)***: Ships armed more than 100 battle force VLS cells, and/or more than 100 battle force missiles;
- ***Second-rate battleships***: Ships armed with 90-99 battle force VLS cells, and/or 90-99 battle force missiles;
- ***Third-rate battleships***: Ships armed with 60-89 battle force VLS cells, and/or 61-89 battle force missiles;
- ***Fourth-rate battleships/frigates***: Ships armed with 48-59 battle force VLS cells, and/or 48-60 battle force missiles;

- ***Fifth-rate battleships/frigates:*** Ships armed with 20-47 battle force VLS cells, and/or 20-47 battle force missiles;
- ***Sixth-rate frigates:*** Ships designed specifically for the protection of shipping role, armed with 8-19 VLS cells or legacy missile systems, and armed primarily with local air defense SAMs. These are augmented by a small number of battle force anti-submarine and anti-ship cruise missiles for convoy defense;
- ***Seventh-rate frigates:*** Warships optimized for a single role, usually either anti-submarine or anti-surface warfare, or for general purpose naval missions. The distinguishing feature of these ships is that they carry only terminal missile defenses—either in the form of rapid fire guns or short-range terminal defense SAMs.

By using this system and tracking the number of combatants planned in future navies, the crushing US dominance in surface combatants is clearly highlighted, as is the state of the surface combatant design competition.

As stated earlier, at the end of 2004, the world’s navies operated a total of 574 surface combatants with FLDs greater than 2,000 tons. The US operated 101; its 17 closest competitors operated 366. The breakout of ships classes among 467 ships in the 18 top navies was:

First-rate battleships:	23
Second-rate battleships:	50
Third-rate battleships:	7
Fourth-rate battleships/frigates:	3
Fifth-rate battleships/frigates:	35
Sixth-rate frigates:	77
Seventh-rate frigates:	272

The US operated 22 of the 23 first-rate battleships in world navies (CG-52s); Russia operated one. Only one navy besides that of the US is either building or contemplating additional first-rates: the Japanese Maritime Self Defense Force (JMSDF). Once the two planned JMSDF first-rates are commissioned, the US will operate 22 of the world’s 25 first-rates (88 percent). All 25 ships will be equipped with VLS.

The US also dominated the second-rate battleship category. Of the 50 in commission, the US operated 46 (two CG-47s; 28 DDG-51s; 16 DDG-79s) and the JMSDF operated four. The US is the only country currently building these ships, with an additional 18 under construction or authorized (DDG-79s). As was mentioned, the US will soon decommission its last two legacy second-rates armed with above-deck rail launchers. In the mid-term, then, the US will operate 62 of the world’s 66 second-rate battleships (94 percent). All 66 ships will be VLS-equipped.

A short time ago, there were 32 third-rates in commission, all in the US and Russian navies. However, this class of ship appears to be a dying breed. By December 31, 2004,

there were only seven left in the world—three in the US Navy (*Spruance*-class destroyers), and four in the Russian. The three US ships will soon all be retired, and no Russian replacements are building or planned. The only two navies now pursuing this class of ships are the Taiwanese Navy, which recently purchased four, second-hand, third-rates discarded by the US, and the South Korean Navy, which is building three new construction VLS-equipped ships. In the near- to mid-term, then, the four Russian, four Taiwanese, and three South Korean combatants will be the only third-rates in the world, with no further ships on the horizon.

Third-rates are in the process being replaced by a new class of VLS-armed fourth-rate battleship/frigates, armed with at least 48 battle force VLS cells. The first of type is the Spanish *Alvaro de Bazan*, a “guided missile frigate” of 5,853 tons at full load, equipped with 48 Mk41 VLS cells, eight *Harpoon* canisters, and a helicopter. The versatility of its VLS system is highlighted by the *de Bazan*’s planned air defense missile load: 32 SM-2 area air defense SAMs in 32 cells, and 64 local air defense Evolved Sea Sparrow Missiles (ESSMs) “quad-packed” in the remaining 16 VLS cells. This total war load of 96 air defense missiles and eight ASCMs is a formidable armament for a 5,800-ton warship.

On December 31, 2004, three *de Bazan*’s were the only ROW fourth-rates in commission. More are on the way. The Spanish Navy will soon commission its fourth *de Bazan*, and a fifth was recently authorized. The PLAN currently has two *Lanzhou*-class “guided missile destroyers” fitting out, with an unknown additional number planned. The Royal Navy is building a class of eight Type 45 *Daring*-class fourth-rate “air defense destroyers,” and the French and Italian Navies are planning to build four to eight fourth-rate *Horizon*-class” air defense frigates.” While these and other navies may commission more of these ships in the future, because of their expense they likely will be relatively few in number; the total number of ROW fourth-rates is unlikely to exceed 25 ships in the mid-term, with the vast majority in navies allied with the US.

As indicated by the types of missiles in their main batteries, these new fourth-rate battleship/frigates will provide area air defense for ROW naval task groups. They will be augmented by slightly less capable (and less expensive) fifth-rate battleships/frigates, typified by the British legacy Type 42 “guided missile destroyers,” with FLDs ranging between 4,100 and 4,600 tons, and the new VLS-equipped German *Sachsen*, a “guided missile frigate” of 5,600 FLD. The former are armed with 22 *Sea Dart* area air defense missiles and a helicopter. The latter are equipped with 32 Mk41 VLS cells, eight *Harpoon* ASCMs, and a helicopter. Like the Spanish *de Bazans*, a *Sachsen*’s main battery will consist of a mixed load of 56 air defense missiles (24 SM-2 area air defense SAMs in 24 cells, and 32 local air defense ESSMs quad-packed in the remaining eight cells) and eight ASCMs—a respectable combat punch.

As indicated above, there were only 35 fifth-rates in commission on December 31, 2004. Twelve were legacy pre-VLS ships: 11 Royal Navy Type 42s, and one “guided missile destroyer” in the French Navy. All are to be replaced by new VLS-equipped fourth-rates. The remaining fifth-rates were new VLS-armed ships: the Japanese Navy had 12; the Canadian Navy, four; the Royal Netherlands Navy, three; the German Navy, two; and the

South Korean Navy, two. These navies have an additional eight ships building. In addition, the Australian Navy is “up-rating” four of its legacy sixth-rates to fifth-rate status, and the Australian, Greek, and Turkish navies are also planning to build more new fifth-rates. In the near- to mid-term, then, there will likely be between 35 and 45 fifth-rates in commission, all in allied navies.

As previously noted, sixth-rate frigates are generally designed for the protection of shipping role; they are armed primarily with local air defense SAMs and a small number of anti-submarine and anti-ship cruise missiles to provide for convoy defense. This group of 77 warships is dominated by aging Garrison Era vessels with legacy rail launchers. Over half of the ships—52 total—are armed with legacy missile launchers designed to fire the US SM-1 local air defense missile. The majority of these ships are equipped with an above-deck Mk13 single-rail missile launcher, serviced by a below-deck 40-round rotary missile magazine. The PLAN, Russian, and Indian navies operate 21 ships with similar Russian-designed, above deck, single-rail rail launchers. Only four Australian ships are armed with newer VLS launchers for the ESSM, and the combat systems to exploit their full potential in the local air defense role.

At the end of 2004, fully 272 of the 467 surface combatants operated by the world’s top 18 navies were seventh-rate frigates (58 percent). They also made up the majority of the 107 combatants operated by the remainder of the world’s smaller navies. These ships—dominated by aging Cold War designs—come in various sizes, but they have one thing in common: they are optimized for a single mission, usually either ASW or ASuW. As stated earlier, the key discriminator for this class of ships is that they can defend only themselves from air and missile attack, as they carry only terminal missile defenses, either in the form of radar-controlled, rapid-fire guns or short-range SAMs.

Over time, new missiles like the Evolved Sea Sparrow Missile and the Aster-15—equally capable in the protection of shipping and terminal defense roles—will blur the distinction between sixth- and seventh-rate combatants. For example, Germany, Australia, and Turkey operate 18 seventh-rates armed with eight Mk41 VLS cells, each filled with one older, *Sea Sparrow* terminal defense missile. However, with their combat systems upgraded and their VLS cells quad-packed with 32 of the newer, more capable ESSM, these ships will become sixth-rates, capable of escorting other ships. The distinction between these two lower combatant classes will increasingly be found in the ship’s combat systems. Those ships that have the combat systems that can exploit the full range of new missiles will be sixth-rates; those that cannot will be seventh-rates.

In the US Navy, seventh-rates are used to complement the US “top-rates” found in the surface battle line, focusing on special-purpose littoral combat missions. At the end of 2004 the US operated 30 seventh-rates, all survivors of a class of 51 *Oliver Hazard Perry* warships built during the Cold War. The *Perrys* were originally commissioned as 4,000-ton, sixth-rate “guided missile frigates,” armed with a Mk13 single-rail missile launcher, 36 SM-1 local air defense missiles, four *Harpoons*, two ASW helicopters, ship-launched torpedoes, a rapid-fire 76mm cannon, and a rapid fire gun for terminal SAM defense. However, by removing the Mk13 missile launcher, air defense missiles, and *Harpoons*,

the DoN has effectively “down-rated” the ships to a seventh-rate littoral ASW frigate. These 30 ships (along with 26 mine warfare ships and eight small Patrol Coastal craft) will be replaced by over 80 new Littoral combat ships.

As is evident by the foregoing discussion, the world-wide conversion to VLS-equipped combatants is well underway. What is less evident is that none of the new generation of VLS-armed combatants comes cheap. In the words of one analyst:

Even for larger navies, state-of-the-art major surface combatants have become difficult to afford...the solution has been to cut current forces to pay for future programs, to cut the number of ships programmed, to cut the capabilities in new ships, or to cut programs.

As a result, the accelerating global transition to VLS-armed combatants is being accompanied by a concomitant reduction in the world-wide inventory of surface combatants. For example, the Japanese Navy recently announced its combatant fleet will shrink from 51 total warships to 48, and the British Royal Navy is reducing its fleet from 31 surface combatants to 25. This trend is being repeated, in more dramatic ways, in less advantaged navies.

Moreover, economic pressures on all but the most richly resourced navies have created a relatively static naval combatant design regime:

...few [navies] have been successful in retaining or even expanding their overall combat potential through the exploitation of new technologies. This is not surprising, for it now takes upward of two decades before a new technology of any complexity can travel the route from conception to operational introduction, and few countries—and, increasingly, even groups of countries—can afford the costs to sustain the necessary political steadfastness to see complex and expensive programs through to their ends.

Based on this discussion, the following closely related observations can be made. First, the US Navy utterly dominates the current surface combatant picture. With “only” 101 combatants (71 first-, second- and third-rates and 30 seventh-rates), it already enjoys greater than a “two-navy” standard. Even more impressive, however, is that it boasts eight times as many of the three top-rate classes than the rest of the world’s navies, combined. As a result, the 71-ship US battle line carries more missiles than the 366 warships operated by the 17 next largest navies. In other words, the US fleet enjoys a “17-navy” firepower standard.

Second, as the number of surface combatants in the rest of the world’s navies decline in numbers, the size of the US surface combatant fleet continues to grow. If no more ships were authorized for the next five years, the surface battle line will still grow to 84 first- and second-rates by 2011. When combined with as many as 63-100 new seventh-rate Littoral Combat Ships, the resulting US surface combatant fleet of 147-184 ships will likely exceed a “four- or five-navy” standard in ship numbers, and will only extend its “17-navy” firepower standard.

Third, over the mid-term, the US will operate 84 of 102 of the world's first-, second-, and third-rate combatants (82 percent). While this represents a slight decline in the *relative* US dominance in the three most powerful warship classes, it also reflects a welcome increase in *allied* capabilities: of the 18 ROW top-rates, 13 will sail in allied navies. Similarly, of the 60 to 70 new and more powerful fourth- and fifth-rates either in commission or building, all but two are found in allied navies. These allied ships will carry among them well over 2,000 additional VLS cells. While the US might not be able to count on any of these ships or VLS cells in a potential naval confrontation, neither will they have to count against them.

Fourth, in contrast to the steadily increasing power of the US fleet, the combat power of its two potential rival navies is holding steady, at best. The 30-ship Russian surface combatant fleet consists of one first-rate; four third-rates; six sixth-rates; and 19 seventh-rates. Four of five Russian first- and third-rates were commissioned in the 1970s and 1980s, and all five ships suffered from lack of upkeep during the 1990s. One of the six Russian sixth-rates was commissioned in 1969; the rest are *Sovremenny*-class "guided missile destroyers" commissioned in the late 1980s and early 1990s. However, these ships have a serious class-wide boiler problem; only five of the 17 originally built remain operational. Of the 19 seventh-rates in commission, six were commissioned in the 1970s, ten in the 1980s, and the remainder in the 1990s. The newest surface combatant in the entire Russian surface combatant fleet was commissioned in 1999.

Despite having an aging fleet in increasing disrepair, the only Russian surface combatant currently under construction is a single, small, seventh-rate frigate that was laid down in 2001, and that will not run sea trials until 2006. Little work on the second ship of the class has been completed. It thus seems certain that the number of total number of Russian combatants will shrink over the decade ahead—especially the number of top-rates—and the overall combat capability of the Russian surface combatant fleet will decline.

In contrast, the Chinese surface fleet is enjoying a resurgence of sorts, with numerous classes of ships under construction. However, the PLAN war fleet has a long way to go before posing a credible threat. It currently operates no first-, second-, third-, fourth-, or fifth-rate combatants, and only four of its 35 combatants classify as sixth-rates. These four ships include two Russian *Sovremennys* and two new Type 052B "guided missile destroyers," armed with ASCMs and a Russian-designed local air defense missile system. The remainder of the fleet consists of seventh-rate warships, armed with heavy ASCM batteries but protected only by the HQ-7 SAM, a Chinese-built terminal defense SAM with an effective range of 13 kilometers. Indeed, the magazine capacity for the entire PLAN surface fleet includes only 446 anti-ship cruise missiles, 176 local air defense missiles, and 480 terminal defense missiles.

The number of PLAN top-rates is sure to expand over time. There are two additional *Sovremenny* sixth-rates on order, and the PLAN recently launched two new fourth-rate battleship/frigates, equipped with phased array radars, and armed with eight, 6-cell vertical launch groups and eight ASCMs. However, these fourth-rates represent the *first*

PRC warships to carry a long-range area air defense missile battery. The 96 SAMs and 16 SAMs the two ships carry could fit inside one CG-52 with magazine capacity to spare. Moreover, while the apparent replacement for the PLAN's many seventh-rate warships—the Type 054 “guided missile frigate”—represents a significant improvement over earlier PLAN ships, the first of the class will see no improvement in anti-air or anti-missile capabilities, carrying as it will the same short-range HQ-7 system as its predecessors. As a result, most analysts reckon the PLAN surface combatant fleet is at least one to two decades away from posing a serious naval threat.

Finally, and perhaps most importantly, the US dominates the current combatant design regime. The rest of the world's navies are struggling to catch up with the Navy's two-decade lead in the VLS-combatant competition, and the designs they are pursuing do not improve on US combatant designs now in service. The large US fleet size and its commanding fighting power, the number of navies allied with the US, the increasing cost of VLS-combatants of any size, and economic pressures—among other things—have dampened the naval combatant design competition:

From a historical perspective, such a lull in the naval combatant design competition is by no means unusual. Perhaps the most applicable example occurred during the latter stages of the age of sail. In 1748, at the second Battle of Finisterre, the British captured several a revolutionary new French warship—a 74-gun, two-deck, third-rate. Despite the reluctance of the Admiralty to adopt a “foreign” design, the “74” was such a patently superior ship that the British immediately set about copying it. The arrival of the first British 74 in 1755 represented “the greatest breakthrough of British naval shipbuilding of the eighteenth century.” The ships were strong and powerful enough to be part of a line of battle, more maneuverable and faster than larger first- and second-rates, and cheap enough to be built in numbers. The definitive design, the *HMS Bellona*, which introduced in 1757, formed the basis for nearly 24 ships of the line.

More to the point, the introduction of the “74s” initiated a nearly century-long lull in the ship design competition for gun-toting top-rates. Innovation continued to occur in smaller navies and in their smaller rate classes, as evident by the aforementioned US “super-frigates” developed toward the end of the century. But the *Bellona's* design proved to be such an excellent, enduring one that “74s” formed the backbone of the British battle fleet throughout the war with Revolutionary France (the *Bellona* herself was not broken up until 1814—after a service life of 54 years). Indeed, the basic “74” was little improved upon until the general transition to the age of steam started in the 1840s.

The foregoing review of the state of the naval competition in general and the surface combatant competition in particular suggests that the current US second-rates—DDG-51s and -79s—represent the contemporary *HMS Bellona*. The only Navy now building first- or second-rates is the JMSDF, and these are copies of the US DDG-79 classes and DDG-51 classes, respectively. The only country building new VLS third-rates is South Korea, and its design is likewise heavily influenced by the US DDG-51/79 classes. The VLS-equipped fourth-, fifth-, and sixth-rate combatants now being built by allied navies are

fine ships and great improvements over their predecessors, but they still cannot compete with the basic design of the US “100s” and “90s” in production since the mid-1980s.

### **Thinking About the DD(X)**

It is in this context that current DoN plan for its surface combatant fleet must be judged. As you know, in FY 2007, the DoN is planning to start building the first of a class of powerful new first-rates called the DD(X) “destroyer.” The ship is touted by the DoN as the first “clean sheet design” since the end of the Cold War. It is designed to be the “nation’s destroyer and future cruiser sea frame,” meaning that its basic design will form the basis for a follow-on “cruiser,” the CGX. This design approach is consistent with that seen during the Cold War, when the *Spruance*-class destroyer hull became the basis for both a guided missile destroyer and the CG-47 and CG-52 classes.

DoN officials tout the DD(X)/CGX first-rates as “integrated warfighting system(s) *unconstrained by previous designs*” (emphasis added). They liken the ships’ expected revolutionary impact to that of the aforementioned *HMS Dreadnought*—“a ship that in one generation set the Royal Navy apart from its peers.” Unfortunately, they are right on the first point, and mischaracterize the second. And therein lays the flaw with the DoN’s plans for the DD(X) and CGX, and the potential seeds for disaster in its overall surface combatant transformation plan.

To the first point: the DD(X) and CGX are the direct result of a 1992 “21<sup>st</sup> Century Destroyer Technology Study,” conducted during the unexpected transition between the Garrison and Joint Expeditionary Eras. At the time, although the future was clouded with uncertainty, it was clear to DoN planners that the future of the Battle Force would be found in the littoral. As a result, they concluded they would need a new, stealthier hull. However, they were also well aware of the expected block retirement of large numbers of Garrison Era third-rate destroyers and sixth/seventh-rate frigates in the early decades of the 21<sup>st</sup> century. Planners therefore concluded the future battle line would consist of a family of “SC-21s”—21<sup>st</sup> century surface combatants—with some more expensive than others. Their original conception was to have a 70/30 split: 70 percent of the surface combatant fleet would consist of full-capability, multi-mission combatants; 30 percent of the fleet would consist of limited capability, focused-mission combatants.

The SC-21 Mission Need Statement was approved by OSD in 1994, immediately after the completion of the Clinton Administration’s Bottom Up Review. The timing was critical. Thinking in both the DoN and OSD was colored by the requirement to “rapidly halt” two, near-simultaneous, cross-border invasions by armored forces. A RAND Study called “The New Calculus...” argued that immediate delivery of massed guided weapon fire could be used to blunt the invasions, by rapidly destroying up to 20 percent of the enemies’ forces. To Navy planners, having a large floating battery of guided missiles in forward theaters would provide the initial firepower needed to attack enemy forces while Joint airpower was diverted to the theater. One option was to pursue an “Arsenal Ship,” a minimally crewed missile barge of upwards of 512 VLS cells; the other was to pursue a more traditional, versatile combatant focused on the land attack mission.

In the event, after an exhaustive Cost and Operational Effectiveness Analysis, the Arsenal Ship became a “Maritime Fire Support Demonstrator Program,” and the DoN—with OSD approval—pursued the DD-21 “Land Attack Destroyer,” the first of the SC-21 combatants. The Operational Requirements Document for the new ship was approved in just as the 1997 QDR approved a future surface combatant for target of 116 combatants. With 27 CG-47s and CG-52s and 57 planned DDG-51s and DDG-79s, the DD-21 was to replace 32 Garrison Era destroyers and frigates. In the 70/30 fleet mix, then, *the 32 DD-21s were to represent the low-cost 30 percent component of the future surface combatant fleet*. The planned unit cost for the ship was \$750 million (FY 96 dollars, by the fifth ship in the class). The 32 DD-21s would be followed by a “full capability” CG-21—the replacement for the legacy “guide missile cruisers”—in the second decade of the 21<sup>st</sup> century.

At this point, Navy’s two-century old preference for pursuing ever more capable warships combined with its inability to sit comfortably on a huge naval lead. The result: the modest plans for the DD-21 were infected by requirements creep, and the DoN’s surface combatant transition plan was completely changed. Instead of being a low-cost, limited capability ship, the DD-21 became a technological pathfinder “vital to the US Navy’s future.” After the 2001 QDR, the SC-21 family of ships and the DD-21 disappeared. They were replaced by a new, three-tier family of fleet surface combatants with three new ships. As outlined in a recent FY 2006 long-range plan for the construction of naval vessels, the family would include 30 new first-rates—12 DD(X)s and 28 CGXs—which would replace the legacy fleet of 22 CG-52 first-rates. The heart of the combatant fleet would remain 62 second-rates, either modernized DDG-51/79s or their future replacement, the new, unspecified DDGX. And the new modular, focused-mission LCS would become the “low cost” component of the surface combatant fleet, replacing legacy destroyers, frigates, mine warfare vessels, and coastal patrol craft.

As one of two new “super first-rates” in the surface combatant hierarchy, and as the new technological pathfinder for the future surface combatant fleet, the new DD(X) is a far cry from the modest expectations for the early DD-21 program. It will be 600 feet long, a beam of 79 feet, and a draft of 28 feet. At a full load displacement exceeding 14,500 tons, it will be nearly 50 percent larger than either the CG-52 first-rate or the DDG-51/79 second-rate, and the largest US surface combatant built since the *USS Long Beach*, a 17,100-ton nuclear-powered guided missile cruiser commissioned in 1961. When commissioned, only one contemporary surface combatant—a Russian 24,000-ton nuclear-powered guided missile cruiser—will be larger. It will be three to four times the size of the fourth-, fifth-, and sixth-rate ships that are the typical “capital ships” in ROW navies.

As you know, the DD(X) will be packed with new technologies and innovations. Among the more important are:

- An Integrated Power System (IPS), consisting of two main and two auxiliary gas turbines that will produce and distribute power for all of the ship’s electric needs—including to new electric drive motors that propel the ship, the ship’s combat systems,

and all hotel loads. These four turbines will produce 78 megawatts of power—ten times the electrical power generation capacity on a DDG-51/79. The dramatic increase in electrical power has two important implications for Navy combatants. First, it facilitates the move to electric drive, which eliminates the requirement that engine rooms be in line with the ship's propeller shafts or even that the ship retain long propeller shafts. It also simplifies the propulsion train in other ways, such as eliminating the need for complex reduction gears. Navy planners liken the shift to IPS as important as the shift from sail to steam.

- Full-spectrum sensor management, including advances in acoustic signatures that will make the ship “as quiet as a submarine” (due primarily to the shift to electric motors), magnetic and infrared signatures, and, perhaps most importantly, radar cross section. The ship will have a new wave-piercing tumblehome hull that disperses radar energy deflect incoming radar signals away from their source, and a composite deck house with embedded sensors and antennae, eliminating completely masts and exposed sensors that act as radar reflectors. These and other advances are designed to “complicate the enemy’s detect-to-engage problem.”
- New automation techniques to dramatically reduce crew size. Despite being 50 percent larger than current first- and second-rates, the DD(X) aims for a crew size that is 37-44 percent smaller. The current target is for a crew of approximately 150, including the ship’s aviation detachment.
- New damage limitation features, including a peripheral vertical launch system (PVLS), designed to disperse the ships VLS cells along the deck edge and to vent sympathetic explosions of ship’s missiles caused by battle damage up and away from the ship; autonomous damage control systems; and new fire suppression systems. Along with the inherent protection afforded by its large displacement and its low signatures, these features will make the DD(X) the most survivable US combatant design since the armored battleships and heavy gun cruisers built just before and after World War II.
- And various improvements to combat systems, weapon systems, and weapons, including: an open-architecture Total Ship Computing Environment to allow frequent cost-effective combat system upgrades throughout the life of the ship; a new dual-band radar consisting of an S-band Volume Search Radar (VSR) and X-band Multi-function Radar (MRF); a new undersea warfighting systems, including a dual-band bow array and a multi-function towed array; and the aforementioned PVLS cells. In addition, the DD(X) will carry two new Advanced Gun Systems (AGSs). The AGS is, in essence, a gun-launched missile system, propelling an 11-foot long, rocket-assisted, GPS-guided, 155mm Long Range Land Attack Projectile (LRLAP) out to ranges of 85 nautical miles (97 statute miles).

The DD(X) would be the most powerful first-rate on the seas. Like the Mk41 VLS, each of its 28-inch square 80 PVLS cells can carry either one, 21-inch diameter land attack missile or four quad-packed ESSMs. However, because of their larger size (the MK 41

cell is 25 inches square), they can also carry two, 13-inch diameter, area air defense SAMs or vertically launched anti-submarine rockets, giving it an equivalent first-rate missile load of 160 battle force missiles. Moreover, the ship's missiles will be augmented by two AGSs, served by an expandable LRLAP magazine that carries 600-920 guided rounds. The ship will have a flight deck big enough to support two MH-60 helicopters, and will carry no less than seven rigid-hulled inflatable boats.

The follow-on CGX first-rate will be based on the DD(X) hull, although Department of the Navy (DoN) officials are now uncertain if the DD(X) hull will be big enough for its combat systems. As a result, the DD(X) hull may have to be "stretched." Under any circumstances, however, the CGX will introduce a new theater air and missile defense combat system into fleet service. The expectation is that it will replace the DD(X)'s AGSs for additional VLS cells, in effect trading the volume dedicated for land attack for improved fleet theater air and missile defense capability, including perhaps new, larger, more powerful ballistic missile defense interceptors. When viewed together, it seems clear that the outdated distinctions of "destroyer" and "cruiser" no longer apply to the DD(X) and CGX. Instead, they should be viewed simply as two closely related classes of large, first-rate, battle network combatants—one that focuses on land attack, and one that focuses on theater air and missile defense.

Of course, the eye-watering technological innovation packed into the DD(X) and CGX hulls comes at a steep price. The original cost projections for the DD(X) were between \$1.2 and \$1.4 billion. In 2004, DoN estimates for the first ship of the class reached \$2.8 billion, while those for the second ship and subsequent ships would be \$2.1 billion and \$1.5-1.8 billion, respectively. Now, the first ship is estimated to be \$3.3 billion, the second ship \$3 billion, and follow-on ships between \$2.2-2.5 billion. Costs for the first five ships of the class, including R&D costs, are estimated by DoN planners to be nearly \$13.8 billion. However, even these sobering estimates may be low. The Cost Analysis Improvement Group in OSD believes actual costs for the ships may be 20 to 33 percent higher.

Under the best case scenario (DoN calculations), the fifth ship of the class will cost \$2.1 billion, at least two-and-a-half times the original DD-21 target, in inflation-adjusted dollars. Moreover, the DD(X) will be the *cheaper* of the two planned first-rates; the CGX, with its more complex and advanced radar and combat system, will undoubtedly be even more expensive. Even in an unconstrained budget environment, pursuing surface combatants with procurement costs over \$2 billion would place a heavy burden on DoN shipbuilding budgets. However, in the current budget environment, the pursuit of a ship "unconstrained by previous designs" is increasingly viewed as less of a virtue and more of a vice. For example, in the words of one naval expert, AD Baker III, former editor of *Combat Fleets of the World*, the DoN's "*call for innovation for innovation's sake...has resulted in a...grotesquely oversized new DD(X)*" (emphasis added).

Proponents of the DD(X) complain that those who focus solely on the DD(X)'s procurement costs are missing the larger picture. In response, they offer six key counter-arguments. The first is that the DD(X) will result in dramatic improvements to fleet strike

capabilities: each ship will be able to carry up to 80 large diameter land attack missiles, and its two Advanced Gun Systems will provide the most powerful US naval surface fire capability since the demise of the battleship and 8-inch gun cruisers. For example, they point that 155mm LRLAP will cover three times as much territory as does the planned 127mm Enhanced Ranged Munitions (ERM) fired from DDGs, and that two DD(X)'s provide the equivalent firepower of one Marine 155mm howitzer battalion. This will result in a 65 percent reduction in the amount of Marine artillery taken ashore. They also point out that the DD(X)'s 78 megawatt IPS system will set the stage for even more powerful weapons, such as electromagnetic rail guns.

These arguments are powerful if viewed in isolation. However, if there is one thing that the US battle fleet is *not* lacking in is strike power. The programmed battle line will already be able to carry nearly 9,000 battle force missiles, with 95 percent being carried in VLS cells (8,486 cells). Moreover, by 2010, a single Carrier Air Wing will be able to strike over 1,000 targets a day. And these numbers do not include the fires from other Joint platforms. Moreover, while the AGS will surely provide improved naval surface fires capabilities, it is not specifically tied to the DD(X) hull. It could easily be fitted onto a cheaper, made-to-purpose naval gunfire ship, or perhaps even on an existing fleet hull, such as the LPD-17. Indeed, the same holds true for a rail gun, which has yet to be perfected, much less fielded. The key question, then, is whether or not the DD(X)'s improvements in fleet strike and gun firepower could be pursued for a cheaper price?

Concerning the DD(X)'s steep price, its proponents make a second argument: that considering the time value of money, the cost of the DD(X) is not disproportionate to past ships. For example, the lead DDG-51 was authorized in FY 1985 at a price of \$1.2 billion; in fiscally adjusted FY 2007 dollars, that amounts to \$2.4 billion. Thus, the "\$3.3 billion for [the lead DD(X)] vs. the \$2.4 is not outrageous." This argument, while technically true, ignores an important point. In FY 1985, the Battle Force was fighting off a concerted challenge by the Soviet Navy. Accordingly, in addition to the single DDG-51 authorized that year, the DoN authorized one *Trident* SSBN; four *Los Angeles*-class SSNs; three CG-52 first rates; two LSD-41s; four mine countermeasure ships; three fleet oilers; two ocean surveillance ships, and two oceanographic survey ships. The \$1.2 billion cost for the lead DDG-51 was perhaps one-twentieth of the total SCN account.

Now, the situation is completely different. The DoN faces no naval challengers, it operates the finest surface combatants in the world; there are no externally driven competitive design challenges—and the relatively modest DoN shipbuilding budgets reflect these basic facts. In these circumstances, the lead DD(X) will consume as much as 30 percent of expected ship-building budgets. The relative burden that the lead DD(X) places on contemporary shipbuilding accounts is thus at least six times higher than the lead DDG-51. The key issue is not how the costs of the lead DD(X) compare with the lead DDG-51; it is whether or not the DD(X) is a sensible ship *given the state of the global naval competition and the current budget environment*.

Third, DoN officials argue that building one DDG-79 per year would cost \$1.8 billion a year compared to the expected \$2.1 billion cost of the *fifth* and later DD(X)s. With its

greater capability, the DD(X) “represent(s) reasonable value.” Again, while this point may be true in a general sense, it likewise fails to consider the cost of the ship within the context of expected shipbuilding budgets, or the impact that the DD(X) might have on the shipbuilding industry. The costs of a DDG-79, a proven design still in production, are well known; one ship would cost no more than 1.8 billion, and possibly less, depending on contractual arrangements. The cost of the fifth DD(X) will cost *at least* \$2.1 billion, and possibly much more. Independent analysts project the cost of the ship to be much more. Within the context of expected shipbuilding budgets, this means that the likelihood that the DoN will ever be able to build more than one DD(X) per year is very low. Incredibly, then, DoN planners are recreating the very same problem they face in the submarine fleet: *they are pursuing warships of unequalled power and capability that can be built at a rate of no more than one per year.*

Accepting this fact, and having no interest in repeating the submarine teaming arrangement in which two yards split the construction of one submarine per year, the DoN moved to kill one of the two remaining US combatant shipyards. In February 2005, it abruptly announced an intended change to the previously announced DD(X) acquisition strategy. Under the old plan, the first DD(X) would be built by Northrop Grumman Ship Systems in Pascagoula, Mississippi, and the second by General Dynamics in Bath, Maine. Contracts for follow-on DD(X)s would be split between the two yards. The two yards would compete for the follow-on CGX. Under the new plan, the DoN would seek OSD approval to pursue a one-time, winner-take-all competition for the entire DD(X) production run. Moreover, the DoN simultaneously backed off from its stated goal to have each yard compete for follow-on CGX orders. The unstated, but inevitable result of these moves would be to force the losing yard out of the surface combatant business. In effect, DoN leadership determined that the \$300 million cost savings per ship that would result from consolidating DD(X) production in one yard was more important than maintaining two surface combatant yards.

Interestingly, top DoN officials justify their decision by arguing that because the DD(X) is so much more capable than originally planned, their numbers could be drastically reduced, and the resulting one-per-year build rate would be unaffordable at two yards. However, this argument ignores the long-term implications of building one ship per year for an extended period of time. The DoN’s long-range shipbuilding plan calls for an ultimate battle line consisting of 30 DD(X)/CGX first-rates and 62 DDG/DDGX second-rates, for a total of 92 ships. This will require a steady state build-rate of 2.6 ships per year. An extended period of building one first-rate per year will mean that future DDGX building rates might need to be three to four per year to keep fleet numbers up. DoN officials are mute as to whether one surface combatant yard will provide sufficient shipbuilding capacity over the long term.

A fourth argument made by DoN leaders in support of the ship is that it “is going to cost dramatically less to operate” than legacy combatants. This is perhaps the most compelling argument made by proponents for the new ship. For example, they point out that the DD(X) will have a crew of 150 or less, compared to crews of 350 to 400 on legacy first- and second-rates. For this and other reasons, ten DD(X) destroyers are

expected to cost \$4.2 billion less to operate over 35 years than a similar number of DDGs. Therefore, they urge that the cost of the DD(X) be viewed within the context of the “cost of the next navy.” In this light, the bold technological steps taken on the DD(X), and their high associated costs, will make the future force far more affordable. Higher procurement costs now are therefore worth it.

While this argument is attractive, it is based on assertions, not facts. In any event, the Navy’s 30-year long transition to the “next navy” fleet-wide O&S costs will likely be higher than they are today. The biggest reason for this is that *fleet-wide* crew savings associated with the introduction of the DD(X) and CGX are decades away. Unlike any other component in the fleet, the manning requirement for the surface battle line is growing substantially. Today, the 71 ships in the battle line require an aggregate crew of 24,918 officers and Sailors. By 2011, the planned fleet of 84 ships will require 29,184. Then, because the CG-52 class will not be retired until the 2020s, the near-term addition of DD(X)s and CGXs will expand the battle line to 101 first-and second-rates by 2024. These ships will have an aggregate crew requirement for 31,384 officers and Sailors—6,326 more than required today. Additionally, the introduction of the new radars, propulsion plants, and combat and weapons systems associated with the DD(X) and CGX is sure to place additional training, maintenance, and logistics burdens on the fleet, resulting in even higher O&S costs.

Moreover, the current transition plan will require a marked increase in spending in DoN weapons procurement accounts. As recounted earlier, in 2011 the fleet’s 22 first-rates and 62 second-rates will carry 8,486 VLS cells and an equivalent magazine capacity of 8,868 battle force missiles. Between 2014 and 2035, as the DD(X) and CGX enter the fleet, the number of fleet VLS cells will continue to rise. Moreover, each of their cells will be able to carry either one large (i.e., 21-inches or larger) or two, 13-inch diameter battle force missiles. By 2024, then, the 12 planned DD(X)s will increase battle line missile capacity by 960-1,920 missiles. Assuming a notional missile load of 200 battle force missiles, eight CGXs might add a requirement 1,600 more, for a total fleet capacity of over 12,000 missiles! Moreover, the gun magazines in the 12 DD(X)s will hold 7,200 to 11,000 LRLAP rounds, each projected to cost as between \$35,000 to \$50,000 apiece. After 2024, battle force missile capacity remains relative constant through 2029, after which it falls gradually to a steady state capacity of just over 11,000 missiles. Given these numbers, it seems quite likely that the increased costs associated with filling out fleet magazines will offset to a great degree any expected savings from O&S accounts.

The fifth argument made by proponents for the DD(X) is that the ship has a significant advantage over legacy surface combatants in the littorals. One Navy admiral flatly states “I would not take the DDG into the littorals as I would the DD(X). While the DD(X), by virtue of its size, stealthy design features, and damage limitation features, would undoubtedly be better protected than the smaller DDGs, the simple fact is that the DDGs today operate daily in the littorals, and they will continue to do so over the next four decades.

Indeed, the DDG-51s are likely the second toughest class of combatants in the world today, and the DDG-79s the toughest. DDG-51s were built with the lessons of the 1982 Falklands War fresh in mind. They are an all-steel ship, protected against nuclear electromagnetic pulse effects and blast overpressure, and with increased resistance to blast, shock, fragmentation and fire damage. For example, the ships have 130 tons of Kevlar armor over the ships vital spaces. Moreover, the ship has two passages on either side of the ship, providing standoff blast and fragment protection internal ship compartments. Its Combat Information Center is placed below the main deck, and its combat system has a distributed architecture. The ship has a radar cross section 1/100 the size of the CG-52 class. Finally it the ship has a full-time, full-coverage four-zone collective protective system (CPS), which protects the crew from chemical, biological, and radiological contamination.

The DDG-79 class further benefited from combat experience gained during the 1990/91 Persian Gulf War. The threat of Iraqi mines led to the addition of the Kingfisher mine avoidance sonar. While the ship lost one CPS zone, it received five additional blast hardened bulkheads; four of them were found fore and aft of each of the ship's two engine rooms. Additional damage control features and improvements were also added.

In other words, in 2011 the Navy will operate a fleet of 62 all-steel, low observable, and extremely tough surface combatants—far tougher than any other combatants in the world today. Indeed, because of rising ship construction costs, many navies are building surface combatants to commercial standards. The DD(X) will certainly improve on their survivability and capability, but the simple question is: how much is enough, and at what cost? For example, the DD(X) will have a 50-fold improvement in radar, acoustic, magnetic, and infrared signatures than the DDG-51/79. However, when asked if the DD(X)'s improvement in signatures management was worth the increased cost of the platform, 10 of 14 admirals replied that it did not. As another example, for all their size and increased power, the DD(X) is assessed to be only 15 percent more effective than the DDG against attacks by swarming boats. Is their greatly increased cost worth this incremental improvement, especially given that the aforementioned LCS is designed as the Fleet's primary anti-boat platform? Similarly, proponents of DD(X)s claim that the ship's greater signal processing capability and improved radars will allow them to engage more targets in the coastal regions than a DDG. However, this is a false comparison. The real question is what will the DD(X) add to a CEC-enabled battle network? In the emerging Naval Battle Network Era, comparing ships with other ships is now far less revealing than trying to determine what capabilities a battle network component adds to the "Total Force Battle Network," or TFBN .

This final point is a key one, and it points to the flaw in the final key argument used to justify the DD(X). Top DoN officials see the ability to protect future Naval Battle Networks and sea bases from maneuvering ballistic missile warheads and high-speed ASCMs as "the brass ring" for future naval operations—its single most important operational capability. Since the DD(X) is the bridge to the CGX, the future theater air dominance platform, they argue that the fleet will never achieve this capability without the DD(X). In essence, this argument represents a return to the idea of the "capital

ship”—that the defeat of the DD(X) and CGX will result in the defeat the fleet. This line of thinking is incongruent with the emerging Naval Battle Network Era, where the power of the network, and not individual platforms, will determine the success of future naval combat.

As a result, *TFBN* defenses against the cruise missile threat will greatly improve with or without the DD(X). The inclusion of the E-2C airborne radar into CEC network will increase the detection volume of future naval Battle Networks by 250 percent, and will provide a “look down” capability against inbound cruise missiles that hug the terrain or ocean surface. Including E-2C data in CEC will allow AEGIS/VLS combatants armed with the new SM-6 Extended Range Active Missile (ERAM) to engage cruise missiles well beyond their radar horizons. Long-range ERAM engagements will be complemented by forward combat air patrols by F/A-18E/Fs and JSFs equipped with the active electronically scanned array (AESA) radars and advanced versions of AMRAAM missile. Mid-range cruise missile defense will be improved by CEC data-sharing and the SM-2 Block IIIB semi-active missile with dual-mode infrared/radio frequency guidance. And terminal defenses will be aided by the SPQ-9B radar, Evolved Sea Sparrow Missiles, the Rolling Airframe Missile, and the Close-in Weapon System.

In fact, the only new capabilities the DD(X) will bring to the *TFBN* cruise missile defense problem will be its new Volume Search Radar and its SPY-3 Multi-function Radar, which are designed to detect and track ballistic missiles and the most advanced low-observable ASCMs. These radars are expected to provide 15 times better detection of sea-skimming targets, a 20 percent advance in tracking range of cruise missiles, and a 10-fold increase in the maximum missile track capacity. As attractive as these capabilities will be, however, the radars that provide them are not tied exclusively to the DD(X). Indeed, the VSR and MFR will be found on future ships like the CVN-21, LHAR, and possibly the LPD-17. Both radars could also go on newly designed—and potentially far cheaper—combatants.

With regard to *TFBN* ballistic missile defenses, CGX ballistic missile sensors, combat systems, and weapons have yet to fully take shape. For example, it is by no means certain that the DD(X) wave piercing tumblehome hull will be the best platform for these sensors, systems, or weapons. Should the DD(X) be cancelled, the combat systems and weapons required to handle future ballistic missile threats could easily migrate to a new platform. The LCS’s rapid requirements definition, design, and procurement schedule suggest a dedicated fleet ballistic missile platform based on a non-DD(X) solution could be in fleet service within a decade.

In the meantime, *TFBN* ballistic missile defenses could be improved by more aggressively exploiting the 84 AEGIS/VLS combatants now either in service, in production, or authorized. For example, one option would be to equip every combatant with the recently developed AEGIS Ballistic Missile Signal Processor (BSP), developed and paid for by the Missile Defense Agency. The BSP, as part of the AEGIS and VLS open architecture initiatives, would convert the entire legacy AEGIS/VLS fleet into ballistic missile defenders. The Block 2006 version of the AEGIS BSP gives the radar an

ability to discriminate reentry vehicles from decoys, and would likely be the best candidate for early insertion into the AEGIS fleet.

A second option would be to enhance the sensitivity of the fleet's proven and reliable AEGIS radars. Every 12 decibel (dB) increase in radar sensitivity results in a doubling of radar's range. Using the solid-state S-band technologies developed for the Volume Search Radar, engineers believe AEGIS radar sensitivity might be increased by as much as 15 to 23 dBs. This would allow future Naval Battle Networks to track and engage ballistic missiles at far greater ranges than possible today. Importantly, these increased tracking and engagement ranges would allow a Battle Network to take multiple shots against inbound missiles, thereby increasing the likelihood of a kill.

A third option would be to improve the numbers and types of sea-based interceptors. A likely candidate for improvement would be the three-stage SM-3 missile developed in conjunction with the MDA and now entering the fleet. The current missile has a 21-inch diameter first stage and 13.5-inch diameter second and third stages. By pursuing 21-inch diameter second and third stages, the missile's speed could be increased by nearly 50 percent, and its engagement envelope expanded accordingly. The Japanese are interested in pursuing this approach to arm their fleet of six first- and second-rates with a ballistic missile defense capability, and might help in its development. Such a missile might also be attractive to other allies that now or will operate AEGIS/VLS combatants, such as the Spain, South Korea, Australia, and Norway.

These steps, while improving fleet ballistic missile defenses over the near- to mid-term, will need to be augmented by additional steps over the long term. Maneuvering ballistic missiles will severely stress fleet defenses. New sea-based sensors, perhaps modeled after the X-band radars produced for the Terminal High Altitude Area Defense system, and new weapons such as new interceptors and directed energy weapons will likely be required. However, none of these new capabilities are directly tied either to the DD(X)/CGX—or to any other particular hull solution. Network solutions allow a variety of different approaches, many of them likely cheaper than following the current trajectory of the DD(X) and CGX.

In summary, then, the arguments in support of the DD(X) appear tenuous. Even worse, they are all based on a fundamentally flawed appreciation of the state of the naval competition. This is evident by the aforementioned comparison of the DD(X) to the *HMS Dreadnought*—a “ship that in one generation set the Royal Navy apart from its peers.” The *Dreadnought*, like the *HMS Warrior* before it, represented a disruptive combatant design introduced by the British Royal Navy during times of intense naval competition. The *Dreadnought's* design was made necessary because increasingly capable naval challengers were pressing the British Royal Navy for the lead in the global naval race, and it was introduced for the specific purpose of reopening that lead.

In stark contrast, the *US surface battle line is already a generation ahead of its peers*. According to DoN officials, the current first- and second-rates will be capable through at least 2030. If this is true, why introduce the DD(X) in fleet service now? What is the

incentive to do so? One DoN official said the DD(X) and CGX are designed to “project power and protect the sea lanes *in the 2020-2040 time frame.*” How can DoN officials be sure they fully understand the design drivers for new combatants two to four decades hence? Might it not be better to exploit the battle line’s formidable lead and delay movement toward a new combatant design until the threats to surface ships and ship technologies are better known or perfected?

There are alternative approaches to injecting the impressive technologies found in the DD(X). The first step would be to build just one, or perhaps two, DD(X) technology demonstrators. The DD-21/DD(X) programs have already served two salutary purposes: they worked to maintain US combatant design expertise during a lull in the naval design competition, and they provided the impetus for new advances in hull design, machinery, propulsion, and combat systems. Building just one or two of the ships would serve a third: further reducing the technological risks associated with its many innovative systems, as well as the integration risks associated with packing so many new technologies into a single hull. Moreover, by designating the DD(X) as a technology demonstrator, Congress might agree to authorize its construction using R&D, rather than SCN dollars.

The second step would be to initiate an associated DD(X) Technology Migration Program. This program would seek to inject as many cost-effective innovations as possible into Navy ship designs. For example, the AGS might be incorporated on other fleet platforms, such as the LPD-17. The VSR/MFR radars might be back-fitted into a variety of platforms. The DD(X)’s new autonomous fire fighting system might be back-fitted on DDG-51/79s.

The third step would be to initiate a new design competition for the next generation of “Large Battle Network Combatants” (LBNCs). The design effort would shoot for true “clean sheet design,” based on a far better appreciation of the nature and challenges of with the Joint Expeditionary Era, its associated Naval Battle Network Era, and the future budget environment. The effort would benefit from lessons learned from the DD(X) and LCS programs. For example, one approach might try to design one or two LBNC sea frames with different battle line modules for land attack, air defense, ballistic missile defense, or anti-submarine warfare. An integral part of the effort should be a series of prototype competitions designed to maintain US combatant design expertise, and to test new approaches to LBNC design.

Assuming an expected service life of 35 years, the current 84-ship battle line will need to be replaced starting in 2021, at an average rate of 2.4 ships per year, or approximately five every two years. This means the LBNC competition would be to have a solid design ready for introduction toward the mid- to latter part of the next decade. Drawing from the LCS program, LBNC sea frames would be designed-to-cost, with “produce-ability” as a key attribute. The only variable in their costs would be whether they carried a “guided missile cruiser,” “guided missile destroyer,” or “destroyer” combat system module, and whether they were configured as a first-, second, or third-rate.

Of course, such a path would require a fourth step in the surface combatant transformation plan: keeping the fleet of 84 first- and second-rate combatants fully up-to-date. Happily, such an effort is already in place. The soon-to-commence CG and DDG Modernization Programs represents a cost-effective and prudent way to maintain fleet combat capability until the new LBNC is designed. These programs will include upgrades to ship's weapons and weapon systems, including the SPQ-9B X-band radar, the ESSM missile, new Tomahawk planning systems, upgraded terminal defense guns, and new electronic warfare systems. The program also includes ship habitability and machinery upgrades, introducing all-electric ship auxiliaries and new integrated bridge systems. The introduction of "Smart-ship" technologies may allow crew reductions of up to ten percent. These and other improvements are expected to extend the expected service lives of the ships from 35 to as much as 40 years, and reduce fleet-wide O&S costs by up to 39 percent.

A key contributor to such impressive O&S savings is the introduction of open architecture standards for the AEGIS combat system, the CEC program, and the VLS. In today's lexicon, the AEGIS combat system was designed from the start to be a "spiral development" program involving successive, progressively more capable software "baseline configurations." Unfortunately, each configuration represented a unique software product, which although interoperable with other baselines, required dedicated technical support, and led to high fleet-wide O&S costs. Worse, the proliferation of different baseline configurations resulted in a surface fleet of differing capabilities. Drawing heavily from the lessons of the Advanced Rapid Commercial-off-the-shelf (COTS) Insertion (ARCI) program developed by the US submarine force, the AEGIS Open Architecture (AOA) program aims to move the entire 84-ship AEGIS fleet from military specification, Navy-unique "UYK" computer hardware and software to a flexible, open architecture based on commercial processors and interfaces. This will allow for a surface combatant fleet Rapid Capability Insertion Process (RCIP) "exploit[ing] ARCI principles."

The AOA program will update the entire combat system, to include its command and decision component, its weapons control, and the SPY-1 radar itself. The upgrades will include a new fiber optic local area network, commercial routers and switches, software modules written in flexible C++ programming language, new "middleware," and new display software and hardware. Not only will the AOA result in a standardized fleet baseline, and a common capability battle line, it will allow but it will facilitate easy fleet-wide combat system upgrades. The shift to the new AOA system began with its "forward fit" on the final three DDG-79s now under construction. The *USS Bunker Hill*, the first CG-52 and the oldest ship in the battle line, is expected to be the first ship to be back-fitted with the new open architecture in 2008. All remaining CG-52s and DDG-51/79s will follow.

The shift to open architecture standards for the AEGIS combat system is being accompanied by a similar shift for the CEC program. The original CEC system included a small, donut-shaped phased array antenna that clips onto a ship's mast and that receives radar data from other CEC-equipped ships. Because of topside clutter, larger ships like

the CG-52 class required two antennae to achieve 360 degree coverage around the ship. The system also includes unique processor that uses proprietary Navy programming language that integrates the ship's own radar data into network-derived composite tracks. The information processed aboard ship is then shared with other CEC ships through the same donut shaped phased array antenna. The CEC open architecture program replaces the old antenna with a new four-face phased array antenna that can be distributed around the ship to provide 360 degree coverage, and the 2,000-pound, legacy refrigerator-size data processing unit with a 55-pound, commercially designed processor using the same C++ language being used in the AOA program. Along with the AOA program, the CEC open architecture program will allow easier fleet-wide CEC upgrades, and help to resolve the nagging problem of non-interoperability or incompatibility among multiple, dissimilar combat systems.

The VLS Open Architecture program is the final part of the battle line architecture modernization plan. There are currently four different VLS baseline configurations in the fleet, and two additional baseline configurations in allied navies. The VLA Open Architecture program introduces new launch control units, launch sequencers, processors, middleware, peripherals, C++ programming language, and communication protocols to allow easy introduction of new weapons into the VLS stable, and to allow rapid updating of fleet-wide weapons control and launch operations. In the near-term, VLA Open Architecture will allow all ships in the battle line to fire all versions of Tomahawks, all variants of the Standard SAM, vertical launch ASW rockets, and the new ESSM. In the far-term, it will allow all ships to receive and fire new missiles, such as the aforementioned SM-6 ERAM now in development, more powerful anti-ballistic missiles, and other guided weapons, such as advanced versions of the Tomahawk, or navalized versions of the Army Tactical Missile System (ATACMS).

The move toward a fleet-wide open architecture for AEGIS, CEC, VLS and other combat systems will make the programmed 84-ship battle line even more powerful, and allow it to make the rapid interim technological responses required by a Strategy of the Second Move. The modernization program will also give DoN planners more latitude in planning for bolder, more disruptive changes. Because the modernization programs will increase the service lives of AEGIS/VLS combatants from 35 to up to 40 years, they expand the time window for which the DoN might introduce the follow-on LBNC. This will allow Navy planners greater flexibility in choosing the time to trigger advantageous, disruptive change.

This four step plan maintains and widens US surface combatant dominance, exploits DD(X) technology innovations, preserves US surface combatant design expertise, and positions the US to upend the naval competition at a time of its choosing over the next two decades. However, it does not help to maintain the US surface combatant industrial base, a clear concern of the Congress. An *optional* fifth step therefore would be to adopt a force planning model similar to the one used by the JMSDF for its submarine fleet. The JMSDF submarine requirement is for a fleet of 16 boats. Because the boats have much longer potential service lives than 16 years, one force planning and shipbuilding option would have been to build a fleet of 16 boats, and halt production for ten years or so

before building a replacement class. Unfortunately, in the interim, the Japanese design and shipbuilding base would wither away. Therefore, the Japanese authorize one new submarine every year. Every time a new submarine is commissioned, the oldest boat in the fleet is first transferred to training duties, and then retired. The oldest submarine in the fleet is thus 16 years old, and the average age of the fleet only eight years. In this way, Japanese design expertise is maintained (by starting periodic new classes), as is the submarine construction industry.

In a similar way, starting in FY 2007, the DoN could authorize one DDG-79 a year, but with the intent of keeping the AEGIS/VLS fleet at a steady state force of 84 ships. As these ships entered the fleet in FY 2012 and beyond, they would replace the oldest non-modernized DDG in the force. Moreover, each new ship could be used as the basis for injecting new innovations into the fleet, such as new solid state S-band radars, or AEGIS BSPs, or technologies derived from the DD(X) program. Priority would be given to systems that could be back-fitted into other DDG-51/79s. The construction work on these ships would help to maintain the US shipbuilding base. Moreover, this plan would minimize O&S expenditures over the near-to mid-term, by establishing a steady-state baseline for fleet manning and weapons procurement.

### **Summary**

In fleet service, the DD(X) would set the world standard in surface combatant design. It would be a technological marvel, and by far the most powerful surface combatant in the world. However, that is not the issue. These are:

- Given the stunning US lead in the global naval competition, is this the right time to be introducing an even more powerful first-rate surface combatant?
- Is the DD(X) attuned to likely US shipbuilding budgets? Would its introduction cause unfavorable tradeoffs among competing Navy platform requirements, or lead to unwanted reductions in US shipbuilding capacity?
- Could its individual warfighting capabilities be pursued at a more reasonable price?
- Are there viable near-term alternatives that would maintain US fleet combat capabilities until these lower priced alternatives could be pursued?

These answers to the questions appear to be, in order: no, no, yes, and yes. Therefore, a prudent step would be to build one DD(X) technology demonstrator/integrator platform—with R&D money—and to initiate a new design competition for a Large Battle Network Combatant.

Mr. Chairman, distinguished members of the subcommittee, this concludes my testimony. Thank you again for the opportunity to appear before you to discuss these issues. I will be pleased to respond to any questions you might have.