A
CBO
STUDY

MOVING U.S. FORCES: OPTIONS FOR STRATEGIC MOBILITY

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NOTES

Unless otherwise indicated, all years referred to in this study are fiscal years and all values are in 1997 dollars.

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

Preface

What combination of strategic mobility forces—airlift planes, sealift ships, and sets of military equipment prepositioned abroad—best suits the needs of the United States? Since the Department of Defense (DoD) no longer plans to confront a well-armed Soviet Union in a European conflict, some people might argue that its need for mobility forces has declined. But today the Administration envisions a smaller, yet more flexible, set of forces that can counter regional aggressors anywhere in the world. For that reason, proponents say a robust system for transporting military forces over intercontinental distances is more important than ever.

This analysis, conducted by the Congressional Budget Office (CBO) for the House Committee on National Security, looks at several alternatives for modernizing DoD's strategic mobility forces and compares the costs and capabilities of each option with those of the Administration's plan. In keeping with CBO's mandate to provide objective analysis, the study makes no recommendations.

Rachel Schmidt of CBO's National Security Division prepared the study under the general supervision of Cindy Williams and R. William Thomas. Shaun Black developed CBO's analytic model for sealift analysis and wrote sections of Chapter 3. Nathan Stacy wrote most of the discussion of the Civil Reserve Air Fleet in Chapter 2 and Appendix B. Jo Ann Vines, Jeannette Deshong, and Victoria Fraider of CBO's Budget Analysis Division provided the cost analysis. The author would like to thank Evan Christman, Ivan Eland, Wayne Glass, Frances Lussier, and Doug Taylor of CBO, as well as numerous employees of the Department of Defense and the military services, for their help. Philip Webre and Arlene Holen of CBO, David Kassing of RAND, and Owen Cote of Harvard University's Center for Science and International Affairs provided thoughtful comments on an earlier draft of the study. (The assistance of external participants implies no responsibility for the final product, which rests solely with CBO.)

Christian Spoor edited the manuscript, and Marlies Dunson provided editorial assistance. Judith Cromwell produced drafts of the study. Kathryn Quattrone and Jill Sands prepared the report for publication.

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Summary

In the aftermath of the Cold War, some military analysts believe that strategic mobility—the system of equipment, personnel, and logistical know-how for moving military forces over intercontinental distances—is more important than ever before. The Department of Defense (DoD) has reduced the number of U.S. troops stationed abroad, so the United States will need to deploy forces over a longer distance if it becomes involved in a foreign conflict. The ability to project large numbers of forces quickly has been a distinctive feature of the U.S. military. In the opinion of some analysts, it is one means of maintaining the nation's status as a superpower.

The Administration envisions having a smaller, but more flexible, set of forces that the United States could use to counter regional aggressors anywhere in the world. As a result, strategic mobility is a top priority: the Administration proposes to spend nearly $20 billion (in current dollars) between 1998 and 2002 to acquire new cargo planes and sealift ships. That amount constitutes about 7 percent of proposed military procurement spending over the period.

However, spending for strategic mobility will take place during a period of intense competition for funding—both in the defense budget and in the federal budget as a whole. In light of that competition, the Congress may want to consider alternatives to the Administration's plan for mobility forces that would provide similar capabilities at a lower cost. In doing so, policymakers need to understand the implications of using different modes of lift and how military planners arrived at their numerical requirements for mobility forces. This study examines those issues and evaluates the costs and capabilities of five alternative approaches to modernizing strategic mobility. (The study uses the terms "strategic mobility" and "strategic lift" interchangeably.)

Current Mobility Forces and Requirements

The U.S. military delivers troops and cargo over strategic (that is, intercontinental) distances in three ways: by air, ship, or flying troops abroad to meet up with equipment already stored ("prepositioned") there. Each of those modes has its own combination of strengths and weaknesses. Airlift planes travel very quickly, but their great expense makes them impractical for delivering more than a small portion of cargo in a large-scale deployment. DoD used sealift ships to move more than 70 percent of all dry cargo during the Persian Gulf War, but those ships took three to four weeks to travel from the United States. Prepositioning combines the speed of airlift with the volume of cargo that sealift can provide. But storing military equipment in other countries requires planners to determine ahead of time where conflicts are likely to occur and which units they would deploy first. Moreover, host countries may limit how and where the United States can use that equipment, and large prepositioned U.S. stocks can present an attractive target for potential enemies.

In the past, the United States relied heavily on commercial planes and ships to move its forces. Today, DoD has sizable mobility forces of its own, but it

would still need help from participants in the Civil Reserve Air Fleet (CRAF) and the Voluntary Intermodal Sealift Agreement (VISA) during major conflicts. Under CRAF and VISA, commercial companies agree to make planes and ships available to the military during wartime, in exchange for a share of the government's transportation business during peacetime. Those arrangements benefit both the companies and DoD, which would otherwise have to pay for procuring and operating an equivalent number of planes and ships. In recent years, the needs of the military and the commercial transportation sector have diverged somewhat, and DoD has bought its own fleet of planes and ships. But considerable debate still exists about whether DoD needs as large a fleet as it proposes or whether it could broaden its reliance on civil transportation.

Once DoD uses strategic mobility to move forces from the United States to distant theaters, it needs intratheater cargo planes, heavy-duty trucks, trains, and smaller watercraft to move those troops and their gear forward to the battlefront. DoD also needs many other components to operate a complete transportation system: skilled personnel to run airfields and ports, computer systems that allow military commanders to communicate their priorities for deploying forces, and a broad array of smaller equipment such as elevator loaders, cargo containers, cranes, and forklifts, to name a few. Investments in those less obvious components of DoD's transportation system can be just as important as the decisions about large planes, ships, and prepositioning.

Defense planners have focused increasingly on strategic mobility since the 1990 deployment of U.S. forces to the Persian Gulf for Operations Desert Shield and Desert Storm. In the aftermath of that war, the Office of the Joint Chiefs of Staff concluded that although the deployment was largely successful, those troops who were deployed earliest faced considerable risk, particularly if Iraq had immediately invaded Saudi Arabia. Since then, military planners from the Joint Chiefs of Staff have emphasized the need for deploying heavy ground forces—those with tanks or armored vehicles and lots of firepower—early in a conflict to halt an enemy's advance.

If a conflict broke out in the Persian Gulf today, for example, the Army would try to deploy a full heavy division to the region in about two weeks. That strategy would reduce the risk to U.S. troops who deployed first. And if those early forces were able to halt an attack quickly, the Army's plan could lower the total number of troops the United States would need to send abroad.

But such an approach would place significant demands on U.S. strategic mobility. Indeed, the Army's goals would require DoD's transportation system to deliver a heavy division to the Persian Gulf in about half the time it did in 1990. That task is even harder today because the Army—which defense planners believe would create 77 percent of DoD's mobility workload in a major conflict—requires more floor space and has gotten heavier over time as it has modernized its equipment.

Yet recent deployments to the Persian Gulf, such as Operation Vigilant Warrior in 1994, suggest that DoD may be able to achieve its delivery goals through prepositioning. Immediately after the Gulf War, the Joint Chiefs recommended that DoD preposition equipment for combat and combat-support units on board ships. Combined with additional brigade-size sets that the Army is prepositioning on land, that equipment might allow military planners to meet their objectives.

The Administration's Plan for Mobility Forces

The Administration would devote most of DoD's funding for strategic mobility to purchasing airlift planes, though it would continue to buy sealift ships as well. At the same time, defense officials recognize how important prepositioning is for their strategy and plan to expand the amount of equipment placed overseas.

Plans for Modernizing Military Airlift and Sealift

A central component of the Administration's plan for mobility forces is the C-17, the Air Force's new cargo plane that will replace the aging C-141. In November 1995, the Administration recommended that the Congress fund a total of 120 C-17s rather than the alternatives it was considering: a mixture of planes with fewer

C-17s and either C-5Ds (a new version of DoD's largest airlift plane) or C-33s (a military version of Boeing's 747-400 freighter). Under the Administration's plan for multiyear procurement, C-17 purchases would cost $16.1 billion between 1998 and 2002, with the last planes being bought in 2003 (see Summary Table 1).

The Air Force has already purchased 48 C-17s. Buying 72 more would account for more than a third of the cost of the Administration's plan for strategic mobility between 1998 and 2020, according to the Congressional Budget Office's (CBO's) estimate. Operating and supporting 120 C-17s would cost another

Summary Table 1.
The Administration's Plan for Modernizing Strategic Mobility
(In millions of 1997 dollars of budget authority)

	1997 and Earlier	1998	1999	2000	2001	2002	Total, 1998-2002	Total, 1998-2020
C-17s								
Quantity	48	9	13	15	15	15	67	72
Acquisition costs	24,868	2,584	3,384	3,433	3,435	3,232	16,067	18,251
Operation and support costs[a]	n.a.	376	503	597	725	886	3,086	27,240
Large, Medium-Speed Roll-on/Roll-off Ships								
Quantity	16	2	1	0	0	0	3	3
Acquisition costs	5,016	628[b]	282[c]	0	0	0	909	909
Operation and support costs for ships based in the United States	n.a.	0	12	25	37	46	120	985
Costs of Prepositioning Afloat	n.a.	110	132	175	175	175	768	4,101
Costs of Prepositioning in Korea and the Persian Gulf								
Acquisition costs	n.a.	45	0	0	0	0	45	45
Operation and support and military construction costs	n.a.	85	105	109	112	112	522	2,707
Total Costs	n.a.	3,826	4,418	4,339	4,484	4,451	21,517	54,239

SOURCE: Congressional Budget Office.

NOTES: The costs shown above do not reflect all mobility forces—only those that will vary among the five alternatives presented in this study. For example, the costs do not include operation and support of other cargo planes, such as C-5s and KC-10s, or other sealift ships, such as SL-7s. Nor do they include any additional purchases of smaller roll-on/roll-off ships for the Ready Reserve Force.

Operation and support costs include the costs of operation and maintenance as well as compensation for associated military personnel.

n.a. = not available.

a. Includes operation and support costs for the first 48 C-17s. At a steady-state level, those 48 planes (41 primary aircraft authorized) would cost approximately $533 million a year (in 1997 dollars) to operate and support.

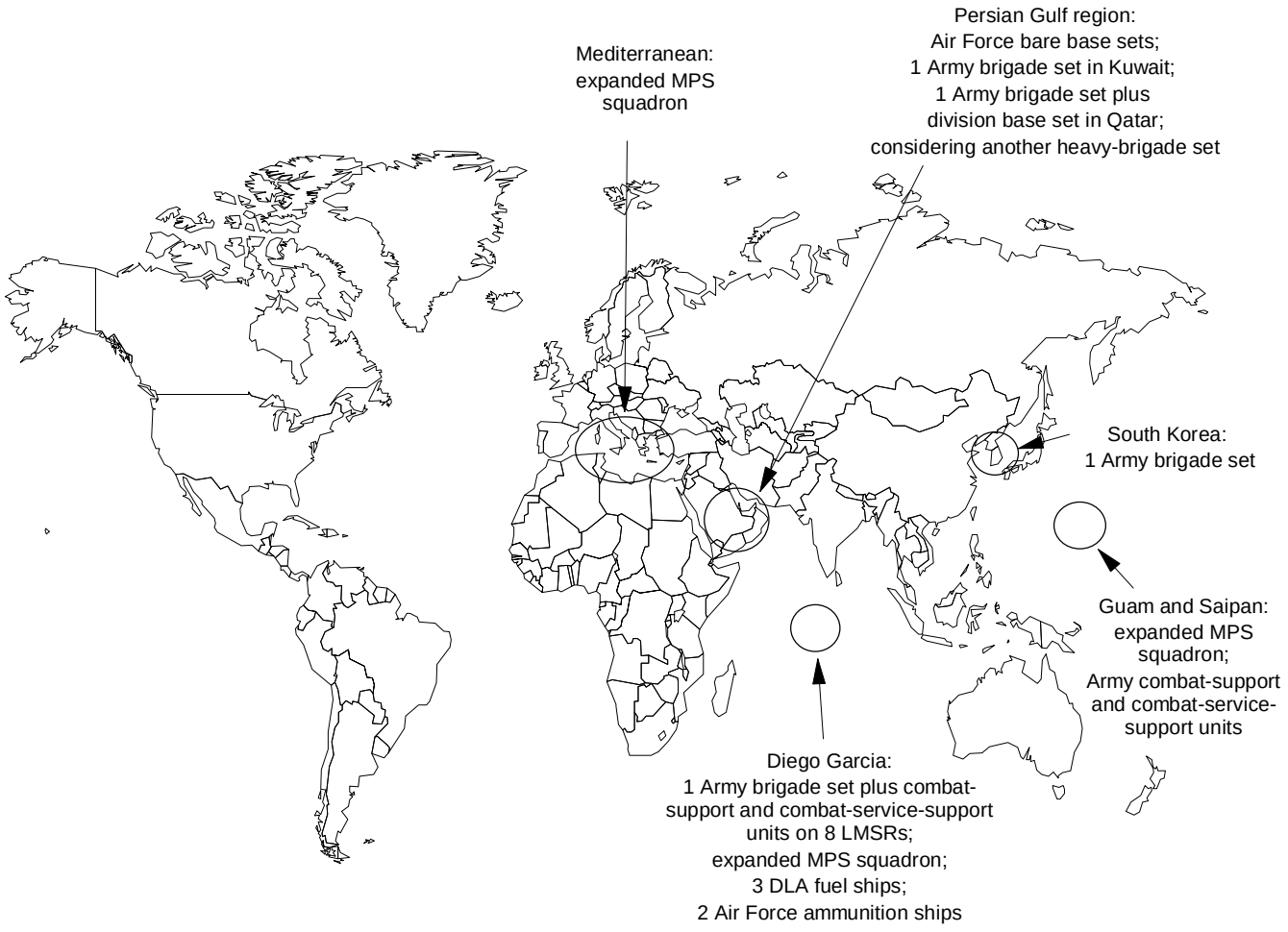
b. Includes advance procurement funding for one ship in 1999.

c. For 1997, the Congress added $300 million to the Administration's request in order to speed up the purchase of one ship. As a result, CBO reduced the Administration's plan in 1999 by one ship at a cost of $300 million.

$27.2 billion during that period, bringing the share associated with the C-17 to nearly 85 percent of total costs for the Administration's plan. Because DoD would incur most of the costs of buying C-17s between now and 2002, the plane's share of total costs would be even higher in the near term.

To improve its sealift capacity considerably, the Administration also plans to buy a total of 19 large, medium-speed roll-on/roll-off ships (LMSRs). Eight of those vessels would be used to preposition equipment for heavy forces and support units; the other 11 would transport equipment from the United States (so-called surge sealift). To meet that plan, DoD would acquire three more LMSRs in 1998 and 1999 at a total cost of $909 million. The Administration is also examining ways to add capacity to its fleet of smaller roll-on/roll-off ships in the Ready Reserve Force. (The Ready Reserve Force is a fleet of inactive cargo ships maintained by the Department of Transportation's Maritime Administration. In the event of a conflict, those vessels would supplement DoD's other sealift ships.)

Summary Figure 1.
The Administration's Plan to Preposition Equipment for Two Major Regional Conflicts



SOURCE: Congressional Budget Office.

NOTE: MPS = Maritime Prepositioning Ships; LMSR = large, medium-speed roll-on/roll-off ship; DLA = Defense Logistics Agency.

Plans to Expand Prepositioning

In its most recent comprehensive military plan—the 1993 Bottom-Up Review—DoD focused on a scenario in which the United States would fight two nearly simultaneous major conflicts (or contingencies, as DoD calls them) on the Korean Peninsula and in the Persian Gulf region. As a result, DoD has begun prepositioning equipment in those areas.

Current plans call for the Army to preposition enough equipment for two heavy brigades and a divisional headquarters in the Persian Gulf region over the next several years (see Summary Figure 1). (A brigade is roughly one-third the size of a division.) The Air Force has prepositioned equipment in the Persian Gulf as well: materiel that would allow it to set up and operate air bases quickly in the event of conflict. In South Korea, the Army recently prepositioned tanks and armored fighting vehicles for one heavy brigade. Since the Army already has two manned heavy brigades stationed there, the additional equipment would help provide a complete division quickly if war broke out.

Both the Marine Corps and the Army intend to expand the amount of equipment that they have prepositioned on ships, which DoD could send to any number of contingencies. The Marines plan to add one ship to each of three existing squadrons of vessels located in the Mediterranean, at Diego Garcia in the Indian Ocean, and at Guam and Saipan in the Pacific. Each extra ship would hold equipment for an expeditionary airfield, a fleet hospital that would be set up on land, a construction battalion, and headquarters units to support Marine operations. In 1993, the Army began placing equipment for a heavy brigade and support units on seven roll-on/roll-off ships anchored at Diego Garcia. DoD planners expect to replace those ships with eight LMSRs by the end of the decade, more than doubling the amount of cargo space available.

Evaluating Requirements for Strategic Mobility

DoD bases its numerical requirements for strategic mobility forces on a 1995 analysis called the Mobility Requirements Study Bottom-Up Review Update (MRS BURU). That study closely followed the assumptions of the two-war planning scenario outlined in the Bottom-Up Review.

The recommendations of the study supported some positions that were already part of the Administration's plans. For example, the study reinforced an earlier recommendation by the Joint Chiefs of Staff to buy 19 LMSRs and smaller roll-on/roll-off ships, which would allow the Army to expand its afloat prepositioning program and also provide DoD with considerably more capacity to carry cargo on ships from the United States. When the MRS BURU was published, the Administration had not yet decided whether to follow through on an earlier decision to buy 120 C-17s or instead purchase a mixture of C-17s and other airlift planes. However, the recommendations of the MRS BURU about airlift were consistent with what the Air Force would achieve if it added 120 C-17s to its fleet.

How do planners decide what type and amount of strategic lift is best? The authors of the MRS BURU first identified how much force they believed the United States would need to halt enemy assaults on the Korean Peninsula and in the Persian Gulf region. Using computer simulations of combat, the Joint Chiefs of Staff and other DoD analysts tried to establish when certain units would need to arrive in order to limit the amount of risk faced by the forces who deployed earliest. Then, using simulations of cargo deliveries, they determined what combinations of mobility forces would allow DoD to meet those timelines.

Every analysis of mobility requires a vast number of assumptions. Those assumptions can be grouped in three broad categories: the nature of whom the United States would need to fight and how that foe might prosecute an attack; which U.S. forces would be sent to the conflict and whether they would be ready to deploy; and whether military and commercial planes and ships would be available and would operate as expected. So much uncertainty surrounds each of those issues that there is room for debate over almost any assumption that planners make. Probably no mobility analysis can definitely settle how much lift is enough and what combination of mobility forces best suits the needs of the United States. Ultimately, that is a subjective judgment in which decisionmakers must balance the cost of investing in mobility forces against the capabilities that those forces would provide.

Besides uncertainty, another problem inherent in determining lift requirements is that planning for a major deployment involves two very different communities of military analysts: those who prepare for combat operations and those who plan to deliver the forces. Historically, warfighters and mobility planners have approached their task from widely different viewpoints. Warfighters, such as regional commanders, face the consequences of risk most directly, so they make plans to deploy a large enough force to ensure dominance on the battlefield.

Mobility planners, less directly exposed to risk, tend to use fairly optimistic assumptions about what the United States could deliver early in a conflict. In the MRS BURU, for example, mobility planners assumed that reserve personnel would be called up quickly, that the weather would be clear, and that DoD would supplement its military airlift and sealift fleets quickly with commercial transportation. One assumption to which the MRS BURU is perhaps most sensitive is that decisionmakers would receive unambiguous warning of an attack and then act quickly on that intelligence. Unfortunately, history is replete with examples of how leaders saw warnings of an impending attack and yet failed to act.

Options for Modernizing Strategic Mobility Forces

In order to look at different approaches to strategic mobility, CBO developed five alternatives to the Administration's plan. The options represent only marginal changes from that plan because they all propose continuing to purchase mobility forces for the military rather than expanding commercial transportation programs. The options also have the vast majority of strategic mobility forces in common, including airlift planes such as the C-5 and KC-10, SL-7 fast sealift ships, other roll-on/roll-off vessels from the Ready Reserve Force, and commercial planes and ships.

Four of the five alternatives would cost significantly less than the Administration's plan because they would substitute prepositioning, sealift, or less expensive airlift planes for purchases of C-17s (see Summary Table 2). CBO also included one alternative in which DoD would buy a larger number of C-17s than under the Administration's plan but would simultaneously reduce the amount of equipment it prepositioned afloat.

Option I: Buy Fewer C-17s and Preposition More Equipment Afloat

Under the first alternative, DoD would purchase a total of 72 C-17s rather than 120. In place of airlift, Option I would substitute one additional LMSR that DoD would use to keep a larger amount of equipment prepositioned afloat.

How can one LMSR substitute for 48 planes? Each new vessel can preposition at least 250,000 square feet of cargo (after adjusting for reserve stowage space). By contrast, each C-17's cargo hold can carry approximately 1,500 square feet. It would take a total inventory of 38 to 52 C-17s to deliver 250,000 square feet of cargo from the United States to the Persian Gulf in the same amount of time as one LMSR steaming there from Diego Garcia and unloading its cargo (about 11 to 12 days). In fact, that number understates the comparison: airlift loads are constrained more by the weight and three-dimensional shape of their cargo than by floor space. So one LMSR prepositioned abroad could quite arguably replace airlift deliveries by 48 C-17s over the first two to three weeks of a major regional conflict.

The Army already plans to preposition much of its heaviest equipment, but it may be able to do more. For example, at least half of the weight associated with Army aviation units comes from trucks, trailers, and other vehicles that could be stored on an LMSR. Similarly, the Air Force deploys most of its cargo by airlift, including heavy equipment for engineering units that could be prepositioned. For Option I, CBO identified nearly 260,000 square feet (or 11,400 tons) of equipment that DoD could preposition on board an additional LMSR—or roughly 14 percent to 19 percent of the total amount that would otherwise be airlifted during the first two to three weeks of a major conflict.

Under Option I, the Navy and the Army would face higher costs associated with buying one additional ship and another set of equipment. CBO also assumed that the average cost of purchasing C-17s would be higher if the Air Force bought just 72 rather than 120. Never-

theless, CBO estimates that Option I would cost $18.2 billion less than the Administration's plan over the 1998-2020 period. More than $7 billion of those savings would accrue by 2002 (see Summary Table 3).

Option II: Buy Fewer C-17s and Preposition More Equipment on Land

CBO's second alternative is similar to Option I in that DoD would limit its C-17 purchase to 72 planes. Rather than expanding prepositioning on ships, however, Option II would preposition more equipment in warehouses erected both in South Korea and in the Persian Gulf region. The services would need to purchase two extra sets of equipment—one for each location—so Option II would actually cost slightly more than Option I, even though DoD would not be buying an additional LMSR. But DoD could tailor the prepositioned sets for the scenario at hand, including important equipment, such as that to support a Patriot air-defense artillery battalion, that DoD believes does not stand up well to prepositioning at sea.

CBO estimates that the savings associated with a smaller airlift purchase would far outweigh the added costs of building warehouses, buying extra equipment,

Summary Table 2.
Five Alternatives for Modernizing Strategic Mobility

Option	Airlift	Land-Based Prepositioning	Afloat Prepositioning	Surge Sealift
Administration's Plan	120 C-17s	Two heavy-brigade sets in the Persian Gulf, one in South Korea	One heavy-brigade set and support units on board eight LMSRs	11 LMSRs
I	48 fewer C-17s[a]	Same as Administration's plan	One more LMSR	Same as Administration's plan
II	48 fewer C-17s[a]	Adds 240,000 square feet of prepositioning in both the Persian Gulf and South Korea	Same as Administration's plan	Same as Administration's plan
III	48 fewer C-17s,[a] adds 30 C-33s[b]	Same as Administration's plan	Same as Administration's plan	Same as Administration's plan
IV	20 more C-17s[c]	Same as Administration's plan	One fewer LMSR	Same as Administration's plan
V	48 fewer C-17s[a]	Same as Administration's plan	Same as Administration's plan	One more LMSR

SOURCE: Congressional Budget Office.

NOTE: LMSR = large, medium-speed roll-on/roll-off ship.

a. A total of 72 C-17s, or 61 primary aircraft authorized.

b. A total of 30 C-33s, or 27 primary aircraft authorized.

c. A total of 140 C-17s, or 119 primary aircraft authorized.

Summary Table 3.
Comparison of the Costs and Capabilities of Alternatives for Modernizing Strategic Mobility

	Administration's Plan	Option I	Option II	Option III	Option IV	Option V
Cumulative Costs (In billions of 1997 dollars)						
1998-2002						
Total	21.5	14.4	15.1	17.5	21.3	14.0
Savings from the Administration's plan	n.a.	7.1	6.4	4.0	0.2	7.5
1998-2020						
Total	54.2	36.1	37.5	45.8	60.5	35.3
Savings from the Administration's plan	n.a.	18.2	16.8	8.4	-6.3	18.9
Cumulative Airlift Deliveries to the Persian Gulf Plus Sustainment to Korea (In thousands of tons)[a]						
By day 20, including incremental prepositioning[b]	119.9	123.1	123.0	114.6	117.6	111.6
Difference from the Administration's plan	n.a.	3.1	3.1	-5.3	-2.4	-8.3
Outsize Airlift Deliveries to Korea (In thousands of tons)[c]						
By day 20	22.0	20.8	20.8	21.8	27.8	20.8
Difference from the Administration's plan	n.a.	-1.2	-1.2	-0.3	5.7	-1.2
Flexibility to Handle Changes in Deployment Schedules	Very flexible	Less flexible	Least flexible	Very flexible	Most flexible	Flexible but slow
Vulnerability to Enemy Attack	Less vulnerable	More vulnerable	Most vulnerable	Less vulnerable	Least vulnerable	More vulnerable
Risk Associated with Cargo Deliveries to Smaller Operations[d,e]						
Peacekeeping missions, humanitarian assistance, and evacuations	Low	Low	Low	Low	Low	Low
Peace enforcement missions	Low	Moderate	Moderate	Moderate	Low	Moderate
Risk Associated with Special Airlift Missions[d]						
Strategic brigade airdrops[e]	Low	High	High	High	Low	High
Intratheater unit moves	Low	High	High	High	Low	High
Direct delivery	Low	High	High	High	Low	High

SOURCE: Congressional Budget Office.

NOTE: n.a. = not applicable.

a. While deploying forces by air to the Persian Gulf, cargo planes would also continue airlift operations on a smaller scale to the Korean Peninsula. The values shown here include airlift deliveries to Korea that would occur at the same time as the deployment to a second conflict in the Persian Gulf. They include airlift deliveries for flexible deterrent options in the Persian Gulf region.

b. For two of the alternatives, CBO included deliveries of 11,400 tons of additional equipment prepositioned either afloat (Option I) or on land (Option II). For deliveries under Option IV, CBO subtracted 11,400 tons to reflect one fewer large, medium-speed roll-on/roll-off ship used for afloat prepositioning.

c. Includes deliveries for flexible deterrent options.

d. Risk in this case refers to risk of failing to complete the delivery mission in the required time.

e. CBO was unable to independently assess the risk associated with these missions. The levels shown are based on Defense Department analysis.

and guarding and maintaining it. Net of those costs, Option II would save $16.8 billion compared with the Administration's plan over the 1998-2020 period, or $6.4 billion through 2002.

Option III: Buy a Mixture of Airlift Planes

Under the third alternative, DoD would acquire the same theoretical airlift capacity that 120 C-17s provide but with a less expensive mixture of planes: 72 C-17s plus 30 modified commercial wide-body jets like the C-33. Each C-33 can hold more cargo than a C-17, but the latter can carry a wider variety of military equipment because of the larger width and height of its doors and cargo hold. Nevertheless, this option would give DoD a comparable level of theoretical airlift capacity as the Administration's plan. (Theoretical airlift capacity measures the amount that all airlift planes in a fleet could carry when fully mobilized, using average measures of each plane's performance. Actual airlift deliveries tend to be lower than theoretical capacity.)

Under Option III, DoD would buy C-17s at a rate of just eight per year. Thus, the average cost of those planes would be higher than under the Administration's plan, in which DoD would purchase C-17s at a maximum of 15 per year. Nevertheless, CBO estimates that Option III would cost $8.4 billion less than the Administration's plan over the 1998-2020 period—nearly $4 billion less over the first five years.

Option IV: Buy More C-17s and Preposition Less

To demonstrate all of the trade-offs between prepositioning and airlift, Option IV is the reverse of Option I: it would add airlift to the Administration's plan and subtract prepositioning ships. Specifically, Option IV would buy a total of 140 C-17s rather than the 120 the Administration intends but one fewer LMSR for afloat prepositioning. That larger number of C-17s would give DoD about 7 percent more theoretical airlift capacity from its own fleet than the Administration's plan would.

Because airlift is so much more expensive than other modes of lift, the cost of a larger number of C-17s would far surpass the savings associated with one fewer LMSR. CBO estimates that Option IV would cost roughly the same as the Administration's plan between 1998 and 2002 but $6.3 billion more than the plan through 2020.

Option V: Buy Fewer C-17s and More Surge Sealift

The fifth alternative would once again limit DoD's C-17 purchases to a total of 72, but in the place of airlift, it would buy an additional LMSR that DoD would use to surge cargo from the United States during wartime. Compared with ships prepositioned in the Indian Ocean, surge sealift vessels would have a longer distance to travel, so Option V would not permit DoD to complete deliveries as quickly as Option I, whose forces are identical. But if DoD's assumptions about how much equipment it could deliver quickly by airlift and prepositioning are implausible, Option V may be more practical.

Option V is the least costly of the alternatives. CBO estimates that it would save $18.9 billion compared with the Administration's plan over the 1998-2020 period and $7.5 billion between 1998 and 2002. Through 2020, it would also cost $746 million less than Option I.

Comparing the Capabilities of the Alternatives

The Congress might want to consider three categories of capabilities when comparing options for strategic mobility: how well each alternative delivers cargo to two major regional conflicts, how much flexibility each provides for delivering cargo to smaller contingencies, and how well each performs special airlift missions.

Cargo Deliveries to Major Regional Conflicts

Because DoD's plan to fight two major regional contingencies is so demanding, CBO estimated how much each option could deliver in that scenario. Specifically,

CBO focused on what the MRS BURU considered the most taxing conditions for mobility forces: a war in the Persian Gulf region that broke out shortly after one in the Korean Peninsula. CBO estimated how much equipment each option could deploy during the halting phase of a conflict in the Gulf (roughly the first two to three weeks, in DoD's assessment) while still delivering supplies to Korea to sustain operations there.

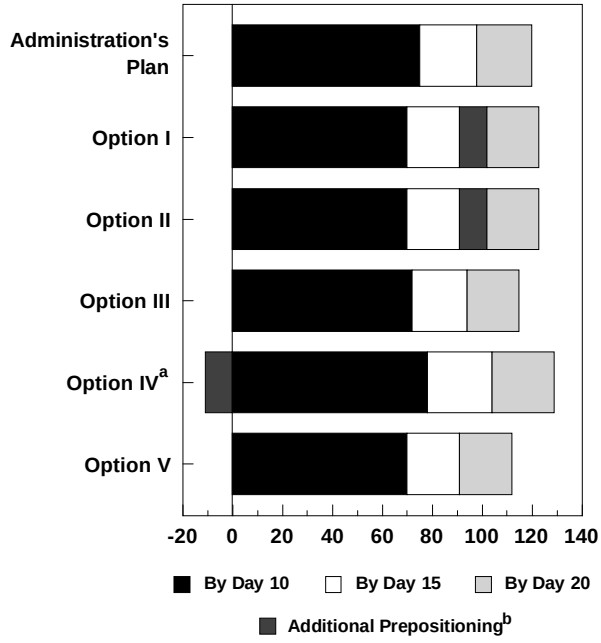
One recommendation of the MRS BURU was to devote one LMSR or two smaller roll-on/roll-off ships to additional prepositioning rather than to surge sealift. However, since DoD has not yet carried out that recommendation or included the necessary funding in its budget requests, CBO did not consider that additional prepositioning to be part of the Administration's plan. If defense officials carried out the recommendation in the future, DoD would be able to deliver considerably more equipment during the halting phase of a major regional contingency. As a result, those alternatives that include additional prepositioning (Options I and II) or that emphasize surge sealift (Option V) would compare much less favorably with the Administration's plan than they do here.

CBO's analysis suggests that the alternatives that emphasize prepositioning, Options I and II, might allow DoD to deliver slightly more equipment over the first two to three weeks of deliveries. But that margin is small: just 3,100 tons, or about 3 percent of total airlift deliveries that the Administration's plan might achieve over the same period (see Summary Figure 2).

Based on CBO's analysis, Options III, IV, and V would each deliver less cargo early in a second regional contingency than the Administration's plan. In Option III, the larger size of commercial wide-body jets could constrain their use if airfields were congested, so that alternative might deliver roughly 4 percent less in three weeks than a plan with 120 C-17s. Option IV includes 140 C-17s and thus it can deliver more by airlift. But the additional planes would not make up for having one fewer LMSR, and CBO estimates that Option IV would deliver about 2 percent less cargo than the Administration's plan. Since Option V includes fewer airlift planes and no additional prepositioned equipment, it would deliver the least amount of cargo early in a second major contingency—roughly 7 percent less than the Administration's plan.

Compared with requirements during the Cold War, today DoD plans to send relatively less outsize cargo by airlift. (Outsize is the term DoD uses to describe the largest pieces of cargo, which can fit only on C-17 or C-5 aircraft.) Yet some analysts believe that having larger numbers of planes that can carry outsize cargo is important so military commanders can keep their units together during a deployment. For that reason, CBO also analyzed how well each option could deliver outsize cargo in the scenario that, according to DoD officials, would feature the most congested airfields: a major conflict on the Korean Peninsula.

Summary Figure 2.
Airlift Deliveries to a Conflict in the Persian Gulf, Plus Sustaining Operations in Korea, Under the Administration's Plan and Five Alternatives (In thousands of tons delivered)



SOURCE: Congressional Budget Office.

a. Because Option IV includes one fewer large, medium-speed roll-on/roll-off ship than the Administration's plan, it would need to deliver additional cargo by airlift that would otherwise have been prepositioned. As a result, Option IV would deliver about 2,400 tons less by day 20 than the Administration's plan.

b. The total amount of prepositioned equipment that the military would deliver to a major regional conflict is classified information, so the prepositioning shown here is the amount that CBO added to or subtracted from the Administration's plan.

Among the five alternatives, only Option IV could deliver more outsize cargo than the Administration's plan. CBO estimates that the larger number of C-17s under that option might allow DoD to deliver 26 percent more outsize equipment over the first 20 days of a Korean deployment. Even with wider doors and strong floors, commercial jets like the C-33 cannot carry most types of outsize equipment. Nevertheless, CBO estimates that Option III would deliver just 1 percent less over the first three weeks of deployments than the Administration's plan. Options I, II, and V would each deliver about 6 percent less outsize cargo because of their smaller number of airlift planes.

In addition to how quickly each option delivers cargo, the Congress might want to consider other characteristics of the different modes of lift. For example, if DoD relied more heavily on prepositioned forces (as in Options I and II), military commanders would need to decide far in advance of a conflict which units they planned to deploy first. Although that arrangement would reduce the demands on DoD's transportation system, it would not allow commanders to change their deployment plans as the situation unfolded. Alternatives that include more airlift (like Options III and IV) might provide flexibility for last-minute changes to the deployment schedule, so long as the adjustments did not call for sending heavy forces.

Some types of mobility forces could also be more vulnerable to attack than others. An enemy wishing to slow the pace of deployments from the United States would be wise to target both airfields and ports. But most countries have more airfields than ports, and therefore it might be harder for an enemy to predict precisely where the United States would send its airlift planes. Moreover, the larger concentrations of cargo on ships and in prepositioning warehouses probably makes those modes somewhat more vulnerable to attack than airlift planes.

Flexibility for Delivering Cargo to Smaller Operations

Smaller military operations can pose different sorts of problems for strategic mobility than major regional conflicts. For example, such operations would probably take place without reserve personnel or the Civil Reserve Air Fleet being activated. There are also more regions where the United States might need to become involved in smaller operations, including countries that are landlocked or that lack modern airfields. Thus, the Congress might want to consider how well various investments in mobility forces would perform in those sorts of scenarios.

To examine that issue, CBO applied the results of a 1995 DoD study of smaller contingencies to each of its five alternatives. DoD's analysis examined how quickly airlift fleets that included different numbers of C-17s could deliver cargo to smaller operations and how well they could perform special airlift missions. Because of the large number of classified assumptions about where those operations would take place and how they would proceed, CBO was unable to conduct a similar independent analysis. Thus, readers should bear in mind that the assessments of risk presented here are largely those of DoD, and its analysis is subject to the uncertainties described earlier.

The DoD study looked at four representative situations in which the United States might need to deliver cargo short of a major regional conflict: a peacekeeping mission, a humanitarian operation, an evacuation of noncombatants from a foreign country, and a peace enforcement operation. DoD analysts concluded that for the first three categories, airlift fleets with as few as 40 C-17s could complete deliveries with little risk of falling behind the timelines set by military planners. Based on that finding, the Administration's plan and all five of CBO's options could conduct similar types of operations with low risk.

Peace enforcement operations, however, such as the recent deployment of U.S. forces to Bosnia, could be more demanding. In that type of situation, military troops would not operate in as secure an environment. Thus, DoD would need to deploy heavier equipment to protect U.S. troops from the warring parties, and it might need to do so on a quicker schedule. For those reasons, DoD concluded that an airlift fleet with 72 or 86 C-17s would face a moderate risk of completing deliveries too slowly, whereas a fleet with 100 or more C-17s would have a low risk. Is a moderate amount of risk acceptable? Opinions will undoubtedly differ. But in other analyses, such as the MRS BURU, the Joint Chiefs of Staff argued that a moderate level of risk was acceptable given budget constraints.

Other Special Airlift Missions

The Administration points to special additional types of airlift missions for which DoD would need larger numbers of C-17s. One example is a strategic brigade airdrop, in which the United States would need to deploy roughly 2,500 paratroopers and their equipment quickly into hostile territory far from the United States. DoD officials argue that they would require at least 100 C-17s to perform such a mission under the tight timelines laid out by military planners, and Army officials contend that the Air Force would need 120 C-17s to meet their requirement. Thus, if one believes that the United States will need to use that capability in the future, DoD's analysis would place a lower bound on the number of C-17s that it must buy.

Historically, however, the United States has performed very few airdrop operations, and it has conducted none outside the Western Hemisphere since the Vietnam War. A brigade-size intercontinental airdrop would be more demanding than operations like those into Grenada in 1983 and Panama in 1989, since the large number of parachutists would fly for many hours over longer distances, conduct a parachute assault to seize an airfield, and then prepare to receive reinforcements through traditional airlift deliveries. The difficulties of such an operation have led some defense analysts to deem it a highly unlikely event. Other analysts, however, contend that retaining such a capability would deter potential aggressors.

Another mission that might require more C-17s is moving key pieces of outsize equipment within a theater of operations in the midst of a major deployment. Without more planes, devoting one or two squadrons of C-17s to such intratheater airlift could slow the pace of deliveries from the United States. Based on its 1995 analysis, DoD officials argue that a fleet with 86 C-17s and 30 C-33s could complete strategic deliveries for a major conflict in a timely manner. But if military commanders chose to use C-17s for moving cargo within a theater, fewer of those planes would be available to transport forces from the United States, and thus the deployment would take more time. As a result, some military leaders recommend buying 14 additional C-17s for intratheater deliveries. Of course, DoD could continue to rely on trains, trucks, or in some cases smaller watercraft to move outsize cargo within a theater, as it has for years.

One final type of special airlift mission is direct delivery, in which cargo planes fly from the United States directly to airfields close to the battlefront rather than to larger staging bases at the rear of operations. DoD concluded in its 1995 analysis that fleets with at least 72 C-17s (when combined with C-33s) would still allow the United States to deliver some equipment directly to the front. But such a fleet would complete those deliveries more slowly than one with 120 C-17s, and thus the risk associated with having just 72 C-17s would be higher. In the opinion of DoD officials, fewer C-17s would raise the risk of such missions unacceptably, whereas larger numbers (as in the Administration's plan and Option IV) would reduce that risk. Alternatively, DoD could continue to conduct airlift deliveries as it has in the past: by delivering equipment to staging bases by air and then moving it to the battlefront by means of trucks, railways, smaller cargo planes, or watercraft.

Based on DoD's analysis, then, alternatives that include just 72 C-17s (Options I, II, III, and V) might not be adequate to conduct special missions like strategic brigade airdrops and intratheater deliveries. However, airlift is the most costly mode of lift, and the C-17, although a very capable plane, is also quite expensive. Thus, the Congress may want to balance the cost of larger numbers of C-17s against the likelihood that the United States will need to perform the types of special airlift missions for which they are necessary.

Chapter One

Introduction

The United States has one of the largest collections of advanced military equipment and some of the best-trained troops in the world. But that military strength means little if the nation cannot deploy its forces quickly wherever they are needed. Indeed, some defense analysts consider the ability of the United States to move forces rapidly over long distances an important means of keeping its status as a superpower.[1]

Moving U.S. troops and military cargo is the role of strategic mobility—the system of equipment, personnel, and logistical know-how that allows the Department of Defense (DoD) to deliver forces over intercontinental distances. Three major types of equipment are used for strategic lift: aircraft to fly cargo and personnel, ships to steam cargo and sustainment supplies from the United States, and ships or warehouses based abroad that the United States uses to "preposition" military stocks closer to regions where conflicts might occur. (This study uses the terms "strategic mobility" and "strategic lift" interchangeably.)

Although this study focuses on strategic (or intertheater) planes and ships, tactical (or intratheater) mobility assets are also critically important for delivering equipment over shorter distances within a theater of operations. Tactical mobility assets include planes, trucks, trains, smaller watercraft, and other apparatus to handle cargo—such as heavy-equipment transports, elevator loaders for airplanes, railcars, and the like. Policymakers may find the issues involved in planning to receive troops and equipment in distant theaters and to move them to the battlefront mundane. But failing to make such plans can undermine the benefits of buying larger planes and ships.

Why Is Strategic Mobility an Issue for the Congress?

Since the end of the Persian Gulf War, the United States has made sizable investments in mobility forces. The Administration plans to spend nearly $20 billion (in current dollars) to acquire additional sealift ships and airlift planes between 1998 and 2002. But today, competition for those resources is intense.

For example, in order to modernize weapons more quickly, military leaders have called for raising yearly procurement spending from $45 billion in 1997 to $60 billion (in current dollars) in 1998. But such an increase would require more funding than the Administration proposed in its budget for 1997 through 2000 or than the Congress proposed in its 1997 budget resolution for defense for the next several years. DoD might finance more weapons procurement by reforming its acquisition process or by cutting its system of bases and support personnel, but saving money through those measures has proved challenging. Moreover, factors outside the defense budget, such as growth in spending for Medicare and Medicaid, could restrain military spending in the future. Thus, it is important for the Congress to review how much priority DoD should place on mobility forces, and whether alternatives to the

1. David Kassing, "Strategic Mobility in the Post-Cold War Era," in Paul K. Davis, ed., *New Challenges for Defense Planning*, MR-400-RC (Santa Monica, Calif.: RAND, 1994), p. 663.

Table 1.
Changes in Combat and Mobility Forces Under the Administration's Plan, 1990-1999

	1990	1995	1999	Percentage Change 1990-1995	Percentage Change 1995-1999	Percentage Change 1990-1999
Combat Forces						
Army						
Active divisions	18	12	10	-33	-17	-44
Reserve component brigades	57	48	42	-16	-13	-26
Tactical Air Forces (PAA)[a]						
Active	2,712	1,784	1,672	-34	-6	-38
Reserve	1,054	662	614	-37	-7	-42
Ship Battle Forces	546	372	346	-32	-7	-37
Mobility Forces						
Intertheater Airlift						
Planes (PAA)[b]	380	357	314	-6	-12	-17
Theoretical fleet capacity (In MTM/D)[c]	48	50	50	3	0	4
Sealift						
Active cargo ships[d]	40	51	44	28	-14	10
Ready Reserve Force ships[e]	96	92	95	-4	3	-1
Surge shipping capacity (In MSQFT)	6.8	4.9[f]	8.7	-28	77	27

SOURCE: Congressional Budget Office based on data from the Department of Defense.

NOTE: PAA = primary aircraft authorized; MTM/D = millions of ton-miles per day; MSQFT = millions of square feet.

a. Includes Air Force, Navy, and Marine Corps fighter and attack aircraft.

b. Includes 37 KC-10s allocated to an airlift role. If the Defense Department retires all C-141s and buys 120 C-17s (102 PAI), the number of intertheater airlift planes will fall to 243 in 2007, or 36 percent below the 1990 level.

c. Includes commercial aircraft in the Civil Reserve Air Fleet.

d. Includes fast sealift, afloat prepositioning, and common-user charter ships.

e. The Defense Department's most recent mobility study recommends retiring 21 ships by 2002, which would leave 75 ships in the Ready Reserve Force, or 22 percent below the 1990 level.

f. Because of cuts in operation and maintenance funding in the Department of Transportation's 1994 budget for the Ready Reserve Force, fewer ships were considered ready to surge in the event of conflict. Since 1995, funding for Ready Reserve Force operations has been provided in the Department of Defense's budget, and the readiness status of previously downgraded ships has improved.

Administration's plan exist that could provide similar levels of capability at a lower cost.

Growing Emphasis on Mobility Forces

The United States is in the midst of reducing the size of its military forces. Under the Clinton Administration's major plan for defense, known as the Bottom-Up Review, most types of combat forces will experience 30 percent to 40 percent cuts during the 1990s (see Table 1).[2] But the same is not true for strategic mobility forces. Although DoD is retiring many of its older planes, it plans to hold current airlift capability relatively constant, expand the number and capacity of

2. Department of Defense, Office of the Secretary of Defense, *Report on the Bottom-Up Review* (October 1993).

sealift ships, and, in some parts of the world where military planners think conflict is most likely, preposition more sets of equipment.

The Congress and the Administration have also spent a larger proportion of defense dollars on strategic mobility in recent years, although that growth is hard to measure precisely because strategic mobility contains many components. One yardstick is a DoD budget category called mobility forces, which includes funding for strategic lift, tactical airlift planes, and the means to run the bases that support mobility operations. Since the Vietnam era, DoD has spent about $7.6 billion (in 1997 dollars) each year for that category, or about 2.4 percent of its total annual budget (see Figure 1). In inflation-adjusted dollars, the United States spent more on active-duty airlift and sealift forces during the mid-1960s than it does today. But at more than 4 percent of the defense budget, today's share is higher.

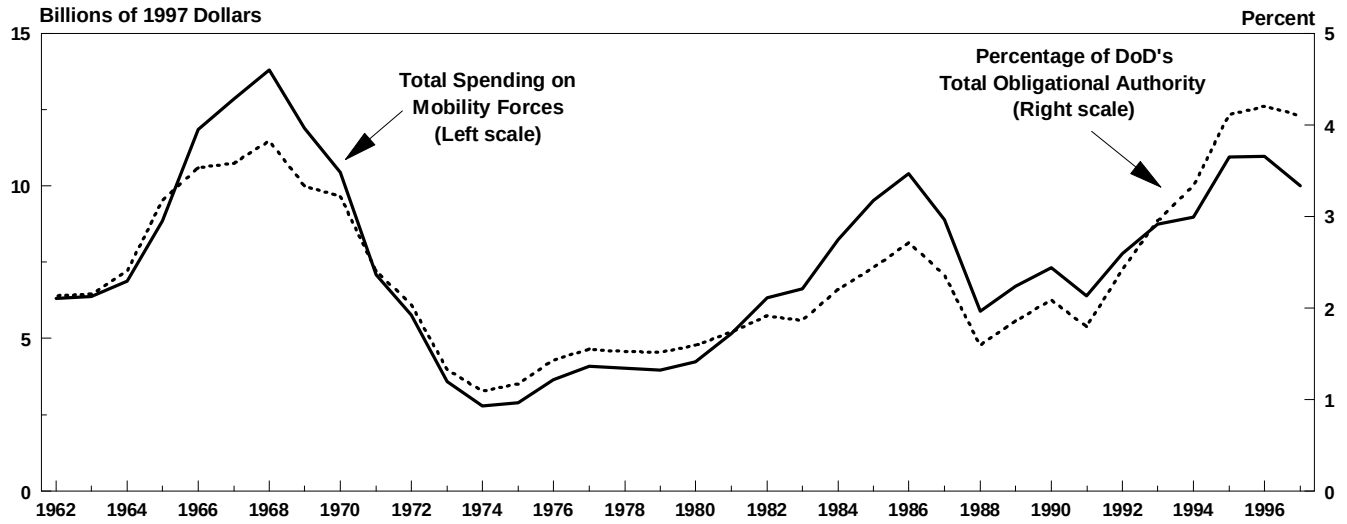
Moreover, if one included the cost of reserve personnel (who are typically counted in a separate budget category), recent spending on mobility would be higher still. During the 1980s, the Air Force began to rely more heavily on Reserve and National Guard personnel to operate airlift planes. Today, around 60 percent of aircrews for airlift planes such as the C-5 and C-141 are made up of reservists. Including those costs raises annual spending on mobility by more than $2.5 billion, for a total of more than 5 percent of the defense budget.

As noted earlier, the Administration plans to invest significant amounts to modernize DoD's mobility forces through at least the early part of the next decade. In its blueprint for the 1997-2001 period, the Administration included more than $17 billion (in current dollars) to acquire new C-17 cargo planes—one of DoD's largest modernization programs. That translates into about $3 billion to $4 billion in annual procurement spending between 1998 and 2002, with program costs tapering off to a little over $2 billion in 2003.

Reasons for the Administration's Emphasis on Strategic Mobility

Why is there so much emphasis on strategic lift today? One reason is that DoD has reduced the number of troops it bases abroad. In 1989, for example, 48 percent of the Army's active-duty forces were based out-

Figure 1.
Department of Defense Spending on Mobility Forces, 1962-1997 (In total obligational authority)



SOURCE: Congressional Budget Office based on data from Department of Defense, Office of the Under Secretary of Defense (Comptroller), *National Defense Budget Estimates for FY 1997* (April 1996).

NOTE: Total obligational authority refers to the sum of new budget authority provided for a given fiscal year and any other amounts authorized to be credited toward accounts in that same fiscal year, such as transfers between funds or accounts.

side the United States. That figure is expected to fall to 32 percent by 1999, primarily because of the withdrawal of U.S. forces from Europe. Thus, if the United States becomes involved in regional conflicts, it will need to deploy forces over longer distances.

A second reason is the experience of the Persian Gulf War. DoD's initial deployment of forces in August 1990 was among the largest the United States has ever undertaken. However, DoD was unable to deliver heavy brigades with tanks or logistical units very quickly, and ultimately, delivering all U.S. forces to the region took about seven months. Although many analysts consider the deployment a success, the military's Joint Chiefs of Staff believe that the U.S. forces that arrived first faced considerable risk.[3] DoD's planners now emphasize delivering heavy forces (units that include armored vehicles) sooner so those troops will be better prepared to withstand an attack. And because it is easier to stop an assault early than to dislodge an enemy from territory it has already taken, military commanders hope to deliver forces more quickly than before. At the same time, regional aggressors may also have learned lessons from the Persian Gulf War, such as how to prosecute an attack more effectively or how to disrupt deployments from the United States.

A final reason for the current emphasis on mobility forces is that now may simply be an opportune time to purchase those assets. DoD bought large numbers of tactical aircraft, combat ships, and tanks during the 1980s. As a result, the Administration has postponed modernizing much of that combat equipment until the next decade, leaving more room in the defense budget today for investments in mobility.

But some Members of Congress and even the Chairman of the Joint Chiefs of Staff have argued recently that the Administration needs to begin modernizing its combat equipment sooner rather than later. At a time when resources for all federal programs are limited, policymakers may need to decide whether investing in airlift planes and sealift ships continues to take a higher priority than modernizing combat forces.

3. Department of Defense, Joint Chiefs of Staff, *Mobility Requirements Study*, vol. 1, *Executive Summary* (January 23, 1992), p. ES-4.

DoD Is Reexamining U.S. Defense Strategy

In the 1993 Bottom-Up Review, the Clinton Administration based much of its plan for the size and composition of U.S. forces on a specific scenario. In that scenario, the military would need to counter regional aggressors on the Korean Peninsula and in the Persian Gulf at nearly the same time. Administration officials developed that strategy because of concern that, if the United States entered one regional conflict, a second aggressor might find that an opportune moment to pursue its interests as well. In 1995, the Administration published an analysis of numerical requirements for mobility forces that closely followed the Bottom-Up Review's scenario of two major regional conflicts (or "contingencies," as DoD calls them).

Defense officials are taking another look at that strategy, however. In November 1996, the Office of the Secretary of Defense, with input from the Joint Chiefs of Staff, began a Quadrennial Defense Review —a wide-ranging examination of threats the United States might face, the force structure that would best counter them, and the infrastructure needed to support those forces. The Congress asked that the Administration undertake the review and that an independent, nonpartisan panel of defense experts evaluate the analysis.

The Congress wants a review of defense strategy because the force structure outlined in the Bottom-Up Review has been criticized on several grounds. One critique is that today's approach puts too much emphasis on large-scale scenarios rather than smaller peacetime missions, which are more likely to occur but are more difficult to characterize with one or two planning scenarios.[4] Other defense analysts do not question the Administration's choice of scenarios, but instead wonder whether the United States needs to mobilize so many forces to deter Iraqi or North Korean aggression.[5]

4. Robert P. Haffa Jr., "A New Look at the Bottom-Up Review: Planning U.S. General Purpose Forces for a New Century," *Strategic Review* (Winter 1996), pp. 21-30; Paul K. Davis, David Gompert, and Richard Kugler, *Adaptiveness in National Defense: The Basis of a New Framework*, Issue Paper (Santa Monica, Calif.: RAND, August 1996).

5. Michael O'Hanlon, *Defense Planning for the Late 1990s: Beyond the Desert Storm Framework* (Washington, D.C.: Brookings Institution, 1995), pp. 48-49.

Critics have also argued that the Administration's plan is being underfunded or is simply unaffordable.[6]

Some analysts have suggested that the Administration should size DoD's force structure for one rather than two major conflicts. Such a change would probably not have much effect on requirements for strategic lift. Although the Administration's 1995 blueprint for mobility forces was designed with two simultaneous contingencies in mind, military planners assumed that cargo planes and sealift ships would swing from one conflict to the next. So, depending on assumptions about how such a conflict would take place, DoD might need roughly the same amount of lift for just one major contingency.

That does not nullify the importance of the Quadrennial Defense Review for strategic mobility, however. Fundamental questions about how the United States will wage war in the future still have important implications for DoD's lift needs. For example, under current plans, the Army accounts for most cargo that would deploy first to a major contingency. If military planners were to rely on airpower rather than Army forces to blunt an enemy assault at the start of a conflict, DoD might need fewer sets of prepositioned Army equipment and more sealift ships to deliver heavy equipment from the United States at a slower pace.

What Drives Today's Requirements for Mobility Forces?

The role each type of strategic lift plays in a conflict is matched to its general characteristics. For example, because of its speed, airlift is used to deliver troops and equipment in the earliest stages of a military crisis. But airlift is many times more expensive than sealift, making it impractical for moving large numbers of forces or units with heavy tanks and armored vehicles. Sealift is much slower than airlift, but each large sealift ship can deliver the equivalent of more than 300 loads of a C-141, today's most common type of airlift plane. By prepositioning materiel, DoD can deploy large numbers of heavy forces much more quickly than with sealift and much more cheaply than with airlift. However, planners must select sites for prepositioned equipment carefully and recognize that political and diplomatic factors can limit how DoD uses that equipment.

Since DoD bases its numerical requirements for strategic mobility on its plans to fight major conflicts, it is important to understand how military officials believe those conflicts will take place.

Today's Planning Focuses on How to Halt an Enemy Attack

Recent DoD analyses depict three phases of a large-scale conflict. During the *halting phase*, U.S. and allied forces would deploy to blunt an initial assault by an aggressor, minimize the amount of territory the invader takes over, and defend sites that are important for continuing military operations, such as ports, airfields, and supply centers. If the United States had to operate with little warning and an enemy's attack proceeded swiftly, airlift and prepositioning might be the only means of delivering forces during the halting phase. Under DoD's assumptions about conflicts in the Korean Peninsula or the Persian Gulf region, the first U.S. heavy ground forces would have to arrive within two to three weeks to halt an initial assault.[7] Given the distances involved, that requirement for early combat units would place the greatest demand on U.S. mobility forces.

Once an aggressor had been stopped, the United States would focus its efforts on deploying additional combat forces and logistical support to the region. During that *buildup phase*, U.S. troops would try to reduce the enemy's military capabilities through sustained attacks. After enough forces had been deployed to the region, the United States and its allies would launch a *counterattack*, a large-scale offensive using air and land forces to push back the enemy and regain lost territory.

6. Lawrence Di Rita, *Clinton's Bankrupt National Security Strategy*, Backgrounder No. 1000 (Washington, D.C.: Heritage Foundation, September 27, 1994); "Bottom-Up Review: A Flawed Approach to Meeting the Challenges of the New Era," statement of Andrew F. Krepinevich, Director, Center for Strategic and Budgetary Assessments, before the House Armed Services Committee, March 10, 1994.

7. Department of Defense, Deputy Secretary of Defense, *DoD Airlift Requirements: Report to Congress Required by the National Defense Authorization Act for Fiscal Year 1994* (January 1995), p. 7.

Ideally, civilian and military leaders would receive early, unambiguous warning of an impending enemy assault and would take a few measured steps to deter it. In military parlance, those steps are called flexible deterrent options—measures aimed at deterring enemy advances or aiding military deliveries that can be taken before the official decision to deploy forces en masse and can be revised quickly if the situation changes. Such measures might include sending an aircraft carrier, a Marine expeditionary unit, or a squadron of fighter aircraft to the region or taking steps to prepare equipment at prepositioning sites.

If an enemy attack occurred quickly and with little warning, however, airlift would be the only way to move equipment and supplies to the region until the closest prepositioned equipment arrived. Units that would have priority for early airlift missions might include equipment to provide air defenses, transportation units that operate ports and airfields, light Army units, supplies to set up bases for air forces, initial squadrons of fighters and bombers, and some special-operations forces (see Table 2).

But there is a limit to what airlift can do. Although it can deliver light Army units quickly, the same is not true for units with more than a handful of tanks, since even the largest military cargo planes can carry only one or two of those vehicles at a time. Thus, DoD cannot rely on airlift to complete deliveries of heavy Army units within the halting phase of a conflict. For that reason, military planners have begun prepositioning

Table 2.
Strategic Lift Requirements of a Hypothetical Major Regional Conflict

Mode of Lift	Before Deployments Begin	Within Two to Three Weeks	Three to Four Weeks and Beyond
Airlift	FDOs	Air-defense units Airfield and port units Army light units FIEs for prepositioned heavy brigades and MEF (Forward) Special-operations forces Fighter and bomber squadrons plus bare base support	FIEs for additional Army divisions and MEFs Army light brigades and helicopter units Fighter squadrons
Land-Based Prepositioning	FDOs	Army heavy brigade(s) Division base set	War reserves Ammunition
Afloat Prepositioning	FDOs	MEF (Forward) Army heavy brigade Theater-opening CS/CSS Port-opening equipment	MEFs Corps-level CS/CSS Air Force ammunition Fuel ships Hospital ships
Surge Sealift	n.a.	n.a.	Heavy divisions Marine AFOE CS/CSS

SOURCE: Congressional Budget Office.

NOTE: FDOs = flexible deterrent options; FIEs = fly-in echelons; MEF = Marine expeditionary force; CS/CSS = combat-support/combat-service-support units; AFOE = assault follow-on echelon; n.a. = not applicable.

equipment for Army brigades with tanks and heavy vehicles in or closer to regions where they believe conflict is most likely.

Not all equipment can be prepositioned, however. Military logisticians do not plan to preposition helicopters, radars, radios, or certain missiles because they are too few in number or too difficult to maintain. Thus, although prepositioning reduces DoD's need to transport some cargo by air, airlift would still deliver the remaining equipment and the troops who operate it (so-called fly-in echelons). If DoD plans to deploy a large number of heavy forces quickly in a conflict, the size of those fly-in echelons could be substantial, driving up requirements for early airlift missions.

After halting the attack, military commanders would send follow-on Army and Marine units and supplies to sustain the operation, with most arriving by sealift from the United States. Other supplies and equipment prepositioned on board ships would also steam to the region, including units to develop more extensive logistical supply lines. Airlift would transport equipment for aircraft squadrons, lighter ground forces, and key units such as corps-level artillery. Those deliveries would continue until military leaders believed they had enough forces and logistical support to launch a counterattack.

Army Forces Would Make Up Most Deliveries

For major conflicts, the Army's need for strategic mobility surpasses that of the other military services. That requirement appears to hold true both in the early stages of a conflict and over an entire deployment.

Consider the Persian Gulf War, for example. During August 1990, the Army accounted for about 43 percent (by weight) of all the equipment for early-deploying units that was sent by airlift, fast sealift, and prepositioning ships. The Marine Corps was responsible for the next largest share, about 35 percent, primarily because its Maritime Prepositioning Ships arrived on the scene early. Air Force cargo, which moved almost entirely by airlift, accounted for almost all of the remaining 22 percent.[8]

For a major conflict in the future, defense planners believe that Army forces will constitute about 77 percent of DoD's total workload for strategic mobility forces.[9] The Army's share of the mobility workload would be somewhat lower in the early part of a deployment, when Air Force and Marine Corps units were moving quickly to the theater. But the Army requires a large number of combat-support and combat-service-support units, many of which would deploy later in a contingency (see Box 1). Thus, the Army's share of the total mobility workload would be greater than 77 percent toward the latter part of a deployment.

Since airlift is the most costly mode of transportation, how much of it each service requires is important. During the first month of the Persian Gulf War, Army units (troops and equipment) accounted for some 46 percent, by weight, of all airlift deliveries. The Air Force required about a quarter of early airlift deliveries to set up aerial port operations, establish bases from which to operate aircraft, and deploy tactical fighter wings. Likewise, the Department of the Navy (which includes Marine forces) accounted for another quarter of airlift deliveries in August 1990. Over the entire Gulf War deployment, Army equipment made up the largest share of airlift deliveries, followed by Air Force and then Marine Corps cargo.

Because the Army represents the bulk of what the United States would deploy to a major contingency, the physical characteristics of Army equipment—its shape and weight—are critical factors for mobility planning. Over time, the weight and square footage of Army units have grown significantly as the service has modernized and reorganized its forces. In 1994, for example, a mechanized division was about 49 percent heavier and took up 17 percent more floor space than the same type of division structured under 1987 guidelines. On average, most types of Army units have grown in square

8. James K. Matthews and Cora J. Holt, *So Many, So Much, So Far, So Fast: United States Transportation Command and Strategic Deployment for Operation Desert Shield/Desert Storm* (Joint History Office, Office of the Chairman of the Joint Chiefs of Staff; and Research Center, U.S. Transportation Command, 1995), pp. 13, 41, 116.

9. Department of Defense, Office of the Under Secretary of Defense for Acquisition and Technology, *Report of the Defense Science Board Task Force on Strategic Mobility (*August 1996), p. 17.

footage by at least 2 percent a year since 1987 and grown in weight by more than 4 percent a year (see Appendix A for more details).

The Army's larger "footprint" reflects the fact that some of today's equipment is more capable and better able to survive enemy forces. But the larger weight of Army units unquestionably poses a bigger burden for mobility forces. Recognizing that burden, many mobility experts have urged designers to pay more attention to a weapon system's "transportability" when designing new equipment.

The Army Has More Ambitious Goals for Deployment

Because senior military officials believe that U.S. troops who deployed to the Persian Gulf War first faced considerable risk, the Army has developed a strategy to reduce that risk. However, the new approach places greater demands on mobility forces.

If the United States needed to stop an Iraqi invasion of Kuwait or Saudi Arabia today, current plans call for deploying an entire heavy Army division within the first two to three weeks of the attack. That goal is much more ambitious than what DoD was able to achieve during the Persian Gulf War, when the first heavy Army unit to arrive, the 24th Mechanized Infantry Division, was not fully in place until 47 days after the United States began deploying forces to the region. The Army's current timeline is also much shorter than the goal DoD used in a 1992 study of mobility requirements: delivering one heavy brigade (roughly one-third of a division) 15 days after the start of deployments. (See Appendix A for more information about the Army's goals for strategic mobility.)

Box 1.
Types of Military Forces: A Summary

In order to describe how a major military deployment takes place, it is important to understand a few basic terms about military forces.

Army Divisions and Brigades. U.S. Army forces are organized into units of various sizes. Larger-size units include brigades, divisions, and corps. Brigades usually consist of 3,000 to 5,000 soldiers from two to five smaller units (called battalions). Divisions are typically composed of three brigades plus additional units in charge of command and control, field artillery, engineering, aviation support, air defenses, and the like. An Army unit that is fully capable of synchronizing and sustaining combat operations is called a corps. Corps typically include two or more divisions plus additional units that help to command combat forces and provide logistical support. In a major conflict, the Army might also deploy echelons above corps—additional units that conduct activities such as providing ballistic missile defenses for all U.S. troops in a theater.

Light and Heavy Units. Army units are described as heavy or light depending on how many tanks, armored vehicles, and other pieces of heavy equipment they include. Armored and mechanized divisions are examples of heavy units. Airborne and light infantry units are designed to be light enough to be transported by air.

Combat Arms, Combat Support, and Combat Service Support. The Army refers to those units that would be directly involved in fighting a conflict as combat arms. Armored, infantry, and attack-helicopter units are some examples. Forces that provide operational assistance to combat arms are known as combat-support units. They include military intelligence; military police; chemical, engineering, and signal forces; and some aviation units. Combat-service-support units perform logistics and administrative functions such as those of quartermasters, transportation specialists, and medical professionals.

Air Force Wings. U.S. Air Force tactical aircraft are organized into wings of approximately 72 planes, with most wings composed of just one type of plane.

Marine Expeditionary Forces. The U.S. Marine Corps is organized into task forces of various sizes, each of which includes both ground and air elements. The largest of those units is the Marine expeditionary force (MEF). The lead elements of a MEF are designated as a MEF (Forward)—a reinforced infantry regiment supported by a Marine air group.

Navy Forces. U.S. Navy ships are organized into task forces of various sizes as the occasion demands. In general, Navy forces tend to carry their own combat equipment, personnel, and logistical support. As a result, the Navy requires relatively little support from mobility forces for moving dry cargo.

Could DoD deploy an entire heavy division to the Persian Gulf in two to three weeks? Because of recent efforts to preposition more equipment in the region, the answer is probably yes. But some defense analysts might question whether delivering so many heavy forces in two to three weeks should be the goal at all.

Airlift Could Be Needed for Special Missions

Airlift is by far the most costly mode of strategic mobility. But in DoD's major planning scenarios, most equipment for a conflict would already be prepositioned or would arrive by sealift. Why then has the Administration chosen to invest nearly $19 billion (in current dollars) in airlift over the next five years? One reason is that transport planes can deliver cargo to locations that do not have access to ports or railroads. Also, for lighter forces, airlift planes deliver equipment much more quickly than sealift ships can. Moreover, airlift is a quick means of delivering cargo to missions such as humanitarian relief operations or transporting military equipment to U.S. forces deployed abroad. But another reason is that some transport aircraft perform special military missions that some defense officials consider important. Whether the United States is willing to pay the higher cost for those capabilities is subject to debate.

Probably the most notable special mission is large-scale, intercontinental airdrop operations. The Army is required to be able to insert brigade-size forces quickly into any region of the world—even countries that are beyond the range of most cargo planes without refueling. During such a mission, airlift planes would drop troops and their equipment by parachute; the troops would then seize control of an airfield and prepare it to receive reinforcements quickly. Since the initial forces would be deploying into hostile territory, military planners set very tight timelines for airdrops. But the United States has used airdrop operations sparingly in the past, especially when paratroopers would need to deploy over long distances; the last time DoD dropped a brigade-size force outside the Western Hemisphere was during the Vietnam War.

Nevertheless, the Army's requirement to prepare for long-range, large-scale airdrops is a key factor in DoD's plans for procuring airlift planes. Only a few types of military transports can be used to drop parachutists. For regions that are closer to the United States, airlift planes could conduct an initial airdrop and then return to the United States to pick up additional loads. For longer-range deployments, however, DoD would need larger numbers of strategic airlift planes to conduct an airdrop and also complete deliveries within the demanding timelines laid out by military planners. Thus, important considerations for the Congress are whether it believes the United States will need to conduct long-range, large-scale airdrop operations in the future and whether that capability is worth the cost.

How Much Civil Transportation Should DoD Count On?

In the past, DoD has often turned to commercial aircraft and ships to help it move U.S. troops and equipment. Although technically the United States could requisition civil planes and ships during time of war, DoD has instead relied on contractual agreements with commercial carriers.

Today, DoD makes use of private airlift and sealift through two programs, the Civil Reserve Air Fleet and the Voluntary Intermodal Sealift Agreement. Those programs give commercial carriers various preferences and advantages in obtaining DoD's (and in some cases the federal government's) transportation business during peacetime in exchange for use of their planes and ships during national emergencies. Participation in the programs has varied over time, but DoD has generally been able to expand civil support by providing carriers with more commercial incentives (see Appendix B).

Nevertheless, DoD has purchased its own mobility forces when its needs have diverged from what the civil sector can provide. Today, for example, commercial sealines own very few of the roll-on/roll-off ships that are most useful for transporting military vehicles. Similarly, commercial transport aircraft do not have the wide, unobstructed cargo holds and reinforced floors needed to move the largest pieces of military cargo.

At times, DoD's decisions about what it needs for mobility pit two sets of commercial interests against one another. On the one side are providers of commercial air and sea transportation services, who might lose DoD's business if the military's fleet of planes and

ships became too large. On the other side are aircraft manufacturers and shipbuilders, who could gain from DoD's purchases of specialized military planes and ships. Both sets of interests have been active players in the debate over DoD's approach to enhancing strategic mobility.[10]

Ultimately, important trade-offs exist between relying on the commercial sector for transportation during wartime and investing in DoD's own mobility fleet. The major advantage of relying on commercial ships and planes is that it allows DoD to avoid much of the cost of procuring and operating those forces during peacetime, freeing up more resources to modernize combat equipment. Today, however, fewer commercial planes and ships are perfectly suited to DoD's needs. And in some cases, the private sector may not be able to make its planes and ships available as quickly as defense planners would like, or it may be more reluctant than the military to travel into dangerous situations.

10. Owen Cote Jr., *Strategic Mobility and the Limits of Jointness*, Center for Science and International Affairs Monograph (Cambridge, Mass.: Harvard University, forthcoming), pp. 12-13, 18-26.

How Much Lift Is Enough?

The Administration's goal of creating a smaller but more flexible military has led to a greater emphasis on improving U.S. mobility forces. But deciding how much lift is enough and what types of lift forces to buy are not simple matters. Part of the United States' status as a superpower derives from its ability to send its military forces anywhere in the world. Yet at a time when federal spending is constrained, the opportunity costs of investing in strategic mobility are readily apparent: the United States might otherwise spend those resources on nondefense priorities or on modernizing combat equipment.

Moreover, the factors that entered into DoD's numerical requirements for mobility forces are numerous and complicated. For those reasons, this study reviews the Administration's investment blueprint for the three types of mobility forces, addresses how military planners developed that plan, and evaluates several alternatives for modernizing strategic mobility.

Chapter Two

Strategic Airlift Forces

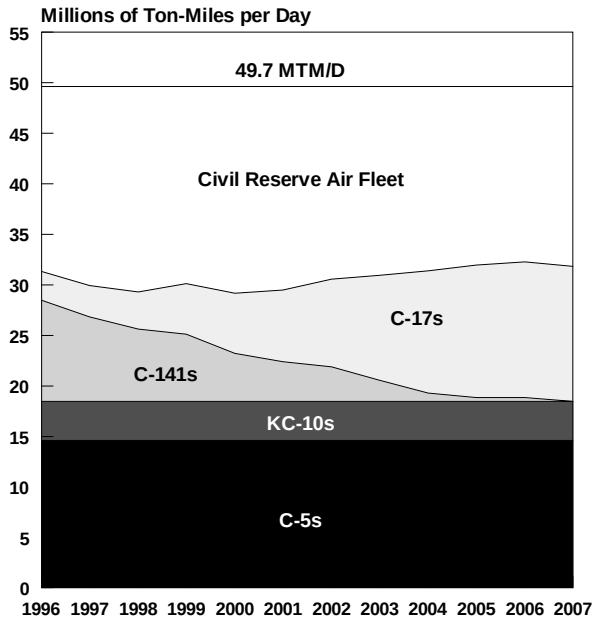
Transport aircraft can move a load of military equipment almost anywhere in the world at more than 400 nautical miles per hour. Because of their speed and the worldwide access they provide, airlift planes are an important means by which the Department of Defense can project its forces.

But planes are also much more expensive than ships or prepositioned sets of equipment, particularly when the United States needs to move large forces. One way that DoD lowers the cost of airlift is by planning to use planes owned by the private sector in the event of war. In the past, DoD has also purchased some planes for its own fleet that are based on civil designs, which tend to be less costly to build than more specialized military aircraft.

The Current Strategic Airlift Fleet

Today's airlift fleet is made up of both planes that are dedicated solely to military missions and commercial aircraft that are part of the Civil Reserve Air Fleet (CRAF). If mobilized fully, the combined fleet would have a total theoretical airlift capacity of almost 50 million ton-miles per day (see Box 2 for a definition of the units of measure used in airlift analysis). Nearly two-thirds of that amount comes from the military's own planes, with the rest contributed by civil carriers (see Figure 2).

Figure 2.
Theoretical Capacity of the Strategic Airlift Fleet Under the Administration's Plan, 1996-2007



SOURCE: Congressional Budget Office based on Department of the Air Force, *1997 Air Mobility Master Plan* (Scott Air Force Base, Ill.: Air Mobility Command, October 11, 1996).

NOTE: Theoretical capacity is based on standard planning factors of the Air Force's Air Mobility Command. Based on a 1995 study of mobility needs and later analysis, the Department of Defense set a requirement of 49.7 million ton-miles per day (MTM/D) for theoretical capacity. To reach that level, the Air Force plans to supplement military planes with Civil Reserve Air Fleet capacity, which would amount to 20.5 MTM/D or less over the 1996-2007 period.

Department of Defense Aircraft

DoD's current fleet of strategic airlifters includes three types of cargo planes and two varieties of tanker aircraft (see Figure 3). Tankers are generally used to refuel other aircraft while in flight, but DoD needs fewer planes for that role today than it did during the Cold War because there is less call for long-range missions by strategic nuclear bombers. Thus, military officials plan to use some tankers for airlift missions.

Military cargo planes such as the C-141, C-5, and C-17 have special features that make them particularly well suited to moving military equipment. For example, they have wings that are high on the fuselage and ramps that are low to the ground so military personnel can move equipment on and off quickly. The C-5 and C-17 also have large doors and unobstructed cargo compartments that can carry the largest or most awkwardly shaped pieces of military equipment, such as tanks and helicopters. Military transports also have multiple sets of electrical and mechanical systems and other safety features so they can continue to operate even if damaged in battle.

By contrast, KC-10 and KC-135 tankers are modified versions of civil planes. Because of intense competition in the market for commercial airliners, civil transports are designed to carry loads of passengers, baggage, and cargo as cost-effectively as possible. With narrower cargo holds and smaller doors, civil transports are better suited for moving bulk cargo on standard-size pallets. On the down side, they require special elevators for loading and unloading since their cargo doors are higher off the ground. They also need longer runways than may be found in some parts of the world. But modern civil transports such as the Boeing 747 are very reliable and can carry larger payloads over a longer range without refueling than most types of military airlift planes. And because civil planes are pro-

Box 2.
Basic Units of Measure and Terms in Airlift Analysis

Tons: The amount of cargo that the Air Force moves by airlift is usually described in terms of its weight in short tons (2,000 pounds). Because of their physical dimensions and shape, however, individual pieces of cargo may not fit on certain aircraft even if they meet the plane's weight limitations.

Ton-miles: A unit of measure that takes into account both the weight of cargo and the distance over which it must be carried. For example, airlifting a 5-ton truck over the 3,500 miles from Dover, Delaware, to Germany would amount to a workload of 17,500 ton-miles. Moving the same truck to Saudi Arabia would take about 32,500 ton-miles.

Millions of ton-miles per day (MTM/D): The standard unit of measure of theoretical airlift capacity. One can think of 49 MTM/D (a recent Defense Department goal) as the ability to move 7,000 tons of cargo over 7,000 nautical miles in a day's time—roughly the equivalent of moving less than one light infantry brigade to the Persian Gulf in one day.

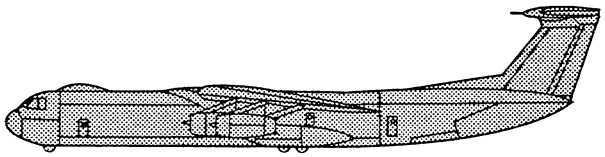
Theoretical capacity: A measure of what, in theory, all airlift planes could carry when fully mobilized. Because theoretical capacity is calculated using average measures of each plane's performance, it does not reflect constraints that the Air Force might face when deploying to a specific conflict. As a result, actual airlift deliveries tend to be lower than theoretical capacity. At the start of Operation Desert Shield, for example, the theoretical capacity of U.S. military and Civil Reserve Air Fleet planes was 48 MTM/D. However, some aircraft were withheld for other missions or suffered from maintenance problems; not all commercial planes in the Civil Reserve Air Fleet were called into service; and reserve aircrews were only partially mobilized. In addition, at the start of airlift operations, the United States had access to a limited number of airfields in Saudi Arabia, some of which lacked trucks and other equipment to refuel planes quickly. As a result, actual deliveries averaged only 11 MTM/D during the first month of operations, or 23 percent of theoretical capacity.

Outsize cargo: Cargo that is so large or bulky that it can fit on only two types of U.S. cargo planes—C-5s or C-17s. Airlift planners categorize cargo as outsize, oversize, or bulk. Oversize cargo is smaller than outsize and can fit on some military and commercial transports, whereas bulk cargo fits on a standard-size pallet and can be accommodated on all types of airlift planes.

Maximum on the ground (MOG): An average measure of the number of planes that a particular airfield can service at any given time. MOG values can vary over time. They reflect both the physical limitations of an airfield—such as ramp space, refueling capabilities, and availability of equipment to load and unload planes—and the competition for its use.

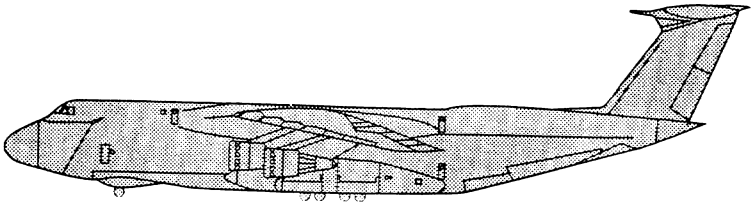
Figure 3.
DoD's Strategic Airlift Planes

The C-141 can carry an average payload of 23 tons. It is the primary plane the Air Force would use to air-drop personnel and supplies over long distances. First built in the 1960s, the average C-141 is nearly 30 years old. The Air Force plans to retire the planes from service by 2007.



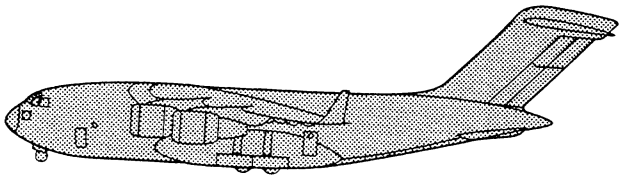
C-141 Starlifter

With an average load of 65 tons, the C-5 is the largest of DoD's military airlift planes. Unlike the C-141, the C-5 was built to carry the biggest pieces of military equipment (called outsize cargo), such as M1 tanks. It has doors and ramps at both nose and tail so cargo can be loaded more quickly.



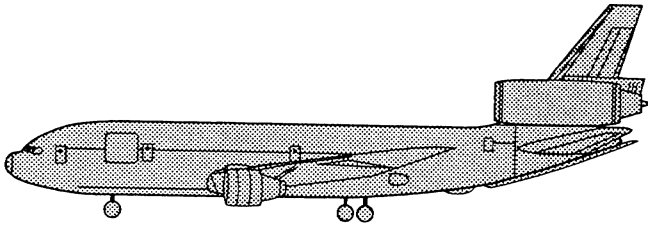
C-5 Galaxy

The C-17 is DoD's newest transport plane. Like the C-5, it can carry outsize cargo. However, it is closer in length to the C-141, so its average payload is smaller than the Galaxy's—45 tons. DoD says the C-17's size and maneuverability on the ground give it an advantage over larger planes when airfields are congested.



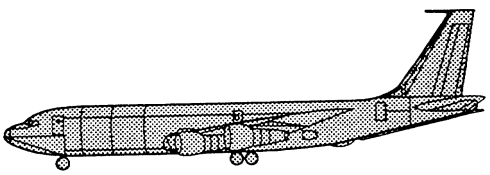
C-17 Globemaster III

The KC-10 is a military version of the McDonnell Douglas DC-10 and can carry an average payload of 40 tons. Although the KC-10 was designed as a tanker, DoD plans to use 37 of them to carry standard-size pallets of cargo in the event of a conflict. As with all civil-style planes, the KC-10 needs special equipment to load and unload its freight.



KC-10 Extender

The KC-135 is a military version of the Boeing 707 that is used to refuel aircraft while in flight. DoD modified a small number of KC-135s to carry an average of about 10 tons of cargo apiece. In the event of a conflict, DoD plans to use 26 of its nearly 500 KC-135s for airlift missions.



KC-135 Stratotanker

SOURCE: Congressional Budget Office.

duced in larger quantities for the commercial market, they tend to cost less to purchase than military transports.

With about 190 operating, the C-141 is the most common type of airlift plane in the military fleet.[1] Those aircraft provide nearly 9 million ton-miles per day (MTM/D) of theoretical capacity—slightly less than a third of the total for military airlift planes in 1996. The Air Force considers the C-141 its core airlifter because the plane can be used not only to deliver cargo but also to conduct special military missions such as air-dropping Army paratroopers and their equipment.

But the C-141 is reaching the end of its service life, and recent experience has led military leaders to question its reliability. In 1993, an Air Force advisory board recommended restricting the weight of cargo that each one can carry. Inspection of the C-141 fleet revealed cracks in the weep holes where fuel circulates within the plane's wings and in some wingboxes that secure the wings to the fuselage. The Air Force repaired some of its C-141s to retain fleet capacity over the next few years, but it also decided to accelerate the plane's retirement. Current plans call for withdrawing the C-141 from active forces by 2003 and from reserve components by 2007.

Because of the sheer number of C-141s in service, that plane has been considered the workhorse of the military's strategic airlift fleet. But nearly 50 percent of the military's theoretical airlift capacity comes from C-5s (see Figure 2 on page 11). Seventy-six A model aircraft were built during the early 1970s and were retrofitted with new wings during the mid-1980s. Beginning in 1986, the Air Force took delivery of 50 new C-5Bs.

Unfortunately, the C-5 (the older A model in particular) has been plagued by low rates of reliability and maintainability. During the Persian Gulf War, an average of more than 30 percent of the Air Force's C-5s were unavailable because they needed maintenance, lacked spare parts, or both.[2] As it is flown and operated today, a C-5A requires about 56 hours of maintenance for every hour of flight, and the B model needs 29 hours per flight hour. The Air Force is considering retiring its C-5As beginning in 2007—even though the average C-5A has just 15,000 flight hours on its airframe out of an expected service life of 30,000 hours.[3]

The Administration plans to use 120 C-17s (102 primary aircraft authorized, or PAA) as the replacement workhorse for more than 200 C-141s. As of December 1996, the Air Force had contracted for 48 C-17s. Twenty-four of those are already operating and contribute about 3 MTM/D of DoD's theoretical airlift capacity. The C-17 has a system of thrust-reversers, flaps, and slats that allows it to land on short or ill-equipped airfields much as the C-130 (the Air Force's primary tactical airlift plane) does. Some military planners would like to use the C-17 to deliver cargo from the United States directly to airfields at the battlefront, rather than transferring equipment from main operating bases by means of ground transportation or on C-130s.

During the mid-1980s, the Congress appropriated funds to purchase 60 KC-10 aircraft (54 PAA), which can be used as either aerial refueling tankers or airlifters. More than two-thirds of those planes are dedicated to an airlift role and provide nearly 4 MTM/D of DoD's theoretical airlift capacity. In the event of a conflict, the Air Force also plans to use a few of its many KC-135 tanker aircraft to carry logistical supplies between military bases, thereby reducing the demand for other military transports.

The Civil Reserve Air Fleet

CRAF is a voluntary partnership between DoD and commercial air carriers designed to provide additional passenger and cargo planes and aeromedical evacuation services to the military during times of crisis. Both

1. That number represents primary aircraft authorized, which excludes planes that are undergoing depot maintenance or being held as reserves against attrition.

2. John Lund, Ruth Berg, and Corinne Replogle, *An Assessment of Strategic Airlift Operational Efficiency*, R-4269/4-AF (Santa Monica, Calif.: RAND, 1993), pp. 53-55.

3. According to a General Accounting Office study, the Air Force might be able to make more of its C-5s available if it improved its process for supplying spare parts and conducted a readiness evaluation similar to that completed for the B-1B aircraft. See GAO, *Strategic Airlift: Improvements in C-5 Mission Capability Can Help Meet Airlift Requirements*, GAO/NSIAD-96-43 (November 1995).

cargo and passenger air carriers participate in one of three stages of the program, which reflect the priority with which planes might be called into service (see Box 3). Planes in Stage I would be called into service most quickly, whereas those in Stage III would be activated only in the event of a national emergency.

As of January 1997, 11 passenger and 16 cargo airlines had enrolled a total of 508 long-range international aircraft in CRAF. If a national emergency occurred today, commercial passenger planes would carry the vast majority of all military personnel who would be deployed to a major conflict. If fully mobilized, cargo carriers who participate in the program would contribute up to 27.8 MTM/D. However, since participation in CRAF has fluctuated over time, the Air Force counts on only about 20.5 MTM/D of cargo capacity from CRAF in its long-term planning, although it prefers to enroll more than that in the program.[4] Defense officials argue that if DoD used much more than that level in a major conflict, civil aircraft would congest airlift operations and make it difficult to complete deliveries of outsize cargo on military transports. (See Appendix B for more information on CRAF participation.)

Those numbers demonstrate the importance of CRAF: buying enough military planes to make up that capability would be expensive and might crowd out funding for other types of forces in the defense budget. DoD also avoids paying for most of the costs of operating and supporting those planes during peacetime. According to one study, the cost of replacing CRAF capacity with military transport planes over the past 30 years would have run to about $3 billion annually.[5]

On August 17, 1990, DoD called up Stage I of CRAF for the first time ever to support deployments for Operation Desert Shield. Even before that call-up, a number of air carriers had volunteered planes for the operation. Stage I provided the Air Force with 17 international passenger aircraft and 21 international cargo planes. On January 17, 1991, Secretary of Defense Dick Cheney activated Stage II of CRAF, providing 77 international passenger and 39 international cargo planes and their aircrews. In addition, at various times air carriers volunteered another 16 to 36 cargo aircraft. In total, U.S. airlines transported nearly two-thirds of the military personnel and one-quarter of the cargo airlifted during the Persian Gulf War. Air carriers also flew additional missions, delivered mail, and transported cargo on the ground between airports.

Box 3.
Activating the Civil Reserve Air Fleet

The Civil Reserve Air Fleet program was created under a plan issued in March 1952. President Truman put forth the initial directive for CRAF by executive order. From its inception, the program's main objective has been to provide for a quick transition of the existing civil air fleet from commercial operations to supporting military airlift in times of crisis.

Today's program maintains a three-stage activation plan, introduced in 1963. With the approval of the Secretary of Defense, the Commander in Chief of the U.S. Transportation Command (USTRANSCOM) initiates Stage I of CRAF (called Committed Expansion) when the military airlift fleet cannot meet deployment and other airlift requirements simultaneously. Stage II, Airlift Emergency, is also activated by the Commander in Chief of USTRANSCOM with the approval of the Secretary of Defense. That stage provides additional airlift beyond the Stage I amount when required for a major airlift emergency that does not warrant full mobilization of most of the nation's civil aircraft. Stage III, designated a National Emergency, is the highest level of CRAF activation. The Commander in Chief of USTRANSCOM activates Stage III with the approval of the Secretary of Defense in time of war or a defense-oriented national emergency declared by the President, in a national emergency declared by the President, in a national emergency declared by the Congress, or in a national security situation before the declaration of a defense-oriented national emergency.

4. The passenger planes that carried troops would also deliver a significant amount of cargo at the same time, but the Air Force does not include those deliveries in its calculations of theoretical airlift capacity for cargo.

5. Jean R. Gebman, Lois Batchelder, and Katherine Poehlmann, *Finding the Right Mix of Military and Civil Aircraft: Issues and Implications*, vol. 2, *Analysis*, MR-406/2-AF (Santa Monica, Calif.: RAND, 1994), p. 44.

Although the activation of CRAF during the Persian Gulf War was generally considered a success, some air carriers—particularly larger airlines—fear that if many of their planes are called away from their commercial routes in the future, U.S. companies might lose market share to foreign rivals and never regain it. Those and other concerns about the program led some carriers to leave CRAF after the 1991 war.

In recent years, DoD and the General Services Administration have made participation in CRAF a prerequisite for firms bidding on the federal government's passenger air travel. That program, known as City Pairs, has expanded the amount of peacetime passenger business associated with CRAF from about $345 million a year to more than $1.5 billion. In addition to that business, DoD awards about $270 million a year to commercial carriers for cargo transportation services. DoD also plans to expand the federal government's small-package air transportation business to CRAF, and under certain circumstances, it is making military airfields available for use by commercial airlines.

CRAF participants generally cite two motives for taking part in the program: patriotism and peacetime business. Although the first motive is certainly important, the amount of peacetime business tied to CRAF has a strong effect on participation. With the end of the Cold War, some carriers anticipate a decline in the need for peacetime airlift and have expressed concern that the Air Force will no longer offer adequate incentives for them to remain in the program. Analysts, however, note that by replacing C-141s with a smaller number of C-17s, the Air Force will have fewer planes in its airlift fleet. Thus, DoD may actually need more airlift services from the commercial sector.

Can DoD continue to count on CRAF for the future? Today, most analysts would say yes; participation in the program is generally regarded as strong. The relative health of the U.S. airline industry is the foundation for that strength. But participation in CRAF will fluctuate over time. Financial downturns within the industry, such as those that led to the bankruptcy of Pan Am, may affect the future supply of aircraft to CRAF. And changes within the airline industry, such as international code-sharing alliances between airlines in different countries, could reduce the number of U.S. long-range international aircraft or their flexibility to participate in CRAF. That could happen if domestic carriers depended on foreign carriers (who are ineligible to participate in CRAF) to operate international routes.

Plans for Modernizing Military Airlift

For over a decade, DoD's plans to modernize its airlift fleet have focused on the C-17. When it began developing the plane in 1979, the military planned to buy 210 C-17s. That number was scaled back to 120 in 1990, however, following a review of the aircraft program. In December 1993, Administration officials limited C-17 purchases to 40 and put the program on probation for two years because of its significant cost growth and difficulty achieving performance goals.[6]

The two-year probationary period gave the plane's producer, McDonnell Douglas, a chance to show whether it could control costs, meet the delivery schedule, and improve quality. During the period, McDonnell Douglas reduced its estimate of production costs and lowered the number of defects on planes coming off the manufacturing line. And in a monthlong evaluation in July 1995, the Air Force and McDonnell Douglas demonstrated that the C-17 can operate at its planned wartime rate of 15.2 hours per day.

After observing how the initial squadron of C-17s operated and reviewing the costs and capabilities of two alternative airlift planes, the Administration announced in November 1995 that it would plan and budget for 80 additional C-17s—for a total of 120 planes. The Congressional Budget Office (CBO) estimated that at the annual rates of production considered at the time, acquiring 80 more C-17s would cost $25.4 billion (in current dollars).[7] Defense officials subsequently proposed buying C-17s at a faster pace than that used in CBO's estimate: McDonnell Douglas now plans to build a maximum of 15 aircraft a year, with the final five planes in 2003.

6. For a discussion of the cost and performance issues in the C-17 program, see Congressional Budget Office, *The C-17: Costs and Alternatives,* CBO Paper (August 1993); and General Accounting Office, *C-17 Aircraft: Cost and Performance Issues,* GAO/NSIAD-95-26 (January 1995).

7. Congressional Budget Office, *Options for Strategic Airlift,* CBO Memorandum (October 1995), p. 22.

In February 1996, DoD's Defense Acquisition Board recommended a plan to buy those planes under a multiyear contract, which the Congress authorized in April. Under the multiyear arrangement, the Air Force will apply $300 million in appropriations from previous years to finance additional cost-reduction initiatives for the C-17 production line and to buy large quantities of parts. CBO estimates that acquisition costs under that plan will total $23.8 billion (in current dollars) over the 1997-2004 period (see Table 3).

The Administration estimates that the average procurement cost per plane under the multiyear plan will be $225 million (in 1997 dollars). That figure includes the cost of associated support and initial spare parts for the 80 planes. By itself, accelerating C-17 production to a rate of 15 per year lowers the program's total acquisition costs by over $800 million (in current dollars) as a result of efficiencies in production. Multiyear contracting saves an additional $1 billion, or 5.6 percent.

Although it would help achieve greater efficiencies in production, multiyear procurement for the C-17 does have some drawbacks. Most notably, the long-term plan could lead to higher costs if competition for funding from other areas of the budget led future Congresses to decide to buy fewer than 80 more C-17s or to procure the planes at a lower rate than 15 per year. If the program was stopped before the 80 additional planes were built, the government would lose any funding that the Congress had already appropriated for advance procurement, and DoD would have to pay some costs for discontinuing the production line. It would also have incurred costs associated with building up an inventory of C-17 parts, some of which would never be used. If the Congress chose to buy 80 more C-17s but over a longer period of time (that is, fewer each year), DoD would have to renegotiate a higher annual purchase price with McDonnell Douglas.

Missions That Determine DoD's Requirements for Strategic Airlift

DoD officials base their numerical requirements for strategic airlift planes on two types of capabilities: the ability to deploy cargo, both during peacetime and to a

Table 3.
Procurement of C-17s Under the Administration's Plan, 1997-2004
(Costs in millions of current dollars)

	1997	1998	1999	2000	2001	2002	2003	2004	Total, 1997-2004
Quantity Previously Under Consideration	8	8	8	10	12	12	12	10	80
Acquisition Costs[a]	2,760	2,820	2,840	3,210	3,600	3,590	3,570	2,960	25,350
Quantity in the Administration's Current Plan	8	9	13	15	15	15	5	0	80
Acquisition Costs[b]	2,550	2,840	3,820	3,990	4,100	3,970	2,100	420	23,790

SOURCE: Congressional Budget Office based on data from the Department of Defense.

NOTE: Acquisition costs include procurement; research, development, test, and evaluation; military construction; and procurement of equipment for modifications.

a. Estimates based on annual-procurement contract strategy.

b. Estimates based on multiyear-procurement contract strategy.

major regional conflict; and the ability to perform special military missions such as air-dropping forces after traveling long distances. Although civil-style planes can help meet the first need, the Administration contends that DoD requires large numbers of military aircraft for the second. But historically, DoD has conducted airdrops only rarely.

The Administration's recent recommendation to buy 80 more C-17s was based in part on the design features of the plane that allow it to perform special missions. Those C-17s are expected to cost significantly more than alternative airlift planes or other types of strategic lift. Ultimately, the Congress's decisions about spending extra resources on C-17s depend on whether the United States might need to conduct special airlift missions in the future and on how much it is willing to pay for the plane's capabilities.

Cargo Deliveries to Major Conflicts

Military planners divide airlift loads into three sizes: bulk loads that fit on a standard pallet, oversize loads that are larger than bulk loads but will fit in a C-141, and outsize loads that can fit only in a C-5 or C-17. Since the military uses many heavy vehicles and awkwardly shaped pieces of equipment, having transport planes that can accommodate that cargo is important.

The mix of equipment DoD would airlift to a major regional contingency today differs from what it planned to send for a conflict with the Soviet Union. According to a 1981 study of mobility requirements, 27 percent (by weight) of the equipment that DoD planned to send to a NATO/Warsaw Pact conflict within the first two weeks was outsize. By comparison, DoD's more recent simulations of deployments to Korea and the Persian Gulf region suggest that 15 percent to 18 percent of airlift deliveries over a similar period would be outsize. Official data for the first two weeks of Operation Desert Shield are unavailable, but during the first month of deployments, approximately 10 percent (by weight) of the cargo loads were outsize and half were bulk.[8]

The decline in the relative need to carry outsize cargo is an important issue in deciding how many military planes like the C-17 are necessary. One advantage of C-17s and C-5s over civil-style planes is their ability to carry such cargo. However, if a large proportion of the equipment that DoD plans to send can fit on modified civil-style planes, DoD might need fewer C-17s.

In 1995, the Pentagon evaluated two alternatives to the C-17: the C-5's D model and the C-33, a military version of Boeing's 747-400 freighter.[9] Both planes were expected to cost less than the C-17, and each could carry a much larger average payload. Air Force analysts used detailed simulations to estimate how much cargo various combinations of C-17s and either C-33s or C-5Ds could deliver in the first two to three weeks of major conflicts in Korea and the Persian Gulf. They then compared the performance of those alternatives with that of an airlift fleet containing 120 C-17s.

The results of their analysis showed that various mixtures of planes were capable of handling deliveries to major regional contingencies, although not quite as well as a fleet with 120 C-17s. Consider a conflict on the Korean Peninsula—a scenario that defense officials argue would be the most taxing on airlift because of congested airfields. Under crowded conditions, one might expect fleets with large planes such as the C-33 or C-5 to deliver substantially less cargo than fleets made up entirely of the smaller and more maneuverable C-17.

In fact, the Air Force analysis showed that although combinations of C-17s and C-33s or C-5s could not deliver as much outsize equipment as 120 C-17s, some alternatives came close. For example, a combination of 58 C-17s and 42 C-33s would deliver 97 percent or more of the amount that 120 C-17s could provide. That mix of planes would complete its deliveries to the Korean Peninsula about one to two days later over a two- to three-week period. According to DoD's estimates, that fleet would cost $11.5 billion less (in 1996 dollars) than 80 more C-17s over the course of the planes' service lives.

8. Gebman, Batchelder, and Poehlmann, *Finding the Right Mix of Military and Civil Aircraft*, p. 26.

9. For a discussion of the costs and capabilities of three alternative airlift purchases, see Congressional Budget Office, *Options for Strategic Airlift.*

If ramp space is limited at airfields in a theater of operations, the C-17's advantage is more pronounced. When the Air Force analysis constrained ramp space at Korean airfields by an additional 15 percent, the fleet of 120 C-17s increased the margin by which it could deliver more outsize cargo than mixtures of C-17s and C-33s. Nevertheless, fleets containing as few as 72 C-17s and 30 C-33s would be able to transport 94 percent or more of the amount of outsize cargo delivered by 120 C-17s, but would cost at least $8 billion less over their projected service life. Since the Air Force expects that more ramp space would be available for airlift planes in the Persian Gulf, combinations of C-17s and C-33s performed better in that scenario than in the Korean case.

To summarize, various combinations of C-17s and C-33s could deliver nearly as much cargo during the first two to three weeks of a conflict on the Korean Peninsula as an airlift fleet with 120 C-17s. The slower pace of deliveries with those mixed fleets could add one or two days to the time needed to finish delivering U.S. forces to the region, and perhaps a week if airfield space was constrained by an additional 15 percent. But DoD officials emphasized alternatives that precisely matched the capability of 120 C-17s rather than options that were slightly less capable at delivering cargo to a major conflict but were much less costly.

Cargo Deliveries to Smaller Operations

Although major conflicts would be the most demanding, smaller deployments could also tax airlift forces because DoD might not call up reserve aircrews or activate the Civil Reserve Air Fleet. Thus, fewer planes—civil or military—would be available for peacetime missions. If the United States needed to conduct operations in regions with short runways or poorly equipped airfields, DoD officials argue, a larger number of C-17s would allow them to deploy forces more quickly.[10] For example, in the recent deployment of U.S. forces to Bosnia for Operation Joint Endeavor, the Air Force flew only C-130s, C-141s, and C-17s into Tuzla airfield because of its small width and limited ramp space.

But how many C-17s would be needed for smaller cargo deliveries? In many cases, the answer appears to be 40 or fewer. In a 1995 study of the tactical utility of various airlift fleets, the Secretary of Defense's Director for Program Analysis and Evaluation looked at what the Administration considers representative cases of four types of smaller missions: a peacekeeping operation, a humanitarian assistance mission, an evacuation of noncombatants from a foreign country, and a peace enforcement operation. The specific assumptions for each scenario were taken from the Administration's Defense Planning Guidance and from intelligence information. The analysis did not examine cases in which the United States conducted several such missions at once, which would most likely raise requirements for airlift.

For peacekeeping missions, the United States would deploy forces to maintain an existing truce, such as in current United Nations operations in the Sinai. Defense officials believe that airlift fleets with as few as 40 C-17s could conduct deployments to a representative peacekeeping operation with little risk of failing to achieve DoD's military objectives. DoD leaders reached the same conclusion for the representative humanitarian mission, which was similar to the delivery of food, medicine, and desalination equipment to Rwanda in 1994, and for an evacuation of noncombatants, similar in nature to the recent evacuation of U.S. citizens from Liberia.

However, one type of mission for which DoD might need more C-17s is a peace enforcement operation, in which U.S. forces would help keep regional foes from fighting one another. (Operation Joint Endeavor in Bosnia is an example of a current peace enforcement operation.) That sort of mission would require deploying heavier forces in order to protect U.S. troops from artillery fire, snipers, and the like.[11] DoD officials concluded that airlift fleets with 72 or 86 C-17s could complete deliveries to such an operation in a short enough time that U.S. forces would face moderate risk of failing to achieve their military objectives. If U.S. airlift forces included 100 or more C-17s, defense officials

10. The C-17 was designed to land on runways as short as 3,000 feet, whereas the only other plane in the Air Force's inventory that can carry outsize cargo, the C-5, typically requires a runway of nearly 5,000 feet. In considering both runway length and the weight-bearing capacity of runways around the world, DoD estimates that the C-17 can land on approximately 3,700 airfields outside the United States, compared with 2,300 for the C-5.

11. For Joint Endeavor, U.S. military leaders originally planned to deploy a peak of 20,000 troops to the region over an eight-week period, including an aviation brigade, two brigades from the 1st Armored Division, and support and sustainment forces.

believe, they could complete deliveries quickly enough to keep the risk at a low level.

But the amount of gross tonnage that an airlift fleet can deliver to major conflicts or smaller missions was not the only basis for the Administration's November 1995 decision to buy a total of 120 C-17s. According to press accounts, DoD's tactical requirements for conducting special airlift missions were the key reason that Administration officials made that recommendation.[12]

Special Airlift Missions

If DoD needed to prepare for other, more specialized types of airlift operations, it might require larger numbers of C-17s. One such mission is an airdrop operation in which airlift planes would deliver paratroopers and equipment from the air after traveling intercontinental distances. Shortly after the initial airdrop, DoD would deliver additional equipment the traditional way by landing cargo planes.

The Air Force now relies on the C-141 and C-130 as the principal platforms for air-dropping paratroopers and equipment. (Most C-130s cannot be refueled in flight, so only the C-141 can be used in situations involving airdrops over intercontinental distances.) Despite some difficulties in airdrop tests, the Air Force and Army have committed themselves to using C-17s as the replacement for C-141s in that role.[13]

Without the C-141, DoD officials believe, the Air Force would need at least 100 C-17s to air-drop a "medium force package" consisting of 2,552 Army paratroopers and the equipment for the lead brigade that would deploy first from the airborne division. Since each C-17 can drop 102 paratroopers, DoD would need 25 planes simply to air-drop personnel. The remaining C-17s, along with 50 C-5Bs, would air-drop equipment and then deliver additional cargo to support those troops by conventional operations. (The Army does not use C-5Bs to air-drop troops because of concerns about their safety.) A fleet that included 120 C-17s could conduct such a mission with low risk of failure, according to defense officials.

The Secretary of Defense's Director for Program Analysis and Evaluation also examined how many airlift planes would be needed today to conduct airdrop operations like those for the 1989 U.S. deployment to Panama known as Operation Just Cause. Since Panama lies within the range of the C-130, the Air Force could use those tactical airlift planes to support such an airdrop. However, defense officials concluded that the Air Force would need at least 86 C-17s in its fleet to conduct a similarly sized airdrop with moderate risk within the time frame laid out by military planners. Fleets with 100 or more C-17s might allow the Air Force to air-drop more forces or conduct the mission with lower risk of failure. The Army believes that it would need at least 120 C-17s to meet its requirements for a brigade-size airdrop over strategic distances.

Should the United States buy enough C-17s to conduct long-range airdrops of brigade-size forces? Military planners argue yes, since doing so would give the United States the ability to enter countries forcibly anywhere in the world. But the United States has rarely air-dropped paratroopers in actual missions. Airborne forces were dropped during Operation Urgent Fury in Grenada in 1983 and in 1989 during Operation Just Cause in Panama. And arguably, DoD's preparations in September 1994 for a parachute assault into Haiti helped convince that country's military rulers to accept the more peaceful introduction of U.S. forces.

However, in all of those cases shorter-range C-130s could be used. A brigade airdrop over an intercontinental distance would be considerably more demanding on paratroopers: before conducting their jump, they would have to fly long stretches on planes designed primarily to move cargo, conduct a parachute assault to seize and secure an airfield, and then prepare to receive reinforcements from traditional airlift deliveries. The complexity of such an operation has led some analysts to suggest that it is an unlikely event. Other analysts, however, argue that retaining such a capability would deter potential aggressors.

Another type of special airlift mission is delivering cargo from the United States directly to the front of a conflict in the midst of major strategic deployments, such as to forward bases near the border of North and

12. Elaine M. Grossman, "Tactical Utility Analysis Proved to be Key Factor in DAB's C-17 Decision," *Inside the Pentagon*, November 16, 1995, pp. 3-4.

13. Tony Capaccio, "C-17 Still Can't Perform Crucial Army Airdrop Mission," *Defense Week*, November 4, 1996, p. 1.

South Korea. A 1995 DoD study found that a fleet with as few as 72 C-17s (when combined with C-33s) could provide the capability to deliver units directly to the front. But such a fleet would complete those deliveries more slowly than one with 120 C-17s, and thus DoD officials characterize the risk of failure associated with that slower pace as moderate.

Dedicating one or two squadrons of strategic airlift planes to moving cargo within a theater of operations is another mission that could require larger numbers of C-17s. Since it can carry outsize pieces of equipment, the C-17 could be used to move some high-priority cargo within a theater that C-130s cannot, such as batteries of Patriot missiles or multiple-launch rocket systems.

Defense officials believe a fleet with 86 C-17s and 30 C-33s could complete strategic deliveries for a major conflict in a timely manner. If military commanders chose to use C-17s to move equipment within a theater, however, fewer C-17s would be available to deploy forces from the United States, and thus deployments would take more time and involve higher risk. Military leaders recommend buying at least 14 additional C-17s for intratheater deliveries, although the Office of the Secretary of Defense has not yet endorsed that idea.

Some analysts would question the importance of using C-17s in that way, however. Today, military commanders use trucks or railcars to transport outsize cargo within a theater of operations, and those modes would still be available in future conflicts. Given the high cost of C-17s, some policymakers might consider dedicating one or two squadrons of them to that role as unaffordable.

Chapter Three

Strategic Sealift Forces

During the Persian Gulf War, the Department of Defense transported 72 percent of its dry cargo on ships that steamed from the United States, and another 13 percent on ships that held prepositioned equipment nearer the region.[1] Although sealift ships travel much more slowly than transport planes, they are usually less expensive to purchase and operate, and a single large ship can carry literally hundreds of plane loads. For those reasons, defense planners anticipate that sealift will also deliver the vast majority of cargo and supplies to future major conflicts.

The Current Strategic Sealift Fleet

Military analysts characterize sealift's role in a future war as one of either surge or sustainment. In a surge role, ships would carry the equipment for combat and support units, including a large number of vehicles such as tanks and trucks, from their peacetime garrisons. Once that equipment was delivered, sealift ships would focus on sustaining operations—that is, delivering supplies of spare parts, food, water, petroleum, ammunition, and other items to support the operation.

Today, DoD's surge sealift fleet includes about 95 ships and has the capacity to carry more than 7 million square feet of cargo (see Box 4 and Figure 4). As recently as the Persian Gulf War, DoD relied on commercial ships to deliver both surge and sustainment cargo. For the future, however, defense officials contend that commercial ships will not be available at a moment's notice to transport initial combat forces, and thus military ships must fill that role. However, DoD planners intend to use commercial shipping extensively to sustain military operations.

Box 4.
Basic Units of Measure in Sealift Analysis

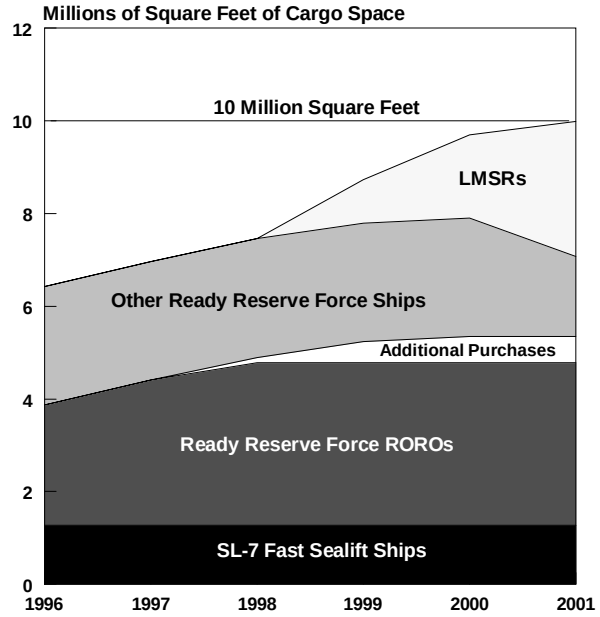
Square feet: Sealift loads and the capacity of individual ships are usually described in terms of the amount of their deck space as measured in square feet. Although the physical dimensions of a piece of cargo may not fit on certain ships, that problem occurs much less frequently than with airlift.

Stowage area: The amount of usable square feet for storing cargo on board a ship. Transportation specialists typically plan to load only about 75 percent of a ship's available deck space with cargo. That figure takes into account obstructions in the cargo hold, space required for lashing down pieces of equipment, fire lanes, and the like.

Millions of square feet: Total sealift capacity is the sum of all stowage space in a single sailing of all available sealift ships, typically measured in millions of square feet.

1. James K. Matthews and Cora J. Holt, *So Many, So Much, So Far, So Fast: United States Transportation Command and Strategic Deployment for Operation Desert Shield/Desert Storm* (Joint History Office, Office of the Chairman of the Joint Chiefs of Staff; and Research Center, U.S. Transportation Command, 1995), pp. 13, 116.

Figure 4.
Sealift Capacity Under the Administration's Plan, 1996-2001



SOURCE: Congressional Budget Office based on data from the Department of Defense.

NOTES: LMSRs = large, medium-speed roll-on/roll-off ships; ROROs = roll-on/roll-off ships.

The Department of Defense relies on commercial ships to provide additional sealift capacity in times of need.

In 1996 and 1997, the Administration requested funding for five used, foreign-built ROROs that it would reflag and then add to the Ready Reserve Force, for a total of 36 such ships. In both of those years, however, the Congress denied funding for the request. The above figure reflects additional purchases that would provide capacity equivalent to five ROROs in order to reach DoD's goal of 10 million square feet of storage space.

DoD's Surge Sealift Ships

Only those ships that can be readied most quickly—in 20 days or less—are considered part of DoD's surge sealift fleet (see Figure 5). The Navy operates the largest of those military vessels, but many are part of the Ready Reserve Force (RRF), a fleet of inactive cargo ships maintained by the Department of Transportation's Maritime Administration.

The type of vessel best suited for carrying military combat units is the roll-on/roll-off ship, or RORO. Army and Marine Corps combat units include large numbers of wheeled and tracked vehicles (for example, one armored division contains more than 3,700 self-propelled vehicles and 2,500 towed pieces). ROROs are ideal for carrying such units because they contain a system of external and internal ramps and open storage bays, which allows stevedores to drive the vehicles on the ship and then park and secure them quickly.

Just prior to the Persian Gulf War, however, the most common type of military ship available was the breakbulk. Those are general cargo ships that have their own system of booms, cranes, and winches to load equipment into cargo holds. They are usually powered by steam engines rather than more modern diesel engines. Because breakbulks carry their own cranes, they can be used in a variety of ports, including ones that lack modern facilities. However, ROROs are easier to load and unload than breakbulk ships, particularly when transporting military vehicles. Generally, breakbulks are much smaller and take two to three days longer to load and unload than RORO vessels.[2] For that reason, DoD chartered commercial ROROs early in Operation Desert Shield to supplement the ones it activated from the RRF.

Today, U.S.-flag commercial carriers use few ROROs, with the exception of vessels that transport cars. Instead, most of the world's commercial ships are designed to hold a large number of containers, usually 20 feet or 40 feet in length. Those containers fit into cellular storage areas that are stacked tightly on the ship's decks to maximize its load. (For some loads, ship operators can fit racks over the containership's cells to create deck space for transporting a limited number of vehicles.) In order to keep transportation costs low, containerships do not carry their own crane system, relying instead on shore-side cranes at ports or on auxiliary crane ships to load and unload their cargo.

Beginning in the 1980s, DoD began purchasing its own fleet with RORO capacity rather than relying on commercial shipping, which was increasingly turning to containerships. For example, to support DoD's plans for a rapid deployment force, the Navy bought eight

2. Department of Defense, *Final Report to Congress: Conduct of the Persian Gulf War* (April 1992), p. 378.

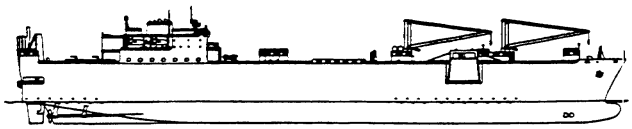
Figure 5.
DoD's Surge Sealift Ships

SL-7 Fast Sealift Ships

The Department of Defense (DoD) owns eight SL-7s, 950-foot ships that hold both containers and roll-on/roll-off cargo. They steam at an average speed of 27 knots and a maximum of 33 knots. One of the largest ships in the surge fleet, SL-7s can hold about 150,000 square feet of cargo plus 188 20-foot-equivalent containers.

Large, Medium-Speed Roll-On/Roll-Off Ships

Through 1997, the Congress appropriated funds for 16 of these ships, called LMSRs. DoD received the first two in 1996. Each 950-foot vessel will carry 225,000 to 300,000 square feet of cargo and will be equipped with its own set of cranes. LMSRs also contain systems to control the ships' humidity and suppress fires. Their maximum speed is 24 knots.



Roll-On/Roll-Off Ships in the Ready Reserve Force

Today's Ready Reserve Force includes 31 roll-on/roll-off ships (ROROs), but some are being used to preposition equipment for the Army in the Indian Ocean until DoD receives more LMSRs. Since 1993, the United States has purchased and reflagged 14 used ROROs. Each ship holds about 100,000 square feet of cargo; maximum speeds vary between 17 knots and 25 knots.

Breakbulks and Barge Carriers

The Ready Reserve Force (RRF) includes 35 breakbulks—vessels that carry their own cranes and have open bays for stowing cargo. Each ship holds about 50,000 square feet of cargo and maintains a speed of 17 knots to 20 knots. The RRF also includes four lighter-aboard ships and three sea barges—both types of ships that carry barges loaded with cargo.

Special-Purpose Ships

The RRF includes 10 auxiliary crane ships, which are used to unload cargo from other ships that lack their own system of cranes. The Ready Reserve Force also has seven tanker vessels that carry petroleum, oil, and lubricants and two ships devoted solely to carrying troops.

SOURCE: Congressional Budget Office.

SL-7 containerships from Sea-Land Services in the early 1980s and converted most of their holds into roll-on/roll-off compartments. It also added cranes and helicopter landing pads. Although the SL-7s were used as containerships before they were converted for the military, a Navy study concluded that they will not need to be replaced until 2020. Today, they make up almost 20 percent of DoD's surge sealift capacity and can be activated within four days.

Operations Desert Shield and Desert Storm were the first instance in which all eight SL-7s were activated together.[3] As a whole, they performed well: in a total of 32 voyages, seven of the ships transported over 13 percent of all unit equipment for the operations.[4]

3. Navy League of the United States, *The Almanac of Seapower, 1996* (Arlington, Va.: Navy League of the United States, 1996), p. 166.

4. Matthews and Holt, *So Many, So Much, So Far, So Fast*, p. 116.

Box 5.
Readiness Categories for Surge Sealift

The Department of Defense (DoD) gives its sealift ships a readiness designation—a description of how quickly they could be activated when needed. For example, the SL-7 fast sealift ships are maintained in a four-day status; in other words, DoD expects that under normal circumstances they would be activated and en route to their loading port in four days.

Before the Persian Gulf War, most ships in the Ready Reserve Force (RRF) were kept in a five-, 10-, or 20-day readiness status (known as RRF-5, RRF-10, or RRF-20). During that deployment, however, many RRF ships took longer to activate than DoD had planned—on average, they were nine days late. Since then, the Departments of Defense and Transportation have established a new readiness category for vessels that would transport equipment with the highest priority. Known as reduced operating status (ROS), ships kept in ROS-4 and ROS-5 have a 10- or nine-member crew on board, respectively, who perform routine maintenance on the vessel and get to know its idiosyncrasies so they can activate it with minimal outside assistance. Rather than planning to tow the vessel to a shipyard for activation, this strategy permits DoD to keep the ship closer to the port at which it would load its cargo. Ships designated as ROS-4 also undergo annual sea trials, whereas those that are ROS-5 alternate each year between sea trials and dockside trials. Twenty-four Ready Reserve Force roll-on/roll-off ships are now kept in ROS-4 status, and 10 break-bulks, nine auxiliary crane ships, two sea barges, and two tanker ships from the RRF are kept in ROS-5. DoD also plans to keep the new large, medium-speed roll-on/roll-off ships (LMSRs) it is procuring and its eight SL-7s in a reduced operating status.

DoD preserved the RRF-10, RRF-20, and RRF-30 designation for ships that do not keep equipment operating or have any crew assigned. If activated, those vessels would be towed to a shipyard, where personnel would remove dehumidification equipment, bring engineering systems on-line, and perform general repairs. Ships kept in RRF-10 or RRF-20 status also undergo sea or dockside trials to test their readiness but on a less frequent basis. Out of today's RRF fleet, 21 breakbulks, four lighter-aboard ships, one sea barge, one tanker, and two troop ships are kept in RRF-10 status, and four breakbulks and two tankers are kept in RRF-20. RRF-30 status would apply to ships that receive limited preventive maintenance, do not undergo sea or dockside trials, and are not considered part of DoD's surge sealift fleet. No ships are kept in RRF-30 today, but DoD plans to move 21 breakbulks to that status and ultimately remove them from the Ready Reserve Force after all its LMSRs are delivered.

The SL-7s were not without problems, however. Three ships took longer than four days to activate, and one, the *Antares*, suffered a boiler failure during her first voyage and was lost for the remainder of the operations.[5] Since then, the Navy has activated the fast sealift ships on several occasions to conduct readiness exercises or to support humanitarian missions and other operations.

Since 1993, the Congress has been buying large, medium-speed roll-on/roll-off ships (LMSRs) to add to DoD's surge sealift capacity. Each LMSR has one and a half to two times the capacity of an SL-7. As of 1997, the Congress has appropriated funding for 16 LMSRs at an average cost of about $314 million. Newport News Shipbuilding and the National Steel and Shipbuilding Company (NASSCO) are converting five containerships purchased from commercial shippers into LMSRs. Avondale Industries and NASSCO are designing and building the remaining ships from scratch. The Navy plans to keep all LMSRs used for surge sealift in four-day reduced operating status (see Box 5).

Today, DoD expects smaller ships from the Ready Reserve Force to transport much of the cargo for combat. The RRF includes 31 ROROs, which make up over 40 percent of DoD's surge sealift capacity.[6] Four-

5. However, the *Antares* had just completed six months of exercises prior to Operation Desert Shield and was scheduled to undergo major repairs before returning to service. Thus, DoD assumed the risk that the *Antares* might suffer a maintenance problem when it activated the ship. See Matthews and Holt, *So Many, So Much, So Far, So Fast*, p. 120.

6. A few of the 31 ROROs are being used temporarily to preposition Army equipment in the Indian Ocean. Those ships are not considered part of DoD's sealift capacity that would surge from the United States.

teen of those vessels were added since the end of the Persian Gulf War: the Maritime Administration and the Navy bought them from commercial sources and then modified and reflagged them at U.S. shipyards for military use. Because few U.S. companies use ROROs in their fleets, all of those purchases have been ships that were built and operated in foreign countries. To date, the United States has spent more than $450 million to buy and modify those ships. Navy and Army officials believe that at an average cost of about $32 million per vessel, converting used ROROs acquired from foreign owners is a more cost-effective way to add ships to the RRF than having domestic shipyards build new vessels of similar size, which might cost $100 million to $200 million apiece.

The remainder of the Ready Reserve Force is made up of breakbulks and barge-carrying ships, which provide 37 percent of DoD's current surge sealift capacity. Breakbulks are vessels that have open bays for stowing cargo and their own system of cranes; they can carry about half the load of an average RORO. Barge carriers are designed to carry a number of smaller barges, each loaded with cargo. After reaching a port, the carriers unload their barges using either a system of gantry cranes (in the case of lighter-aboard ships) or elevators (on so-called sea barges). Shore-side cranes then unload cargo from the barges. The RRF uses lighter-aboard ships and sea barges to carry ammunition. Other special-purpose ships in the RRF include auxiliary crane ships, tankers for transporting aviation and diesel fuel, and troop carriers.

In the past, the RRF has faced tight budgets for maintaining ships and conducting readiness exercises. Although the force is intended for use in military operations, the cost of maintaining its ships was until recently funded through the Department of Transportation and was often subject to budget cuts.[7] As a result, the Maritime Administration reduced the readiness status of many ships; some were placed in a 30-day readiness category, effectively removing them from the surge fleet. Beginning in 1996, however, funding for the RRF was shifted to DoD's budget.

7. DoD officials blame chronic underfunding for the slow activation of RRF ships during Operations Desert Shield and Desert Storm. More recent experience, when DoD activated ships for operations in Haiti, suggests that the RRF is in better shape today. See Department of Defense, Joint Chiefs of Staff, *Mobility Requirements Study Bottom-Up Review Update* (February 13, 1995), p. IV-B-11.

Commercial Sealift for Sustaining Military Operations

Cargo to resupply U.S. forces—such as food, construction materials, spare parts, medical supplies, ammunition, and the like—can fit more easily in standard-size containers than military vehicles can. Since containerships are more common than ROROs among U.S.-flag shippers, DoD might rely on commercial carriers to transport most types of sustainment cargo.

But are there adequate numbers of U.S.-flag ships? Since 1936, the federal government has protected the U.S. shipping industry on the premise that, in the event of war, it would need U.S.-manned ships to move military cargo. In the past, the Department of Transportation has paid the difference between the costs of U.S. ship operators—including the higher wages of crews made up of U.S. citizens—and the costs of foreign shippers.[8] Yet even with those subsidies, U.S. ship operators have not held on to market share. By one estimate, U.S. carriers had about 4 percent of the world market for ocean shipping trade in 1995, compared with nearly 43 percent in 1950.[9] Because of the higher wages that U.S. crews demand, operators have a strong incentive to reflag their ships in foreign countries. As a result, the number of U.S.-flag vessels has dropped precipitously—from more than 2,000 in the 1940s and 850 in 1970 to about 320 in 1996.[10]

Nonetheless, recent analysis by DoD suggests that sufficient numbers of U.S.-flag, effectively U.S.-controlled (EUSC), and allied containerships are available in the commercial market to support most military requirements for delivering sustainment supplies.[11] In a national emergency, the President could technically req-

8. Over the past 60 years, the federal government has paid a total of $10 billion in operating-differential subsidies through the Maritime Administration. The last of those contracts with commercial shippers has expired, but the Congress recently replaced that arrangement with the Maritime Security Program, which will provide operators of 47 U.S.-flag ships with nearly $1 billion over the next 10 years.

9. Bill McAllister, "End of Merchant Marine May Be on the Horizon," *Washington Post,* September 18, 1995, pp. A1, A10.

10. Eric Schmitt, "The Senate Clears $1 Billion in Subsidies to Shipping Lines," *New York Times,* September 25, 1996, p. D1.

11. EUSC refers to ships owned by U.S. citizens that are registered under the flags of Panama, Honduras, Liberia, the Bahamas, or the Marshall Islands. If the President requisitioned U.S.-flag commercial ships during a national emergency, EUSC vessels would be available as well.

uisition U.S.-flag and EUSC ships to transport military cargo. But unless the United States faced two major regional contingencies at the same time, it would probably not need to requisition ships because the Navy has set up contractual agreements with U.S.-flag carriers (similar to the Civil Reserve Air Fleet) so DoD can use commercial ships for national emergencies. And DoD might also approach allies for additional shipping capacity or charter foreign-flag vessels.

During Operations Desert Shield and Desert Storm, for example, the Navy activated RRF ships and chartered U.S.-flag and foreign vessels to move unit equipment and sustainment supplies. DoD did not even need to activate the Sealift Readiness Program (SRP), a shipping agreement in which U.S.-flag carriers committed half of their cargo capacity to the program during wartime in return for operating subsidies and the opportunity to bid on military shipping contracts during peacetime.

The SRP was never activated because of concerns that the program's participants would lose market share to foreign shipping lines.[12] DoD officials also found that many commercial ships were available for charter. DoD set up the Special Middle East Sealift Agreement, which contracted for about 30 percent of the container capacity aboard commercial liners to transport military supplies. That plan minimized disruption to business because it allowed commercial ships to continue their regular schedule of deliveries. About 55 percent of the dry-cargo ships enrolled in the SRP moved U.S. military cargo under the terms of the special agreement.

More recently, the Departments of Defense and Transportation have drawn up a successor to the SRP known as the Voluntary Intermodal Sealift Agreement (VISA). VISA is a three-stage program that has been incorporated into the Maritime Security Program, a federal government plan to help U.S.-flag merchant vessels remain economically viable. As part of the Maritime Security Program, the Department of Transportation is providing operators of 47 U.S.-flag ships with roughly $2 million per vessel in 1997. But in order to be eligible for those subsidies, domestic carriers must enroll in Stage III of VISA.

Stage III is structured in a similar way to the SRP: U.S.-flag shippers commit 50 percent of their capacity to moving military supplies during wartime in exchange for federal operating subsidies. However, unlike the SRP, which made carriers designate specific ships that they would make available to DoD in wartime, VISA enrollees simply commit to transporting a certain amount of cargo using their entire intermodal systems. That arrangement allows U.S. shippers to substitute among ships during an activation, or even use their foreign-flag vessels if those are more readily accessible. Under VISA, ship owners can also carry commercial cargo back to the United States.

Although DoD is still working out the details, Stages I and II of VISA will be analogous to the lower stages of CRAF: they would allow DoD to call up smaller numbers of civil carriers more quickly in a national emergency. Shipping companies would be provided with incentives for participating in early stages, such as preferences when bidding on DoD's peacetime shipping contracts. The arrangement will also give commercial carriers a better idea of what DoD's shipping requirements would be during a war, which might help them devise strategies to protect their market share.[13]

Although commercial sealift can transport most sustainment cargo, there may be one exception: ammunition. DoD planners believe few shippers would be willing to risk the safety of their commercial cargo by carrying ammunition in the same load. Thus, in the event of a major conflict, DoD plans to either charter ships that would be dedicated solely to transporting ammunition or keep some breakbulks and lighter-aboard ships within the RRF that it might otherwise retire. According to military officials, the ships that participate in the Maritime Security Program may provide sufficient capacity for that purpose.

Plans for Modernizing Surge Sealift

Ultimately, the Defense Department plans to have a military surge fleet capable of transporting 10 million

12. Department of Defense, *Conduct of the Persian Gulf Conflict: An Interim Report to Congress* (1991), p. 3-3.

13. Sean Naylor, "VISA Buys Access to Sealift Resources," *Army Times*, September 4, 1995.

square feet of equipment in each load. According to DoD, that level would allow the United States to deploy an offensive force large enough to handle any situation until reinforcements arrived. Defense officials define that force as two armored divisions plus the assault follow-on echelon for a Marine amphibious task force, which DoD would need to deliver in about 30 days. The Administration's plan to buy LMSRs for the Navy and smaller ROROs for the Ready Reserve Force would provide that 10 million square feet of surge sealift capacity by 2001 (see Figure 4 on page 24).

Large, Medium-Speed Roll-on/ Roll-off Ships

The core of the Administration's plan for expanding its surge sealift fleet is the purchase of three more LMSRs, for a total of 19. Eleven of those ships will be used to move cargo quickly from the United States; they will ultimately provide nearly 30 percent of DoD's surge capacity. The remaining eight will preposition Army equipment.

When it began procuring LMSRs, the Navy decided to transform five large containerships into ROROs because military officials believed that converting the ships would take less time and money than constructing LMSRs from scratch. During the 1980s, modifying DoD's eight SL-7s with some RORO capacity took roughly 24 months. In 1992, officials predicted that by using modular production technologies, shipyards could convert existing hulls into the LMSR configuration in about 18 months, compared with at least four years to build a new ship. However, converting existing hulls has taken more time and money than expected. All five conversion LMSRs have been 15 to 24 months behind schedule. The first two were delivered to the Navy in the fall of 1996, and under current plans, the last will arrive in November 1997 (see Table 4). If schedules do not slip further, those conversions will have taken well over three years to complete.

What explains the delays? Initially, the shipyards had to remove and replace substantially more of the existing structure than anticipated. They also had to revise their designs for fire-fighting systems to meet Coast Guard standards for certification. Two firms that bid for the conversion contract protested the Navy's award—a dispute that required four months to resolve. And contracts for government-furnished cranes fell behind schedule, which held back work on the LMSRs.

Current estimates suggest that deliveries of newly constructed LMSRs will fall behind schedule as well. Defense officials now expect delivery about three to six months later than originally proposed. Thus, the cost of those ships could rise too.

ROROs for the Ready Reserve Force

Over the past two years, the Navy planned to continue modernizing the RRF by purchasing five more smaller ROROs for a total of 36 in the fleet. But with the exception of ships for Marine Corps prepositioning, the Congress has forbidden the Navy to buy used, foreign-built ROROs. In order to meet its requirement for five more ROROs in the RRF, the Defense Department is examining ways to add capacity to its existing fleet or buy new ships from U.S. shipyards.

Each RORO can only hold about 35 percent to 50 percent as much cargo as an LMSR. But at an average cost of $30 million to $35 million each to purchase and reflag, they are only about one-tenth as expensive to acquire. Per square foot of cargo space, a fully equipped new-construction LMSR costs about $800, compared with about $230 to buy and reflag a foreign-built RORO.

Table 4.
Expected Delivery Schedule for LMSRs, 1996-2001

	1996	1997	1998	1999	2000	2001	Total, 1996-2001
Conversion Ships	2	2	1[a]	0	0	0	5
New Constructions	0	0	2	3	4	5	14
Total	2	2	3	3	4	5	19

SOURCE: Congressional Budget Office based on data from the Department of Defense.

NOTE: LMSR = large, medium-speed roll-on/roll-off ship.

a. This ship is expected to be delivered in November 1997 (fiscal year 1998).

Are large ROROs (LMSRs) preferable to smaller ones? Large vessels have the virtue of holding more cargo and can travel somewhat faster, but they may need special accommodations and could congest port operations. Since LMSRs are up to 950 feet long, they require large berths when unloading cargo from their side ramps.[14] And when they are fully loaded, their drafts require deep ports.

Today, DoD's major planning scenarios—conflicts on the Korean Peninsula and in the Persian Gulf—are located in regions that can easily accommodate large ships. Both Saudi Arabia and South Korea have modern port facilities with berths that are long and deep enough for LMSRs. But less well equipped facilities could pose problems. During Operation Restore Hope in Somalia, for example, the port at Mogadishu had only one berth capable of handling 950-foot ships. For that reason, the six SL-7s that carried Army cargo to Somalia had to unload one at a time, whereas smaller ships probably could have unloaded more quickly.[15]

Could DoD Rely More on Commercial Shipping?

Military officials base their numerical requirements for sealift primarily on the ability to deploy cargo, particularly to major regional contingencies. But over the past several years, defense officials and the Congress have been at odds about whether DoD needs its own fleet of ships to meet those requirements or can rely to a greater degree on commercial shipping.

In particular, the Congress has taken issue with at least one aspect of the Administration's sealift plan: buying foreign-built ROROs for the Ready Reserve Force. In recent years it has turned down DoD's request to buy and reflag foreign-built ROROs, instead authorizing and appropriating funds to establish a national defense features program.

The Congress's Preference: A National Defense Features Program

Under such a program, DoD would pay for the cost of building, installing, and maintaining national defense features on commercial ships.[16] For example, DoD might cover the cost of strengthening ramps and decks on ships that carry automobiles so they could also bear the weight of tanks. Representatives of shipping companies have met with Navy officials to discuss which features would be most useful to the military but would not leave the ships commercially uncompetitive.

Perhaps the most compelling argument for a national defense features program is its relatively low cost. Commercial carriers would bear most of the expense of procuring the ships and operating them during peacetime, allowing the military to avoid those costs. DoD's own analysis suggests that over a 40-year period, the cost per square foot of cargo capacity on a commercial ship with special features would be one-half to two-thirds that on a reflagged RORO in the RRF.[17] That calculation includes the cost not only of installing and maintaining the features but also of paying the annual operating subsidies that the Congress historically has provided to U.S. ship operators.

Another argument by proponents is that a national defense features program would ensure that trained and fully staffed crews were available when needed. In recent years, supporters of U.S. merchant mariners have warned that DoD might not have adequate crews of U.S. citizens if it needed to activate the Ready Reserve Force. The number of licensed and unlicensed U.S.

14. That problem may be mitigated somewhat because LMSRs will be equipped with stern ramps so they can sit perpendicular to a dock to unload.

15. David Kassing, *Transporting the Army for Operation Restore Hope*, MR-384-A (Santa Monica, Calif.: RAND, 1994), p. xiv.

16. In order to comply with the recent shipbuilding agreement among members of the Organization for Economic Cooperation and Development, federal funds could not be spent on features that are typically found on commercial ships.

17. Department of Defense, Office of the Deputy Secretary of Defense, *National Defense Features* (February 8, 1995), p. 6.

mariners is projected to fall by 2001, which might leave just enough to crew ships for a major conflict.[18] Under a national defense features program, DoD would not need to find as many crews for RRF ships because it would rely more on commercial vessels, which would already have U.S. crews aboard.

That issue is a contentious one, however. In an exercise conducted in 1996, the Maritime Administration found that more than 8,200 mariners were available to fill about 2,300 positions if the RRF had been activated. And DoD's manpower requirements will fall if it retires breakbulk ships from the RRF as it plans.

A national defense features program could also benefit the U.S. shipbuilding industry, which has fared poorly in recent years. Throughout the 1980s and early 1990s, U.S. shipyards built few commercial vessels; instead, they focused on DoD orders. That attention to the military market resulted from two factors: significant growth in Navy spending for hull construction, and a 1981 decision by the Reagan Administration to cancel subsidies that underwrote the difference in construction costs between U.S. and foreign ships. Without that support, U.S. shipbuilders lost commercial orders to foreign shipyards that built vessels at a lower cost. Although some foreign governments have subsidized the cost of building ships, U.S. shipbuilders have until recently been slower to invest in more modern facilities and equipment than their foreign competitors. By raising the demand for military characteristics on new commercial ships, a national defense features program might bring new business to U.S. shipbuilders.

DoD's Preference: Purchase a Military Fleet

Before the 1980s, DoD relied on the U.S. merchant fleet and commercial ship operators from NATO countries to deliver not only sustainment cargo for military operations but also unit equipment. With the growing popularity of containerships among U.S.-flag carriers, however, defense officials argue that DoD needs its own fleet of ROROs. Although ship operators can fit special racks on containerships to help them accommodate a limited number of military vehicles, ROROs can be loaded and unloaded more quickly and are better suited for the large number of vehicles that DoD would need to transport to a major conflict. Indeed, some analysts argue that it is simply impossible to modify containerships enough to make them as useful to the Army as ROROs within the time constraints of a major regional conflict.[19]

Although defense officials are interested in the capability that a national defense features program could provide, they believe the best method to add to DoD's surge sealift capacity would be to buy and reflag used, foreign-built ROROs. According to DoD documents, commercial ships with national defense features might replace ships that will be retired after 2000. But for the near term, officials believe that buying foreign-built ROROs would allow DoD to reach its requirement for surge sealift more quickly than would constructing new commercial ships with national defense features, which might take two or three years.

A dedicated fleet of military ships might also be ready to depart more quickly than privately owned vessels, which could be far from the United States at the start of a conflict. Under a national defense features program, operators of commercial ships would immediately steam their vessels at top speed back to U.S. seaports when notified. How long might that take? In a study requested by the Congress, DoD found that in 1991 and 1992, about 50 percent of commercial 20-knot ROROs would have needed 15 days to steam to a designated port, and about 90 percent could have steamed where needed within 25 days.[20] With those time frames, commercial ROROs probably could not deliver the initial surge of cargo for major contingencies. However, they might help transport unit equipment to reinforce combat operations.

18. Robert Kestelroot, "For Whom the Bell Tolls: The U.S. Merchant Marine," in Navy League of the United States, *The Almanac of Seapower* (Arlington, Va.: Navy League of the United States, 1996), p. 78.

19. Owen Cote Jr., "Enhancing Surge Sealift Capabilities: The Case for the Ready Reserve Fleet" (unpublished paper, Center for Science and International Affairs, Harvard University, 1995), p. 4.

20. Department of Defense, *National Defense Features*, Appendix F.

Some analysts contend that a national defense features program and arguments about the declining number of merchant mariners are thinly veiled appeals to subsidize U.S. shipyards and shipping companies.[21] Others argue that the federal government's policy of protecting shipbuilders and the merchant fleet is even contributing to its demise.[22] DoD's recent investments in its own fleet of ROROs suggest there is less national security justification for subsidizing U.S.-flag ships than in earlier times. The Navy has also begun employing more civilian crews on auxiliary and prepositioning ships during peacetime—a trend that may help ensure that crews of U.S. citizens are available for war. And there are alternative ways to make sure adequate manpower is available, such as establishing a reserve crew program or leasing RRF ships back to commercial operators during peacetime.[23] For those reasons, military officials have been reluctant to include the cost of operating subsidies for U.S. carriers in DoD's budget.

A Third Approach: Charter U.S.- and Foreign-Flag Ships When Needed

Critics of both the Administration's plan and a national defense features program might argue that neither is critical for ensuring adequate surge sealift. Instead, the United States could simply charter U.S. and foreign vessels to supplement the Ready Reserve Force when needed for major contingencies. But for such an approach to work, DoD would need to count on foreign crews and ships during time of war.

The U.S. military has relied extensively on chartered ships as recently as in Operations Desert Shield and Desert Storm: it contracted for 29 U.S.-flag and 162 foreign-flag dry-cargo vessels that ultimately delivered 12.3 million square feet of unit equipment and support cargo.[24] The first of those U.S.-flag ROROs was ready to depart just 12 days after the start of the deployment, and the first foreign-flag charter was ready in 19 days. Chartered ships moved 30 percent of combat and support equipment during the first phase of the deployment and more than 50 percent during the second phase.

Why were charters used so extensively? At the time of the Gulf War, the Ready Reserve Force contained just 17 ROROs, the preferred vessel for transporting military vehicles. Thus, DoD looked to the commercial market to supplement those ships. The RRF was also slow to activate; only 20 out of 62 dry-cargo ships were activated on schedule.[25] By comparison, chartered vessels were readily available and came with full crews on board.

Charters were also less expensive than RRF ships. According to a study by the Center for Naval Analyses, the average daily cost for chartered ROROs was $23,000, compared with a daily operating cost for RRF ships of about $40,000.[26] Charters compared favorably because DoD bore the expense of only a one-way trip, and it did not have to pay for activating and deactivating those ships as it would with the Ready Reserve Force.

Yet DoD officials contend that in the future the United States may not have the same degree of cooperation from the international community, and thus foreign charters may not be available. If the United States had faced a foe more capable of interdicting sea lanes than Iraq, commercial charters might have found the task too risky to undertake.

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21. Cote, "Enhancing Surge Sealift Capabilities," p. 4.

22. Rob Quartel, "America's Welfare Queen Fleet: The Need for Maritime Policy Reform," *Regulation: The Cato Review of Business & Government* (Summer 1991), pp. 58-67.

23. Michael Blaney, "Ready Reserve Ships Require Ready Reserve Crews," *Naval Institute Proceedings* (January 1995), pp. 50-51.

24. Ronald Rost, John Addams, and John Nelson, *Sealift in Operation Desert Shield/Desert Storm: 7 August 1990 to 17 February 1991*, CRM91-109 (Alexandria, Va.: Center for Naval Analyses, May 1991), pp. 30-31.

25. Matthews and Holt, *So Many, So Much, So Far, So Fast*, p. 122.

26. Rost, Addams, and Nelson, *Sealift in Operation Desert Shield/Desert Storm*, p. 31.

Chapter Four

Prepositioned Forces

As the Department of Defense learned during the war with Iraq, by placing equipment for certain units at key sites and then flying personnel and material from the United States to meet up with it, DoD can deploy heavy forces (armored or mechanized units) quickly and at relatively low cost. In the next few years, DoD plans to significantly boost the amount of equipment it has prepositioned in areas of potential conflict, particularly the Persian Gulf region and South Korea.

A Lesson from Desert Shield: Preposition Heavy Forces

Today's thinking about prepositioning has been heavily influenced by the U.S. experience in Operations Desert Shield and Desert Storm. Even the most direct routes to the Persian Gulf lie nearly 7,000 nautical miles by air or roughly 8,000 to 10,000 nautical miles by sea from the continental United States, making all deployments to the region difficult. One lesson of the Persian Gulf War was that in order to deliver heavy units over such distances very early in a major conflict, DoD needs to preposition much of the units' equipment.

Deploying Initial Ground Forces for the War

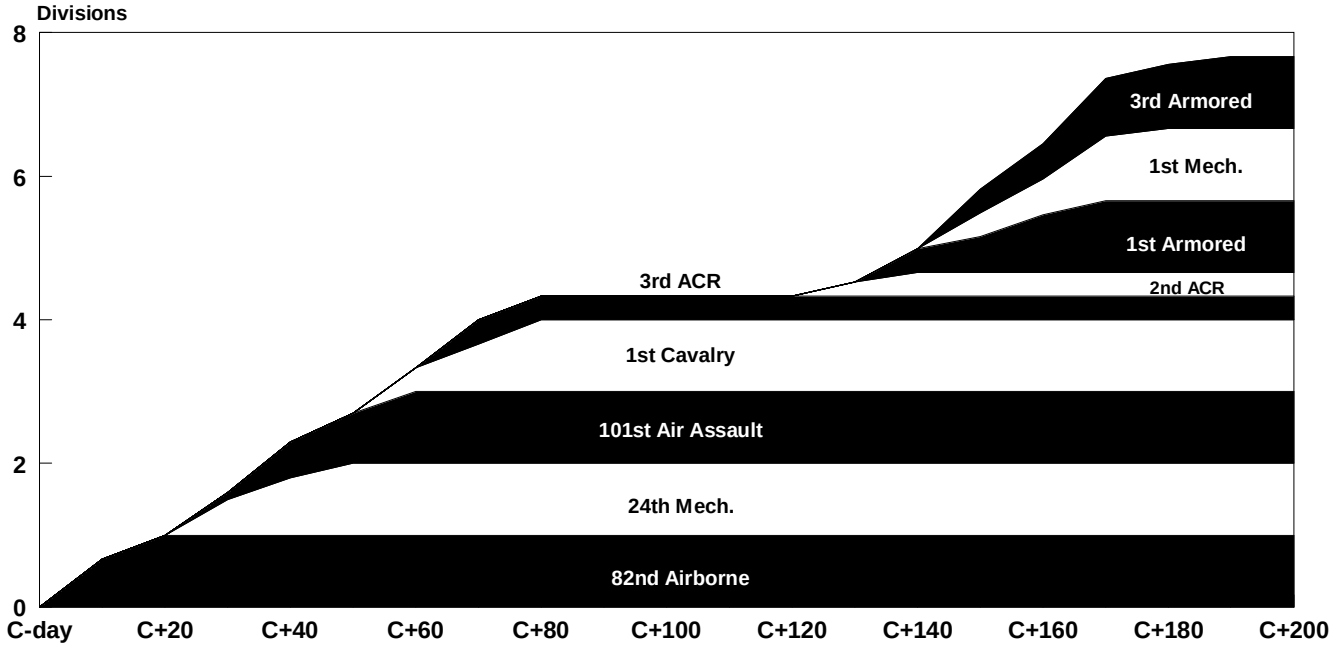
DoD had virtually no warning before it was called on to deploy troops for Operation Desert Shield. Saddam Hussein's forces invaded Kuwait on August 2, 1990, and the United States began sending troops to the region five days later. On the heels of an eight-year war with Iran, Iraq's armed forces numbered about 1 million active-duty troops and were believed to be equipped with about 5,500 tanks, including 1,000 of the more modern T-72s. Although the United States immediately deployed light Army units to the region by airlift, DoD officials saw those forces as little more than a trip wire and a sign of U.S. resolve.

Among the first forces flown to the Persian Gulf were lightly armed units from the 82nd Airborne Division, who were intended to deter Iraq's armored forces from moving from Kuwait into Saudi Arabia. But other than conducting air and missile strikes, the United States had no way to blunt further armored assaults until 123 prepositioned M-60 tanks from the 7th Marine Expeditionary Brigade (MEB) and the 1st MEB arrived by ship from the Indian Ocean and Guam by August 25. Those forces were followed by the 24th Mechanized Infantry Division, whose final units reached Saudi Arabia from the United States about a month later (September 23) with more capable M1A1 tanks and other fighting vehicles. Yet Iraq initially chose not to attack farther south, and instead replaced the Republican Guards who had led the invasion of Kuwait with infantry units, who dug in defensive positions along the Kuwait-Saudi Arabia border.[1]

Early on, U.S. military planners realized that they could not transport the entire set of combat units and

1. Michael Gordon and Gen. Bernard Trainor, *The Generals' War: The Inside Story of the Conflict in the Gulf* (Boston: Little, Brown, 1995), p. 65.

Figure 6.
Arrival Times of Army Combat Forces Deployed in the Persian Gulf War



SOURCE: Congressional Budget Office based on data from the U.S. Transportation Command and Ronald Rost, John Addams, and John Nelson, *Sealift in Operation Desert Shield/Desert Storm: 7 August 1990 to 17 February 1991*, CRM91-109 (Alexandria, Va.: Center for Naval Analyses, May 1991).

NOTES: C-day was August 7, 1990. Phase I of U.S. deployments took place over the first 111 days. The ground war began on February 24, 1991 (C+201).

ACR = armored cavalry regiment; Mech. = mechanized infantry.

logistical support from the United States by their deadline of mid-November. Instead, they chose to give priority to Army combat and combat-support units at the expense of logistics and administrative units, relying on support from the host nation, Saudi Arabia, as much as possible.[2] It took 111 days to complete deliveries of all defensive Army forces to the region, although most were in place 80 days after deployments began (see Figure 6). Ultimately, the United States deployed seven and two-thirds Army divisions to the region. By the start of offensive operations against Iraq, the United States had six carrier battle groups in the region, nearly 1,300 combat and combat-support aircraft, and almost half of the Marine Corps's active-duty forces.

Evaluating the Gulf War Experience

Following the Gulf War, the Office of the Joint Chiefs of Staff began assessing U.S. mobility forces to see how well they suited the requirements of a post-Cold War era. The Joint Chiefs concluded that "the Desert Shield deployment had been a success, but that limitations in mobility forces had imposed considerable risk."[3] In other words, they were troubled by the pace at which the United States was able to deploy heavy forces and logistical support. Many military analysts argue that if Iraq had continued its assault into Saudi Arabia, the Persian Gulf War would have been longer and far more arduous for the United States.

2. Lt. Col. F. Marion Cain III, "Building Desert Storm Force Structure," *Military Review* (July 1993), pp. 21-30; Department of Defense, *Conduct of the Persian Gulf Conflict: An Interim Report to Congress* (1991), p. 3-2.

3. Department of Defense, Joint Chiefs of Staff, *Mobility Requirements Study*, vol. 1, *Executive Summary* (January 23, 1992), p. ES-4.

The Joint Chiefs called for new investments in strategic lift. They based that recommendation on the 1992 Mobility Requirements Study, which looked at what forces the United States would need to fight two major regional conflicts in quick succession. Besides new airlift and sealift forces, the Joint Chiefs recommended that the Army preposition sets of heavy equipment and combat-support units on board ships placed closer to DoD's key planning scenarios. That prepositioned equipment would allow the United States to deploy forces more quickly than it did during Operation Desert Shield.[4]

The idea for more afloat prepositioning was based partly on the example provided by the Marine Corps's Maritime Prepositioning Force (MPF). The MPF program was created in the early 1980s as the Marine Corps's answer to calls for a rapid deployment force for the Middle East. MPF ships delivered the first tanks for the 7th MEB to Saudi Arabia in Operation Desert Shield.

At the same time the Joint Chiefs were conducting their review, the Army began drawing up its own vision of how to improve on its Gulf War experience. The result was a blueprint known as the Army Strategic Mobility Program (see Appendix A for details). It called for prepositioning equipment for one heavy Army brigade and combat-support and combat-service support units on board ships in the Indian Ocean, from where they could be delivered to either the Persian Gulf or the Korean Peninsula within 15 days. Surge sealift ships would then transport two heavy Army divisions from the United States to reinforce operations within 30 days. Ultimately, the Army would deploy a five-division corps with its accompanying support and sustainment within 75 days.

In October 1994, the Army tested the afloat prepositioning concept when Iraqi forces began massing near the Kuwaiti border. DoD responded with Operation Vigilant Warrior, in which prepositioning ships steamed to Saudi Arabia, unloaded their cargo, and met up with personnel from the 24th Mechanized Infantry Division. The first of those ships began unloading cargo 12 days after sailing from Diego Garcia. In addition, U.S. troops flew to Kuwait to meet up with tanks and other combat equipment already prepositioned there. (By comparison, it took about 20 days to deliver the first elements of the 24th Infantry Division from the United States during Operation Desert Shield.)[5] Altogether, DoD aircraft flew more than 21,000 personnel to the region during Vigilant Warrior, most within 25 days. If Iraq had not withdrawn its forces, the United States had planned for a far larger buildup.

4. Ibid., p. ES-5.

Current Land- and Sea-Based Prepositioning

Many defense analysts consider the pace of deployment for Vigilant Warrior a strong improvement over Desert Shield. That experience reinforced DoD's efforts to preposition more equipment both on land and on ships that are closer to regions in which the United States may need to fight.

Equipment Prepositioned on Land

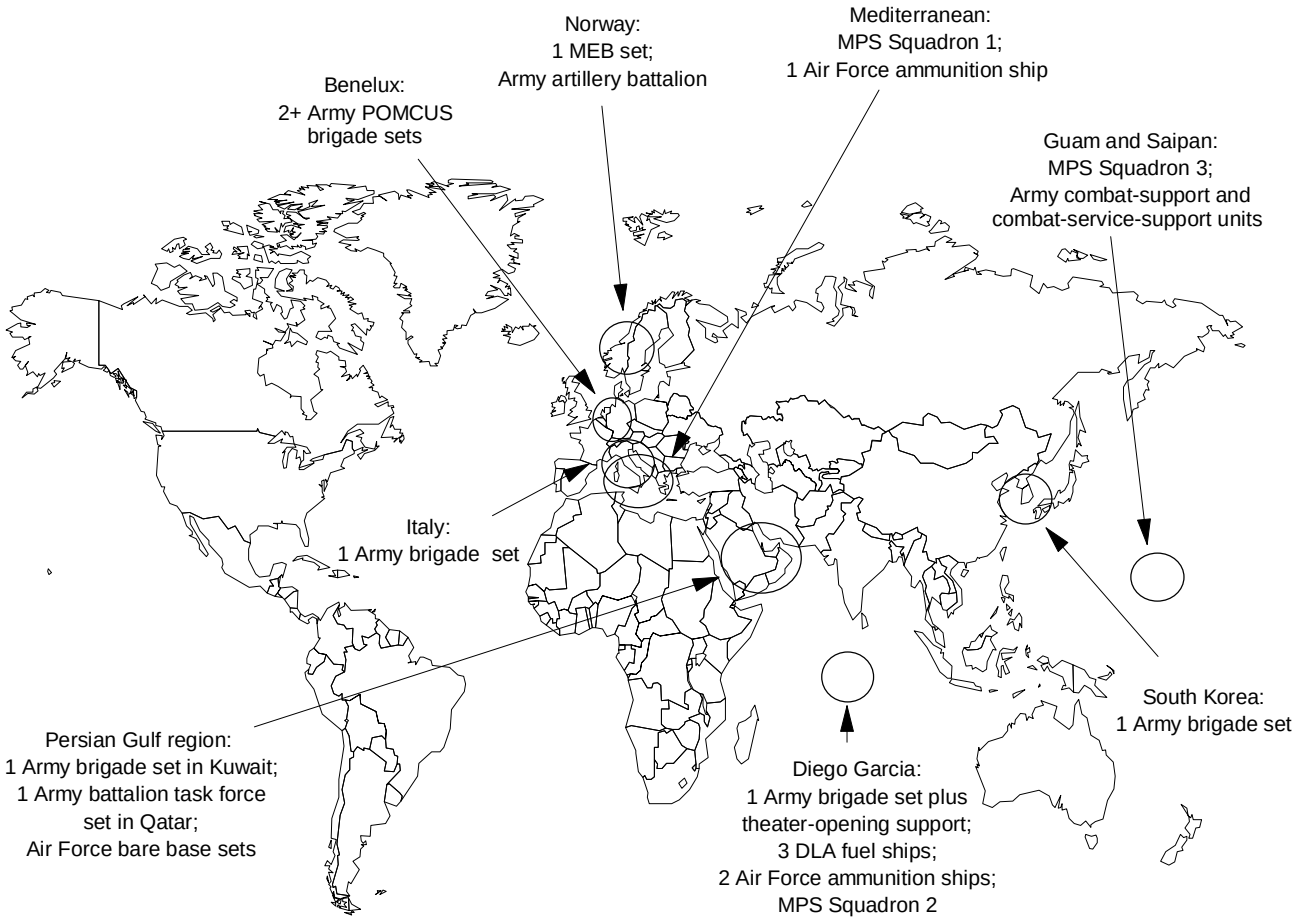
Prepositioning military equipment on land is a potent political signal. When DoD places equipment on an ally's territory, it sends a message that the United States is willing to use force to protect that region from aggressors. Similarly, when a host nation agrees to allow the United States to put equipment on its land, it signifies that U.S. forces would probably also be allowed to operate there. Because of the importance of those signals, military planners tend to preposition equipment in only a few key countries.[6]

Europe. Although all four services preposition equipment and supplies, the Army prepositions the most on land. At the height of the Cold War, it placed equipment for a number of heavy divisions and support units in Europe under a program known as Prepositioning of Overseas Materiel Configured to Unit Sets (POMCUS). Recently, the Army has been drawing down the four sets of POMCUS gear in Belgium, the Nether-

5. Ronald Rost, John Addams, and John Nelson, *Sealift in Operation Desert Shield/Desert Storm: 7 August 1990 to 17 February 1991*, CRM91-109 (Alexandria, Va.: Center for Naval Analyses, May 1991), p. 19.

6. John M. Collins, *Prepositioned Weapons, Equipment, and Supplies: Overviews and Evaluations*, CRS Report for Congress 95-1073 S (Congressional Research Service, October 27, 1995).

Figure 7.
Current Sites of Prepositioned Equipment



SOURCE: Congressional Budget Office.

NOTE: Benelux = Belgium, the Netherlands, and Luxembourg; POMCUS = Prepositioning of Overseas Materiel Configured to Unit Sets; MEB = Marine expeditionary brigade; MPS = Maritime Prepositioning Ships; DLA = Defense Logistics Agency.

lands, and Luxemburg to equip new prepositioning sites elsewhere. Ultimately, two brigade sets will remain in the Benelux region (see Figure 7). The Army has another heavy-brigade set in Italy.

The Marine Corps has equipment for a Marine expeditionary brigade prepositioned in Norway that was originally designed to reinforce Northern European countries against a Soviet invasion.[7] Today, the Marines keep howitzers, trucks, generators, and engineering equipment in Norway for use in cold-weather training exercises. The Army also maintains an artillery battalion in Norway.

The Korean Peninsula. The Army recently prepositioned stocks in South Korea in addition to the equipment and personnel permanently deployed there. (In military parlance, troops stationed abroad are "forward deployed." DoD prepositions sets of equipment and supplies, not people.) Two brigades and division-level units for the 2nd Mechanized Infantry Division are forward deployed in South Korea, along with other units such as aviation and military police brigades, combat-service-support units, a Patriot missile battalion, and

7. A Marine expeditionary brigade is a notional structure that would support a 17,300-person Marine expeditionary force or smaller, tailored units.

two Air Force tactical fighter wings. In the fall of 1996, the Army completed most transfers of equipment from Europe to establish a prepositioned heavy-brigade set in Korea. That set includes 120 M1A1 tanks and 68 M2A2 Bradley and Bradley Stinger armored fighting vehicles; it would help round out a complete division quickly if conflict erupted on the peninsula.

The Persian Gulf Region. Because of the experience of the Gulf War and changes in U.S. national security strategy, the Army has expanded its land-based prepositioning in the region. Today, it keeps a heavy-brigade set in Kuwait, including 116 M1A1 tanks, 68 Bradley and Bradley Stinger fighting vehicles, 24 self-propelled howitzers, 30 armed multipurpose wheeled vehicles, and supplies to sustain the brigade for 15 days. In 1995, the Army added a multiple-launch rocket system battery to that set. Because of Kuwait's small size, the equipment is situated just a few tens of miles from the Iraqi border.[8]

In January 1996, the Army also placed 30 M1A1 Abrams tanks and 28 Bradley fighting vehicles in Qatar, which would support a heavy-battalion task force. Today, the combined equipment prepositioned on land in the Persian Gulf region would allow the Army to deploy 146 Abrams tanks and 96 Bradley fighting vehicles in less than a week.

For Operation Southern Watch, in which U.S. and other troops enforce the no-fly zone south of the 33rd parallel in Iraq, coalition forces have deployed hundreds of combat and combat-support aircraft to the region, mostly from the U.S. military. Even before the Gulf War, the Saudi government allowed the Air Force to preposition some equipment on its territory: seven Harvest Falcon sets that provided enough hard-wall shelters, tents, vehicles, power generators, and other "bare base" equipment to support at least five aircraft squadrons with a total of 10,800 people.[9] According to a 1994 press report, the Air Force expanded its equipment in Saudi Arabia so it could support at least 15 tactical and support squadrons of 24 aircraft each.[10] The Saudis have been more reluctant to allow new prepositioning of Army equipment on their territory, although the United States does have a Patriot missile battalion forward deployed at the airfield in Riyadh.

The Air Force is expanding the amount of equipment it prepositions in the Gulf region. Under a concept called Air Expeditionary Forces, Bahrain, Jordan, and Qatar have signed agreements that would help the Air Force deploy its units more quickly if a conflict ignited. The Air Force is placing equipment at sites in those countries so troops could deploy from the United States and rapidly establish air traffic control, maintenance, intelligence, and mission-planning operations to support combat aircraft missions. Ultimately, the Air Force plans to have five bare bases in the region, possibly including sites in the United Arab Emirates and Oman as well.[11]

Equipment Prepositioned on Ships

The Joint Chiefs' plan to preposition equipment for a heavy Army brigade on ships is now known as the Army Prepositioned Afloat (APA) program. In 1993, the Army began placing enough equipment for a heavy brigade, support units, and 15 days of supplies on board seven roll-on/roll-off ships (borrowed from the Navy's Ready Reserve Force) at Diego Garcia, a British island in the Indian Ocean. That equipment includes 123 M1A1 tanks and 126 Bradley and Bradley Stinger fighting vehicles and can be configured as an armored or a mechanized brigade. With additional aviation units flown in on airlift planes, the set might also be configured as an armored cavalry regiment. Two auxiliary ships with equipment that would set up unloading operations accompany the seven ROROs. Three vessels loaded with munitions and two containerships carrying 30 days' worth of essential supplies for a contingency force are based at Diego Garcia, Guam, and Saipan and would also deploy as part of the APA. That equipment would allow DoD to deploy a heavy brigade within 15 days.

8. David Kassing, *Army and Marine Corps Prepositioning Programs: Size and Responsiveness Issues*, PM-378-CRMAF (Santa Monica, Calif.: RAND, April 1995), p. 14.

9. Eliot Cohen and others, *Gulf War Air Power Survey*, vol. 3, *Logistics and Support* (Department of the Air Force, 1993), pp. 45-47.

10. David Morrison, "Gathering Storm," *National Journal* (August 20, 1994), p. 1963.

11. Tony Capaccio, "Five New Rapid Reaction Air Bases for Middle East Take Shape," *Defense Week*, June 10, 1996, pp. 1, 8.

Box 6.
Lessons Learned About Afloat Prepositioning from Operation Vigilant Warrior

In October 1994, Iraq built up its forces along the Kuwaiti border, prompting concern that it might try to seize Kuwaiti territory, as it did in August 1990. In response, the United States steamed ships loaded with equipment for a heavy Army brigade from Diego Garcia and the Pacific to Ad Damman, Saudi Arabia, and flew units from the 24th Infantry Division at Fort Stewart, Georgia, to meet up with the cargo. By all accounts, the pace of the deployment reflected a marked improvement over Operation Desert Shield. Although successful, Operation Vigilant Warrior did not go off without a hitch, and the Army took away some important lessons.

One major lesson was to not pack equipment too tightly inside prepositioning ships. By using almost all of the available space for vehicles and equipment, the Army did not allow room for routine maintenance. As a result, many of the vehicles had flat tires and dead batteries. And because the interim Army Prepositioned Afloat program uses ships that have less elaborate climate control systems and worse ventilation than the large, medium-speed roll-on/roll-off ships that will ultimately house the equipment, crews are unable to start the vehicles as frequently as they would otherwise to keep those batteries charged.

After it became clear that Iraq would not invade Kuwait or Saudi Arabia, the Army took the opportunity to rearrange each ship's configuration as it was reloaded. Equipment to unload the ships is now situated closest to the exits so it can be taken off first. Each ship now holds a battalion task-force set that can operate somewhat independently if need be. Previously, similar equipment was loaded together—for example, all artillery pieces on one ship with their ammunition in containers on another. The new arrangement allows the Army to deploy just a few ships to a region to help conduct smaller operations or humanitarian missions.

Among other lessons, the Army learned that sending extra maintenance-crew members with the prepositioning ships from Diego Garcia (a common Marine Corps procedure) can speed up deployment. The Army did not do that during Vigilant Warrior, and in retrospect, maintenance personnel could have anticipated and begun to address many of the problems that awaited the unloading party in Saudi Arabia. For the future, both the Army and Marines plan to use that approach.

Military planners anticipate that the Army's prepositioning ships would provide equipment to a major regional contingency in either the Persian Gulf or South Korea. For that reason, the Army prepositions supplies and equipment that are common to several types of divisions, such as water trailers, barrier materials, forklifts, trucks, and heavy-equipment transports.[12] The best candidates for prepositioning are heavy or oversize pieces of equipment and cargo—such as tanks, engineering trucks, and artillery—that can weather long-term storage well.

The Army considers some equipment inappropriate for prepositioning because the supply is scarce, the equipment contains sensitive electronic components, or it is difficult to maintain on board ships. Helicopters are a prime example. Although they can be shrink-wrapped before being transported on ships to lessen their exposure to salt water, neither the Marine Corps nor the Army believes doing so provides a good means of long-term storage since there is no opportunity to run the aircrafts' engines or perform routine maintenance on them. In the event of a conflict, both services would transport helicopters on airlift planes.

In order to increase the Army's flexibility in how it can use the APA, it has loaded the ships with smaller configurations of forces in mind. For example, one LMSR and its auxiliary ships contain enough equipment to open up ports and airfields and initially supply a small humanitarian mission.[13] The Army has also reconfigured the cargo loads on each ship so those vessels can deploy more effectively to major conflicts than they did to Operation Vigilant Warrior (see Box 6). How-

12. Maj. Gen. Fred E. Elam and Lt. Col. Mark Henderson, "The Army's Strategic Mobility Plan," *Army Logistician* (May/June 1992), p. 4.

13. Department of the Army, *Army Prepositioned Afloat*, FM100-17-1 (June 1995), pp. B-3 and B-4.

ever, the size and draft of LMSRs may keep DoD from using that equipment in some ports around the world.

The Marine Corps maintains 13 ships for its Maritime Prepositioning Force, which are organized into three squadrons situated in the Mediterranean, at Diego Garcia, and at Guam. Each squadron houses some of the ground equipment and 30 days of supplies for a brigade-size air/ground force. With a decade and a half of experience in operating the MPF program, the Marines have learned to keep to a minimum the amount of airlift needed to match up personnel and accompanying supplies with those prepositioned forces.

The Air Force's afloat prepositioning program is modest compared with those of the Army and Marine Corps. It consists of three ships that house munitions: one in the Mediterranean and two at Diego Garcia. Three fuel tankers owned by the Defense Logistics Agency are also situated in the Indian Ocean.

DoD's Plans to Expand Prepositioning

The Defense Department's plans to increase both land- and sea-based prepositioning focus on putting more U.S. equipment in or around the Persian Gulf region. Many military analysts believe that deploying heavy forces rapidly is the key to preventing Iraq from gaining territory if it undertakes future invasions.

Prepositioning More Equipment on Land

In the Persian Gulf region, the Army is expanding the amount of equipment prepositioned in Qatar (see Figure 8). Ultimately, it will place enough gear for a second heavy brigade in the region, including most of the same equipment that is already prepositioned in Kuwait. But in addition, the government of Qatar has agreed to allow prepositioning stocks for a division base set—equipment for divisional headquarters units. Both the brigade set and the equipment for the division base units are scheduled to be in place by about 2000.[14] DoD officials have been approaching other countries in the region to see if they would house equipment for a third brigade set on land.

Prepositioning More Equipment on Ships

The Army intends to more than double the square footage of cargo it prepositions afloat by the end of the decade. Following the 1992 recommendation of the Joint Chiefs of Staff, the Navy is buying eight large, medium-speed roll-on/roll-off vessels to hold equipment for a heavy Army brigade. When those ships are in place by 2000, they will house 470,000 square feet of equipment for a heavy brigade and 1.53 million square feet of combat-support and combat-service-support equipment and supplies. The Army plans to begin moving cargo from interim ships to the first LMSR in February 1997. It is also considering placing other equipment on ships, but the service has not yet included such actions in its budget plans.

One problem with augmenting U.S. prepositioning ships is the limited number of places where DoD can put them. Much of today's current and planned fleet would be based at Diego Garcia. The number of unused anchorages there is dwindling, however, especially since ships that contain ammunition cannot be placed as closely together as other ships.

Steaming prepositioning ships between bases in the region is one way to reduce the need for anchorages. For example, the ships that house the APA might sail between Diego Garcia and Guam, which would keep them relatively close to either the Persian Gulf or the Korean Peninsula. But such a strategy might also add to the costs of operating and supporting those ships.

Another approach is to ask foreign governments for permission to place U.S. prepositioning ships in their harbors. As in the case of equipment prepositioned on land, such a decision can be politically controversial. For example, the United States recently asked the government of Thailand for permission to site prepositioning ships in its harbors, since that location is nearly

14. William J. Perry, Secretary of Defense, *Annual Report to the President and the Congress* (March 1996), p. 197.

Figure 8.
Sites for Expanded Prepositioning Under the Administration's Plan

SOURCE: Congressional Budget Office.

NOTE: MPS = Maritime Prepositioning Ships; APA = Army Prepositioned Afloat program.

equidistant between current prepositioning sites at Diego Garcia and Guam. Thailand refused. According to press reports, DoD has also asked Vietnam and the Philippines whether it might keep prepositioning ships at Cam Ranh Bay and Subic Bay.[15]

The Marine Corps plans to enhance its prepositioning program by adding one additional ship to each of its three squadrons. Those ships would hold equipment for an expeditionary airfield, a fleet hospital that would be set up on land, a Navy construction battalion, equipment for command headquarters, and sustainment supplies.

Although top military leaders have supported the Marine Corps's plan to enhance its Maritime Prepositioning Force, the Administration did not include funding for additional enhancement ships in its budget requests of recent years. DoD officials reportedly believed that completing the purchase of LMSRs and smaller ROROs for the Ready Reserve Force was a higher priority. But the Congress disagreed: over the 1995-1997 period, it appropriated $360 million to build or convert three used, foreign-built ships at U.S. shipyards for the Marine Corps's enhancement program.

15. William Matthews, "Sealift Command Eyes Vietnam for a Port," *Navy Times*, September 25, 1995, p. 22.

Army Versus Marine Corps Prepositioning

Disagreements between the Congress and the Administration about funding are the latest manifestation of a debate over whether the United States should support Army or Marine Corps prepositioning programs, or both. The fact that both services plan to expand afloat prepositioning in the midst of declining defense budgets has led to questions about overlap between the two.

Some overlap appears obvious. Both services prepare to conduct operations in which the United States would need to forcibly insert military troops. Those troops would then need to be reinforced quickly with additional equipment from prepositioning ships. Since at least 1992, some Marine Corps officials have challenged the need for an Army brigade afloat. They argue that with some enhancements, the Marines could provide much the same capability but at a lower cost.

Yet the two programs have some important distinctions. Although Marine prepositioning squadrons may be effective for military operations near a coast, they have fewer tanks and armored fighting vehicles than an Army heavy brigade and lack the support equipment needed to conduct missions 200 to 300 kilometers inside a theater (see Table 5). However, unlike the Army

Table 5.
Comparison of Army and Marine Corps Afloat Prepositioning

	Marine Squadron Set	Army Brigade Set
M1A1 Tanks	30 (58 planned)[a]	123
Artillery (155 mm howitzers)	30 towed	24 self-propelled
Bradley Fighting Vehicles	0	126 with TOWs
Armored Personnel Carriers	109	100
Armed HMMWVs	129 (72 with TOWs)	40
Multiple-Launch Rocket System	0	9
Personnel to Marry Up with Each Set	17,300	9,900 interim; 19,900 final
Aircraft to Marry Up with Each Set	73 fixed-wing, 75 rotary-wing	0
Strategic Airlift Sorties Required	249 (including sorties carrying rotary-wing aircraft)	101 interim; 152 final
Sustainment	30 days	15 days for a heavy brigade; 30 days on separate prepositioned containerships

SOURCE: Congressional Budget Office based on data from the Department of Defense and Lt. Col. Paul Wisniewski, USMC, "Dueling Prepo," *Armed Forces Journal International* (September 1994), p. 23.

NOTE: TOW = tube-launched, optically tracked, wire-guided missile; HMMWV = high mobility multipurpose wheeled vehicle.

a. One Marine squadron already includes 58 M1A1 tanks, and the Marine Corps plans to increase the number in the other two squadrons by 1998.

program, Marine prepositioning provides support for both ground and air units. Because of differences in how each service trains, equips, and organizes its forces, some analysts contend that comparing the two prepositioning programs is inappropriate.

In principle, DoD has quelled the debate by supporting both. Two separate reviews of the roles and missions of the military services concluded that the programs were complementary rather than duplicative.[16] But since the Administration has included funding only for the Army's program in its budget requests thus far, tension about which program should receive priority continues.

The Benefits and Risks of Prepositioning

As with airlift and sealift, DoD's efforts to preposition equipment overseas carry distinct risks and benefits. The main benefits are the ability to deliver heavy forces to a conflict more quickly and at a lower cost than by other modes of lift. Balanced against that are risks associated with having to plan for conflicts in advance: the risk that equipment will be put in the wrong place, that two conflicts will break out at the same time, or that DoD will need more flexibility than prepositioning allows. Other risks include that prepositioned equipment might prove a tempting target for enemies and that U.S. allies might have less incentive to provide for their own defense.

Quicker Delivery Time for Heavy Forces

The key benefit of prepositioning was demonstrated during Operation Desert Shield when ships from the Maritime Prepositioning Force completed deliveries of Marine tank units about a month before the first heavy Army units finished arriving by ship from the United States. Subsequently, the Army has demonstrated on three occasions that its equipment prepositioned on land would allow the United States to deploy a brigade-size or larger force in about four to six days. In situations in which the United States would need a significant number of heavy forces to halt an invasion, DoD could greatly reduce delivery time by prepositioning sets of equipment.

For example, assume the President decided to deploy a 4,700-person heavy armored cavalry regiment with equipment and supplies weighing more than 33,000 tons from the United States to the Persian Gulf. Since the regiment includes more than 200 main battle tanks and tracked fighting vehicles along with other pieces of large or heavy cargo, 72 C-17s assigned solely to move its equipment would take about 24 days to complete their deliveries. (The number of planes excludes additional aircraft that would be held in reserve or that would be undergoing maintenance and repairs.)

Two large, medium-speed roll-on/roll-off ships could move the regiment from the East Coast of the United States in roughly the same amount of time, approximately 24 days (see Figure 9). If those vessels were prepositioned in the Indian Ocean, however, delivery time could be halved. And if equipment for the armored cavalry regiment was prepositioned on land, the delivery time might be even smaller.

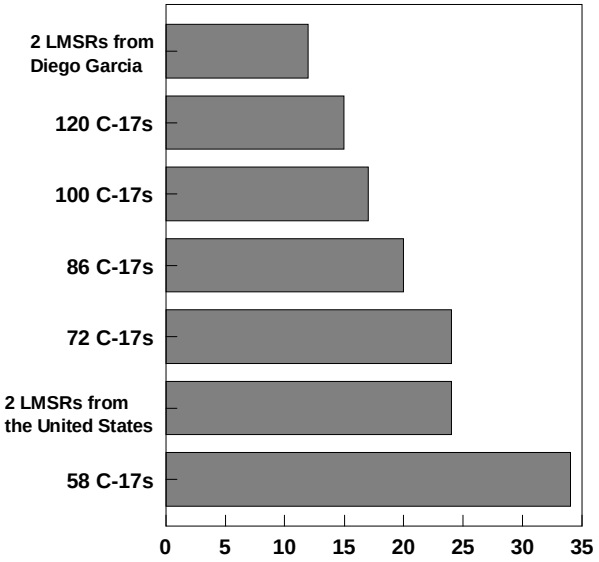
The quickness with which the United States can deploy heavy forces underscores another advantage of prepositioning: its deterrent effect. Indeed, advocates would contend that over the past 30 years, the United States has never faced a war in regions where DoD has placed forward-deployed troops or prepositioned equipment.

Relatively Low Cost

Using airlift to match the delivery time of prepositioned equipment would be prohibitively expensive. In the preceding example, if the Air Force devoted its entire planned fleet of 120 C-17s to moving the armored cavalry regiment (again, excluding backup planes), they could complete the job in about 14 to 15 days—just a little longer than two LMSRs from the Indian Ocean.

16. Chairman of the Joint Chiefs of Staff, *Report on the Roles, Missions, and Functions of the Armed Forces of the United States* (February 1993), pp. III-35 to III-37; Department of Defense, Commission on Roles and Missions of the Armed Forces, *Directions for Defense* (May 1995), pp. ES-5, 2-29. Also see Kassing, *Army and Marine Corps Prepositioning Programs*, which was written to support the latest Commission on Roles and Missions.

Figure 9.
Length of Time That Various Airlift and Sealift Forces Would Take to Complete Deliveries of an Armored Cavalry Regiment to the Persian Gulf (In days)



SOURCE: Congressional Budget Office based on data from the Military Traffic Management Command.

NOTES: The figure assumes an armored cavalry regiment weighing 33,000 tons.

LMSRs = large, medium-speed roll-on/roll-off ships.

But doing so would require the Air Force to buy 72 C-17s (in addition to the 48 it has already begun procuring), at a total cost of $16.2 billion (in 1997 dollars).[17] By comparison, buying two LMSRs to preposition the equipment at Diego Garcia would cost about $600 million.

Prepositioning ships also cost considerably less to operate and support than airlift planes. The Navy expects its large prepositioning ships to cost about $10 million a year each to operate and support, compared with about $161 million a year (in 1997 dollars) to operate and support one active-duty squadron of C-17s. And an airlift squadron would carry far less cargo than one LMSR.

The cost of prepositioning equipment on land can be even lower than for afloat prepositioning if host nations pay to build the facilities that house the equipment and help cover the costs of maintaining it. For example, Kuwait has paid most of the costs of warehousing, maintaining, and exercising the Army's heavy-brigade set prepositioned there. The exact size of that contribution is unclear, but as an indication, the Army expects that operating and supporting a heavy-brigade and division base set in Qatar without host-nation support will cost roughly $70 million per year (in 1997 dollars) beginning in 1999.

As DoD increases the amount of materiel prepositioned overseas, it may need to buy extra sets of equipment to place at those sites. With the United States cutting the size of its forces in the aftermath of the Cold War, a surplus of combat equipment is available to preposition for the time being. But in the future, DoD may have to buy equipment in larger numbers to modernize prepositioned stocks. The cost could be relatively minimal if DoD prepositioned items such as engineering equipment, tents, forklifts, and the like. If it chose to preposition weapon systems such as Patriot missile batteries or multiple-launch rocket systems, however, the cost of modernizing that equipment would be substantially higher.

Risk of Planning for the Wrong Contingency

Perhaps the biggest hazard associated with prepositioning is that, by poor intelligence or bad luck, military planners might place equipment at the wrong location. For example, if DoD prepositioned equipment on land in the Persian Gulf region and conflict broke out in Europe, the fastest sealift ships would take at least a month to steam from the continental United States to the Middle East, load the equipment, and then transport it to Europe.

That risk is smaller for equipment prepositioned on ships, since the vessels can steam to any place with a port. But since equipment prepositioned afloat needs to be useful in any number of situations, it may not be tailored for the specific contingency that erupts.

17. That figure assumes an average unit procurement cost of $225 million (in 1997 dollars), the Administration's December 1995 estimate of average costs for the last 80 C-17s (out of a total purchase of 120 planes) under a multiyear-procurement strategy.

Risk That Two Conflicts Will Occur Nearly Simultaneously

One benefit of prepositioning heavy Army equipment on ships is that it can be used for either of DoD's major planning scenarios. Those forces would be an important means of stopping an enemy assault quickly. But what would DoD do if the two major conflicts broke out in quick succession? If the equipment was sent to a first contingency, it would not be available for the second.

To solve that problem, the Joint Chiefs of Staff recommended that unless DoD withholds the equipment to use only in the second major conflict, the Army should plan to regenerate its afloat prepositioning package. In other words, after unloading cargo at a conflict, the prepositioning ships would steam to the United States and take on a second set of equipment, tailored for the next most likely conflict. The Army has been investigating whether it has enough stocks to regenerate the equipment or whether it needs to purchase more. Preliminary comments by Army officials suggest that because of the drawdown of U.S. forces in Europe, reserves of combat equipment are probably adequate. Equipment for combat-service-support units is in shorter supply, but the Army has no plans to purchase additional stocks. If a second major contingency erupted shortly after the equipment had been deployed to an earlier conflict, the Army might have to use equipment from reserve forces in the United States to regenerate its theater support units.

Risk of Reduced Flexibility

One reason military leaders might prefer to keep prepositioning to a minimum is that it can complicate a deployment by breaking up military units. As the Army has begun prepositioning more equipment in the Persian Gulf, it has also been conducting training exercises in which troops learn how to "marry up" with those stocks. DoD will need to continue that sort of training to ensure that future deployments go smoothly.

Another risk associated with prepositioning is that military leaders would need to select which units they intended to deploy long before any sign of conflict. But if circumstances changed, a different mix of military units might better address the situation. For that reason, a deployment strategy that relies on prepositioning may not provide regional commanders with as much flexibility to meet changing needs as would deploying forces by sea and air from the United States.

A Potential Target for Enemies

Prepositioned stocks can also provide a vulnerable target for potential enemies. By seizing large concentrations of U.S. equipment and supplies, a foe could weaken DoD's ability to blunt attacks against other countries in a region or could possibly even use that equipment against U.S. forces.

Recent terrorist acts against U.S. facilities in Saudi Arabia and unrest in other Persian Gulf nations underscore the political riskiness of prepositioning equipment on land. Such stocks could attract the attention not only of other nations in the region but also of extremist groups within a country. By virtue of keeping a sizable military presence in the Middle East, the United States runs the risk of inciting unrest or even an arms buildup by a potential aggressor. For example, some defense officials believe that Iraq moved forces toward the Kuwaiti border in October 1994 out of fear that allied air operations in the region signified imminent bombing.[18]

Discouraging Self-Defense

Another risk of prepositioning is that by signaling that it is willing to defend certain allies, the United States might lessen the incentives for those countries to provide for their own defense. That concern may be especially important in an era when the Congress and the Administration have devoted considerable attention to reducing the federal budget deficit and thus want U.S. allies to shoulder as much of their own defense burden as possible.

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18. David Fulghum, "Iraqi Invasion Threat Reassessed by Military," *Aviation Week and Space Technology*, November 14, 1994, p. 18.

Chapter Five

Evaluating Lift Requirements and Capabilities

With fewer combat units stationed abroad today, the United States needs strategic mobility forces to project its military might. But at a time when all types of federal funding are tightly constrained, it is important to revisit the issues of how much strategic mobility is enough and what mix of lift forces best suits the needs of the United States.

Since the end of the Persian Gulf War, the Office of the Joint Chiefs of Staff has coordinated two analyses of the U.S. military's strategic lift needs: the 1992 Mobility Requirements Study, and the 1995 Mobility Requirements Study Bottom-Up Review Update (MRS BURU). Rather than looking at a broad range of scenarios in which the United States might need to move its forces, both analyses focused on a few scenarios that military planners believe will place the greatest demands on strategic mobility. However, because determining future lift requirements involves making a host of assumptions, the results of those and similar analyses are bound to be contentious.

Problems in Identifying Lift Requirements

The authors of the MRS BURU evaluated the military benefits of delivering combat forces more quickly by judging whether earlier arrivals would reduce the risk that U.S. forces would face. But the uncertainties in any analysis of mobility requirements are enormous—so large that some mobility experts believe that analysis alone cannot provide a final answer about how much lift is enough.[1]

The Uncertainties of Planning for Deployments

The Department of Defense's requirements for mobility forces are open to question because they hinge on a large number of assumptions about how major deployments will take place. First, there is the nature of future conflicts: which aggressors might the United States face? How would they prosecute an attack? How much warning might leaders have? Will the United States have support from host nations or coalition partners? Second, there is uncertainty about which U.S. forces would be sent to the conflict, and whether they are adequately trained and ready to deploy. Finally, there are uncertainties about whether military and commercial transportation would be available when needed and would perform as expected. Those uncertainties are so fundamental that there will always be room for debate over how much lift is enough.[2]

Despite the uncertainties, of course, defense officials must still decide how to allocate resources for lift.

1. David Kassing, "Strategic Mobility in the Post-Cold War Era," in Paul K. Davis, ed., *New Challenges for Defense Planning*, MR-400-RC (Santa Monica, Calif.: RAND, 1994), p. 671.

2. Ibid.

Because the future is unclear, military planners would probably prefer a larger number of mobility forces to handle any sort of contingency. But acquiring enough mobility forces to address all uncertainties would almost certainly be unaffordable.

Airlift requirements set by DoD planners during the Cold War provide an example. During the early 1980s, DoD set a goal of purchasing 66 million ton-miles per day of airlift capacity—more than twice the level that existed at the time. The Congress invested a considerable amount of money to achieve that goal, including funds to buy C-5Bs and KC-10s and to develop the C-17. But that substantial investment left DoD far short of its goal with around 50 MTM/D of airlift capacity. And even the 66 MTM/D goal was not nearly large enough to address what defense officials thought they would need for a conflict with the Soviet Union; that level was lowered because of fiscal realities.[3]

Balancing Risk and Cost Versus Setting Absolute Requirements

The uncertainties surrounding plans for strategic mobility are probably greater today than during the Cold War, when defense officials could focus on planning for a major conflict against the Soviet Union in Central Europe. But mobility planners faced similar problems even then. As a senior analyst who led research on mobility requirements for the Office of the Secretary of Defense during the 1980s commented:

> There's a lovely quote from Harold Brown that says "There's no such thing as a defense requirement." There is nothing about which you can say, "With this I shall surely succeed, and without this I shall surely fail. . . ." I keep trying to strike the lexicon of requirements out of people anyway—it's too arguable. . . . You can't prove that you have to get there on that schedule.[4]

Ultimately, policymakers must decide how much the United States is willing to pay to lower the risks associated with deploying forces abroad. But some might argue that defense planners occasionally focus on absolute requirements—the minimum number of forces that they believe will meet DoD's military needs—without fully weighing the relative risks and costs of alternative levels.

An example of that might be found in the Administration's 1995 recommendation to buy a total of 120 C-17s for DoD's airlift fleet. Defense officials based that decision in part on the findings of an Air Force study that compared the costs and capabilities of such a purchase with those of three airlift planes: the C-17, the C-5D, and the C-33 (a military version of the Boeing 747-400 freighter). As explained in Chapter 2, that analysis found that certain combinations of C-17s and alternative planes could deliver nearly as much cargo to major regional conflicts as an airlift fleet with 120 C-17s, even if airfields were congested. Yet in their decision, DoD officials emphasized those alternatives that precisely matched the capabilities of 120 C-17s rather than options that were somewhat less capable but much less costly.

Supporters of the decision would counter that defense officials did evaluate the alternatives thoroughly. In their opinion, those options simply gave up too much military capability.

Mismatch Between the Assumptions of War Fighters and Mobility Planners

One factor that highlights the difficulty of setting numerical requirements for strategic mobility is the difference in approaches between officials who plan for combat and those who plan for mobility. A recent DoD task force characterized the approach of war fighters as "just-in-case" planning, whereas DoD's mobility planners have tended to use "best-case" assessments of how much U.S. lift forces could deliver.[5]

War Fighters' Incentive to Minimize Risk. In a conflict, military troops are the people who face the conse-

3. Congressional Budget Office, *Options for Strategic Airlift*, CBO Memorandum (October 1995), pp. 4-5.

4. Deborah Christie, former division director for mobility forces, Office of the Secretary of Defense for Program Analysis and Evaluation, as cited in Schuyler Houser, *The Congressionally Mandated Mobility Study*, Case C16-87-789.0 (Boston, Mass.: Harvard University, Kennedy School of Government, 1987), p. 10.

5. Department of Defense, Office of the Under Secretary of Defense for Acquisition and Technology, *Report of the Defense Science Board Task Force on Strategic Mobility* (August 1996), p. 11.

quences of risk most directly. Since the price of failure is so high, military commanders try to minimize the amount of risk that their personnel may face on the battlefield. One way to do that is to require enough strategic mobility assets so the United States could deliver overwhelming force very quickly.[6]

But, some defense analysts contend, transportation assets are always likely to be scarcer than regional military commanders would like. One reason is the organizational structure DoD uses to prepare for war. Specifically, because the responsibilities for minimizing risk and purchasing forces are separate, those military officials who plan for conflicts tend to treat transportation as though it were costless.[7]

DoD's organizational structure includes five U.S. regional commands that plan and prepare for military operations in different geographical areas of responsibility—roughly, Europe, East Asia and the Pacific, the Persian Gulf region, the Southern Hemisphere, and North America. Those commands are responsible for planning what types of forces they would need for conflict, setting priorities for the order in which the forces would be needed, and deciding when the forces would have to arrive.

During a war, the regional commander in chief would be responsible for conducting combat operations using forces from all of the military services. (The U.S. Atlantic Command would provide the regional commander with the forces he needs, and the U.S. Transportation Command, which plans and coordinates transportation between theaters, would move the troops to the appropriate theater of operations.) That organizational structure was designed to strengthen joint military planning and limit the influence of any one service. However, the military services and the Office of the Secretary of Defense control funding for new weapon systems and mobility forces—not the regional commanders. Thus, although regional commanders are responsible for minimizing the risk to U.S. forces, they do not directly face the cost of equipping troops or purchasing the means to transport them.

Regional commanders can voice their opinions about which mobility forces to buy through the recommendations of the Joint Requirements Oversight Council, an organization designed specifically to give officials in charge of combat more input into DoD's acquisition decisions. The council's recommendations frequently hold considerable sway. Regional commanders can also influence key decisions such as whether sets of equipment should be prepositioned on land in their geographic area (thereby falling under their organizational control) or on ships that, during peacetime, are under the purview of the military services.

Optimistic Assumptions by Mobility Planners. Whereas regional commanders have an incentive to want large numbers of forces for war, mobility planners tend to use assumptions about how much strategic lift forces can deliver that, on balance, are probably optimistic. In the MRS BURU, for example, mobility planners assumed that U.S. lift forces would operate in clear weather and would not face such hindrances as naval mines or surface-to-air missiles.

DoD's plan to deploy an effective defense to distant regions is based on many technical assumptions that affect the tempo of airlift and sealift operations. Those assumptions include the amount of warning of an attack, early decisionmaking to begin deployments, quick call-up of reserve personnel, timely access to commercial planes and ships, the availability of airfields and ports en route and in the theater of operations, and the amount of time that would separate the two conflicts (see Appendix C for more details about DoD's assumptions).

No one knows for sure how optimistic those assumptions are. But comparing what DoD expects to airlift to two major regional conflicts with what it was able to deliver to the Persian Gulf War offers some insight. According to DoD's estimates, in order to hold risk of mission failure to a moderate level, U.S. military and civil planes would need to supply about 60 percent to 70 percent more cargo (by weight) during the first two to three weeks of the second of two major regional contingencies than the United States was able to deliver during the first *month* of Operation Desert Shield. That estimate was for one of the most demanding scenarios

6. That incentive has led one mobility planner to characterize what regional commanders would like to send to a conflict as "Star Trek-like requirements that would require a transporter room the size of Rhode Island"; Maj. Kirk A. Yost, "Measuring Pants Legs to the Nearest Inch and Waist Size to the Nearest Foot: Input-Model Disconnects in Airlift Analysis," *Phalanx: The Journal of the Military Operations Research Society* (December 1995), p. 32.

7. Kassing, "Strategic Mobility in the Post-Cold War Era," p. 679.

outlined by military planners: sustaining a major conflict in Korea while delivering equipment for the halting phase of a second conflict in the Persian Gulf.

Is that swifter pace achievable? Some factors have changed that might allow the United States to airlift cargo more quickly. For example, today DoD has some of the more capable C-17 aircraft on hand; none were in its inventory during the Persian Gulf War. However, most of the expected improvement in airlift operations from what DoD experienced in the Persian Gulf War follows from assumptions about quick availability of commercial planes from the Civil Reserve Air Fleet, early call-up of reserve aircrews, and access to staging bases within the theater of operations.

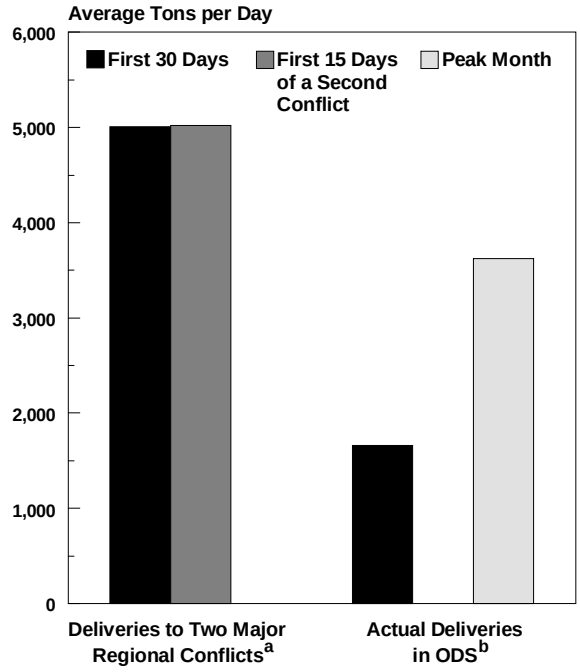
Using the same assumptions as in the MRS BURU, DoD estimates that the United States might deliver an average of about 5,000 tons per day to an initial contingency in Korea over the first 30 days of deliveries, and about 5,000 tons per day over the first 15 days of deliveries to the second of two nearly simultaneous conflicts (see Figure 10). By comparison, the United States was able to move an average of only about 1,700 tons per day during the first month of Operation Desert Shield and just over 3,600 tons per day during the peak month of January 1991. Obviously, DoD is counting on much more efficient airlift deliveries in the future.

One difference defense planners are assuming is an earlier call-up of the Civil Reserve Air Fleet. During the Gulf War, DoD activated Stage I of CRAF 10 days after the start of deployments. But it did not mobilize Stage II until five months later, and it never called up Stage III. For the MRS BURU, mobility planners assumed that DoD would have access to Stage II planes much earlier in the first of two conflicts, and if a second contingency erupted, decisionmakers would activate Stage III.

Calling up Stage II sooner could significantly boost airlift deliveries. During the Gulf War, CRAF cargo deliveries jumped by an average of about 650 tons per day when Stage II was activated.[8] Over a two- to three-week period, that would have added 9,100 to 13,650 tons of cargo deliveries. In recent years, the Air Force has encouraged airlines to place more of their planes in Stages I and II. Based on current CRAF enrollment, calling up Stage II would provide 76 more passenger aircraft and 57 more freighters beyond the amount already in Stage I, which could add considerably to delivery capability.

But those gains make a difference only if DoD has access to them earlier. And based on DoD's experience during the Persian Gulf War, some officials believe it is optimistic to assume that the United States would activate Stage II more quickly. In the opinion of some military and civilian defense analysts, many of DoD's other

Figure 10.
Estimated Daily Airlift Deliveries to Two Major Regional Conflicts Versus Actual Deliveries in the Persian Gulf War



SOURCE: Congressional Budget Office based on data from the Department of Defense and John Lund, Ruth Berg, and Corinne Replogle, *An Assessment of Strategic Airlift Operational Efficiency,* R-4269/4-AF (Santa Monica, Calif.: RAND, 1993).

a. Results for two major regional conflicts assume an airlift fleet with 49 million ton-miles per day of theoretical capacity. For those estimates, the lefthand bar (showing the first 30 days) represents deliveries to an initial conflict in Korea; the righthand bar shows the first 15 days of deliveries to a second conflict in the Persian Gulf plus sustainment deliveries to Korea.

b. The peak month for airlift deliveries during Operations Desert Shield and Desert Storm was January 1991.

8. John Lund, Ruth Berg, and Corinne Replogle, *An Assessment of Strategic Airlift Operational Efficiency*, R-4269/4-AF (Santa Monica, Calif.: RAND, 1993), p. 13.

assumptions about timing—including the amount of warning, quick decisionmaking, and early call-up of reservists—are also optimistic. If so, DoD might take longer than its estimated two or three weeks to move enough forces to halt an enemy attack.

Some analysts might conclude from such uncertainties that DoD needs to invest its resources in the types of strategic mobility forces that arrive first at a conflict—that is, more airlift planes and prepositioned sets of equipment. However, others might argue that if halting an enemy invasion would take longer than two or three weeks, the military would ultimately need more heavy forces for its counterattack. Under those circumstances, DoD might do well to emphasize more prepositioning and surge sealift in its deployment strategy rather than airlift.

Mobility Planning by Consensus

Planning for strategic mobility is an activity that is notoriously less glamorous in the eyes of military personnel than, say, planning tactical air operations or naval surface combat. Part of its status reflects the fact that airlift and sealift crews often provide transportation for Army troops rather than supporting their own military service. As a result, some defense analysts argue, airlift and sealift have until recently been "orphans" within the Air Force and Navy budgets: their advocates have tended to lose institutional battles for funding to missions with higher prestige.[9]

That perception was one impetus behind the Goldwater-Nichols Reorganization Act of 1986, which strengthened the role of joint military planning over the interests of individual services.[10] The Office of the Joint Chiefs of Staff was a major beneficiary of those efforts. In terms of strategic mobility, it has overall responsibility for coordinating the military's position on how much DoD will need. The Defense Department's Director for Program Analysis and Evaluation also plays an important role in evaluating which mobility forces best serve U.S. interests as a whole. In turn, the acquisition authorities within each military service and the Office of the Secretary of Defense weigh the recommendations of those organizations when developing their annual budget requests.

However, no single DoD office is responsible for both analyzing mobility forces and deciding how to spend resources. Recently, one method for coordinating the views of the various organizations who play a role in lift has been to conduct a major study of mobility requirements every few years. Those analyses involved the Joint Chiefs of Staff, the military services, the Office of the Secretary of Defense, the U.S. Transportation Command, unified regional commands, and other key organizations. Their primary goal was to look at trade-offs among modes of lift and make decisions about how to allocate resources. But a senior mobility researcher has characterized that decisionmaking process as follows:

> In effect, DoD mobility planning proceeds by a committee process, with all the well-recognized advantages and drawbacks of such processes. Study projects, like committees, draw diverse organizations together and focus their attention on important questions. But there is a price. Committees tend toward consensus decisions that provide something for all participants.[11]

The most recent of those studies, the MRS BURU, recommended buying airlift planes and sealift ships to modernize U.S. mobility forces. But although those investments account for the vast majority of lift spending, some analysts contend that they contribute relatively little to addressing the major problem that the Joint Chiefs observed after the Persian Gulf War: how to reduce the risk faced by those U.S. forces who arrive at a conflict first.[12] DoD has addressed that risk by increasing the amount of equipment prepositioned in or near the Persian Gulf—a step that costs comparatively little.

9. Houser, *The Congressionally Mandated Mobility Study*, p. 2.

10. Owen Cote Jr., *Strategic Mobility and the Limits of Jointness*, Center for Science and International Affairs Monograph (Cambridge, Mass.: Harvard University, forthcoming).

11. Kassing, "Strategic Mobility in the Post-Cold War Era," p. 688.

12. Cote, *Strategic Mobility and the Limits of Jointness*, pp. 4-11.

The Importance of Smaller Investments

Recent studies of mobility requirements devote most of their attention to whether DoD should purchase major platforms. But larger numbers of planes, ships, and prepositioned stocks do not by themselves guarantee that future deployments will proceed more swiftly. Other, smaller investments can be equally important for major deployments.

DoD is already investing in facilities, equipment, and training that will help move troops from their peacetime bases to U.S. ports more quickly. For example, the Army has purchased railcars, improved railways, upgraded piers, and started constructing a facility on the West Coast to load ammunition into containers. Those measures have begun to address past problems that could slow troop movements within the United States.

But according to a recent DoD study, mobility planners need to continue focusing attention on alleviating bottlenecks that are likely to crop up at air and seaports both in the United States and in distant theaters of operation.[13] During the Persian Gulf War, for example, both airports and seaports in Saudi Arabia developed backlogs because there were too few trucks, heavy-equipment transports, pallets, elevator loaders, and the like to move the cargo forward.[14] Such bottlenecks are particularly troublesome because they can pose an attractive target for an enemy attack.[15] Thus, it is important to make those smaller investments that help move cargo within a theater and, in the event of a conflict, to make sure that units who operate seaports and airfields are among the first to arrive.

Other investments can have large payoffs as well. For example, having up-to-date intelligence about the characteristics of ports and airfields worldwide is vital. Knowing the capabilities of regional groups that might hinder U.S. mobility operations through small measures, such as naval mines, or more unconventional threats, such as chemical or biological attack, is obviously important as well.

Improving the information systems that DoD uses to command and control strategic lift is another critical way of smoothing mobility operations. During the Gulf War, for example, the electronic management system that theater commanders used to sort out and communicate their priorities for deployment became gridlocked.[16] Some of the system's users were simply unfamiliar with it; others found it so cumbersome that they circumvented it by sending messages for airlift missions. As regional commanders changed deployment schedules at the start of the conflict, several airlift planes were sent before units were ready to deploy, or were the wrong type of plane for the cargo load.

That problem was compounded by DoD's poor means of tracking which cargo loads and passengers were already en route to the war. Without that information, military leaders reordered deliveries of equipment and supplies, thus placing even greater demands on the mobility system.[17] Similarly, containers of materials were not always labeled, and a backlog grew as port operators opened many of them to verify their contents.

DoD has begun modernizing those information systems, making them easier to use. For example, the military has put bar codes on much of its equipment and containers to keep better track of them while in transit. Nevertheless, experts still believe that DoD's systems for managing information are relatively primitive by commercial standards.[18] More modern command and control systems would allow military commanders to adjust their deployment plans more quickly as tactical conditions changed.

13. Department of Defense, *Report of the Defense Science Board Task Force on Strategic Mobility*, p. 8.

14. Lt. Gen. William G. Pagonis, *Moving Mountains: Lessons in Leadership and Logistics from the Gulf War* (Cambridge, Mass.: Harvard Business School Press, 1992), pp. 205-206; Lund, Berg, and Replogle, *An Assessment of Strategic Airlift Operational Efficiency*, pp. 46-47.

15. Department of Defense, *Report of the Defense Science Board Task Force on Strategic Mobility*, p. 56.

16. James K. Matthews and Cora J. Holt, *So Many, So Much, So Far, So Fast: United States Transportation Command and Strategic Deployment for Operation Desert Shield/Desert Storm* (Joint History Office, Office of the Chairman of the Joint Chiefs of Staff; and Research Center, U.S. Transportation Command, 1995), pp. 21-22.

17. Ibid., p. 27.

18. Department of Defense, *Report of the Defense Science Board Task Force on Strategic Mobility*, p. 45.

DoD's Most Recent Requirements for Strategic Mobility Forces

Not long after the Office of the Joint Chiefs of Staff released its Mobility Requirements Study in 1992, the Pentagon completed the Bottom-Up Review, a comprehensive plan for future U.S. force structure. Subsequently, the Joint Chiefs updated their mobility study to follow the Bottom-Up Review's planning scenarios: fighting major regional conflicts on the Korean Peninsula and in the Persian Gulf. The result was the Mobility Requirements Study Bottom-Up Review Update.

The MRS BURU had a dual focus. On the one hand, the analysis used computer simulations of combat and deployments to estimate the number of planes, sealift ships, and prepositioning sites that DoD would need to deliver military forces within a specific timeline. On the other hand, its authors were warned that the plan for mobility forces resulting from the study would have to be affordable.[19] Thus, the MRS BURU tried to quantify how much risk U.S. forces might face while keeping an eye both on military objectives and on cost.

The authors of the review conducted simulations for four scenarios set in 2001—a single major regional contingency on the Korean Peninsula, one in the Persian Gulf, a conflict in Korea followed shortly by another in the Persian Gulf, and the same two conflicts but in the reverse order. The study concluded that two of those scenarios imposed the heaviest demands on U.S. mobility forces: a single conflict in the Persian Gulf, and two conflicts in which the Korean one began first.

In the case of a single regional conflict in the Persian Gulf, the MRS BURU concluded that the U.S. military would face a shortfall in the amount of lift needed to deliver enough forces to blunt an assault and keep warfighting risk at an acceptable (moderate) level. The study suggested that DoD resolve the shortfall either by purchasing additional airlift planes or by prepositioning another 280,000 square feet of cargo on ships closer to the region. That amount of cargo is equivalent to the capacity of one large, medium-speed roll-on/roll-off ship or two smaller roll-on/roll-off ships from the Ready Reserve Force. The total volume of cargo that DoD would need to transport to such a conflict is classified, but according to press reports, some defense officials believe that shortfall is small enough to fall within the margin of error of the models used to estimate lift requirements.[20]

Requirements for Prepositioning Afloat

The MRS BURU suggested that the Army preposition more combat-support and combat-service-support equipment on board ships to make up for the shortfall that would otherwise exist in a single major regional contingency. Specifically, the study recommended transferring one LMSR or two smaller ROROs to a prepositioning role from the fleet that would be used to surge equipment from the United States. DoD officials have not yet decided whether to follow that recommendation.

For a scenario in which the United States deployed forces to fight two conflicts, the MRS BURU's authors identified a fundamental problem related to the Army's heavy-brigade equipment prepositioned afloat in the Indian Ocean. That equipment is important for stopping an enemy assault quickly. But if it was used for a contingency in Korea, it would be unavailable for a second conflict in the Persian Gulf. The study recommended that, unless DoD prepositions more equipment or plans to withhold the Army's afloat prepositioning to use in a second conflict, it should plan to regenerate the prepositioning package. That is, after unloading equipment at the first conflict, the prepositioning ships would steam to the United States and take on a second set of equipment for the next conflict.

Requirements for Airlift

The MRS BURU recommended that DoD procure enough airlift planes to provide between 49.4 and 51.8 million ton-miles per day of theoretical airlift capacity.

19. Department of Defense, Joint Chiefs of Staff, Logistics Directorate, *Mobility Requirements Study Bottom-Up Review Update Study Plan* (July 1994), p. 2.

20. Elaine M. Grossman, "OSD Debates How to Explain Military's Difficulty with Two-War Strategy," *Inside the Pentagon*, January 26, 1995, pp. 1, 10.

Rather than specifying a single requirement, the study set that range depending on how much more equipment military planners are able to preposition. If defense officials can add 280,000 square feet to prepositioned stocks, 49.4 MTM/D might provide enough capability to complete deliveries for the halting phases of two major conflicts with an acceptable level of risk. However, if DoD cannot preposition more forces or if the Army's afloat prepositioning is not held in reserve for a conflict in the Persian Gulf, the study's authors believe more airlift is advisable.

The Administration's decision to purchase 120 C-17s would provide DoD with the 49.4 MTM/D of theoretical airlift capacity recommended by the analysis. To meet the higher level, the Air Force would need to procure a total of 140 C-17s or equivalent capacity with other airlift planes (after retiring all C-141s from service).

Following the MRS BURU, the Army conducted further analysis of what additional equipment it might preposition. Based on that work, DoD raised the requirement for theoretical airlift capacity to 49.7 MTM/D, making up the slight increase with deliveries by the Civil Reserve Air Fleet.

Requirements for Sealift

The MRS BURU concluded that the Navy should continue taking steps to fill the sealift requirements that were identified in the 1992 Mobility Requirements Study. That analysis called for purchasing 19 LMSRs, some of which would be used to preposition equipment, and establishing a fleet of 36 smaller ROROs for the Ready Reserve Force. Once those purchases were completed, the study's authors wrote, a number of older breakbulk ships could be retired from the RRF.

The MRS BURU also concluded that DoD could rely on commercial shipping to transport sustainment supplies in a timely manner. The analysis estimated that DoD would need to contract with shipping companies for 6,000 to 6,500 20-foot-equivalent containers per week to carry cargo, plus 13 to 16 containerships or a limited number of breakbulk ships to deliver ammunition under dedicated charter agreements.

Criteria for Evaluating Strategic Lift Options

Because of the uncertainties in forecasting mobility requirements, it is hard for policymakers to know how much lift the United States needs for the future and how it should be apportioned among airlift, sealift, and prepositioning. Ultimately, that judgment is probably a subjective one, based on what decisionmakers believe is a reasonable balance between cost and capabilities. The rest of this chapter lays out criteria that the Congress may want to use in evaluating the Administration's plan for investing in strategic mobility and the alternative plans presented in Chapter 6.

Cost

Given the degree of competition for federal resources today, the cost of purchasing and operating mobility forces over the next several decades is obviously an important criterion. Because airlift is more expensive than sealift or prepositioning, an investment strategy that includes larger numbers of cargo planes will tend to cost considerably more.

The distribution of mobility costs among the military services may also be of interest to the Congress. For example, an investment approach that included more prepositioned sets of Army equipment and fewer airlift purchases would tend to raise annual costs for the Army and lower procurement spending in the Air Force's budget. That information may be of interest if, for example, one believes there are higher priorities within the Air Force's budget than buying cargo planes.

Cargo Deliveries to Major Regional Conflicts

Unless the Administration changes its approach to defense planning as a result of the Quadrennial Defense Review, the most demanding scenario for mobility is likely to remain two major regional conflicts that occur at nearly the same time. According to the MRS BURU, the greatest challenge to U.S. strategic mobility would come from a scenario in which a major conflict broke

out on the Korean Peninsula followed shortly by another in the Persian Gulf region. Thus, it is important to consider how quickly alternative sets of mobility forces would deliver cargo in such a scenario.

Deliveries During the Halting Phase. Sealift ships require at least three weeks to load, steam from the United States to regions as far away as the Persian Gulf, and then unload their equipment. But under DoD's assumptions about how major conflicts would take place, the first U.S. forces would need to arrive within two to three weeks to halt an enemy assault.

If DoD's assumptions about timing are plausible, that halting phase would place the greatest demands on the fastest modes of transportation—airlift and prepositioning. The halting phase of a second conflict that overlapped an initial war would be especially arduous: DoD might need to deliver heavy units to the Persian Gulf and, at the same time, continue moving cargo to sustain operations in Korea. Thus, when comparing alternative plans for mobility forces, one important indicator is the amount of equipment and supplies that each could deliver two to three weeks after the start of deployments to the Persian Gulf.

Another important measure of capability is the amount of outsize cargo that different mixes of mobility forces could deliver to regional conflicts. According to DoD officials, the Korean scenario is the one in which airlift planes would need to fly into the most highly congested airfields. Thus, another key indicator of capability is the amount of outsize cargo that alternative sets of mobility forces could transport to the Korean Peninsula during the first two to three weeks of deployments.

Flexibility to Handle Changes in Deployment Schedules. In the fall of 1989, General Norman Schwartzkopf, then commander in chief of U.S. Central Command, began revising military plans in the event of an Iraqi attack on Kuwait or Saudi Arabia.[21] (Central Command is the regional command responsible for U.S. operations in the Persian Gulf.) However, Central Command had not completed its detailed schedule for deploying forces when its planning was overtaken by events. As a result, military officials had to draw up an operational plan in the midst of a situation that was unfolding rapidly.

Today, regional commands draw up detailed operational plans for a wide variety of contingencies so they will be prepared before a conflict occurs—a lengthy process that can take at least a year to complete. Still, military planners cannot anticipate everything, and conflicts may not follow the script that officials believed they would. Therefore, military commanders would probably prefer DoD to purchase a set of mobility forces that would give them flexibility to change their deployment plans to suit changing conditions.

Certain mixes of mobility forces would limit that flexibility. If DoD relied to a greater extent on prepositioned equipment, for example, military commanders would need to select which units to preposition well before any conflict arose. By contrast, larger investments in airlift forces would provide more flexibility to make last-minute decisions. Thus, another criterion to consider when evaluating alternatives for mobility forces is the amount of flexibility each provides to accommodate changing circumstances.

Vulnerability to Enemy Attack. Most recent DoD studies of mobility requirements have assumed that U.S. deployments would take place in a relatively secure environment—that is, one not under attack. But since the United States would need to move so many forces to fight a major conflict, an enemy would have a strong incentive to slow U.S. deployments by targeting ports and airfields.

To hinder U.S. deliveries, an enemy could mine the waters of ports and harbors, destroy airfield runways, or use missiles or advanced munitions against air or seaport facilities, planes, and ships. As countries continue to develop longer-range missiles, the United States cannot discount the notion that an enemy could target air and seaports with unconventional (chemical, biological, or even nuclear) weapons as well.

Certain types of mobility forces may be more vulnerable to attack than others. Many regions of the world have fewer ports than airfields. Thus, one could conclude that because each LMSR carries such a large concentration of cargo, mining or attacking a major port could lead to greater risk and delays than closing one or two airfields. During Operations Desert Shield and

21. Matthews and Holt, *So Many, So Much, So Far, So Fast,* p. 19.

Desert Storm, for example, the United States delivered 96 percent of sealift cargo to just two ports in the Persian Gulf. Airlift deliveries were not quite as concentrated: five airfields accommodated 78 percent of DoD's airlift cargo.[22] Seaports may also provide a more lucrative target for attack than airfields because of the large volume of cargo that ships unload.

Access to critical sea lines, choke points, en route airfields, and the air space of other countries is also an important consideration. For example, if U.S. sealift ships were unable to travel through the Suez Canal on their way to the Persian Gulf, they would have to steam around the southern tip of Africa instead. That would add 3,000 nautical miles to each trip, or five to six more days for an LMSR traveling at 24 nautical miles per hour. Again, airlift is probably less limited by such constraints than sealift, since ships have fewer alternative paths.

Nevertheless, policymakers should keep in mind that for major conflicts, experience from Desert Storm suggests that sealift ships would move more than three-quarters of the total dry cargo. Thus, on the margin, an investment plan that substituted one or two more sealift ships for fewer airlift planes might not make U.S. deployments much more vulnerable to attack.

Flexibility for Delivering Cargo to Smaller Operations

Because of the sheer magnitude of equipment and supplies needed to fight two major regional contingencies, that planning scenario has driven DoD's assessment of its overall requirements for airlift, sealift, and prepositioning. But lesser regional contingencies may pose different sorts of problems for strategic lift. For example, the United States may need to deploy into places that are landlocked or far from ports, which would call for more airlift planes or greater use of ground transportation. And unlike Korea or the Persian Gulf region, which have modern airfields and ports, some areas lack long runways, deep ports, and equipment to unload planes and ships.

Planning for those sorts of situations can raise DoD's requirements for planes and ships that have unique military features. Most recently, defense officials looked at examples of smaller operations to decide how many C-17s DoD would need to conduct such missions quickly. Thus, the Congress may want to consider whether alternative investments in mobility forces include enough C-17s to deliver cargo to smaller operations under timelines laid out by DoD. But, as discussed earlier, the exact nature of future missions is highly uncertain. There is also room for debate about whether DoD must precisely meet the timelines set by military planners or whether policymakers are willing to accept a somewhat slower (and thus riskier) deployment.

Peacekeeping Missions, Humanitarian Assistance, and Evacuations of Noncombatants. A 1995 analysis by DoD concluded that 40 C-17s could deliver cargo to any of three representative cases of smaller operations with little risk of an extensive delay. Those cases were taken from the Administration's Defense Planning Guidance; they included a peacekeeping mission, a humanitarian operation, and an evacuation of noncombatants from a foreign country. DoD's analysis did not evaluate how many C-17s the United States would need if it became involved in several cases simultaneously.

Peace Enforcement Missions. The United States may need to deploy larger numbers of troops to enforce a peace between rivals, such as in the current U.S. operations in Bosnia. That type of operation would be smaller than a major regional conflict but might take place under tighter schedules than, say, a peacekeeping deployment, and it would probably involve more troops and heavier equipment to protect them. Thus, peace enforcement missions could place greater demands on airlift and raise requirements for military planes such as the C-17.

In their recent analysis of a representative peace enforcement mission, DoD planners found that an airlift fleet with 72 or 86 C-17s could deploy U.S. forces within a time frame that they characterized as having moderate risk. If the Congress chose to include larger numbers of C-17s in its mobility purchases, that level of risk might fall because the United States could probably conduct the deployment more quickly. Alternatively, DoD could buy fewer than 72 C-17s and accept

22. Department of Defense, *Report of the Defense Science Board Task Force on Strategic Mobility*, p. 56.

somewhat slower airlift deliveries to such a mission. Policymakers might find that higher level of risk acceptable if, for example, they believe that the timelines laid out by military planners are too ambitious. Or, as in the 1996 deployments to Bosnia, factors such as bad weather might keep the United States from completing more than a few airlift missions per day, thus keeping commanders from meeting their tight schedules.

Other Special Airlift Missions

In the Administration's 1995 recommendation to buy a total of 120 C-17s, defense officials pointed to certain missions that they believe only the C-17 can accomplish: conducting large airdrops over intercontinental distances, moving key combat units within a theater of operations, and delivering cargo from the United States directly to a battle front. But the C-17's military capabilities come at a high cost. Therefore, the Congress may want to weigh that cost against the likelihood that the United States will need to conduct such special airlift missions in the future.

Long-Range Airdrops of Large Forces. Under DoD's current requirements, the Army must be prepared to deploy brigade-size forces anywhere in the world within a short time frame. To that end, military planners must prepare to air-drop a "medium-force package" consisting of more than 2,500 troops and some of their equipment that have traveled intercontinental distances. (After the airdrop, cargo planes would deliver additional equipment to reinforce those units from airfields that the paratroopers had seized.)

Defense officials believe that once the C-141 is retired from service, DoD will need at least 100 C-17s in its inventory to conduct such a large airdrop at a moderate level of risk. With a smaller number of planes, the United States could not insert its forces as quickly, and thus such a mission would be riskier. Alternatively, defense officials contend, a fleet with 120 C-17s would ensure that DoD could deliver brigade-size forces within the timelines laid out by military planners. Army officials believe that DoD would need at least 120 C-17s for that mission.

But historically, the United States has rarely airdropped such a large number of paratroopers, and it has not conducted such a mission in distant theaters since Vietnam. (However, DoD has conducted large airdrops over shorter distances into Grenada in 1983 and Panama in 1989, and it was prepared to conduct one into Haiti in 1994.) A brigade-size airdrop over longer distances would be much more demanding and thus, in the opinion of some analysts, an unlikely event. However, other analysts argue that by maintaining the capability to enter other countries forcibly, the United States can deter potential aggressors before they act.

Intratheater Deliveries. Rather than devoting all of DoD's C-17s to strategic airlift, regional commanders would like to devote one or two squadrons to moving key pieces of equipment within a theater of operations. A 1995 DoD analysis concluded that the Air Force could conduct a strategic airlift deployment to DoD's major planning scenarios with mixtures of 86 to 100 C-17s when combined with additional planes like the C-33. If military commanders chose to use some C-17s for intratheater deliveries, however, DoD would need to buy more of those aircraft. In order to use C-17s in that way, some military leaders recommend increasing DoD's planned purchase of 120 planes by 14.

With fewer planes, DoD might not have enough to devote to intratheater deliveries without significantly slowing the pace of deliveries from the United States. Alternatively, military planners could rely on trains and trucks to move outsize cargo, albeit more slowly than by airlift.

Direct Deliveries. Because the C-17 can carry outsize cargo and land at short, ill-equipped airfields, military planners who prepare for combat might prefer that the Air Force deliver cargo directly from the United States close to a battlefield. The Congress may want to consider whether using some C-17s in that way would significantly slow down the pace of deployments from the United States.

According to DoD's analysis, airlift fleets with as few as 72 C-17s, when combined with additional C-33s, would allow the United States to conduct some direct deliveries but still keep an airlift deployment to a major regional conflict going at a pace associated with moderate risk. Fewer C-17s (or fleets with 72 C-17s but no C-33s) would slow that pace and, in the opinion of defense officials, unacceptably raise the risk that DoD could not complete its deliveries quickly enough. Alternatively, DoD could continue to conduct its airlift

deployments the way it has in the past: delivering equipment to larger bases farther away from combat and then using trucks, railways, and smaller planes to move the equipment forward.

Chapter Six

Options for Modernizing Strategic Lift

Knowing how the United States will need to use force in the future is difficult, so selecting the most appropriate amount and mix of strategic lift is even harder. Would a greater emphasis on prepositioning allow the United States to fight major contingencies at lower cost? Would such an approach force the Department of Defense to give up other types of military capabilities, such as conducting long-range, brigade-size airdrops? Is the ability to perform special airlift missions just as important for national security as delivering cargo to major conflicts? In order to look explicitly at the trade-offs between different ways to move forces, this chapter reviews the Administration's strategy for investing in strategic mobility and examines the costs and capabilities of five possible alternatives.

The Administration's Plan

The Administration's blueprint for modernizing strategic mobility is an ambitious one with two main areas of investment. First, it calls on the Navy to purchase large, medium-speed roll-on/roll-off ships and use some of them to preposition equipment for a heavy brigade closer to regions of potential conflict. That afloat prepositioning would allow DoD to deliver heavy forces much more quickly than it did during Operation Desert Shield. To that end, the Administration's plan would also preposition equipment for one heavy brigade on land in South Korea and for two heavy brigades plus support units on land in the Persian Gulf region.

Second, the Administration recommends that the Air Force buy a total of 120 C-17 aircraft. Those planes would give DoD the ability to perform a variety of special airlift missions, such as conducting a large-scale airdrop over intercontinental distances or devoting one or two squadrons of C-17s solely to moving cargo within a theater. Modernizing strategic lift forces with those missions in mind provides considerable military capability. It also costs more, however, because it requires a larger number of planes than DoD would need for more traditional airlift missions.

The Congressional Budget Office (CBO) estimates that the Administration's plan for purchasing and operating LMSRs and C-17s and expanding prepositioning would cost nearly $3.8 billion in 1998 and $21.5 billion over the next five years (see Table 6). Buying, operating, and supporting all of those strategic lift forces would cost just over $54.2 billion between 1998 and 2020. Note that although those figures include acquisition, operation, support, and construction costs associated with C-17s, LMSRs, and prepositioned equipment, they do not reflect the cost of all mobility forces (as discussed in the next section).

About 84 percent of the costs in Table 6 would fall within the Air Force's budget since they result from purchasing and operating C-17s. Indeed, the C-17 acquisition program is the largest in the Air Force's budget until the end of the decade, when the service will begin procuring F-22 fighters in large quantities. Most of the remaining mobility costs shown in Table 6 are associated with prepositioning U.S. equipment in the

Persian Gulf, on the Korean Peninsula, and on ships. The costs of building warehouses and operating and supporting prepositioned sets of equipment will largely fall to the Army, and the costs of procuring LMSRs will fall to the National Defense Sealift Fund, which is administered by the Navy.

A caveat about the Administration's plan is in order. The Mobility Requirements Study Bottom-Up Review Update recommended devoting one LMSR or two smaller ROROs to additional prepositioning rather than to surge sealift, as DoD originally intended. Such a step would allow DoD to move an additional 280,000 square feet of equipment for combat-support and combat-service-support units to a major regional conflict during its halting phase—which the study's authors deemed necessary to hold the risk of failing to achieve military objectives to a moderate level.

Table 6.
The Administration's Plan for Modernizing Strategic Mobility (In millions of 1997 dollars of budget authority)

	1997 and Earlier	1998	1999	2000	2001	2002	Total, 1998-2002	Total, 1998-2020
C-17s								
Quantity	48	9	13	15	15	15	67	72
Acquisition costs	24,868	2,584	3,384	3,433	3,435	3,232	16,067	18,251
Operation and support costs[a]	n.a.	376	503	597	725	886	3,086	27,240
Large, Medium-Speed Roll-on/Roll-off Ships								
Quantity	16	2	1	0	0	0	3	3
Acquisition costs	5,016	628[b]	282[c]	0	0	0	909	909
Operation and support costs for ships based in the United States	n.a.	0	12	25	37	46	120	985
Costs of Prepositioning Afloat	n.a.	110	132	175	175	175	768	4,101
Costs of Prepositioning in Korea and the Persian Gulf								
Acquisition costs	n.a.	45	0	0	0	0	45	45
Operation and support and military construction costs	n.a.	85	105	109	112	112	522	2,707
Total Costs	n.a.	3,826	4,418	4,339	4,484	4,451	21,517	54,239

SOURCE: Congressional Budget Office.

NOTES: The costs shown above do not reflect all mobility forces—only those that will vary among the five alternatives presented in this study. For example, the costs do not include operation and support of other cargo planes, such as C-5s and KC-10s, or other sealift ships, such as SL-7s. Nor do they include any additional purchases of smaller roll-on/roll-off ships for the Ready Reserve Force.

Operation and support costs include the costs of operation and maintenance as well as compensation for associated military personnel.

n.a. = not available.

a. Includes operation and support costs for the first 48 C-17s. At a steady-state level, those 48 planes (41 primary aircraft authorized) would cost approximately $533 million a year (in 1997 dollars) to operate and support.

b. Includes advance procurement funding for one ship in 1999.

c. For 1997, the Congress added $300 million to the Administration's request in order to speed up the purchase of one ship. As a result, CBO reduced the Administration's plan in 1999 by one ship at a cost of $300 million.

Military officials have been debating whether to carry out that recommendation since 1995, but DoD has not yet made a decision. Although the Army has told the Joint Chiefs of Staff that it might be able to preposition more equipment, it has not included the additional funding that would be needed for such a measure in its budget proposals. For that reason, CBO did not consider the additional prepositioning to be part of the Administration's plan.

Five Alternatives to the Administration's Plan

To examine the costs and capabilities of other investment strategies, CBO developed five alternatives to the Administration's plan for strategic mobility. Each was designed to meet the needs associated with DoD's current planning scenario: fighting two major regional contingencies that occur at nearly the same time. Most of the alternatives would cost significantly less than the Administration's plan. Thus, they could free up resources for different types of defense spending, for deficit reduction, or for other federal priorities.

The five alternatives emphasize different modes of lift (see Table 7). Options I and II would expand prepositioning (afloat and on land, respectively) beyond what the Administration envisions, at the cost of fewer C-17s for airlift. Options III and IV focus on airlift. Option III would use a different mix of planes than the Administration's plan: fewer C-17s and more commercial wide-body jets. Option IV would add 20 C-17s to the Administration's planned airlift fleet, while scaling

Table 7.
Five Alternatives for Modernizing Strategic Mobility

Option	Airlift	Land-Based Prepositioning	Afloat Prepositioning	Surge Sealift
Administration's Plan	120 C-17s	Two heavy-brigade sets in the Persian Gulf, one in South Korea	One heavy-brigade set and support units on board eight LMSRs	11 LMSRs
I	48 fewer C-17s[a]	Same as Administration's plan	One more LMSR	Same as Administration's plan
II	48 fewer C-17s[a]	Adds 240,000 square feet of prepositioning in both the Persian Gulf and South Korea	Same as Administration's plan	Same as Administration's plan
III	48 fewer C-17s,[a] adds 30 C-33s[b]	Same as Administration's plan	Same as Administration's plan	Same as Administration's plan
IV	20 more C-17s[c]	Same as Administration's plan	One fewer LMSR	Same as Administration's plan
V	48 fewer C-17s[a]	Same as Administration's plan	Same as Administration's plan	One more LMSR

SOURCE: Congressional Budget Office.

NOTE: LMSR = large, medium-speed roll-on/roll-off ship.

a. A total of 72 C-17s, or 61 primary aircraft authorized.

b. A total of 30 C-33s, or 27 primary aircraft authorized.

c. A total of 140 C-17s, or 119 primary aircraft authorized.

back the number of LMSRs on which the Army would preposition equipment. Option V would emphasize sealift by purchasing an additional LMSR for surge sealift and fewer C-17s for airlift.

In many ways, those options represent only marginal changes from the Administration's plan. All of the alternatives would have the vast majority of strategic mobility forces in common. In each case, DoD would have 102 C-5 and 37 KC-10 aircraft devoted to airlift operations, all C-141s would be retired from service by 2007, and the military would have access to planes from the Civil Reserve Air Fleet. Similarly, the Administration's plan and all of CBO's options assume that if conflict arose, DoD could use its eight fast sealift ships, its fleet of roll-on/roll-off ships and other vessels from the Ready Reserve Force, and commercial sealift to transport cargo.

Since many alternatives to the Administration's plan are possible, the options presented here are intended to be illustrative. Like the Administration's blueprint, each of CBO's alternatives includes sizable new investments in the military's own strategic lift forces. That is, none of the options would expand DoD's access to commercial airlift and sealift as an alternative to purchasing more military planes and ships. Nor would the alternatives invest in a program to install national defense features on commercial ships rather than buying LMSRs, although such a measure might be a reasonable approach to lower DoD's costs.

Rather than including costs for mobility forces that are common to all options, the tables that follow display costs for those elements of mobility forces that differ from the Administration's plan. For example, since DoD would incur the costs in any event, the tables do not reflect operating and supporting C-5 squadrons and SL-7 fast sealift ships or buying ROROs for the Ready Reserve Force. Thus, readers should bear in mind that although CBO's estimates allow for comparing costs among alternatives, they do not reflect DoD's total costs for procuring, operating, and supporting all mobility forces.

Option I: Buy Fewer C-17s and Preposition More Equipment Afloat

Under the first option, DoD would limit its purchases of C-17s to 72 aircraft, or 48 fewer than under the Administration's plan. In their place, DoD would buy one additional LMSR in 1999, which would carry prepositioned equipment with or near the Army's other prepositioning ships in the Indian Ocean. Option I would raise the total number of LMSRs used for prepositioning to nine, with a combined storage space of more than 2.25 million square feet.

CBO chose 72 as the size of the C-17 fleet in Option I (and several other options) because two 1995 analyses of how many C-17s DoD might require, conducted by the Air Force and the Office of the Secretary of Defense, included a total purchase of 72 as one alternative. By using the same number, CBO could apply the lessons learned in those analyses.

How does one ship substitute for 48 C-17s? Each newly constructed LMSR can preposition at least 250,000 square feet of cargo. That is equivalent to the floor space on 160 to 225 C-17s (depending on whether the space on the plane's ramp is included). If C-17s were flown at the maximum rate used by mobility planners, it would take a total inventory of 38 to 52 of them to deliver 250,000 square feet of cargo to the Persian Gulf over an 11- to 12-day period—the same amount of time it would take one LMSR to steam from Diego Garcia and unload its prepositioned equipment.[1]

Airlift loads are constrained not only by the amount of available floor space on each plane but also by height and weight limitations. So the number of airlift missions required to move a comparable amount of heavy or bulky equipment on board one LMSR will almost always be larger than the square footage example described above. Based solely on the cumulative amount of cargo that each can move by the end of a two-week period, one additional LMSR devoted to prepositioning could arguably offset the deliveries of 48 C-17s.

What might DoD preposition on another LMSR? Given that the Army already plans to preposition a considerable amount of equipment, answering that question is not necessarily easy. To reduce airlift requirements, DoD would need to preposition equipment that it would

1. A prepositioned LMSR would need 14 to 15 days to steam from Diego Garcia to the Korean Peninsula and unload its equipment there. The comparable inventory of C-17s needed to move 250,000 square feet of cargo to Korea over the same amount of time (assuming no height or weight constraints) would be 26 to 35.

otherwise airlift early in a contingency. If instead it prepositioned the equipment for a heavy brigade that was not needed until the end of the first month of a contingency (and thus would normally be transported by surge sealift), airlift requirements might actually increase rather than decrease. The reason is that having prepositioned equipment closer to hand could lead regional commanders to place those units higher on their list of priorities for deployment. And because most units include some equipment that is not suitable for prepositioning, airlift would be needed to transport that equipment.

The Army's current plans involve placing equipment for one heavy brigade, its support units, and theater- and corps-level equipment on board eight LMSRs. Those plans by no means exhaust the Army's possibilities for prepositioning. For instance, helicopters are not suitable for storing on ships because performing routine maintenance on them would be difficult. But at least half of the weight of a heavy division's aviation units comes from trucks, trailers, and other vehicles that could be placed on an LMSR. Likewise, a few critical units that would most likely deploy during the halting phase of a major conflict—such as air-defense and artillery units—could be prepositioned as well.

Table 8.
Total Costs Under Option I (In millions of 1997 dollars of budget authority)

	1998	1999	2000	2001	2002	Total, 1998-2002	Total, 1998-2020
C-17s							
Quantity	8	8	8	0	0	24	24
Acquisition costs[a]	2,473	2,643	2,290	520[b]	438[b]	8,364	8,502
Operation and support costs[c]	376	503	597	684	772	2,932	17,666
Large, Medium-Speed Roll-on/Roll-off Ships							
Quantity	2	2	0	0	0	4	4
Acquisition costs	663[d]	558	0	0	0	1,220	1,220
Operation and support costs for ships based in the United States	0	12	25	33	46	116	981
Costs of Prepositioning Afloat							
Operation and support costs	110	132	175	197	197	811	4,562
Cost of buying extra equipment	0	248	124	0	0	372	372
Costs of Prepositioning in Korea and the Persian Gulf							
Acquisition costs	45	0	0	0	0	45	45
Operation and support and military construction costs	85	105	109	112	112	522	2,707
Total Costs	3,750	4,201	3,320	1,547	1,565	14,383	36,056
Savings from the Administration's Plan	76	217	1,019	2,937	2,886	7,134	18,183

SOURCE: Congressional Budget Office.

a. Assumes an annual-procurement strategy rather than a multiyear-procurement strategy.

b. Includes funding for support equipment, spare parts, and costs associated with shutting down the manufacturing line.

c. Includes operation and support costs for the first 48 C-17s. At a steady-state level, those 48 planes (41 primary aircraft authorized) would cost approximately $533 million a year (in 1997 dollars) to operate and support.

d. Includes advance procurement funding for two ships in 1999.

Other military services may be able to expand their prepositioning as well. The Air Force already prepositions a considerable amount of equipment on land so it can quickly establish air bases in remote or undeveloped regions. Yet other units might also be reasonable candidates. For example, Air Force engineering units perform jobs that aid the deployment of troops, such as creating and augmenting airfields or, as in Bosnia, building housing. Because of their numerous trucks, bulldozers, forklifts, cranes, and the like, those units weigh a considerable amount, but the Air Force plans to deploy them by air. By purchasing additional sets of equipment for engineering units and prepositioning it afloat or on land in the Persian Gulf and Korea, the Air Force might be able to conserve on demand for early airlift deliveries.

CBO identified nearly 260,000 square feet (over 11,400 tons) of equipment that could be prepositioned on board an additional LMSR—about 14 percent to 19 percent of the tonnage that DoD projects would otherwise be airlifted during the halting phase of a major conflict. CBO chose units that are likely to have high priority for early delivery during a major conflict to ensure that prepositioning the equipment would offset airlift requirements rather than add to them.

Table 9.
Total Costs Under Option II (In millions of 1997 dollars of budget authority)

	1998	1999	2000	2001	2002	Total, 1998-2002	Total, 1998-2020
C-17s							
Quantity	8	8	8	0	0	24	24
Acquisition costs[a]	2,473	2,643	2,290	520[b]	438[b]	8,364	8,502
Operation and support costs[c]	376	503	597	684	772	2,932	17,666
Large, Medium-Speed Roll-on/Roll-off Ships							
Quantity	2	1	0	0	0	3	3
Acquisition costs	628[d]	282	0	0	0	909	909
Operation and support costs for ships based in the United States	0	12	25	37	46	120	985
Costs of Prepositioning Afloat (Operation and support)	110	132	175	175	175	768	4,101
Costs of Prepositioning in Korea and the Persian Gulf							
Acquisition costs	245	0	803	401	0	1,449	1,449
Operation and support and military construction costs	85	105	109	112	170	580	3,857
Total Costs	3,915	3,677	3,999	1,930	1,600	15,121	37,470
Savings from the Administration's Plan	-89	741	340	2,554	2,851	6,396	16,768

SOURCE: Congressional Budget Office.

a. Assumes an annual-procurement strategy rather than a multiyear-procurement strategy.

b. Includes funding for support equipment, spare parts, and costs associated with shutting down the manufacturing line.

c. Includes operation and support costs for the first 48 C-17s. At a steady-state level, those 48 planes (41 primary aircraft authorized) would cost approximately $533 million a year (in 1997 dollars) to operate and support.

d. Includes advance procurement funding for one ship in 1999.

Roughly one-third of that weight is associated with Air Force units; the remaining two-thirds is composed of Army equipment.[2] CBO assumed that DoD would purchase additional sets of equipment to preposition rather than use existing stocks, which results in a relatively conservative estimate of the option's cost.

CBO anticipates that the cost of Option I, including one additional LMSR plus new equipment for prepositioning, would total $14.4 billion over the 1998-2002 period or about $36.1 billion through 2020 (see Table 8 on page 61). Since Option I contains fewer airlift purchases than the Administration's plan, CBO estimates that it would cost $18.2 billion less over the 1998-2020 period.

CBO's estimate assumes that the Air Force will buy the 24 remaining C-17s it needs to reach a total of 72 more slowly than now planned. C-17 purchases would reach a maximum rate of only eight planes a year under Option I rather than 15, which would lower costs in the short run. But the average cost per plane would be somewhat higher since they would be built at a less efficient rate than anticipated and without the savings associated with a multiyear-procurement strategy.

Option II: Buy Fewer C-17s and Preposition More Equipment on Land

Under Option II, DoD would also purchase 24 additional C-17s over the next three years for a total of 72 planes. Instead of buying another LMSR for prepositioning, however, DoD would build climate-controlled warehouses in both the Korean and Persian Gulf regions and preposition nearly 240,000 square feet (or about 11,400 tons) of equipment at each site. As with Option I, CBO selected equipment for prepositioning that is likely to be of high priority in DoD's deployment schedule. That measure helps to ensure that the additional prepositioning offsets rather than adds to airlift requirements.

Although Option II would not buy any additional ships, its costs are not necessarily lower than those for Option I because DoD would need to purchase two sets of equipment—one for each site. Under Option I, DoD could send equipment prepositioned on ships to either major conflict. But in order to deliver roughly the same amount of cargo during the halting phase of each conflict as the Administration's plan, Option II includes additional warehouses and equipment in both theaters.

CBO estimates that the cost of building warehouses and buying additional equipment would push Option II's price tag about $1.4 billion above Option I's through 2020. However, Option II would still cost $16.8 billion less than the Administration's plan during that time (see Table 9). In all, CBO estimates that Option II would cost $15.1 billion over the 1998-2002 period or about $37.5 billion between 1998 and 2020.

In order not to underestimate the costs of buying additional equipment, CBO included purchases of some major weapon systems, including a Patriot missile battalion for each region. (Maintaining the Patriot's sensitive electronics on board ships is difficult, so that system was not included among the equipment purchased for Option I.) If DoD substituted other units for the more expensive Patriot battalion, Option II might cost $460 million less over the 1998-2020 period. Given uncertainties about the type of equipment that DoD would need to purchase for those two alternatives, readers could consider their costs to be roughly comparable.

As with Option I, CBO assumed that the Air Force would procure the remaining 24 C-17s more slowly than current plans allow. That assumption leads to lower total acquisition costs in the near term (since DoD would buy fewer aircraft), but a higher average cost for each one.

Option III: Buy a Mixture of Airlift Planes

This alternative would allow DoD to maintain the same level of theoretical airlift capacity as the Administration’s plan. But instead of procuring a total of 120 C-17s, Option III would purchase 24 more C-17s (for a total of 72) plus 30 commercial wide-body jets, which are larger and less expensive. (CBO used estimates of the cost and capabilities of the C-33, a military version of the Boeing 747-400 freighter, for this analysis.)

2. One disadvantage of that arrangement is that the Army and Air Force would need to develop guidelines over which service had control of the ship. Ammunition deliveries are one precedent where military services have shared ship space.

CBO estimates that total costs for Option III, including purchases of C-17s and commercial planes, would be about $4.1 billion in 1998, or $0.3 billion more than the Administration's plan in that year (see Table 10). Over the 1998-2020 period, however, Option III would cost $8.4 billion less. Nearly half of those savings would take place over the next five years.

As with Options I and II, DoD would purchase its C-17s at a slower pace than under the Administration's budget proposal—a maximum of eight per year rather than 15. Thus, the average cost of each C-17 would be higher under these alternatives.

Table 10.
Total Costs Under Option III (In millions of 1997 dollars of budget authority)

	1998	1999	2000	2001	2002	Total, 1998-2002	Total, 1998-2020
C-17s							
Quantity	8	8	8	0	0	24	24
Acquisition costs[a]	2,473	2,643	2,290	520[b]	438[b]	8,364	8,502
Operation and support costs[c]	376	503	597	684	772	2,932	17,666
C-33s							
Quantity	1	1	6	6	6	20	30
Acquisition costs	429	180	1,025	1,040	1,152	3,827	5,959
Operation and support costs	0	0	0	5	48	53	4,932
Large, Medium-Speed Roll-on/Roll-off Ships							
Quantity	2	1	0	0	0	3	3
Acquisition costs	628[d]	282	0	0	0	909	909
Operation and support costs for ships based in the United States	0	12	25	37	46	120	985
Costs of Prepositioning Afloat (Operation and support)	110	132	175	175	175	768	4,101
Costs of Prepositioning in Korea and the Persian Gulf							
Acquisition costs	45	0	0	0	0	45	45
Operation and support and military construction costs	85	105	109	112	112	522	2,707
Total Costs	4,145	3,857	4,221	2,574	2,743	17,540	45,807
Savings from the Administration's Plan	-319	561	118	1,910	1,708	3,977	8,432

SOURCE: Congressional Budget Office.

a. Assumes an annual-procurement strategy rather than a multiyear-procurement strategy.

b. Includes funding for support equipment, spare parts, and costs associated with shutting down the manufacturing line.

c. Includes operation and support costs for the first 48 C-17s. At a steady-state level, those 48 planes (41 primary aircraft authorized) would cost approximately $533 million a year (in 1997 dollars) to operate and support.

d. Includes advance procurement funding for one ship in 1999.

Option IV: Buy More C-17s and Preposition Less

Under this option, DoD would rely more heavily on airlift to deliver cargo during the halting phase of two major regional contingencies. Specifically, Option IV would buy a total of 140 C-17s. That size fleet would provide the Air Force with the upper end of its desired range for theoretical airlift capacity—nearly 52 MTM/D by 2006. But the alternative would also scale back purchases of LMSRs by one, leaving seven rather than eight ships to house prepositioned Army stocks in the Indian Ocean. For that reason, Option IV can be thought of as the reverse of Option I, which would add an LMSR for afloat prepositioning and subtract C-17s.

Purchasing 20 more C-17s than the Administration's plan would lower the average procurement cost of each plane. But even with one less LMSR to buy, the larger number of airlift planes would add considerably to total costs. CBO estimates that Option IV's price tag would be $3.8 billion in 1998 and $21.3 billion over the 1998-2002 period (see Table 11). Through 2020, Option IV would cost $60.5 billion, or about $6.3 billion more than the Administration's plan.

CBO assumed that DoD would purchase C-17s at a maximum rate of 15 per year under a multiyear-procurement contract, as in the Administration's current plan. Under Option IV, DoD would buy its 20 additional planes in 2003 and 2004.

Table 11.
Total Costs Under Option IV (In millions of 1997 dollars of budget authority)

	1998	1999	2000	2001	2002	Total, 1998-2002	Total, 1998-2020
C-17s							
Quantity	9	13	15	15	15	67	92
Acquisition costs	2,584	3,384	3,433	3,440	3,399	16,238	21,865
Operation and support costs[a]	376	503	597	725	886	3,086	30,662
Large, Medium-Speed Roll-on/Roll-off Ships							
Quantity	2	0	0	0	0	2	2
Acquisition costs	611	0	0	0	0	611	611
Operation and support costs for ships based in the United States	0	12	25	41	46	124	989
Costs of Prepositioning Afloat (Operation and support)	110	132	154	154	154	702	3,619
Costs of Prepositioning in Korea and the Persian Gulf							
Acquisition costs	45	0	0	0	0	45	45
Operation and support and military construction costs	85	105	109	112	112	522	2,707
Total Costs	3,809	4,136	4,317	4,471	4,595	21,329	60,497
Savings from the Administration's Plan	17	282	22	13	-145	189	-6,259

SOURCE: Congressional Budget Office.

a. Includes operation and support costs for the first 48 C-17s. At a steady-state level, those 48 planes (41 primary aircraft authorized) would cost approximately $533 million a year (in 1997 dollars) to operate and support.

Option V: Buy Fewer C-17s and More Surge Sealift

The final alternative would rely more extensively on surge sealift to transport cargo for major regional contingencies. Like most of the previous options, Option V would purchase a total of 72 C-17s. In place of additional airlift, it would buy an extra LMSR that DoD would use to steam equipment and supplies from the United States. Thus, the major purchases under Option V would be the same as under Option I, but the additional large, medium-speed RORO would be used for surge sealift rather than prepositioning.

Option V is the cheapest of the alternatives that CBO examined. (Option I included purchases of equipment for prepositioning that Option V does not.) CBO estimates that Option V would cost $3.8 billion in 1998 and about $14.0 billion over the next five years (see Table 12). In all, this alternative would cost nearly $19 billion less than the Administration's plan over the 1998-2020 period.

Table 12.
Total Costs Under Option V (In millions of 1997 dollars of budget authority)

	1998	1999	2000	2001	2002	Total, 1998-2002	Total, 1998-2020
C-17s							
Quantity	8	8	8	0	0	24	24
Acquisition costs[a]	2,473	2,643	2,290	520[b]	438[b]	8,364	8,502
Operation and support costs[c]	376	503	597	684	772	2,932	17,666
Large, Medium-Speed Roll-on/Roll-off Ships							
Quantity	2	2	0	0	0	4	4
Acquisition costs	663[d]	558	0	0	0	1,220	1,220
Operation and support costs for ships based in the United States	0	12	25	37	50	124	1,068
Costs of Prepositioning Afloat (Operation and support)	110	132	175	175	175	768	4,101
Costs of Prepositioning in Korea and the Persian Gulf							
Acquisition costs	45	0	0	0	0	45	45
Operation and support and military construction costs	85	105	109	112	112	522	2,707
Total Costs	3,750	3,953	3,196	1,529	1,547	13,975	35,310
Savings from the Administration's Plan	76	465	1,143	2,955	2,904	7,542	18,929

SOURCE: Congressional Budget Office.

a. Assumes an annual-procurement strategy rather than a multiyear-procurement strategy.

b. Includes funding for support equipment, spare parts, and costs associated with shutting down the manufacturing line.

c. Includes operation and support costs for the first 48 C-17s. At a steady-state level, those 48 planes (41 primary aircraft authorized) would cost approximately $533 million a year (in 1997 dollars) to operate and support.

d. Includes advance procurement funding for two ships in 1999.

Table 13.
Comparison of the Costs and Capabilities of Alternatives for Modernizing Strategic Mobility

	Administra-tions Plan	Option I	II	III	IV	V
Cumulative Costs (In billions of 1997 dollars)						
1998-2002						
Total	21.5	14.4	15.1	17.5	21.3	14.0
Savings from the Administration's plan	n.a.	7.1	6.4	4.0	0.2	7.5
1998-2020						
Total	54.2	36.1	37.5	45.8	60.5	35.3
Savings from the Administration's plan	n.a.	18.2	16.8	8.4	-6.3	18.9
Cumulative Airlift Deliveries to the Persian Gulf Plus Sustainment to Korea (In thousands of tons)[a]						
By day 10	74.6	69.7	69.7	71.8	78.2	69.7
By day 15 (plus or minus incremental prepositioning)[b]	97.5	102.2	102.1	93.3	92.8	90.7
By day 20 (plus or minus incremental prepositioning)[b]	119.9	123.1	123.0	114.6	117.6	111.6
Difference from the Administration's plan	n.a.	3.1	3.1	-5.3	-2.4	-8.3
Outsize Airlift Deliveries to Korea (In thousands of tons)[c]						
By day 10	13.8	12.8	12.8	13.6	15.9	12.8
By day 15	18.0	17.0	17.0	17.8	22.9	17.0
By day 20	22.0	20.8	20.8	21.8	27.8	20.8
Difference from the Administration's plan	n.a.	-1.2	-1.2	-0.3	5.7	-1.2
Flexibility to Handle Changes in Deployment Schedules	Very flexible	Less flexible	Least flexible	Very flexible	Most flexible	Flexible but slow
Vulnerability to Enemy Attack	Less vulnerable	More vulnerable	Most vulnerable	Less vulnerable	Least vulnerable	More vulnerable
Risk Associated with Cargo Deliveries to Smaller Operations[d,e]						
Peacekeeping missions, humanitarian assistance, and evacuations	Low	Low	Low	Low	Low	Low
Peace enforcement missions	Low	Moderate	Moderate	Moderate	Low	Moderate
Risk Associated with Special Airlift Missions[d]						
Strategic brigade airdrops[e]	Low	High	High	High	Low	High
Intratheater unit moves	Low	High	High	High	Low	High
Direct delivery	Low	High	High	High	Low	High

SOURCE: Congressional Budget Office.

NOTE: n.a. = not applicable.

a. While deploying forces by air to the Persian Gulf, cargo planes would also continue airlift operations on a smaller scale to the Korean Peninsula. The values shown here include airlift deliveries to Korea that would occur at the same time as the deployment to a second conflict in the Persian Gulf. They include airlift deliveries for flexible deterrent options in the Persian Gulf region.

b. For two of the alternatives, CBO included deliveries of 11,400 tons of additional equipment prepositioned either afloat (Option I) or on land (Option II). For deliveries under Option IV, CBO subtracted 11,400 tons to reflect one fewer large, medium-speed roll-on/roll-off ship used for afloat prepositioning.

c. Includes deliveries for flexible deterrent options.

d. Risk in this case refers to risk of failing to complete the delivery mission in the required time.

e. CBO was unable to independently assess the risk associated with these missions. The levels shown are based on Defense Department analysis.

Comparison of the Alternatives by Various Measures

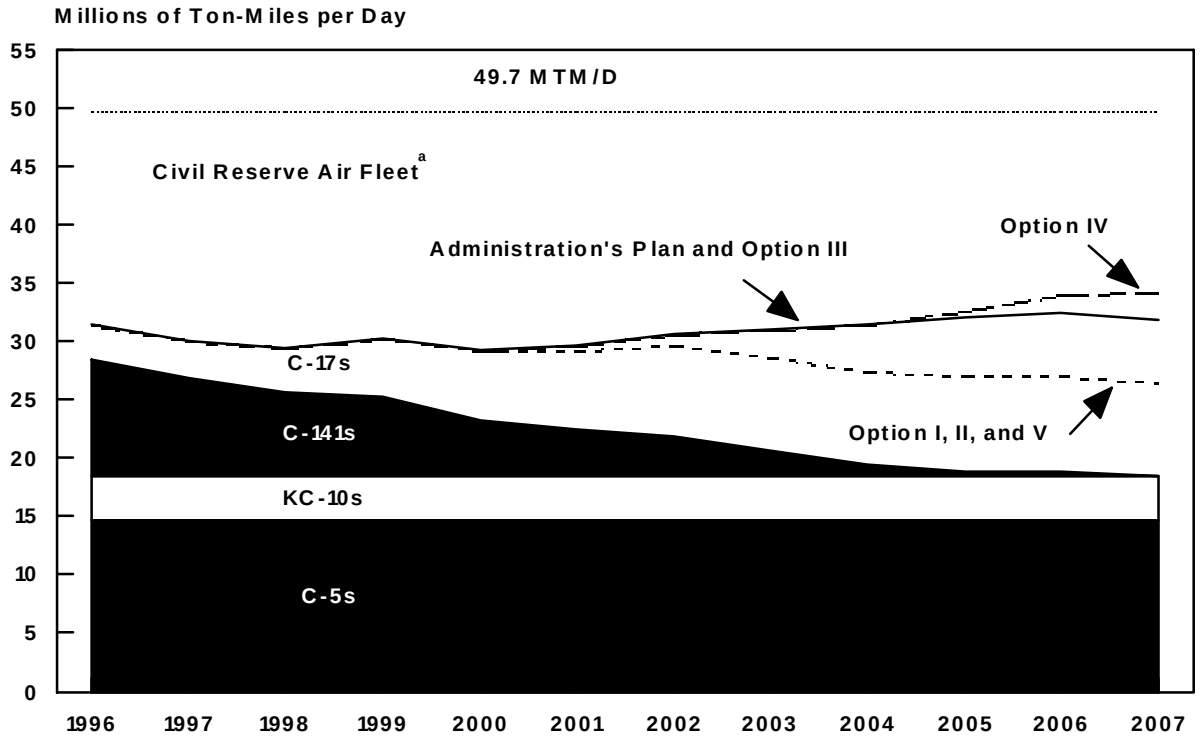
Because they emphasize different modes of lift, the alternatives presented here vary in capabilities as well as in cost. The mix of mobility forces that best serves DoD's needs depends on what types of capabilities decisionmakers believe the United States will need for the future, and how much they are willing to pay.

Cost

Four of the five alternatives would cost less to purchase, operate, and support than the Administration's plan. Total costs for Options I, II, III, and V would range from $8 billion to $19 billion less between 1998 and 2020, mostly because of smaller numbers or less expensive combinations of airlift planes (see Table 13 on page 67). Option IV, which includes a larger purchase of C-17 aircraft, would cost over $6 billion more than the Administration's plan during that period.

Among the alternatives that cost less than the Administration's plan, the majority of savings would accrue in the Air Force's budget because of smaller purchases of C-17s. In the case of Options I and II, however, the Army and Navy would face higher costs because they would need to buy larger stocks of equipment for prepositioning, build warehouses, or add an additional LMSR to their budgets. Although the Air Force would buy fewer C-17s under Option III, much of the savings would be offset by purchases of C-33s. In

Figure 11.
Theoretical Airlift Capacity Under the Administration's Plan and Five Alternatives, 1996-2007



SOURCE: Congressional Budget Office.

a. In order to reach the Defense Department's requirement for 49.7 million ton-miles per day of theoretical capacity, the Air Force would supplement military planes with capacity from the Civil Reserve Air Fleet.

the case of Option IV, the Air Force would need to find an additional $6.3 billion in its budget over the next two decades to purchase and operate 20 more C-17s than the Administration now plans to acquire.

Theoretical Airlift Capacity

Theoretical airlift capacity provides a rough measure of the capability of an airlift fleet by showing how many ton-miles of cargo it could carry (under ideal conditions) in one day. The three CBO alternatives that emphasize prepositioning or sealift (Options I, II, and V) would buy a total of 72 C-17s. Including DoD's other military airlift planes, those options would provide a total of 26.5 million ton-miles per day of theoretical airlift capacity by 2007—16 percent less than the current level and 17 percent less than under the Administration's plan (see Figure 11). In order to reach DoD's requirement of 49.7 MTM/D of theoretical capacity, those alternatives would need to rely on the Civil Reserve Air Fleet for as much as 23.2 MTM/D.

Option III, which would substitute purchases of commercial-style transport planes for C-17s, would include roughly the same level of theoretical capacity as the Administration's plan. Although the C-33 is based on a commercial aircraft design that could be delivered fairly quickly, modifying the planes to carry heavier loads or wider pieces of equipment would take time. Thus, the alternative would probably not provide airlift capacity any faster than the Administration's plan. In order to achieve DoD's airlift requirement of 49.7 MTM/D, Option III would rely on approximately the same amount of Civil Reserve Air Fleet capacity as the Administration's plan—a maximum of 20.5 MTM/D between now and 2007.

Option IV, which features the largest purchase of C-17s, would produce the greatest capacity of all of the alternatives. By 2007, the theoretical capacity of military planes under that option would reach 34.1 MTM/D—nearly 9 percent more than the current level and 7 percent more than under the Administration's plan. Option IV would need to rely on the least amount of airlift from CRAF—just 15.6 MTM/D in 2007.

Cargo Deliveries to Major Regional Conflicts

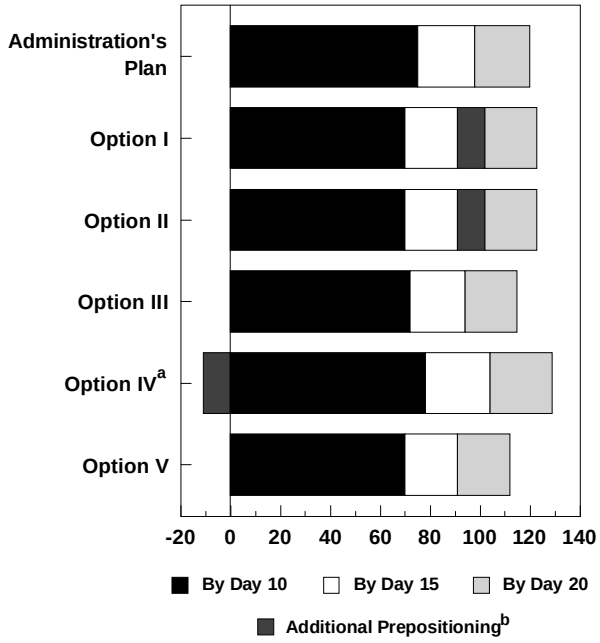
For each option, CBO estimated how much cargo those mobility forces could deliver to a major conflict in Korea, followed shortly by a second regional contingency in the Persian Gulf—the most demanding scenario of the MRS BURU. CBO followed the assumptions of the MRS BURU as closely as possible with regard to warning, call-up of reservists, and the like. But unlike that study, whose scenarios were set in 2001, CBO's analysis assumed that DoD would no longer have C-141s available for strategic airlift operations.

The Congressional Budget Office estimated deliveries using two tools: the Airlift Cycle Assessment System, a spreadsheet model developed by the Air Force; and the Sealift Factors and Closure Approximation Tool, a simulation program that CBO developed. (For a description of both models and more details about CBO's assumptions, see Appendix D.) Data on how much prepositioned equipment DoD would deliver to a major regional conflict are classified, so in estimating cargo deliveries for each option, CBO included prepositioning only to the extent that it would differ from the Administration's plan.

CBO used one assumption in its estimates of cargo deliveries that deserves particular attention. Despite the recommendation of the MRS BURU, CBO did not assume that the Administration's plan includes an additional 280,000 square feet of combat-support and combat-service-support equipment prepositioned on one LMSR or two smaller ROROs. If defense officials carry out that recommendation in the future, DoD will be able to deliver considerably more equipment during the halting phase of a major regional contingency than it otherwise could. In that case, the alternatives that include additional prepositioning (Options I and II) or that emphasize surge sealift (Option V) would compare much less favorably with the Administration's plan than they do here.

Deliveries During the Halting Phase. If a second conflict broke out in the Persian Gulf on the heels of one in Korea, ships prepositioned at Diego Garcia

Figure 12.
Airlift Deliveries to a Conflict in the Persian Gulf, Plus Sustaining Operations in Korea, Under the Administration's Plan and Five Alternatives (In thousands of tons delivered)



SOURCE: Congressional Budget Office.

a. Because Option IV includes one fewer large, medium-speed roll-on/roll-off ship than the Administration's plan, it would need to deliver additional cargo by airlift that would otherwise have been prepositioned. As a result, Option IV would deliver about 2,400 tons less by day 20 than the Administration's plan.

b. The total amount of prepositioned equipment that the military would deliver to a major regional conflict is classified information, so the prepositioning shown here is the amount that CBO added to or subtracted from the Administration's plan.

would take 11 to 12 days to reach the Gulf region and unload their cargo.[3] Before that, airlift and land-based prepositioning would provide the only means of delivering unit equipment and supplies.

Under that scenario, two of CBO's five alternatives might be able to deliver a slightly larger amount of equipment during the halting phase than the Administration's plan. CBO estimates that roughly two weeks after the start of deployments, Options I and II would deliver 90,700 tons by air to a Persian Gulf conflict while also carrying sustainment supplies to combat operations in Korea. That amounts to about 6,700 fewer tons than under the Administration's plan, and the shortfall would grow to 8,300 tons by the third week (see Figure 12). But with an additional 11,400 tons prepositioned either afloat or on land, those options might allow DoD to deliver 3,100 more tons overall. That advantage amounts to an extra 3 percent of the total deliveries that DoD might be able to achieve over the first three weeks of airlift operations.

Between Options I and II (land- and sea-based prepositioning), it is unclear which would deliver forces more quickly. At first glance, land-based prepositioning seems to lend itself to faster deployments, since DoD would only need to transport troops to meet up with the equipment. Prepositioning ships, by contrast, would need to steam to the region before their cargo could be unloaded—a process that, in total, could take 10 days to two weeks. But the relative speed of the two deliveries depends to a large degree on where an enemy initiates its attack. If prepositioning sites on land were far from a foe's assault, it might take just as long or even longer for DoD to move that equipment over land than to steam prepositioning ships to the nearest port and unload their cargo.

Perhaps a more important issue than the location of a conflict is whether the Army would be able to regenerate its afloat prepositioning package for a second contingency, as the Joint Chiefs of Staff suggested in 1995. Thus far, the Army has not developed such a doctrine. Without that preparation, the risk exists that if two major conflicts did overlap, DoD might not be able to react quickly enough. In that respect, Option II, with its larger amount of equipment prepositioned on land, might have real advantages over Option I.

The amount of time required to complete airlift deliveries is sensitive to assumptions about how many planes each airfield can accommodate at once, or the "maximum on the ground" (MOG). Constraints on MOG include the amount of ramp space that military planners devote to airlift deliveries and the availability of resources such as fuel, maintenance personnel, and equipment to unload cargo. In most airlift analyses, those factors are lumped together in one or two variables to indicate how well an airfield can accommodate each type of airlift plane at a given time. The physical amount of space that each plane requires is the key con-

3. That estimate assumes that the Army would withhold its package of prepositioned equipment for the second conflict or regenerate the set after unloading it at the first conflict.

straint that MOG captures. Thus, as that variable is used in airlift models and simulations, an airfield cannot simultaneously handle as many large planes (C-33s or C-5s) as it can smaller planes (C-17s or C-130s).

During the early part of Operation Desert Shield, however, airlift deliveries were constrained not only by lack of access to airfields but also by too few trucks and drivers to move fuel from storage facilities to aircraft that needed refueling.[4] Once military officials realized the problem, they sent additional trucks and personnel to ease the situation. Some officials believe that during the war, availability of fuel constrained airlift operations more tightly than airfield ramp space did.[5] If that were true in the future, smaller planes such as the C-17 might not fare any better than larger ones such as the C-5 or C-33.

To estimate delivery times conservatively, CBO constrained the MOG of airfields in the Persian Gulf and Korean Peninsula to roughly the same levels that the Institute for Defense Analyses used in its 1992 study of the C-17's cost and operational effectiveness.[6] As a result, CBO estimates that the airlift fleet proposed under Option III (72 C-17s and 30 C-33s) would deliver its cargo at a somewhat slower pace than a fleet that included 120 C-17s. By the 15th day after the start of deployments, CBO estimates, Option III would deliver about 4,200 fewer tons of cargo than the Administration's plan. By the 20th day, that difference would amount to 5,300 tons, or roughly 4 percent less.

Because Option IV would purchase the largest number of C-17s (140), it would allow DoD to deliver cargo by airlift more quickly than would the Administration's plan or the other alternatives. CBO estimates that Option IV would move 104,300 tons by air in 15 days of deployments and about 129,000 tons in 20 days. The latter amount is about 9,000 tons more than under the Administration's plan. However, that margin would not be large enough to offset the lower amount of equipment delivered by prepositioning ships. With one fewer LMSR, Option IV would require DoD to transport an additional 11,400 tons of cargo by air during the halting phase. Overall, CBO estimates, an airlift fleet with 140 C-17s would leave DoD with 2,400 fewer tons than the Administration's plan 20 days after the start of deliveries.

Because Option V emphasizes surge sealift rather than airlift, it would deliver cargo at a slower pace than the Administration's plan. In 10 days of deployments to the Persian Gulf, Option V's airlift fleet (like those in Options I and II) would deliver about 4,900 fewer tons of equipment than a fleet that included 120 C-17s. By day 20, the shortfall would be nearly 8,300 tons.

Without additional airlift or prepositioned stocks of equipment to make up for slower initial deliveries, that shortfall would continue to grow until sealift ships began arriving from the United States 25 to 30 days after the start of the deployment. Would an additional LMSR surging from the United States be able to make up for the early shortfall? The answer depends on assumptions about how such a scenario would unfold.

According to military planners, the United States would be more likely to lose territory if it could not deliver forces as quickly as planned. And those U.S. troops who did deploy quickly would be exposed to a higher level of risk, potentially leading to more casualties. If the assumptions behind mobility analyses like the MRS BURU are credible, Option V's shortfall in deliveries could lead to higher costs for the United States—in terms of the number of forces it would need to deploy for a counterattack and quite possibly in the number of lives lost.

Yet some analysts question the underlying assumptions of combat simulations, including whether the United States can realistically deliver forces in the short span of time laid out by mobility planners. If, for example, weather delayed airlift operations, as it did recently in Bosnia, the initial deployment of U.S. forces could take considerably longer than a two- to three-week halting phase. If deployments stretched toward three to four weeks, the first sealift ships would already be arriving from the United States. Thus, barring similar delays in sealift operations, some analysts might consider a strategy that relied more on surge vessels than airlift or prepositioning to be a reasonable approach.

4. Eliot Cohen and others, *Gulf War Air Power Survey*, vol. 3, *Logistics and Support* (Department of the Air Force, 1993), p. 101.

5. Jean Gebman, Lois Batchelder, and Katherine Poehlmann, *Finding the Right Mix of Military and Civil Aircraft: Issues and Implications*, vol. 3, *Appendixes*, MR-406/2-AF (Santa Monica, Calif: RAND, 1994), pp. 37-38.

6. W. L. Greer, *Cost and Operational Effectiveness Analysis of the C-17 Program*, Report R-390 (Alexandria, Va.: Institute for Defense Analyses, December 1993), pp. D-22, D-23.

Deliveries of Outsize Cargo. Besides looking at initial airlift deliveries, CBO analyzed how well each alternative would airlift outsize cargo—the largest pieces of equipment that can fit only on C-5s or C-17s. DoD expects outsize pieces to make up a much smaller share of total cargo in a future contingency than they would have in a conflict with the Soviet Union. Nevertheless, some analysts contend that in order to keep military units together during deployment, it is important to have an airlift fleet with planes that can carry all sizes of equipment—bulk, oversize, and outsize.

CBO analyzed early deliveries of outsize cargo to a Korean conflict, the scenario for which DoD officials believe airfields would be most congested. Since Option IV includes more C-17s than the Administration's plan or any of the other alternatives, it would deliver the most outsize cargo by air during the first 20 days of a Korean deployment—5,700 tons, or 26 percent, more than the Administration's plan (see Figure 13).

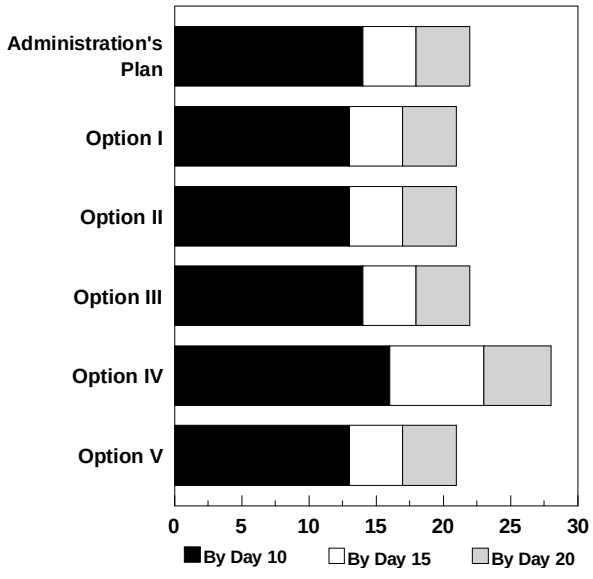
Option III, with its mix of planes, would airlift only slightly less outsize cargo than the Administration's plan: 300 tons, or about 1 percent, less according to CBO's estimates. By contrast, Options I, II, and V would deliver about 1,200 fewer tons of outsize equipment by air over the first 20 days of deployments. That amounts to about 6 percent less than outsize deliveries under the Administration's plan. However, if military planners selected units for prepositioning that had large amounts of outsize cargo, Options I and II might not result in as large a deficit during the first 20 days.

Flexibility to Handle Deployment Changes. Options I and II rely to a greater degree on prepositioning for major deployments than the other alternatives do. But with such an approach, military commanders would need to be certain of which units they would want to deploy early in each conflict so as to preposition the appropriate types of equipment. In other words, Options I and II might not permit military leaders to rearrange the order in which they deployed particular units as quickly as the other alternatives.

Of the two, however, Option I might allow the greater flexibility. With equipment prepositioned on ships rather than on land, military leaders could make significant changes in where they chose to deploy those units for a major regional conflict. For example, they would have the flexibility of unloading prepositioning ships in Kuwait or in ports farther south in the Persian Gulf, depending on circumstances. They could also use equipment prepositioned on ships for smaller operations elsewhere in the world without the complexity of redeploying units prepositioned on land.

Option III includes more airlift capacity than Options I and II, so it would provide military commanders with more flexibility than either of those alternatives. But depending on what airfields were available to the United States early in a major conflict, Option III might not allow war fighters to adapt as quickly to changing circumstances as the Administration's plan would. Although each commercial wide-body jet in Option III can carry a larger load than a C-17, it requires a long runway with special equipment to unload cargo. The Korean Peninsula and the Persian Gulf both have modern airports with such features. But if the United States could not gain access to those facilities early in a con-

Figure 13.
Airlift Deliveries of Outsize Cargo to a Korean Conflict Under the Administration's Plan and Five Alternatives
(In thousands of tons delivered)



SOURCE: Congressional Budget Office.

flict, Option III would not provide as much flexibility as the Administration's plan.

Correspondingly, Option IV would be more flexible because it includes a larger number of C-17s than the Administration's plan. But readers should also bear in mind that by including one fewer LMSR, Option IV would need to rely on airlift to deliver the equipment that would otherwise have been prepositioned afloat. The greater demand on airlift might limit how much of that flexibility military commanders could actually use.

With an additional LMSR used for surge sealift, Option V would allow commanders to alter their priorities about which forces to send based on changing circumstances. But sealift is a slow way to deliver cargo and thus would not help military leaders if they needed to adjust the delivery schedule of units that would deploy during a conflict's halting phase. Only those options with more airlift planes provide both speed and flexibility for making changes in the earliest part of delivery schedules.

Vulnerability to Enemy Attack. If an enemy wanted to slow the pace of U.S. deployments to a major regional contingency, it would be wise to target both airfields and ports. On the surface, then, all types of mobility forces appear equally vulnerable to attack. Yet, on balance, those alternatives that include relatively more airlift might be somewhat less vulnerable. Most regions of the world have more airfields than ports, so an enemy would be less certain of precisely where the United States would send its forces. And each sealift ship or warehouse for prepositioned equipment would constitute a more concentrated load of cargo than would any single airlift plane, providing a greater incentive for attack.

Option II would probably be the most vulnerable among the five alternatives because it relies the most on land-based prepositioning. When U.S. equipment is kept at a fixed site, potential foes have more time to plan how they might stymie its use. Those alternatives that include more LMSRs (Options I and V) are the next most vulnerable because the concentrated loads of those ships make them more attractive to attack than larger numbers of airlift planes, such as in the Administration's plan and Options III and IV.

Flexibility to Airlift Cargo to Smaller Operations

In terms of early equipment deliveries, the scenario of two major regional conflicts would place the greatest demands on U.S. mobility forces. But some military analysts argue that the United States is far more likely to become involved in smaller operations. Since those missions usually take place without the United States calling up reserve aircrews or commercial planes, they can be difficult to conduct.

For that reason, CBO applied the results of a 1995 DoD study that focused on such missions to each of its five alternatives for modernizing mobility forces.[7] DoD's analysis examined how well fleets with various numbers of C-17s could deliver cargo to smaller airlift operations and how well they could perform special airlift missions. The study involved a large number of classified assumptions about how such operations would proceed and how quickly the United States would need to complete airlift deliveries to keep risk to a minimum. Because of those complexities, CBO could not conduct a similar analysis independently. Thus, the reader should bear in mind that the assessment of risk in this and the following section is DoD's, and its analysis is subject to all of the uncertainties described in Chapter 5. In DoD's study, risk referred to the risk of failing to complete a delivery mission in the required time.

DoD's analysis looked at four representative cases of smaller airlift operations taken from the Administration's Defense Planning Guidance: a peacekeeping mission, a humanitarian assistance operation, an evacuation of noncombatants from a foreign country, and a peace enforcement operation. In the first three cases, the study concluded that airlift fleets with as few as 40 C-17s could conduct deployments with little risk of failing to complete deliveries as quickly as war planners would like. Based on that standard, the Administration's plan and all five of CBO's alternatives would complete such airlift deliveries with minimal risk.

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7. "Tactical Utility Analysis: Lesser Regional Conflicts," a classified briefing presented by the Office of the Secretary of Defense, Director for Program Analysis and Evaluation, to the Defense Acquisition Board in November 1995.

A peace enforcement operation, such as the 1995-1996 deployment of U.S. forces to Bosnia, would be a more difficult undertaking. To protect U.S. troops from warring parties, DoD planners would almost certainly deploy heavier equipment than they would to a more benign peacekeeping mission. Depending on circumstances, the military might also need to complete its deliveries on a quicker schedule.

Based on DoD's 1995 analysis, defense officials concluded that airlift fleets with 72 or 86 C-17s could complete deliveries to a peace enforcement operation with moderate risk of significantly exceeding their deadline. If airlift forces included 100 or more C-17s, military officials believe, they could complete deliveries quickly enough to keep that risk to a low level.

Based on those findings, the Administration's plan and Option IV (with 120 and 140 C-17s, respectively) could conduct a similar peace enforcement mission quickly enough to keep risk low. Options I, II, III, and V, which each include 72 C-17s in their airlift fleet, would complete deliveries more slowly and thus raise risk associated with a longer timeline to a moderate level. Is that amount of risk tolerable? Analysts will undoubtedly differ in their opinions. But for other analyses, such as the MRS BURU, the Joint Chiefs of Staff deemed a moderate level of risk acceptable given budget constraints.

Special Airlift Missions: Long-Range Airdrops, Intratheater Deliveries, and Direct Deliveries

In its 1995 study of smaller airlift operations, DoD also analyzed how quickly various airlift fleets could air-drop U.S. personnel and equipment over long distances. Based on the results of that study, DoD officials argue that the Air Force needs at least 100 C-17s to air-drop the personnel and equipment for today's brigade-size forces at a moderate level of risk. A fleet with 120 C-17s could do so at low risk, they contend.

By DoD's standards, the risk is high that airlift fleets under Options I, II, III, and V could not air-drop brigade-size forces quickly enough to meet the timelines set by military planners. If one accepts those schedules, only the Administration's plan and Option IV would be able to conduct such missions with low risk. Thus, moving to an investment strategy for mobility forces with fewer C-17s would mean losing the ability to conduct large, long-range airdrops. But readers should weigh whether that capability is one the United States is likely to need for the future.

During a major contingency, military commanders might decide to use some C-17s to move outsize cargo within a theater of operations. That diversion of planes could slow the pace of strategic airlift deliveries from the United States. Based on DoD's study, a combination of 86 C-17s and 30 C-33s could complete the strategic deployment quickly enough to keep risk at a moderate level. But if military commanders chose to dedicate one or two squadrons to intratheater deliveries, defense officials conclude, the Air Force would need to buy additional C-17s. Thus, a fleet with just 72 C-17s would not have enough planes to use some in that way.

That analysis suggests there is high risk that the airlift fleets in Options I, II, III, and V could not simultaneously move equipment within a theater and complete the strategic deployment as quickly as military leaders would like. The Administration's plan and Option IV, by contrast, include enough C-17s to perform both tasks with only a low risk of slowing the overall deployment. Of course, military commanders could continue to rely on ground transportation and smaller airlift planes like the C-130 to deliver cargo within a theater, while dedicating all C-17s to strategic airlift deliveries.

Similarly, DoD assessed how well various airlift fleets would perform if they used some of their C-17s to deliver equipment from the United States directly to forward bases in a Korean conflict rather than to staging areas in the theater. Based on the results of that study, defense officials contend that a fleet with 86 or more C-17s and 30 C-33s could dedicate some C-17s to direct-delivery missions and still run a low risk of completing the overall deployment more slowly than planned. But for fleets with just 72 C-17s and no C-33s, DoD would probably judge that risk to be high. Based on that analysis, using the airlift fleets in Options I, II, III, and V for both direct deliveries and strategic deployments would entail high risk for the latter. The airlift fleets in Option IV and the Administration’s plan could perform both such missions with low risk.

Conclusions

Each of CBO's five alternatives reflects a unique combination of costs and capabilities. How to balance the trade-offs between risk and cost depends on the likelihood that the United States will become involved in major or smaller regional conflicts, as well as whether U.S. forces will need to perform special airlift missions. Ultimately, those are subjective judgments that defense officials and the Congress must make.

Alternatives that include more prepositioned equipment—either on board ships (Option I) or in foreign countries (Option II)—would cost less than the Administration's plan. Based on CBO's estimates, those savings could be considerable: approximately $18.2 billion or $16.8 billion, respectively, over the 1998-2020 period. However, those alternatives would require DoD to accept some additional risks. For instance, military leaders would need to be sure which units they would dispatch first to major conflicts, since rearranging the priority for deploying units would be more difficult. Of course, redeploying prepositioned equipment to other regions, if needed, would also take time, although Option I would be more flexible in that regard than Option II. And sending troops to meet up with prepositioned gear makes deployments more complicated; the services would need to conduct more exercises in which personnel practice unloading, distributing, and deploying with prepositioned sets of equipment.

A key difference between Options I and II is that prepositioning equipment on an ally's territory can be more sensitive politically than storing it on board ships that steam through international waters or are based at a friendly port such as Diego Garcia. Thus, one hurdle to carrying out Option II would be securing agreements with allied nations to host prepositioning sites. Although such agreements have not been difficult to obtain with South Korea, there have been more sensitivities in placing U.S. equipment in Saudi Arabia and other parts of the Persian Gulf region. Moreover, even if the United States obtained approval to expand prepositioning in a region, those political sensitivities might continue to limit how and when the equipment was used.

However, one benefit of prepositioning equipment on land rather than afloat is that it can be tailored to the scenario at hand. For example, prepositioning sites in the Persian Gulf would most likely include larger numbers of heavy-equipment transports or desalination units than equipment sets in South Korea.

Alternatives that substitute more sealift ships for airlift—either as a platform on which to preposition equipment (Option I) or to surge cargo from the United States (Option V)—also introduce some risks. Since each LMSR carries such a large concentration of cargo, mines or attacks on harbors could cause greater delays in deliveries than if one or two airfields were closed. Deliveries might also be delayed if U.S. ships were unable to transit key choke points such as the Suez Canal or the Strait of Hormuz.

Yet despite those risks, LMSRs provide considerable delivery capacity at relatively low cost. For example, even if DoD purchased a total of 140 C-17s (as in Option IV), the addition of 20 planes beyond the Administration's planned level could not offset one fewer LMSR prepositioned in the Indian Ocean. Thus, according to CBO's estimates, Option IV could not deliver as much cargo to two major regional conflicts during the crucial halting phase as the Administration's plan.

Option III would give DoD some of the advantages of airlift, such as more flexibility to adjust deployment schedules to changing circumstances, at a savings of $8.4 billion over the 1998-2020 period. But like Options I, II, and V, Option III would not include enough C-17s to perform certain types of special airlift missions, such as strategic airdrops of brigades or cargo deliveries within a theater.

Although they cost the most, alternatives that include the largest numbers of C-17s (such as the Administration's plan and Option IV) have some distinct advantages. They would permit the Air Force to conduct a wider range of smaller deployments or special airlift missions with more confidence. And military commanders would have more flexibility to rearrange the order in which they deploy units to a major regional contingency. But whether those advantages are worth the considerable cost of the C-17 depends on whether decisionmakers believe that DoD is likely to need to perform those tasks or to require the flexibility of 120 C-17s in the years ahead.

Appendixes

Appendix A

The Army's Goals for Strategic Mobility

In response to its experience in the Persian Gulf War, the Army has designed its own set of goals for deploying forces rapidly to regional conflicts. That plan assumes that the United States will have fewer forces abroad in the future than it did during the Cold War. The Army's focus is preparing a five-division contingency corps (with one airborne, two heavy, one air assault, and one light division) that would deploy on short notice and be capable of using force immediately upon entering a region.[1]

Under the Army's plan, the contingency corps would face a tight delivery schedule: a ready brigade from a light division would arrive in the region of conflict four days after the start of deployments (C+4), with most of the rest of the division following by C+12.[2] One heavy brigade would be delivered by C+15 under the plan, with two reinforcing divisions (one armored plus either one mechanized or one air assault) arriving by C+30. The full five-division contingency corps plus a corps-support command would be in place by C+75.

That schedule serves as a rough guideline: the precise timing for deliveries would vary depending on the scenario at hand. In the case of a conflict in the Persian Gulf, for example, the Army has set an even tougher timeline—it plans to have an entire heavy division in place within the first two weeks of deployments. Given competing demands for transportation at the start of a conflict, there would not be enough planes to deliver even a heavy brigade that quickly by airlift alone. For that reason, the Army is prepositioning heavy equipment and some support units in the Gulf region.

To give a sense of the scope of the Army's mobility requirements, Table A-1 shows the average number of airlift sorties or shiploads required to transport parts of a notional contingency corps. For example, an airborne division would need 1,101 C-141 and 78 C-17 sorties—or nearly three large, medium-speed roll-on/roll-off shiploads—to move its equipment and accompanying supplies.[3] (All units would require some C-17s or C-5s to move their outsize cargo, but the remaining equipment could be flown on C-141s.) Although Table A-1 shows information for a notional corps-support command, it does not reflect all the corps-level units and support units for echelons above corps that would deploy, such as air defense, artillery, and some headquarters units and additional aviation brigades. Thus, lift requirements for an entire corps would be much larger than the sum of those units shown.

Besides planning new deployment schedules, the Army has also changed aspects of its force structure in response to the Persian Gulf War. For example, during

1. Maj. Gen. Fred Elam and Lt. Col. Mark Henderson, "The Army's Strategic Mobility Plan," *Army Logistician* (May/June 1992), pp. 2-6.

2. The military refers to the day that deployments begin as C-day, with subsequent days denoted as C+1, C+2, and so on.

3. The amount of time required to conduct airlift sorties or steam sealift ships will differ depending on the distance involved. For one point of reference, during the Persian Gulf War daily airlift sorties reached a peak of 121 on January 20, 1991. That number includes C-5, C-141, and KC-10 aircraft along with Stage II of the Civil Reserve Air Fleet.

Table A-1.
Approximate Lift Requirements for Army Contingency Forces

Notional Army Unit	Number of Personnel	Unit Weight (Tons)	Airlift Sorties (C-141/C-17 mix)[a]	Number of LMSRs[b]
Airborne Division	13,242	26,699	1,101/78	2.8
Air Assault Division	15,840	35,860	1,412/195	3.9
Armored Division	17,756	110,431	1,761/1,274	6.2
Mechanized Division	17,982	109,116	1,708/1,275	6.2
Light Infantry Division	11,036	17,092	769/41	1.8
Corps-Support Command	22,410	98,717	3,599/500	8.5

SOURCE: Congressional Budget Office based on Department of Defense, Military Traffic Management Command, *Deployment Planning Guide*, 94-700-5 (Newport News, Va., September 1994).

NOTE: Based on data from the Army's April 1994 Tables of Organization and Equipment. Actual deployment values will be different for specific units and scenarios. Estimated weights include accompanying supplies, equipment, and ammunition.

a. The number of C-141 and C-17 sorties required to move each unit's equipment based on simulations of aircraft loading. Although the sorties shown would move some of the unit's personnel, additional passenger sorties by Civil Reserve Air Fleet planes would be necessary.

b. The number of large, medium-speed roll-on/roll-off ships required to transport each unit, assuming minimum containerization of unit equipment.

Operation Desert Shield, two divisions that were deployed early (the 24th Mechanized Infantry Division and the 1st Cavalry Division) each only had two active brigades; the 197th Separate Infantry Brigade and the Tiger Brigade were sent to round out those divisions. Immediately after U.S. forces returned from the Gulf, those divisions were each assigned a third active brigade. Now, all five divisions of the Army's contingency corps contain only active-duty units.

The Army has made other changes as well. Its Tables of Organization and Equipment (which describe the service's force structure) now include a corps-support group as a new unit in the contingency corps, and the Army is considering adding such a group to other corps as well. The service has installed an engineering brigade made up of three mechanized combat engineering battalions in each heavy division.[4] Formerly, each heavy division included only one engineering battalion, but extra engineering battalions were deployed for Operation Desert Storm to get troops around the extensive system of defensive barriers that Iraq had erected along the Kuwaiti border.

Even with those changes, the average number of personnel in Army combat divisions has grown only modestly in recent years (see Table A-2). Mechanized and armored divisions have grown by the largest amount—4 percent and 5 percent, respectively—since the end of the Gulf War. In the past decade, the Army has actually reduced the average number of personnel in its armored cavalry regiments.

But although the number of personnel in combat divisions has changed little, a recent study, the Total Army Analysis, suggests the service may need as many as 185,000 more support troops to accompany combat forces for two major regional conflicts. If its recommendations are carried out, the Total Army Analysis could result in higher lift requirements, including for units that would deploy early in major conflicts.

4. Lt. Col. F. Marion Cain III, "Building Desert Storm Force Structure," *Military Review* (July 1993), p. 30.

Table A-2.
Changes in Number of Personnel in Various Army Combat Units, 1987-1994

	Number of Personnel			Percentage Change		
	1987 TOE	1990 TOE	1994 TOE	1987-1990	1990-1994	1987-1994
Airborne Division	12,971	13,109	13,242	1	1	2
Air Assault Division	15,795	16,170	15,840	2	-2	0
Armored Division	16,724	16,921	17,756	1	5	6
Mechanized Division	17,073	17,235	17,982	1	4	5
Light Infantry Division	10,854	10,871	11,036	0	2	2
Armored Cavalry Regiment	6,167	4,663	4,627	-24	-1	-25

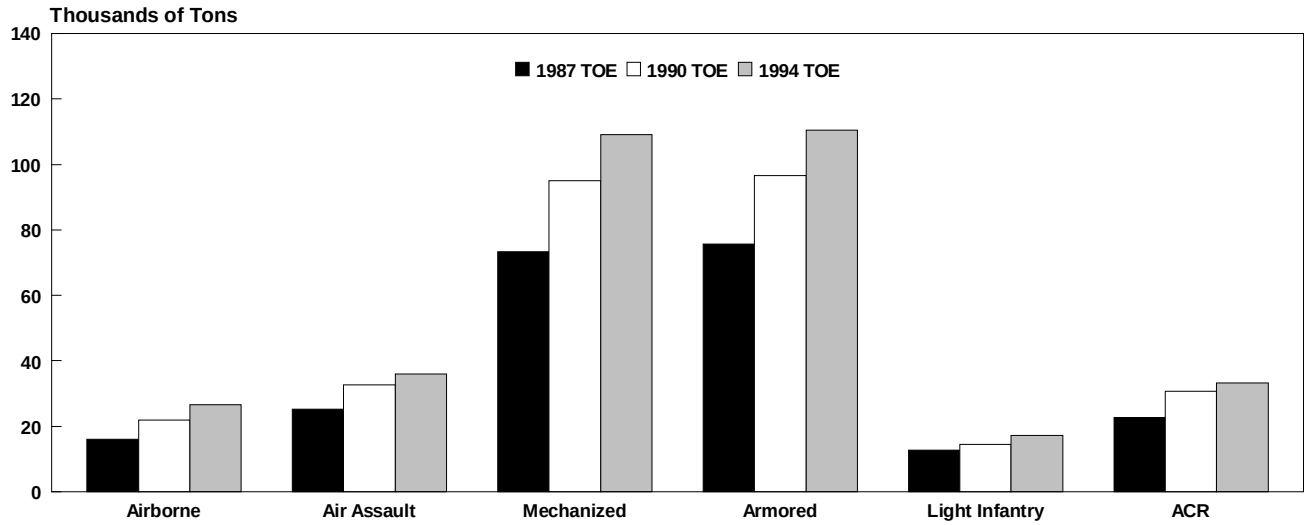
SOURCE: Congressional Budget Office based on data from the Military Traffic Management Command.

NOTE: TOE = Tables of Organization and Equipment.

As the Army has modernized its equipment and reorganized its forces, combat divisions have grown significantly heavier—an average of more than 4 percent heavier a year for most types of units. They also take up more floor space, but that increase (an average of more than 2 percent a year) is not as substantial as their growth in weight. Generally speaking, the additional weight increases mobility requirements for transporting units abroad—particularly those units that rely on airlift for deployment. Since the Army accounts for the majority of equipment and supplies that would be airlifted to a major regional contingency, the growing weight of its units has strong implications for overall airlift needs.

Under the Army's 1994 Tables of Organization and Equipment (the most recent version), a notional mechanized division weighs 49 percent more than it did under 1987 guidelines (see Figure A-1). The other military services have grown heavier as well, but less unclassified information is available about the effects of modernization and reorganization on the weight of Air Force, Navy, and Marine Corps units.

Figure A-1.
Changes in Weight of Various Army Combat Units, 1987-1994



SOURCE: Congressional Budget Office based on data from the Military Traffic Management Command.

NOTES: The weight of each unit includes accompanying supplies, equipment, and ammunition.

TOE = Tables of Organization and Equipment; ACR = armored cavalry regiment.

Appendix B

Participation in the Civil Reserve Air Fleet

If the United States had to fight one or two major regional conflicts today, the Civil Reserve Air Fleet (CRAF) would provide as much as 40 percent of the U.S. military's capacity to airlift cargo. Commercial air carriers would also transport most military personnel to those conflicts. Participants in CRAF agree to make a certain number of their planes available to the Department of Defense (DoD) in the event of a crisis in return for preference in bidding on the government's air transportation business. Keeping U.S. carriers involved in CRAF is vitally important because otherwise DoD would need to purchase additional aircraft itself and incur the cost of operating them during peacetime.

CRAF was activated for the first time in the Persian Gulf War. Although considered a success, that activation was not without difficulties.[1] Government-sponsored liability insurance presented one problem: some air carriers feared that gaps in DoD's War Risk Insurance would leave them without coverage for their planes and aircrews. There was also some question about whether, in the event of a wartime accident, DoD's indemnification program would cover CRAF participants for the value of the lost use of their planes. Some carriers feared potential delays in collecting claims against the federal government. Other problems included complications in transporting hazardous materials, delays associated with too few elevator loaders and other equipment to handle cargo, incompatible civil and military communication systems, and lack of chemical-protection gear for civilian aircrews.

Collectively, those issues caused dissatisfaction among some carriers, who withdrew from the program temporarily. CRAF participation has fluctuated since then, but DoD is taking measures to address concerns of the air carriers and provide stronger incentives for them to commit planes to the program.

Incentives to Participate in CRAF

How do commercial air carriers decide how many of their planes to enroll in CRAF? The answer depends to a large degree on the amount of peacetime business that a carrier might win from the federal government in exchange for participating. But in recent years, DoD has had to look for other incentives as well.

Since the end of the Cold War, the amount of business DoD has offered to CRAF participants has been considerable but has fluctuated over time. Contracts for the Air Force's cargo and passenger business totaled $466 million in 1989 and $659 million in 1990. That value shot up to nearly $1.9 billion in 1991 because of contracts associated with the Gulf War deployment (see Table B-1). Over the next five years, Air Force contracts averaged nearly $620 million annually.

1. Mary Chenoweth, *The Civil Reserve Air Fleet and Operation Desert Shield/Desert Storm: Issues for the Future*, MR-298-AF (Santa Monica, Calif.: RAND, 1993).

In recent years, the Air Force has chosen to expand peacetime contracts when its airlift needs increased rather than activating a CRAF stage. (See Box 3 on page 15 for details of the various stages of CRAF.) The larger amount of peacetime contracts was perhaps most apparent in 1994, when demand for airlift services was high because of U.S. operations in Somalia, Rwanda, the Persian Gulf, and elsewhere. At the same time, many of the Air Force's C-141s were unavailable because they were undergoing repairs.

In an attempt to broaden the number of carriers in the program, the Air Force has begun working with the General Services Administration (GSA) to tie additional government business to CRAF. In 1995, GSA began requiring eligible carriers to participate in the CRAF program in order to obtain passenger business associated with its City Pairs program. Under City Pairs, GSA awards annual contracts for air passenger transportation services between specific points of origin and destination. The program has an estimated annual value of $1.0 billion to $1.2 billion, substantially more than DoD's peacetime business. Although City Pairs has boosted participation in CRAF, some carriers have complained that the requirement is coercive and have protested various provisions of the program from year to year.

Some smaller airlines participate in City Pairs, but larger scheduled passenger carriers are the main beneficiaries of GSA's business. In contrast, smaller carriers, who tend to run charter operations, rely more heavily on peacetime contracts with the Air Force. Small carriers are also more likely to benefit financially when CRAF is activated, whereas larger scheduled carriers are apt to be more concerned about losing market share to foreign competitors and rivals who are not in the program. Since small carriers often do not operate scheduled routes, CRAF activation represents additional business for them and is not as disruptive as it may be to larger scheduled carriers.

DoD has taken other measures as well to appeal to a larger number of carriers. For example, under certain circumstances, commercial companies can use military airfields. By obtaining a CRAF Alternate Permit, carriers can specify military airfields as alternate landing sites (the locations where they would land in the event of an emergency). Since many of those alternative airfields are closer than the civil ones that carriers would otherwise designate, their planes can carry less fuel and thus incur lower operating costs.

An incentive targeted toward cargo carriers would allow those who participate in CRAF to use military

Table B-1.
Value of Air Force Passenger and Cargo Contracts Associated with the Civil Reserve Air Fleet (In millions of dollars)

	1991[a]	1992	1993	1994	1995	1996	1997[b]
Passenger	1,090.3	375.3	395.5	386.8	300.7	271.7	196.5
Cargo	807.2	158.5	138.8	306.2	295.7	462.5	246.2
Total	1,897.5	533.8	534.3	693.0	596.4	734.2	442.7

SOURCE: U.S. Air Force, Air Mobility Command.

a. Includes contracts associated with Operations Desert Shield and Desert Storm.

b. Actual as of January 30, 1997.

bases in the continental United States on a rental basis. Although cargo carriers have expressed some interest, industry officials argue that DoD has been slow to implement the program.

Amount of Participation in CRAF

The Persian Gulf War was the only time that CRAF has been officially activated, but civil carriers who participate in the program have provided airlift services in support of many other military operations (see Table B-2). During the Vietnam War, for example, CRAF carriers transported more than 11 million passengers and 1.3 million tons of cargo over a 10-year period. During the Persian Gulf War, CRAF planes carried more than 400,000 personnel and 171,000 tons of cargo on more than 3,600 missions. More recently, civil carriers have supported numerous smaller operations on a charter basis.

Table B-2.
Participation of Commercial Air Carriers in Military Contingencies, 1964-1996

Location/Operation	Year Operation Began	Flights by Commercial Carriers		
		Number of Flights	Cargo Delivered (In tons)	Passengers Delivered
Vietnam War[a]	1964	n.a.	1,313,776	11,436,165
Panama (Just Cause)	1989	12	346	2,929
Persian Gulf (Desert Shield/Desert Storm)	1990	3,604	171,170	405,448
Philippines (Fiery Vigil)	1991	68	2,412	16,882
Northern Iraq (Provide Comfort)[b]	1991	172	2,898	18,294
Former Soviet Union (Provide Hope)[b]	1992	82	4,895	100
Bosnia (Provide Promise)	1992	36	145	2,345
Somalia (Restore Hope)	1992	234	463	52,136
Rwanda (Support Hope)	1994	65	2,138	548
Cuba (Sea Signal V)	1994	214	848	29,524
Panama (Panama Haven/South Haven)	1994	24	n.a.	4,647
Haiti (Phoenix Shark)	1994	141	1,823	33,546
Cuba (Safe Haven/Safe Passage)	1994	27	0	4,050
Persian Gulf (Vigilant Warrior)	1994	119	1,389	12,010
Bosnia (Joint Endeavor)[c]	1995	534	7,332	41,333

SOURCE: Congressional Budget Office based on information from the U.S. Air Force, Air Mobility Command.

NOTE: n.a. = not available.

a. Figures for cargo and passenger transport during the Vietnam War are approximate.

b. As of August 1995.

c. As of January 1997.

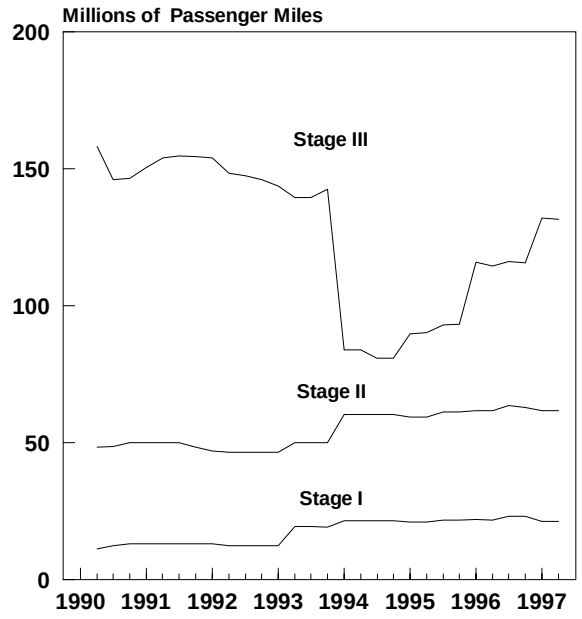
Passenger Air Carriers

Immediately after the Gulf War, CRAF's passenger airlift capacity declined only modestly because most carriers had signed a nearly three-year contract with the Air Force in 1990 (see Figure B-1). After that contract ran out at the end of 1992, the Air Force was able to secure only a nine-month contract. However, that agreement resulted in nearly a 50 percent increase in Stage I capability, allowing it to provide the same amount of airlift as was used in the Persian Gulf War. Thereafter, the Air Force and CRAF participants signed contracts annually on a fiscal year basis.

Today, all of the major passenger airlines and several smaller regional carriers participate in CRAF (or receive certificates of technical ineligibility). But that was not the case in the past few years. At the start of fiscal year 1994, United Airlines decided to stop participating in CRAF, which removed 77 out of a total of 253 wide-body passenger planes from Stage III of the program. The following year, after CRAF was tied to the City Pairs program, United recommitted 46 aircraft to Stage III. American Airlines, which also withdrew in 1994, recommitted 39 aircraft in 1995. In fiscal year 1997, American sharply expanded the number of planes included in Stage III to 86 and doubled the number in Stage II.

Although major airlines such as United, Northwest, and American provide most of the wide-body passenger aircraft now committed to Stages II and III of CRAF, smaller carriers provide most of the wide-body passenger planes for Stage I. For example, American Trans Air and Tower Air, both charter and scheduled passenger air carriers, each have seven wide-body passenger planes committed to Stage I. American Airlines is the only major carrier with as many planes enrolled in Stage I.

Figure B-1.
Participation of Long-Range International Passenger Aircraft in the Civil Reserve Air Fleet, Fiscal Years 1990-1997



SOURCE: Congressional Budget Office based on data from the U.S. Air Force, Air Mobility Command.

NOTE: Passenger planes owned by civil carriers who participate in the Civil Reserve Air Fleet would be called into service in three stages. Defense Department officials would call up the planes enrolled in Stage I first, whereas those in Stage III would be activated only in the event of a national emergency.

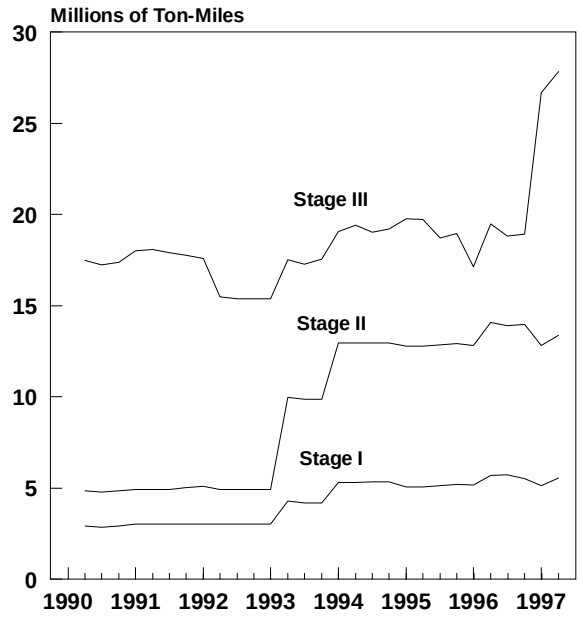
Cargo Air Carriers

As with passenger airlift, CRAF's long-range cargo capacity remained at relatively constant levels during the contract period from January 1990 through December 1992 (see Figure B-2). In fiscal year 1993, several carriers committed more planes to the program, increasing capacity in all three stages. Federal Express accounted for much of the increase in Stage II by committing an additional 12 cargo aircraft to the program. That trend continued in 1994 as well.

At the start of fiscal year 1997, commitments by Federal Express, one of the nation's largest cargo carriers, represented around 45 percent of the total number of long-range, wide-body cargo aircraft committed to Stage III. By contrast, United Parcel Service (UPS), another leader in the cargo industry, commits just six of its long-range, wide-body fleet to the program. The main reason UPS cites for its more limited participation is that it specializes in delivering small packages rather than heavy or bulk cargo.

Industry officials, particularly those of cargo carriers, have voiced concern about the allocation of the Air

Figure B-2.
Participation of Long-Range International Cargo Aircraft in the Civil Reserve Air Fleet, Fiscal Years 1990-1997



SOURCE: Congressional Budget Office based on data from the U.S. Air Force, Air Mobility Command.

NOTE: Cargo planes owned by civil carriers who participate in the Civil Reserve Air Fleet would be called into service in three stages. Defense Department officials would call up the planes enrolled in Stage I first, whereas those in Stage III would be activated only in the event of a national emergency.

Force's peacetime business. In the past, for example, one carrier has complained of a mismatch between its level of commitment to the CRAF program and the share of total peacetime business it receives. Other carriers are also concerned about losing market share during a CRAF activation. That could occur if a carrier's competitors had a lower CRAF commitment or, in the case of international and some domestic carriers, no commitment at all.

In an effort to encourage broader participation among cargo carriers, DoD has expanded the amount of peacetime business associated with CRAF. Under the City Pairs program, GSA now requires a minimum level of participation in CRAF in order for carriers to win delivery contracts for express small packages, third-business-day packages, and express cargo. As of 1996, companies must take part in CRAF to bid on those contracts, which total about $100 million annually. As a condition of award, contractors must increase their commitment to CRAF by at least 15 percent of their long-range international aircraft capacity. By tying new federal business to CRAF, the Air Force hopes to increase the incentives for carriers to commit larger portions of their fleet to the program.

The Effect of DoD's Aircraft Purchases on CRAF Participation

A few CRAF participants became involved during the Administration's 1995 review of how many C-17s to buy for the Air Force. One trade association comprising mainly smaller cargo and passenger air carriers argued that if DoD purchased C-33s, the amount of business available to CRAF participants during peacetime could decline. Their line of reasoning was that the Air Force could easily modify C-33s to include passenger seats, which would make them similar to the commercial planes those carriers operate.

Typically, the military would primarily use C-33s for training during peacetime. But with modifications, they could also transport loads that are now delivered by carriers on contract to DoD. If CRAF carriers anticipated less peacetime business from the military, they might reduce the number of planes in their inventory and ultimately lower participation in CRAF.

During the fall of 1995, then Commander in Chief of the U.S. Transportation Command, Gen. Robert Rutherford, noted that if the Air Force purchased C-33s, it would fly each plane only around 600 hours per year—too little to significantly affect DoD's demand for commercial air transportation during peacetime.[2] Moreover, some defense officials argued that since the C-141 fleet will be replaced by a smaller number of planes (with or without C-33s), the Air Force's demand for commercial airlift contracts may even grow over time. Nevertheless, DoD officials cited concern among civil air carriers as one issue that affected their decision to buy C-17s rather than C-33s.

2. "NDAA Buy Wouldn't Affect CRAF Use, Rutherford Says," *Aerospace Daily*, September 15, 1995, p. 411B.

Since the Civil Reserve Air Fleet allows DoD to avoid the cost of buying planes, defense officials asked the Air Force to study whether it might be able to expand the program. The analysis examined whether DoD can provide incentives for commercial carriers to purchase Boeing 747-400 freighters—the most efficient civil-style plane for hauling military cargo during a major conflict. Based on market projections over the next decade, the Air Force found that no carriers plan to buy 747-400s, typically because the plane's extensive range and payload capabilities do not fit into the route system and business strategy of those firms. Eight CRAF participants expressed interest in an enhancement program if DoD covered the added costs of buying 747-400s that are modified to carry military cargo. Since modified 747-400 freighters are heavier than their civil counterpart, commercial carriers could also seek compensation for higher operating costs because the military planes would be less fuel-efficient.

In the late 1980s, the Air Force modified 24 commercial planes that belonged to CRAF carriers at a cost of more than $600 million so those aircraft could accommodate military equipment. DoD also provided operating subsidies to pay for the additional fuel those planes required. But the experience was not considered a success. Pan Am, the carrier with the largest number of planes modified under the program, went bankrupt in 1991, and ultimately the Air Force lost access to many of those aircraft. For that reason, some analysts believe that a similar enhancement program today would be risky. And in the fall of 1995, the Air Force Chief of Staff, Gen. Ronald Fogleman, told reporters that the service would not reenter the business of providing operating subsidies to U.S. air carriers.[3]

3. "USAF Chief Sees Advantages to Low C-17 Buy Rate," *Aerospace Daily*, November 30, 1995, p. 334.

Appendix C

Key Assumptions About Mobility Operations

In recent analyses such as the Mobility Requirements Study Bottom-Up Review Update (MRS BURU), Defense Department mobility planners have used a series of technical assumptions that, on balance, some analysts have characterized as optimistic. This appendix reviews the assumptions that have the greatest effect on mobility requirements.

Warning Time and the Decision to Begin Deployments

One lesson from the Persian Gulf War was that unambiguous warning and quick decisionmaking are the keys to deploying forces rapidly. Assumptions about warning time are critical because if the United States had less advance notice of a conflict, it would need more airlift and prepositioning to get forces to the theater and halt an enemy's attack. With more warning, the Department of Defense (DoD) might be able to rely more extensively on sealift.[1] If intelligence is clear that an attack is imminent and decisionmakers act quickly on that information, DoD can begin to smooth the way for further deployments.

The MRS BURU assumes that in a future conflict, critical decisions will be made in a timely fashion. Unfortunately, neither unambiguous warning nor quick decisions were apparent in July and August 1990, when Iraq was threatening Kuwait, which has led some military officials to call the MRS BURU's assumptions about warning time unrealistic. However, press reports suggest that the MRS BURU assumed less warning time than DoD used in its 1992 Mobility Requirements Study.[2]

Should DoD expect very little warning? In the case of the Bottom-Up Review's planning scenarios—major regional conflicts in the Persian Gulf and Korea—the answer may well be yes. Some defense officials believe that the Iraqi military has improved its ability to move smaller numbers of divisions with less notice than in the past.[3] And with much of the large North Korean army stationed close to the demilitarized zone, it would seem prudent to make such an assumption for a potential conflict on the Korean Peninsula.

For its part, DoD has prepared itself to respond more rapidly today. Military officials quickly activated land-based and afloat prepositioning forces near the Persian Gulf in several recent incidents in which Iraqi

1. "U.S. At 'High Risk' of Being Unable to Carry Out Two-War Strategy Until 2006," *Inside the Pentagon*, September 22, 1994, pp. 1, 6.

2. "Final Draft of Mobility Requirements Study Update to Go to Services," *Inside the Pentagon*, November 3, 1994, p. 3.

3. Department of Defense, "CENTCOM Theater Update," background briefing by a senior defense official, October 16, 1995 (available through DefenseLINK News at http://www.dtic.mil/defenselink/news/Oct95/x101695_xback-a1.html).

forces appeared to be on the move.[4] After one such operation, the October 1994 deployment known as Vigilant Warrior, the United Nations designated the 32nd parallel as a "no-drive zone," strengthening the existing "no-fly zone." Thus, the international community would consider any movement by Iraqi forces south of that line as a sign of probable attack.[5] After Saddam Hussein involved Iraqi troops in a September 1996 conflict among Kurdish factions, the United States expanded the no-fly zone to include the 33rd parallel.

Even when warning is clear, however, decisionmakers do not always act quickly on that intelligence. For example, satellite data before August 2, 1990, showed that Iraqi troops were massing on the Kuwaiti border. But many U.S. intelligence analysts believed that Iraq was merely trying to intimidate its neighbor into lowering oil production.[6] Moreover, commanders did not take immediate steps to begin a deployment, presumably because U.S. officials were still broaching the idea of allowing military forces to operate in the Gulf with the leaders of those countries. In most other cases in the 20th century, attacks were foreshadowed by prolonged tension, yet leaders were surprised not because of a lack of intelligence but because of their political disbelief.[7]

The Availability of Personnel

Another factor that could affect the pace of deliveries to a future conflict is the early availability of personnel to crew planes and ships, maintain equipment, and help establish DoD's transportation network. Reservists are particularly important for airlift operations: during the Persian Gulf War, they made up 60 percent of C-5 aircrews, about 50 percent of C-141 aircrews, and significant numbers of personnel in maintenance and aerial port squadrons. For sealift, the Navy does not have a cadre of reservists to fill out crews but rather relies predominantly on U.S. merchant mariners to man the Ready Reserve Force. However, reservists do fill many of the Army's transportation units that would help set up port operations and load and unload ships.

In the past, DoD has relied heavily on volunteers from the reserves before the President calls them up. Although useful, the skills of volunteers do not necessarily match those needed during the start of a conflict. Thus, to use mobility forces to their fullest potential, reservists must be called up quickly. Similarly, tapping merchant mariners as soon as possible is critical to getting sealift ships under way.

Recent history does not clearly show whether reservists could be activated quickly enough to help complete deliveries over the first two to three weeks of a conflict. At the time of the Gulf War, for example, the President did not authorize activation of the first reserve aircrews (two C-5 and three C-141 units) until August 23, 1990—16 days after the start of deployments.[8] In 1994, by contrast, the President authorized a limited call-up of reserve personnel for U.S. operations in Haiti within 24 hours of DoD officials' requesting such authority.

During Desert Shield, shortages of certain types of skilled personnel kept DoD from filling some of its sealift crews within required times.[9] Despite a recent exercise by the Maritime Administration, which showed that sufficient manpower is available for the Ready Reserve Force, the declining number of U.S. merchant mariners has raised concern that DoD might experience crew shortages in the future, thus delaying deployments. The Navy's plan to retire 21 ships from the Ready Reserve Force by 2002 may eliminate such shortages. Moreover, ships that are kept in higher readiness categories (four- or five-day reduced operating status) would have higher priority for crewing.

4. David Kassing, *Army and Marine Corps Prepositioning Programs: Size and Responsiveness Issues*, PM-378-CRMAF (Santa Monica, Calif.: RAND, April 1995), p. 25; Douglas Jehl, "U.S. Ships Steam to Gulf in Response to Iraqi Move," *New York Times*, January 30, 1996, p. A-6.

5. Untitled news briefing by Department of Defense spokesman Kenneth H. Bacon, ATSD/PA, January 30, 1996 (available through DefenseLINK News at http://www.dtic.mil/defenselink/news/Jan96/t013096_tbb0130.html).

6. Michael R. Gordon and Bernard E. Trainor, *The Generals' War: The Inside Story of the Conflict in the Gulf* (Boston: Little, Brown, 1995), pp. 14-20, 26.

7. Richard K. Betts, *Surprise Attack: Lessons for Defense Planning* (Washington, D.C.: Brookings Institution, 1982), p. 18.

8. John Lund, Ruth Berg, and Corinne Replogle, *An Assessment of Strategic Airlift Operational Efficiency*, R-4269/4-AF (Santa Monica, Calif.: RAND, 1993), pp. 30-31.

9. Thomas McCaffrey, *Ready Reserve Force Contingency Crewing Requirements Study* (Alexandria, Va.: McCaffery & Whitener, December 15, 1995), p. ES-1.

Those are also the ships that would transport the initial surge of combat equipment to reinforce the units DoD plans to use to halt an enemy attack. Thus, although the Navy might possibly experience some delays associated with having too few merchant mariners, units that would be among the first to sail on DoD's sealift ships would probably not be as affected as units that would deploy later. However, too slow a call-up of reservists in port-control and transportation units could hinder the loading and unloading of ships.

Early Access to Commercial Planes and Ships

During the Gulf War, DoD activated Stage I of the Civil Reserve Air Fleet 10 days after the start of deployments and did not mobilize Stage II until five months later. The authors of the MRS BURU, however, assumed that in the future DoD would have access to Stage II planes much earlier in the first of two conflicts. In the event of a second conflict, the study assumed, decisionmakers would activate planes enrolled in Stage III. But based on DoD's experience in Operations Desert Shield and Desert Storm, some military officials have called the assumption about Stage II optimistic.

The MRS BURU used a more conservative approach in its assumptions about commercial sealift than about airlift. Although commercial shipping would deliver most sustainment supplies to two major conflicts, the study assumed that very few civil vessels would be used to move the initial surge of equipment and supplies from the United States. Defense officials made that assumption on the grounds that commercial ships might not be close enough to U.S. ports to begin a deployment at a moment's notice. The MRS BURU also assumed that DoD would use only U.S.-flag vessels. However, during the first three months of the Persian Gulf War, DoD relied extensively on both U.S.- and foreign-flag charter vessels.[10]

10. Ronald Rost, John Addams, and John Nelson, *Sealift in Operation Desert Shield/Desert Storm: 7 August 1990 to 17 February 1991*, CRM91-109 (Alexandria, Va.: Center for Naval Analyses, May 1991), p. 30.

Access to Airfields and Ports

Because of the distances involved in deployments to either the Persian Gulf or the Korean Peninsula, the Air Force uses bases in foreign countries so it can refuel airlift planes and change aircrews en route. Constraints on access to such bases can delay airlift operations. During the Gulf War, for example, three European bases—Zaragoza, Torrejon, and Rhein-Main—supported 61 percent of U.S. airlift traffic.[11] But several of DoD's en route bases are no longer available, and it is uncertain whether the United States will have the same degree of access to alternative bases.

Airlift also operates more efficiently when planes can land at a staging base—a stop in or near the theater of operations where aircrews can rest while fresh crews fly the planes back for their next mission. During the Persian Gulf War, U.S. Central Command denied the Military Airlift Command (MAC) access to a staging base in the theater.[12] Instead, MAC added extra members to each crew so they could fly longer missions from en route bases in Europe to the Gulf region and back. Unfortunately, the larger aircrews meant that those personnel used up their maximum number of flying hours more quickly.[13] One study of airlift operations concluded that when access to aircrews is limited, the lack of a staging base can reduce strategic airlift capacity by 20 to 25 percent.[14]

Some military analysts have argued that the MRS BURU uses fairly optimistic assumptions about access to infrastructure, such as en route and staging bases, that would support airlift operations. If that is true, airlift deliveries might take place more slowly than planned. The MRS BURU also assumes that the Navy would not need to clear mines from ports or choke

11. Lund, Berg, and Replogle, *An Assessment of Strategic Airlift Operational Efficiency*, pp. 81-82.

12. The Military Airlift Command was renamed the Air Mobility Command on June 1, 1992.

13. To help ensure safety, the Air Force normally limits aircrews to flying a maximum of 16 hours per day, 125 hours per 30 days, and 330 hours over 90 days. During Desert Shield, those limits were raised to 18 hours per day, 150 hours per month, and 400 hours per 90-day period.

14. Lund, Berg, and Replogle, *An Assessment of Strategic Airlift Operational Efficiency*, pp. 31-35.

points like the Strait of Hormuz before sealift ships could complete their deliveries. Yet if that circumstance occurred, it could significantly slow the pace of a major deployment.

Time Between the Two Conflicts

Another critical assumption is the amount of time separating two major regional contingencies. Some analysts believe that in order for an aggressor to take advantage of U.S. involvement in one contingency, the conflicts would need to be between one and three months apart.[15] For the MRS BURU, that assumption was not left to the discretion of the study's authors; it was specified in the Administration's Defense Planning Guidance.

According to a 1993 study by RAND, strains on tankers and airlift planes would prevent the United States from prosecuting a second conflict successfully if the two were separated by fewer than three weeks.[16] Similarly, defense officials have argued that the sealift requirements set in 1992 (and reiterated in the MRS BURU) would be insufficient if DoD actually found itself sending equipment to two major conflicts at the same time rather than consecutively. And without sufficient time between the two conflicts, military officials might not be able to regenerate the Army's set of afloat prepositioning equipment. Clearly, separation time is a variable that can have significant implications for strategic mobility requirements.

15. Michael O'Hanlon, *Defense Planning for the Late 1990s: Beyond the Desert Storm Framework* (Washington, D.C.: Brookings Institution, 1995), p. 7.

16. Christopher Bowie and others, *The New Calculus: Analyzing Airpower's Changing Role in Joint Theater Campaigns*, MR-149-AF (Santa Monica, Calif.: RAND, 1993), p. xix.

Appendix D

Details About CBO's Analysis

To compare the capabilities of various options for strategic mobility, the Congressional Budget Office (CBO) used two tools: a spreadsheet model called the Airlift Cycle Assessment System (ACAS) and a simulation called the Sealift Factors and Closure Approximation Tool (SeaFAXT). Those models allowed CBO to estimate the amount of time required to deliver cargo during the early part of two major regional conflicts.

Airlift Estimates

For the purposes of this study, the Department of Defense (DoD) provided CBO with estimates of airlift requirements for the halting phase of the most difficult scenario of the Mobility Requirements Study Bottom-Up Review Update (MRS BURU)—a major regional conflict on the Korean Peninsula followed shortly by another in the Persian Gulf region. Although two of the options in Chapter 6 preposition some of the equipment that would otherwise deploy by airlift during a conflict's halting phase, CBO did not adjust DoD's data on airlift requirements for any of the alternatives. Using those requirements, CBO estimated how much cargo various airlift fleets could deliver to the conflicts using the Airlift Cycle Assessment System.

ACAS is a deterministic spreadsheet model that the Air Force developed to quickly estimate airlift delivery capability. It uses standard Air Force planning factors that describe the average payload, speed, and maximum flying hours of airlift planes. ACAS uses those and other factors such as the availability of aircrews as inputs to a series of equations that calculate airlift cycles and delivery time.

The ACAS model does not simulate the loading, departure, and landing of individual planes from specific points of embarkation and debarkation as other, larger simulations do. Instead, it calculates how quickly a fleet can deliver a specific amount of bulk, outsize, and oversize cargo by distributing the weight among the airlift fleet based on the average payload of each type of aircraft. Since real-world airlift deliveries are constrained by the shape and volume of individual pieces of equipment as well as by total weight, the ACAS model may understate the amount of time required to deliver cargo. However, CBO calibrated its estimates using simulation results that DoD provided for airlift fleets with 120 or 140 C-17s.

Sealift Estimates

To assess how quickly different fleets of ships could deliver cargo to two major regional conflicts, CBO developed the Sealift Factors and Closure Approximation Tool. SeaFAXT simulates the flow of cargo on board individual ships between various ports of embarkation and debarkation, tracking their delivery time. By simulating individual ships, SeaFAXT allows analysts to look at how congested sealift operations might become if there were too few berths, or if ships were too long or had too deep a draft for a given port, or needed cranes and other equipment to unload their cargo.

Table D-1
Comparison of Assumptions in the MRS BURU and CBO's Analysis

	Mobility Requirements Study Bottom-Up Review Update (2001 time frame)	CBO's Analysis (2007 time frame)
Airlift (In primary aircraft authorized)[a]	88 C-141s 104 C-5s 55 C-17s 37 KC-10s 26 KC-135s	No C-141s 104 C-5s Number of C-17s varies 37 KC-10s 26 KC-135s Option III includes 30 C-33s
Civil Reserve Air Fleet	Stage II for one MRC Stage III for two MRCs	Same as MRS BURU
Land-Based Prepositioning	Equipment at various sites	Same MRS BURU, except that Option II would add 240,000 square feet to each site
Afloat Prepositioning	8 LMSRs for Army prepositioning 1 auxiliary crane ship heavy lift ships miscellaneous containerships lighter-aboard ships 3 Marine squadrons	Same as MRS BURU, except that Options I and IV would add or remove one LMSR, respectively
Surge Sealift	8 SL-7 fast sealift ships 11 LMSRs 36 RRF ROROs 44 other RRF ships	Same as MRS BURU, except that Option V would add one LMSR
Sustainment Shipping[b]	11 U.S.-flag vessels 90 effectively U.S.-controlled ships 43 allied vessels	Same as MRS BURU

SOURCES: Congressional Budget Office and Department of Defense, Joint Chiefs of Staff, *Mobility Requirements Study Bottom-Up Review Update* (February 13, 1995).

NOTE: MRC = major regional contingency; LMSR = large, medium-speed roll-on/roll-off ship; RRF = Ready Reserve Force; RORO = roll-on/roll-off ship.

a. Includes planes withheld by the Joint Chiefs of Staff for other missions.

b. Assumes no maritime reform. Number of U.S.- flag vessels excludes ships that would be withheld for commercial purposes during wartime.

Like most simulations, SeaFAXT does not optimize: in other words, it does not pick the best type of ship for a given sealift load or for a given port or berth. Nor does SeaFAXT determine in what order units would be sent to a conflict. CBO relied on military planning guides, unclassified data from the MRS BURU, and historical experience to determine the inputs for SeaFAXT. CBO also calibrated its estimates with actual sealift deployment times observed during Operations Desert Shield and Desert Storm.

Assumptions Behind CBO's Estimates

To estimate delivery time, CBO's analysis followed the assumptions of the MRS BURU as closely as possible. For example, it phased in the number of airlift planes and aircrews available for deployment based on timelines in the MRS BURU for reserve call-up, activation of the Civil Reserve Air Fleet, and the speed with which maintenance personnel can prepare military airlift planes for operations. When necessary, CBO used other information about the average capability of planes from Air Force Pamphlet 76-2, which lists standard airlift planning factors.

For assumptions about the number of planes that airfields in the Persian Gulf region and on the Korean Peninsula could service (that is, maximum on the ground, or MOG), CBO began with the most restrictive constraints that the Institute for Defense Analyses used in its 1993 study of the C-17.[1] CBO then tightened or loosened MOG values to match DoD's estimates for airlift fleets that included 120 or 140 C-17s.

For sealift forces, CBO followed the MRS BURU's assumptions about when ships from the Ready Reserve Force would become available at ports of embarkation, the number of berths and the amount of cargo processed per day at ports in the United States and at each regional scenario, and the amount of time U.S. forces would need to move equipment from their home bases to embarkation ports. When necessary, CBO used supplemental information from the Military Traffic Management Command's *Logistics Handbook for Strategic Mobility Planning* (94-700-2) of April 1994.

For the MRS BURU, DoD analysts assumed that the United States would face two major regional contingencies in 2001, and thus the authors projected what number of planes and ships would be available by then. As a result, the study assumed that the Air Force would have 88 C-141s and 55 C-17s (both in primary aircraft authorized) available for airlift missions, among other lift assets (see Table D-1). For the options in this study, however, CBO estimated the delivery times of airlift fleets that included no C-141s, replacing them entirely with some number of C-17s or a combination of C-17s and C-33s.

Similarly, CBO varied the amount of prepositioned equipment and the number of sealift ships that would be available to DoD. To identify specific units the military might preposition, CBO referred to DoD documents on units that would be sent to two major regional conflicts. In order to keep its analysis unclassified, CBO made subjective assessments about which units were likely to deploy during the halting phases of the conflicts. For its calculations, CBO did not include any equipment that the Army designates as inappropriate for prepositioning.

1. W. L. Greer, *Cost and Operational Effectiveness Analysis of the C-17 Program*, Report R-390 (Alexandria, Va.: Institute for Defense Analyses, December 1993), pp. D-22, D-23.