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Strategic Mobility Innovation: Options and Oversight Issues

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Strategic Mobility Innovation: Options and Oversight Issues

Summary

Since the George W. Bush Administration announced its proposal to reduce the U.S. military overseas basing posture, strategic mobility has been the topic of many policy discussions. The Administration's identification of transformation as a major goal for the Department of Defense (DOD), technological advances, the Quadrennial Defense Review (QDR) deployment goals, and anti-access issues also have relevance with regard to the topic of strategic mobility. The issue for the 109th Congress is to determine which investments should be pursued today to develop strategic mobility platforms to meet tomorrow's National Security Strategy requirements.

Several studies pertain to strategic mobility innovation. These studies include the DOD's Mobility Requirements Study for 2005, the Department of Army's Advanced Mobility Concepts Study (AMCS), the Institute of Defense Analyses' Assessment of the AMCS, a Defense Science Board (DSB) Mobility Study, and the DOD's Transformation Planning Guidance. These studies, along with current U.S. strategic mobility inventories and strategic mobility funding trends, all pertain to the discussion. They examine issues such as DOD's million-ton-mile per day requirement, future mobility concepts and feasibilities, the importance of decreasing the Services' deployment footprint, transformation roadmaps, the DOD's current strategic mobility inventories, and airlift/sealift future funding trends.

Research identifies at least 11 potential strategic mobility platforms, which include four sealift vehicles and seven airlift vehicles. The four sealift vehicles assessed in this report are the Shallow-Draft High Speed Sealift, the Fast Sealift-Monohull, the Navy Vision Trimaran High Speed Sealift, and the Navy Vision Surface Effect Ship High Speed Sealift. The seven airlift vehicles assessed are the Global Range Transport, the Super-Short, Take-off and Landing Aircraft, spiral development of the C-17 - Payload/Range Expansion Program, the Ultra-Large Airlifter, unmanned aerial vehicles, the Wing-in-Ground Effect Aircraft, and Seaplanes.

Strategic mobility innovation raises potential oversight questions for Congress in the following areas: (1) Does Congress have sufficient information about the DOD's plans for lift and potential lift platforms to adequately assess investment options? (2) To what degree, if any, should government funding be used to develop new lift platforms? (3) What mix of lift platforms might be appropriate to both meet future U.S. commercial lift needs and potentially assist in meeting future military strategic lift requirements? (4) Should any of these lift platforms be developed and procured in part to support the defense industrial base? (5) Should procurement of airlift/sealift be expanded beyond current DOD plans, and if so, by how much, and with what platforms?

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Introduction

Issue for Congress

With the George W. Bush Administration proposing a reduction in the U.S. military overseas basing posture and also identifying transformation as a major goal for the Department of Defense (DOD), the need to rapidly transport U.S. military forces from one location to another has appeared to increase in importance. Consequently, Congress may opt to consider what the future holds in the area of strategic mobility innovation.

A central issue for the 109th Congress is the determination of which investments should be pursued today to develop strategic mobility platforms to meet tomorrow's National Security Strategy requirements. Congressional decisions concerning this issue could have significant implications for future U.S. military capabilities, DOD funding requirements, the defense industrial base, and future congressional oversight of DOD activities.

This report will examine strategic mobility innovation in airlift and sealift used to transport cargo and personnel between theaters of operation (inter-theater).

Factors Affecting Strategic Mobility Innovation

One factor affecting strategic mobility innovation is the August 16, 2004 proposal by the Bush Administration to significantly alter the U.S. military overseas basing posture. The proposal, if implemented, would establish new overseas operating sites, and transfer up to 70,000 U.S. troops, plus 100,000 family members and civilians, from Europe and Asia back to the United States. The Administration believes that the current basing arrangements are not optimal for responding to future military challenges.[1] Many analysts believe that this change in global posture may increase the need for additional strategic airlift and high-speed sealift. On September 23, 2004, the U.S. European Command chief, Marine Corps General James Jones, testified to Congress that building a larger array of airlift and sealift platforms is an "essential component" of the sweeping overhaul that would — if approved —

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[1] See also CRS Report RS21975, *U.S. Military Overseas Basing: Background and Oversight Issues for Congress,* by Jon D. Klaus.

position U.S. forces at a number of small, dispersed bases across the European region.[2]

A second factor affecting strategic mobility innovation is defense transformation. Soon after taking office, the George W. Bush Administration identified transformation as a major goal for the Department of Defense (DOD). Since then, the DOD, the Office of Force Transformation (OFT), and the Services have addressed the transformation process. Some observers have emphasized that improving the strategic transportation of U.S. troops and cargo is an integral part of this transformation process. Part of the Navy and Marine's transformation plans include new ship-deployment approaches called Sea Swap and Sea Basing. These concepts call for long-duration forward deployments with crew rotations.[3] Some analysts have noted that these crew rotations will rely on strategic mobility for their success. Part of the Army's transformation revolves around a lighter and leaner force.[4] It would appear that an integral part of this transformation will be the ability to rapidly transport their new combat vehicles, such as the Stryker and the Future Combat System (FCS). The Stryker and the FCS combat vehicles were originally designed so that they could be transported on the Air Force's C-130. The FCS, for example, is being designed with a 19.5-ton limit, which is the maximum weight limit for transportation on the C-130. Some critics of this idea say that past procurement practices have shown that a typical weapon system will increase in weight by 20% during development, making transportation on the C-130 impossible. To date, current designs have the vehicle, fully combat capable at delivery, weighing between 22 and 24 tons.[5] Even if it can be transported on a C-130, some analysts predict that it will need an additional two C-130s to transport the equipment and personnel to support its operation. As the Air Force transforms, it will need to determine the right mix of strategic assets to support both its own operations and those of the other Services. To achieve this, the Air Force is exploiting new technologies and operational concepts to improve its ability to rapidly deploy and sustain forces.[6]

A third factor is technological advances. The main idea behind innovation is to exploit advances in technology to create new platform designs. New lighter weight, stronger composite materials, new advanced engines or propulsion systems, new aerodynamic designs, and new advances in computer technology may allow innovative designs in strategic mobility assets.

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[2] John T. Bennett. "Increased Lift Assets Seen as Key to EUCOM Transformation Plans," *Inside the Pentagon*, Sept. 30, 2004. General Jones gave this testimony to the Senate Armed Services Committee on Sept. 23, 2004.

[3] See CRS Report RS20851, *Naval Transformation: Background and Issues for Congress*, by Ronald O'Rourke, for more information on Navy transformation.

[4] See CRS Report RS20787, *Army Transformation and Modernization: Overview and Issues for Congress,* by Edward F. Bruner, for more information on Army transformation.

[5] Jen DiMascio, "C-130J Termination Raises Questions About FCS Transportability Goal," *Inside the Army,* Vol. 17, No. 1, Jan. 10, 2005.

[6] See CRS Report RS20859, *Air Force Transformation,* by Christopher Bolkcom, for more information on Air Force transformation.

A fourth factor affecting strategic mobility innovation is the 2001 Quadrennial Defense Review's (QDR) deployment goals. The current QDR calls for deployment goals of the so-called "1-4-2-1" and "10-30-30" strategies. The "1-4-2-1" strategy is structured to simultaneously defend the single homeland, conduct deterrence in four regions of the globe, execute two major campaigns in swift fashion — winning one of them by taking over the enemy's capital. The other strategy calls for delivering needed forces to a theater within 10 days of a deployment order, swiftly defeating an enemy there within 30 days, and resetting the force 30 days after that victory.[7] The next QDR is due out this Fall (2005). Its conclusions may have a significant impact on projected strategic lift requirements.

A fifth factor is the issue of "anti-access" or "area denial." Analysts have argued that other countries could become increasingly unwilling to permit U.S. forces to operate out of their country to carry out combined operations. Additionally, some analysts have suggested that future adversaries may not freely allow U.S. forces to build-up their forces at nearby air and sea ports, as in recent wars (e.g. Desert Storm and Operation IRAQI FREEDOM). These access issues could affect our strategic mobility and require the United States to start thinking about not having access to convenient ports and airports. This concern could drive the design of high-speed, shallow draft ships, aircraft that can go from "fort-to-fight" (global-range transports), super-short takeoff and landing aircraft, in addition to planning for decreased local infrastructure.

Organization of the Report

This report first examines a few mobility studies conducted by the DOD and some relevant background literature. Secondly, the report examines innovative designs and platforms that may meet the requirement for next-generation strategic airlift or sealift. Finally, this report examines the potential congressional oversight issues, which could affect future U.S. military capabilities, DOD funding requirements, and the U.S. defense industrial base.

Studies and Background Literature

Mobility Requirements Study for 2005

In 1998, the Deputy Secretary of Defense chartered the Mobility Requirements Study for 2005 (MRS-05). MRS-05 examined the number and mix of mobility systems needed to support two nearly simultaneous major theater wars (MTWs) in the year 2005. MRS-05 investigated mobility requirements in the continental United States as well as between theaters ("strategic" or "inter-theater" mobility) and within individual theaters ("tactical" or "intra-theater" mobility). It was conducted over two years and was then DOD's most comprehensive mobility study. MRS-05 was

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[7] "CRS Analyst Says QDR Should Include Plan for Size, Structure of Navy," *Inside the Pentagon*, Dec. 9, 2004, p. 13.

completed in 2000. At that time of the study's release, the DOD's airlift capability was estimated to be approximately 44 Million-Ton-Miles per Day.[8]

The MRS-05 study gave the following overall assessment:[9]

- An airlift fleet of 49.7 Million-Ton-Miles per Day (MTM/D), the level established after the 1995 Mobility Requirements Study Bottom-Up Review Update (MRS-BURU), is not adequate to meet the full range of requirements.

- To support the warfighting demands of two nearly simultaneous MTWs, the study identified a need for a minimum of 51.1 MTM/D of airlift capability. This number included the airlift demands associated with deployments to the two theaters as well as support for high-priority movements within those theaters.

- The study observed that there are likely to be other demands on the airlift system during the peak periods of operations early in major theater campaigns. Three of these additional demands or missions were judged to be high-priority missions in excess of the 51.1 MTM/D capability needed for fighting two MTWs. The three missions — conducting special operations, deploying missile defense systems to friendly nations, and supporting other theater commanders not directly engaged in the theater campaigns — would yield a total airlift requirement of 54.5 MTM/D. Upon examining all the possible missions and variations in assumptions, the study generated a range of demands up to 67 MTM/D. The Chairman of the Joint Chiefs of Staff, the Service Chiefs, and the CINCs reviewed the study and supported the requirement of 54.5 MTM/D of airlift capability as the minimum "moderate-risk" capability to support the National Military Strategy.

- The sealift investments made in response to DOD's 1995 MRS-BURU were reported to be sufficient. MRS-05 found that the DOD's overall mobility capability could be further augmented through aggressive use of commercial sealift enabled by selective containerization of unit equipment. However, the study noted that the cargo delivery requirements for two MTWs increased by one million tons relative to the 1995 MRS-BURU projected amounts.

- The study also made inter-theater airlift and sealift recommendations. For airlift, it was recommended that the DOD should develop a program to provide between 51.1 MTM/D and 54.5

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[8] Million ton-miles per day (MTM-D) is a commonly accepted measure of performance across the transportation industry. It reflects how much cargo can be delivered over a given distance, in a given period of time.

[9] U.S. Department of Defense, *Mobility Requirements Study for 2005,* Jan. 2001, pp. 4-5.

> MTM/D of airlift capability. For sealift, it said that the programmed organic dry cargo fleet was adequate to meet projected requirements.

Since the September 11, 2001 attacks and the Administration's Global War on Terrorism, the DOD mobility requirements are being constantly reviewed. Some analysts have estimated that during military operations in Iraq the airlift gap between actual and required capability was at least 10 MTM/D. Today, Air Mobility Command (AMC) leaders say, this gap is wider — at least 15 MTM/D, perhaps 22 MTM/D.[10] In 2004, Congress asked AMC to take a "quick look" comparison of the MRS-05 projection with the actual experience in Afghanistan and Iraq. David Merrell, chief of AMC's studies and analysis division, estimated that the current requirement is fast approaching 60 MTM/D.[11]

If the new Mobility Capability Study (MCS), due out in April 2005, corroborates the 60 MTM/D figure, then there would appear to be an additional projected gap of at least 5.5 MTM/D above the 54.5 MTM/D figure. Estimates (as of March 7, 2005) have DOD's actual MTM/D capability at approximately 45, resulting in a projected airlift capability gap of between 9.5 MTM/D and 15 MTM/D.

According to the MRS-05, AMC should be able to reach 54.5 MTM/D with 176 C-17s, a C-5 Mission Capable (MC) rate of 65%, and a Civil Reserve Air Fleet (CRAF) contribution of 20.5 MTM/D. Currently, AMC has 119 C-17s (not including the 11 C-17s in Air Education and Training Command) and the C-5 has a MC rate of approximately 68%.

According to the Air force, a MTM/Day figure was not an original goal of the new MCS study, but it appears that this issue is now being readdressed within the DOD. The methodology used for the new study is called "deterministic modeling". The study examines several different scenarios, which all have a baseline requirement, and then models the options by adding additional airlift and sealift capabilities. Thus far, preliminary data would appear to show that additional airlift capacity in the early stages of a conflict will allow the U.S. earlier delivery of cargo/personnel. Also, it would appear that additional sealift capacity later in a conflict (e.g. sustainment phase) will help to avoid possible delivery shortfalls.[12]

Advanced Mobility Concepts Study (AMCS)

The Defense Planning Guidance (DPG) (2004-09) called for the Advanced Mobility Concepts Study (AMCS) to ensure that DOD's transformed forces would continue to enjoy a strategic and operational mobility advantage over future adversaries by accelerating the transformation of their mobility concepts and capabilities. The Secretary of Army, in collaboration with the Chairman of the Joint Chiefs of Staff (CJCS), the other Military Department Secretaries and the Combatant

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[10] John A. Tirpak, "The Airlift Gap," *Air Force Magazine*, Oct. 2004, p. 34.

[11] Ibid., p. 36.

[12] This information was provided during in-person consultations with the Air Force Studies and Analysis Agency on Feb. 9, 2005.

Commanders, led this comprehensive study to describe the future mobility concepts and capabilities required for the 2015 - 2020 timeframe.[13]

The study considered several future mobility concepts and capabilities with reference to Quadrennial Defense Review (QDR) 2001 transformational goals. In particular, future mobility concepts were assessed against the QDR transformational goal of "projecting and sustaining U.S. forces in distant anti-access or area-denial environments and defeating anti-access and area-denial threats."[14] The study was conducted in two phases. The first phase focused on future mobility platform performance, cost, and risk. The second phase concentrated on performance only.

From an initial set of Service-nominated future mobility platforms, the AMCS chose the most promising systems for evaluation. These strategic airlift and sealift platforms included:

- Global Range Transport (GRT)
- Ultra-Large Airlifter (ULA)
- C-17 aircraft with a Payload/Range Expansion Program (PREP)
- Super Short Take Off and Landing (SSTOL) aircraft
- Shallow Draft High Speed Sealift (SDHSS)
- Fast Sealift Monohull
- Navy Vision Trimaran High Speed Sealift (NVTHSS)
- Navy Vision Surface Effect Ship High Speed Sealift (NVSESHSS)

The studies conclusions are discussed under the "Potential Strategic Mobility Platforms" section of this report.

Institute of Defense Analyses Assessment of the AMCS

In June 2004, The Institute of Defense Analyses (IDA) completed a feasibility analysis of the strategic sealift and airlift platforms examined in the AMCS Phase II. This study is called the "*Technical Capabilities Assessments of the Phase II Advanced Mobility Concepts Study (AMCS) Concepts.*" The assessment was undertaken to:[15]

- Assess the near-term technical performance expectations and the technical feasibility of achieving the capabilities assigned to the concepts.
- Estimate longer term technical performance potential of the AMCS II concepts based upon the identification of critical, enabling technologies and their prospects for maturation.

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[13] U.S. Department of Army, *Advanced Mobility Capability Study*, Dec. 2003, p. iv.

[14] U.S. Department of Army, *Advanced Mobility Capability Study*, Dec. 2003, p. iv.

[15] James Fein et al., "Technical Capabilities Assessments of the Phase II Advanced Mobility Concepts Study (AMCS) Concepts," *Institute for Defense Analyses* (IDA), IDA Document D-2996, June 2004, p. ES-2.

IDA used the following definitions for the Technology Readiness Levels (TRLs):[16]

1 - Basic principles observed and reported
2 - Technology concept and/or application formulated
3 - Analytical and experimental critical function and/or characteristics proof of concept
4 - Component and/or breadboard[17] validation in laboratory environment
5 - Component and/or breadboard validation in relevant environment
6 - System/subsystem model or prototype
7 - System prototype demonstration in an operational environment
8 - Actual system completed and qualified through test and demonstration
9 - Actual system proven through successful mission operations

Defense Science Board -Strategic Mobility Task Force

The most recent Defense Science Board (DSB) report on strategic mobility was released on August 31, 1996.[18] The Task Force did a broad review of strategic mobility including a range of scenarios. They considered Major Regional Contingencies, Lesser Regional Contingencies, and Operations Other Than War. Though the final report was completed almost nine years ago, there are several findings that some observers have noted may still be pertinent today.[19] The Task Force concluded that mobility efforts should be focused on five major areas:[20]

- Shaping the force for rapid response — minimize the deployed footprint ashore
- Improving the deployment architecture, planning, infrastructure and flow
- Improving the information system support for deployment planning and execution
- Improving the protection of the forces entering the theater
- Improving lift and prepositioning capabilities

For improving lift and prepositioning capabilities, the DSB mentioned the importance of the strategic mobility lift triad, which consists of airlift, sealift, and pre-positioned forces. It stressed that the needed lift and pre-positioning programs will face multiple budget exercises, Congresses, and administrations and will need

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[16] James Fein et. al., op. cit., p. 9.

[17] A "breadboard" is an experimental arrangement of electrical/mechanical components that are mounted on a board to test feasibility.

[18] Defense Science Board, *Report of the Defense Science Board Task Force on Strategic Mobility*, Office of the Under Secretary of Defense for Acquisition and Technology, Washington, Aug. 1996.

[19] As a time reference, this report was completed after Desert Shield/Storm and the 1995 MRS-BURU, but before the 2003 Iraq War.

[20] Defense Science Board, op. cit., pp. 12-14.

robust continuing support. The report also mentions: (1) the need to replace the Fast Sealift Ships (FSS) starting around 2010, (2) that a worthy goal would be to replace these FSS with a capability to deliver forces in one half the currently planned time (e.g. commercial initiatives for ships with 50+ knot performance), and (3) the need to track commercial development of very large lighter-than-air craft (e.g. 500 ton capability).[21]

The DSB report maintains one central theme throughout — the importance of minimizing the U.S. footprint at the air and seaports of debarkation. This idea really serves two purposes: (1) avoidance of backlogs at the Ports of Debarkation (PODs) and (2) security of U.S. forces and material. First, the report mentions that more emphasis needs to be put on minimizing the pile-up of forces and material at vulnerable nodes. Those nodes are represented by the PODs. "From a strategic mobility viewpoint, the most critical need is to reduce the day to day footprint at the PODs."[22] Second, the report states that sea and air PODs are attractive targets since there are likely to be bottlenecks where people and material pile-up. In the Gulf War, 96% of all sealift cargo went through two sea ports. For air cargo, 78% went through five airfields. Many of these PODs will be within range of enemy weapon systems, which can disrupt operations. In Operation Desert Shield/Storm, there was no attack on the U.S. forces during the insertion and build-up of forces in theater. Future adversaries may not be as accommodating. "Specifically, the hand-off of personnel, equipment and material from USTRANSCOM (United States Transportation Command) to the CINC (Commander-in-Chief) at the ports of debarkation appears to be the "critical seam" where disruption of the deployment flow is most likely to occur."[23] The Task Force emphasized the need to minimize the bottleneck of exposed forces and material at vulnerable ports.

When looking at a typical ground force deployment, it is broken up into three phases — fort-to-port, port-to-port, and port-to-foxhole. The problems mentioned above are occurring in the port-to-foxhole phase. Many analysts believe that is where our future strategic mobility platforms need to concentrate. The future of strategic mobility could be to transport directly from fort-to-foxhole, or to at least plan for "port denial" and to develop platforms that do not need to operate in these environments.

Another DSB mobility study is currently being conducted and is due to be released in Spring 2005.

Strategic Mobility Inventories

United States Transportation Command (USTRANSCOM) manages all strategic mobility assets. Air Mobility Command (AMC) and Military Sealift Command

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[21] Defense Science Board, op. cit., p. 82.

[22] Ibid., p. 21.

[23] Ibid., p. 36.

(MSC) are two of the three commands that make up USTRANSCOM.[24] AMC is in charge of the U.S. airlift assets and MSC is in charge of the U.S. sealift assets.

Strategic Airlift. As of March 8, 2005, AMC has 119 C-17s, 106 C-5s, and 20 C-141s.[25] Of the 119 C-17s, 111 are active duty AMC assets and 8 are Air National Guard assets. Of the 106 C-5s, 57 are active duty AMC assets and 49 are Reserve assets. Of the 20 C-141s, all are Reserve assets (none in the active duty).[26]

Congress has authorized and appropriated the production of 180 C-17s through 2008. U.S. Transportation command has been lobbying for 42 more C-17s, for a total of 222 C-17s.

The C-17 has a maximum payload capacity of 170,900 pounds (18 pallet positions) and an unrefueled range of approximately 2,400 nautical miles. It can airdrop 102 paratroopers or it can carry large or heavy outsize cargo. It can takeoff and land within 3,000 feet.[27] It can travel at speeds up to 450 knots.[28]

The C-5 is one of the largest aircraft in the world. It can carry up to 270,000 pounds of outsize and oversize cargo (36 pallet positions) with a range of 2,150 nautical miles. It can takeoff fully loaded within 8,300 feet and land within 4,900 feet. It can travel at speeds up to 450 knots.[29]

The C-141 can carry either 200 troops, 155 paratroopers, 103 litters and 14 seats, or 68,725 pounds of cargo (13 pallet positions). It has an unrefueled range of 2,174 nautical miles. It was designed to be able to takeoff within 8,000 feet and land within 4,000 feet. It can travel at speeds up to 434 knots (Mach .74)[30]

Strategic Sealift. Sealift and pre-positioned ships are two other parts of the "strategic mobility lift triad." As of February 1, 2005, MSC's strategic sealift inventory totaled 388 ships, of which 288 are classifies as Dry Cargo, 96 as Tankers, and 4 as Passenger vessels. The Navy only owns/charters 120 of these ships. Of the 120 ships owned or chartered by the Navy, 82 are in the MSC Active Force and 38 are in the Ready Reserve Force.

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[24] The third command in USTRANSCOM is the Surface Deployment and Distribution Command (SDDC).

[25] These numbers do not include the 11 C-17s and 8 C-5s that are in Air Education and Training Command.

[26] See CRS Report RS20915, *Strategic Airlift Modernization: Background, Issues, and Options,* by Christopher Bolkcom, for more information on Strategic Airlift.

[27] See CRS Report RL30685, *Military Airlift: C-17 Aircraft Program,* by Christopher Bolkcom, for more information on the C-17.

[28] Air Force Link - *Fact Sheet: C-17 Globemaster III* [http://www.af.mil/factsheet.asp?fsID=86].

[29] Air Force Link - *Fact Sheet: C-5 Galaxy* [http://www.af.mil/factsheet.asp?fsID=84].

[30] Air Force Link - *Fact Sheet: C-141 Starlifter* [http://www.af.mil/factsheet.asp?fsID=93].

MSC operates a total of 36 pre-positioning ships.[31] 10 ships support the Army, 16 ships support the Marines, and the remaining 10 ships support the Navy, Defense Logistics Agency, and the Air Force. Of the 120 Navy-owned ships, only 28 ships are considered medium speed or higher. MSC owns 8 Fast Sealift Ships (FSS), which can travel in excess of 30 knots, and 19 Large, Medium-Speed, Roll-on/Roll-off (LMSR) ships, which can travel at speeds up to 24 knots. MSC also charters one High Speed Vessel (HSV) for the III Marine Expeditionary Force as a prepositioning ship, which can travel at speeds up to 33 knots.[32]

The Fast Sealift Ships are normally kept in "reduced operating status," but can fully activated and underway to loading ports within 96 hours. Together, all eight ships can transport nearly the equivalent of a full Army mechanized division. These ships can sail from the East Coast to Europe in less than six days and to the Persian Gulf in 18 days. The FSS has a range of 12,200 nautical miles (at 27 knots) and can carry approximately 200,000 square feet of cargo,[33] the equivalent of about 200 C-17 payloads.

Of the 19 Large, Medium Speed, Roll-on/Roll-off ships, 2 are prepositioning ships, 10 are in reduced operating status, and 7 are fully operational. The LMSR has a cargo carrying capacity of more than 300,000 square feet (the equivalent of 400 C-17 payloads), and a range of 12,000 nautical miles (at 24 knots).[34]

This HSV is a high speed roll-on/roll-off catamaran chartered by MSC from Austal Ships of Henderson, Australia. It was originally chartered in January 2002 for 36 months, and has since been renewed. It can carry 32,000 square feet of cargo capacity and 970 passengers, and has a range of 1,100 nautical miles (at 33 knots).[35]

Figure 1: HSV

Source: MSC Fact Sheet Library [http://www.msc.navy.mil/factsheet/]

[31] See CRS Report RL32513, *Navy-Marine Corps Amphibious and Maritime Prepositioning Ship Programs: Background and Oversight Issues for Congress,* by Ronald O'Rourke, for more information on maritime prepositioning ships.

[32] For more information on Military Sealift Command's ship inventory, refer to the following website: [http://www.msc.navy.mil/inventory/].

[33] Norman Polmar, Samuel Loring Morison, Richard R. Burgess, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, (Annapolis: Naval Institute Press, 2000), p. 288.

[34] Norman Polmar, Samuel Loring Morison, Richard R. Burgess, op. cit., p.296.

[35] For more information on the HSV, please refer to the following website: [http://www.navsource.org/archives/09/774676.htm].

Transformation Planning Guidance

When the George W. Bush Administration took office, a heavy emphasis was put on transformation. The Office of Force Transformation (OFT) was created and Transformation Planning Guidance (TPG) was published in April 2003. This guidance defines the primary senior leaders' roles and responsibilities for implementing the transformation strategy. It states:

> The Secretaries of the Military Departments and the Service Chiefs of Staff are responsible for developing specific concepts for supporting operations and core competencies. They will oversee Service experimentation, modify supporting concepts accordingly, and build transformation roadmaps to achieve transformational capabilities to enable those concepts.[36]

The Services and Joint Forces Command submit to OFT their transformational roadmaps for approval no later than November 1 of each year. The 2004 roadmaps were submitted to OFT in the late summer of 2004, however OFT's review of these roadmaps has not been completed to date.

The TPG also directs that an annual strategic appraisal will be written by the Director of OFT and submitted to the Secretary of Defense no later than January 30 each year. The Strategic Transformation Appraisal evaluates and interprets the progress of the transformation strategy, recommending modifications and revisions where necessary.

The 2004 Strategic Transformation Appraisal included several "issues of regret," which outline key technologies that — if not explored — could be in the future viewed as significant lost opportunities.[37] Three "issues of regret" are pertinent to strategic mobility:

- A "super" short-takeoff-and-vertical-landing mobility platform
- A heavy-lift vertical-takeoff-and-landing aircraft
- A shallow draft high-speed vessel with strategic range

Mobility Funding Trends

Table 1 illustrates the funding for airlift/sealift since FY2005, with projections to FY2009.[38]

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[36] U.S. Department of Defense, *Transformation Planning Guidance*, Apr. 2003, p. 13.

[37] Amy Butler, "Pentagon Transformation Analysis Outlines Military Capability Gaps," *Defense Daily*, Nov. 19, 2004, p. 1.

[38] The "Airlift/Sealift" dollar figures are DOD Total Obligation Authority (TOA) numbers. TOA is a DOD financial term which expresses the value of the direct program for a given fiscal year (FY). It is based on the Congressionally approved budget authority (BA) for the program, plus or minus financing and receipts or other adjustments.

Table 1. Mobility Funding Trends

Fiscal Year	Airlift/Sealift (millions)	% of Total DOD TOA
2000	12,660	4.03
2001	12,123	3.86
2002	14,599	3.93
2003	14,340	3.81
2004	13,587	3.57
2005	14,857	3.80
2006	15,748	3.93
2007	14,235	3.46
2008	14,471	3.44
2009	18,270	4.25

Source: FY2004 National Defense Budget Estimates, Table 6-5.

The general trend for the next five years would appear to be relatively flat. Some observers have questioned this flat trend, partly due to the Administration's goal to transform the DOD, of which strategic lift could be considered an integral part.

Potential Strategic Mobility Platforms

Sealift

There are three hull designs and two surface effect ship designs under active consideration for new sealift capability. The potential platform designs are the monohull (one hull), catamaran (two hull), trimaran (three hull), cavity catamaran surface effect ship, and air cushion surface effect ship. In particular, these designs were incorporated into the following potential strategic sealift platforms: the Shallow-Draft High Speed Sealift, the Fast Sealift-Monohull, the Navy Vision Trimaran High Speed Sealift, and the Navy Vision Surface Effect Ship High Speed Sealift. This section will also briefly examine two intra-theater hull designs that may be examined in the future.

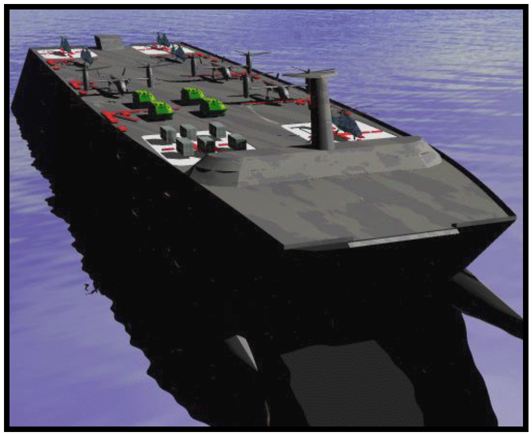

Figure 2: SDHSS

Source: Institute of Defense Analyses

Shallow Draft High Speed Sealift (SDHSS). The SDHSS is intended to be a strategic theater cargo vessel capable of 75 knots, with an intended range of 4,500 nautical miles. It would have a draft shallow enough to access ports not accessible to current sealift.[39] It would carry 86,489 square feet of cargo (or 4,400 short tons), and 1,000 passengers simultaneously.[40]

The SDHSS is a "cavity catamaran," with rigid catamaran-like sidehulls, and about the last half of the ship having a carved out cavity. This cavitation reduces the wetted surface of the hull and consequently lowers the hydrodynamic resistance. The SDHSS would also use a self-generated air cushion to reduce hydrodynamic drag.[41]

Potential advantages of the SDHSS include:[42]

- With a speed of 75 knots, the SDHSS would be nearly three times faster than the current Large, Medium Speed, Roll-on/Roll-off sealift vessel.
- With a shallow draft, the SDHSS could deliver cargo and personnel without having to rely on a deep-water port. This could help minimize the footprint at a deep-water port, thereby increasing the number of possible entry points into a theater of operation.

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[39] "Draft" is the depth of water a ship draws especially when loaded.

[40] U.S. Department of Army, *Advanced Mobility Concepts Study,* Dec. 2003, pp. 4-6.

[41] V.A. Dubrovsky and K. I. Matveev, "Some Aspects of the Growth in Speed of Fast Combat Ships," I*nternational Journal of Maritime Engineering*, Royal Institution of Naval Architects, 2004, p. 3. [[http://www.rina.org.uk/rfiles/IJME/sky.pdf]].

[42] U.S. Department of Army, *Advanced Mobility Concepts Study,* Dec. 2003, pp. 4-7.

Potential disadvantages of the SDHSS include:[43]

- The size of the SDHSS could prevent it from entering many coastal and/or riverine ports, as well as the Panama Canal.
- Its performance may be limited in poor weather and high sea states.

Some of the current issues with the SDHSS are as follows:[44]

- A speed of 75 knots may not be practical. There may be a detrimental effect on passengers in the open ocean. Further open ocean study is needed.

- Some sealift experts and engineers do not think it is feasible to produce a ship with this design. Experts believe that the speed, payload, and range of this vessel would be difficult to achieve. Technological feasibility has not been proven.

- A more aggressive High Speed Sealift Research and Development program would be required to produce a SDHSS that can meet these design parameters. The High Speed Sealift Innovation Cell, a joint effort funded by the Navy and OSD, published a Technical Development Plan that identified $1.2 billion in R&D efforts for the SDHSS, with the preponderance of the effort going to gas turbine research ($700 million).

As mentioned earlier in the report, the Institute of Defense Analyses (IDA) completed a feasibility analysis of the strategic airlift and sealift platforms examined in the AMCS Phase II. The analysis of the SDHSS highlighted a couple of issues:

- "No near-term performance above 40 knots is feasible. The issues of drag, propulsive power, and dynamic stability in waves are unknowns today."[45]

- "In the far term, feasibility is possible with significant investment in critical technologies. However, the issues of installing sufficient power into a hull, designing an integrated propulsion system, reducing drag, and controlling dangerous motions and accelerations must be addressed."[46]

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[43] U.S. Department of Army, *Advanced Mobility Concepts Study,* Dec. 2003, pp. 4-7.

[44] U.S. Department of Army, *Advanced Mobility Concepts Study,* Dec. 2003, pp. 4-8.

[45] James Fein et al., *Technical Capabilities Assessments of the Phase II Advanced Mobility Concepts Study (AMCS) Concepts,* Institute for Defense Analyses (IDA), IDA Document D-2996, June 2004, p. 58.

[46] James Fein et al., op. cit., p. 58.

- Because of these concerns, IDA felt the SDHSS was "Marginally Feasible"[47] in the "Far Term" (FY2016), but with oriented technology investment.[48]

Figure 3: Fast Sealift - Monohull

Source: Institute of Defense Analyses

Fast Sealift - Monohull. The Fast Sealift - Monohull is a semi-planing monohull. The inter-theater vessel would be capable of transporting 8,000 short tons or 158,000 square feet of cargo, traveling at speeds up to 38 knots, with a range of 6,000 nautical miles. It is a commercially designed platform, but with some modifications the ship could move military cargo.[49]

The Monohull design exploits a unique deep, V-shaped bow hull design to create lift at the stern, which coupled with water jet propulsion would allow it to carry heavy loads with great stability at high speeds.

Potential advantages of the Monohull include:[50]

- Given that the Monohull is being developed for commercial application, the technology could be leveraged for military needs with little cost to the DOD.
- With only 12' of stern draft, the Monohull may offer access to shallow draft ports with very steep beach gradients (at least 10%), when "med-moored."[51]
- With 38 knots of speed, it is faster than any current strategic sealift.

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[47] Feasibility assessments are based upon judgements that technology capabilities can be achieved with no more than medium risk. Marginally feasible indicates that the assessed performance "nearly meets" the AMCS performance in the judgement of the (IDA) analyst and/or may be feasible but at high risk.

[48] James Fein et al., op. cit., p. ES-3.

[49] U.S. Department of Army, *Advanced Mobility Concepts Study,* Dec. 2003, pp. 4-16.

[50] Ibid.

[51] "Med-mooring" is defined as a ship that unloads its cargo directly out of the stern (or back) of the ship. Traditionally, ships off-load their cargo while parallel to the shore or pier. The Monohull would off-load its cargo while perpendicular to the shore or pier.

Some of the drawbacks of the Monohull are as follows:[52]

- There are no passenger accommodations. This would affect enroute mission planning and arrival into an operating area ready to fight. NAVSEA is examining the capability to transport passengers using modules, which would be used at the expense of cargo.
- The loaded maximum draft of 35 feet limits access to a number of ports.
- The Monohull has unique load/unload requirements that could limit port access.

When IDA examined the Monohull, it had the following issues:[53]

- Drag. Monohulls have high drag that is caused by frictional drag and wave drag. It is thought that the semi-planing form will reduce drag, but not eliminate it.
- Due to a slender high-speed hullform, there may be a roll stability issue.
- Rough water performance is an issue. Roll and pitch fins may be required, but will also increase the drag.

IDA categorized the Monohull as "Marginally Feasible" in the "Near Term" (FY2006) and "Far Term" (FY2016), without oriented technology investment. It also categorized it as "Feasible" in the "Far Term" (FY2016), but with oriented technology investment.[54]

Figure 4: NVTHSS

Source: Naval Sea Systems Command

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[52] U.S. Department of Army, *Advanced Mobility Concepts Study*, Dec. 2003, pp. 4-17.

[53] James Fein et al., *Technical Capabilities Assessments of the Phase II Advanced Mobility Concepts Study (AMCS) Concepts*, Institute for Defense Analyses (IDA), IDA Document D-2996, June 2004, p. 47.

[54] Ibid., p. ES-3.

Navy Vision Trimaran High Speed Sealift (NVTHSS). The NVTHSS would be 1,060 feet in length and have a beam of 129 feet. It would have a 28-foot draft and a range of 8,700 nautical miles. It would transport 4,500 short tons or 88,500 square feet of cargo, while simultaneously carrying 1,000 passengers. If no passengers are carried, it can transport an additional 32,599 square feet of cargo or 500 short tons. It would be designed to have a cruise speed of 55 knots. The Trimaran design is a slender monohull with two side hulls for added stability. The slender form allows reduced drag and greater speed than conventional sealift.[55]

Potential advantages of the NVTHSS include

- It could deliver cargo/personnel at much higher speeds than current sealift.
- Its shallow draft could decrease dependency on major ports and provide alternatives when adversaries deny access to major sea ports.

Potential disadvantages of the NVTHSS include:

- The NVTHSS's width could prevent transit through the Panama Canal, and the length may restrict access to smaller ports.
- The cargo capacity is less than current sealift (the LMSR can carry 300,000 square feet of cargo).[56]

The Army's AMCS and the IDA study noted the following issues:[57]

- A limited number of shipyards are capable of building this ship owing to its length. The ship is similar in length to an aircraft carrier, and longer than any current sealift ship.
- Further study may be required for passenger transport due to the lift support requirements.
- A speed of 55 knots may not be feasible due to passenger comfort. Further study may be required on the high speed effect on passengers in the open ocean.
- As with the SDHSS, hydrodynamic drag, propulsion, and speed effects are unknown and result in an assessment of "Marginally Feasible" in the "Far Term" (FY2016).[58]

If the speed requirement was decreased to 40 knots (or less), the IDA analysts thought that this design would be feasible in the near term (FY2006).

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[55] U.S. Department of Army, *Advanced Mobility Concepts Study,* Dec. 2003, pp. 4-20.

[56] Ibid.

[57] Ibid.

[58] James Fein et al, *Technical Capabilities Assessments of the Phase II Advanced Mobility Concepts Study (AMCS) Concepts*, Institute for Defense Analyses (IDA), IDA Document D-2996, June 2004, pp. 50 and ES-3.

Navy Vision Surface Effects Ship High Speed Sealift. The Navy Vision Surface Effects Ship High Speed Sealift (NVSESHSS) would have a length of 944 feet and a beam of 195 feet. It would have a variable draft of 9.8' to 24.7'. It has a design range of 8,700 nautical miles and be able to transport 97,700 square feet of cargo or 4,500 short tons, when configured for 1,000 passengers. If not configured for passenger carry, the ship could carry an additional 32,500 square feet of cargo or 500 short tons. It would have a cruise speed of 60 knots.[59]

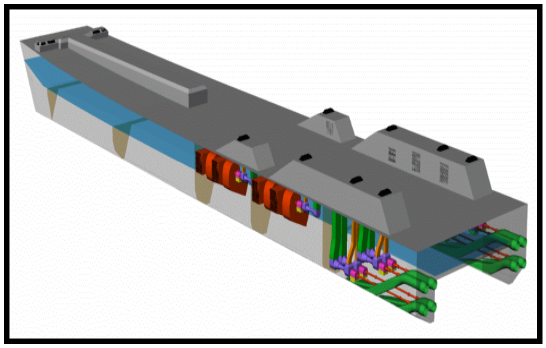

Figure 5: NVSESHSS

Source: Naval Surface Warfare Center - Carderock Division

The Surface Effects Ship also has rigid catamaran-like sidehulls and uses bow and stern seals to create a plenum (or air-filled space) that is pressurized. The result is a ship that is 80% supported by air and 20% by buoyancy. When the plenum is pressurized (on cushion), the wetted surface of the sidehulls is reduced, hence reducing drag and allowing high speeds.[60]

Potential advantages of the NVSESHSS [61] include

- The NVSESHSS could travel almost three times faster in open water than the Large, Medium Speed, Roll-on/Roll-off ship, but with only a third of the cargo capacity and 3/4 of the range.
- With the cushion option, it can use shallow, austere seaports, decreasing dependency on major ports, and increase access alternatives when adversaries deny major sea ports.

Potential disadvantages of the NVSESHSS include

- Due to the ship's length and width, the ship may have limited access to small coastal and riverine ports, as well as the Panama Canal.
- Due to the ship's length and beam, there will be a limited number of ship building yards capable of building the NVSESHSS.

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[59] U.S. Department of Army, *Advanced Mobility Concepts Study,* Dec.2003, pp. 4-21.

[60] For more information on high speed sealift, please refer to the following website: [http://www.globalsecurity.org/military/systems/ship/hss.htm].

[61] U.S. Department of Army, *Advanced Mobility Concepts Study*, Dec. 2003, pp. 4-21.

One of the current issues with the NVSESHSS is as follows:[62]

- Even if 60 knots of speed is possible, the detrimental effects on the passengers may need to be evaluated in an open ocean study.

When IDA examined the NVSESHSS, it had the following issues:[63]

- Speed in excess of 40 knots is not feasible in the near term.
- For the far-term, the Surface Effect Ship (SES) has a distinct disadvantage at lower speeds. The cost of the cushion lift far outweighs any reduced drag. The speed of the SES should only be considered at speeds of 55 knots or higher.
- In the far term, this design is possible with significant investment in critical technologies. The issues of installing sufficient power, designing an integrated propulsion system, reducing drag, and controlling dangerous motions and accelerations must still be addressed.

For the NVSESHSS, IDA categorized it as "Marginally Feasible" in the "Far Term" (FY2016), but with oriented technology investments.[64]

Intra-theater Designs with Potential Strategic Applications. There are two additional ship designs that could possibly be used for strategic lift. They are the high speed catamaran and a "hybrid lifting body ship" that combines the high speed capabilities of a hydrofoil and the rough water stability of a small waterplane area twin hull (SWATH). Currently, these designs pertain to intra-theater vessels, but future technologies may allow this design to be applied to inter-theater vessels.

High speed catamarans are already commercially available, but are primarily used for the intra-theater role. The Australian Navy's HMAS Jervis Bay is an example of this type of technology. It can transport up to 500 troops, with their vehicles and equipment, up to a range of 1,000 nautical miles, at speeds of more than 40 knots.

The U.S. Navy and Army are currently chartering catamarans from two Australian companies, INCAT[65] and Austal. The Navy's Military Sealift Command (MSC) is chartering the Westpac Express (manufactured by Austal) for the III Marine Expeditionary Force. MSC is also chartering another high speed catamaran to support U.S. Navy Mine Warfare Command, the High Speed Vessel (HSV) 2 Swift (manufactured by INCAT).

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[62] U.S. Department of Army, *Advanced Mobility Concepts Study,* Dec. 2003, pp. 4-22.

[63] James Fein et al., *Technical Capabilities Assessments of the Phase II Advanced Mobility Concepts Study (AMCS) Concepts,* Institute for Defense Analyses (IDA), IDA Document D-2996, June 2004, p. 54.

[64] Ibid, p. ES-3.

[65] For more information on INCAT's Catamaran ships, please refer to the following website: [http://www.incat.com.au/defence.cgi?task=HSV].

The Army's Tank Automotive and Armament Command is also leasing two catamarans. The two catamarans are the Joint Venture HSV-X1 and the Theater Support Vessel (TSV) - 1X (both manufactured by INCAT).[66] The Army is using these vessels to demonstrate the range of capabilities that a similarly designed fleet would provide the joint force commander. The TSV is part of the Army's transformation plans. The Army believes that the TSV will greatly enhance intra-theater deployment and logistics support for its units worldwide.[67]

International Catamaran has conducted studies on catamarans with design goals of 3,000 tons of cargo, 50 knots of speed, and a range of 3,000 nautical miles. "In the future, a vessel with 5,000 - 10,000 tons of cargo capability at 40 knots with a range of 35,000 nautical miles may be feasible."[68]

The Navy believes that another future technology could be the "hybrid lifting body ship." The hybrid lifting body ship is a catamaran-like ship with a mid-hull foil and an aft foil with twin propellers. As the ship picks up speed, the hull comes completely out of the water, carried by the wing-like foils. This reduces drag and wave action, thus giving it a smoother ride at faster speeds in rougher seas. Currently, Navatek Ships, a Hawaii-based firm, is testing this technology on the Sea Flyer. Sea Flyer is a 160-foot, 340-ton craft designed in the 1980s as an experimental patrol and support ship. It was mothballed until the Navy donated it to Navatek. In April 2001, Navatek was awarded a $6.3 million Navy contract to demonstrate and evaluate lifting body technology for future hull designs. After modifications, the Sea Flyer can travel at a maximum speed of 30+ knots with a draft of 18.5 feet. Steven Loui, Navatek's president, said: "The goal has been to get the technology that gives us the speed and efficiency of the hydrofoil with the comfort of a SWATH ship."[69] He went on to say that Navatek would like to extend this technology to war ships, but also noted that there is a lot skepticism that this technology can be scaled to the 2,000 to 5,000-ton ship range.

Airlift

A number of potential strategic airlift platforms are under consideration, these include the Global Range Transport (GRT), the Super-Short, Take-off and Landing (SSTOL) aircraft, spiral development of the C-17 - Payload/Range Expansion Program (PREP), the Ultra-Large Airlifter (ULA), Unmanned Aerial Vehicles (UAVs), the Wing-in-Ground Effect (WIG) Aircraft, and seaplanes.

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[66] For more on the HSV-X1, the TSV-1X, the HSV 2 Swift, and the WestPac Express, see [http://www.globalsecurity.org/military/systems/ship/hsv.htm].

[67] For more information on the Army's TSV plans, see [http://www.ausa.org/PDFdocs/tsv.pdf].

[68] "High Speed Sealift," *GlobalSecurity.org*, [http://www.globalsecurity.org/military/systems/ship/hss.htm].

[69] Gidget Fuentes, "Sea Flyer Challenges Rough Waters: Unique Design Boosts Speed, Wave Stability," *Defense News*, Oct. 11, 2004, p. 26.

Figure 6: Global Range Transport

Source: Boeing Frontiers, April 2004

Global Range Transport (GRT). The GRT would be a blended wing body (BWB) aircraft potentially capable of carrying 459,000 pounds with a range of 3,860 nautical miles, or 157,150 pounds of payload with a range of 10,841 nautical miles. It would carry 584 passengers and travel at 489 knots.

If built, it would be the largest aircraft ever designed and flown. It would have a maximum takeoff weight of 1,357,000 pounds. In contrast, the C-5, which is currently the largest U.S. military aircraft, has a maximum takeoff weight of 840,000 pounds.[70]

The GRT is currently one of the notional examples for Air Mobility Command's next generation of airlifters. The next generation airlifter has been dubbed the Advanced Mobility Concept, or AMC-X.[71]

Potential advantages of the GRT include

- The ability to move large amounts of cargo/passengers over long distances. The GRT could transport 2.5 times more cargo than the C-5, but would be approximately the same size as the C-5. This would make for more efficient use of the limited amount of ramp space available at the airports.[72]
- If the military desires this capability, the technology has applicability across a number of missions such as Intelligence, Surveillance, and Reconnaissance, Tanker/Transport and Bomber.

One of the potential disadvantages of the GRT may be that it will require at least a 7,000 foot runway at a fixed aerial port.

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[70] James Fein et al., op. cit., p. 17.

[71] John A. Tirpak, ed., "New Transports Taking Shape," *Washington Watch*, Oct. 2004, Vol. 87, No. 10, p. 5.

[72] U.S. Department of Army, *Advanced Mobility Concepts Study*, Dec. 2003, pp. 4-18.

Some of the current issues with the GRT are as follows:[73]

- There is a limited commercial interest in this concept. Almost all funding for the GRT would have to be by the government, since industry does not appear to be heading in this direction. The government could seek agreement to recoup the RDT&E cost if there is an industry demand.

- There is a technological challenge for a BWB due to manufacturing techniques. This challenge could possibly be mitigated by leveraging the existing work on the B-2 stealth bomber.

When IDA examined the GRT, it documented several issues/challenges:

- One area of concern was the key technologies needed to make this design feasible. IDA mentions weight, propulsion, and the Lift/Drag (L/D) ratio.
- Another area of concern is aerodynamics, in particular the pitching moment.[74] BWBs have no tail to balance the large pitching-moment increases.[75]

IDA's analysis states that the GRT is "Marginally Feasible" in the "Far Term" (FY2016), but "Feasible" in the "Far Term" (FY2016), but with oriented technology investment.[76]

Figure 7: SSTOL Aircraft

Source: Boeing Frontiers, February 2003

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[73] U.S. Department of Army, *Advanced Mobility Concepts Study,* Dec. 2003, pp. 4-18.

[74] A pitching moment determines how much an aircraft's nose will pitch up or pitch down of its own accord.

[75] James Fein et al, "Technical Capabilities Assessments of the Phase II Advanced Mobility Concepts Study (AMCS) Concepts," *Institute for Defense Analyses* (IDA), IDA Document D-2996, June 2004, pp. 18-19.

[76] Ibid., p. ES-3.

Super Short Take-Off and Landing (SSTOL) Aircraft. The SSTOL aircraft is designed as a tilt-wing, no-tail, turbo-prop aircraft capable of taking off and landing in just 1,000 feet of runway. It would be able to carry 72,000 pounds of outsize or oversize cargo, or 80 passengers, or a mix of the two. It is designed to have a cruise speed of 380 knots and a range of 3,100 nautical miles.[77]

The SSTOL aircraft is intended to be big enough to deliver the Army's Future Combat System (FCS) vehicles directly to the forward area. The cargo capacity could be 50 - 100 percent greater than the C-130, the current primary transport aircraft.

Potential advantages of the SSTOL aircraft include:[78]

- By landing in just 1,000 feet, the SSTOL aircraft frees up the limited amount of ramp space available at aerial ports.
- By delivering forces/equipment directly to the battlefield, it minimizes the footprint at the Aerial Ports of Debarkation (APODs).
- In contrast to the C-130, the SSTOL will be able to carry oversize and outsize cargo. Currently, only the C-5 can carry oversize and outsize cargo.

Two potentially constraining factors for SSTOL development are cost and unproven technology.[79] Since there is limited commercial use for this aircraft, DOD would have to provide all research and development funding. The wing and flight controls for the "no-tail" design pose a significant technological challenge. Leveraging the work done on the Osprey may mitigate risk for the tilt wing. Leveraging the work done on the B-2 bomber plus teaming with the GRT may mitigate risk for the flight controls.

IDA's analysis states that the SSTOL aircraft is "Marginally Feasible" in the "Far Term" (FY2016), but "Feasible" in the "Far Term" (FY2016), with oriented technology investment.[80]

C-17 Spiral Development (Payload & Range Expansion Program). The C-17 Spiral Development Payload and Range Expansion Program (PREP) is a long-range plan to modernize the C-17 aircraft. The PREP will increase the aircraft's payload and extend its range. The intent is to increase the average payload from 45 short tons (90,000 pounds) to 49 short tons (98,000 pounds) and change the maximum range from 4,600 nautical miles to 6,300 nautical miles.[81]

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[77] U.S. Department of Army, *Advanced Mobility Concepts Study,* Dec. 2003, pp. 4-13.

[78] Ibid.

[79] U.S. Department of Army, *Advanced Mobility Concepts Study,* Dec. 2003, pp. 4-14.

[80] James Fein et al, op. cit., p. ES-3.

[81] U.S. Department of Army, *Advanced Mobility Concepts Study,* Dec. 2003, pp. 4-19.

A potential advantage of the C-17 PREP includes:

- The PREP seeks to allow more flexibility to support strategic and tactical missions by eliminating enroute stops and allowing direct delivery of forces, thereby reducing deployment times.[82]

Potential disadvantages of the C-17 PREP include:[83]

- It may not be possible to take advantage of PREP on all missions. The aircraft could run out of floor space before it actually exceeds aircraft weight limits.
- When the C-17 lands on "soft fields," it may not be able to take advantage of the increased gross weight capacity.

The IDA study states that three modifications would be needed to achieve the desired range and cargo capacity increases. First, the fuselage would need to be strengthened and extended to allow more payload, troops, and fuel to be carried. Second, the C-17 would need a more efficient wing so as to be able to handle the increased weight. Third, the C-17 would need engines with a lower specific fuel consumption (SFC).[84]

In summary, the IDA study thought the C-17 PREP was "Marginally Feasible" in the "Near Term" (FY2006) and "Far Term" (FY2016), and "Feasible" in the "Far Term" (FY2016), with oriented technology investment.[85]

Ultra-Large Airlifters (ULA). There are two ULA designs that this report will examine — the Vertical Take off and Land (VTOL) Crane variant and the Conventional Take Off and Land (CTOL) variant.[86] Both are commonly characterized as lighter-than-air aircraft.

The VTOL Crane variant is based on a conventional ellipsoidal airship that uses a crane to lower/raise the payload bay. It is nominally a vertical takeoff and land vehicle. The VTOL Crane uses static lift (buoyancy) to stay aloft. The VTOL Crane variant had a design goal of 176 short tons.

Source: Office of Force Transformation

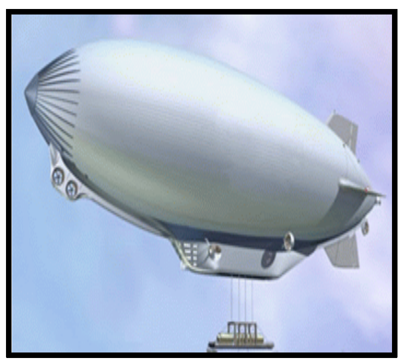

Figure 8: VTOL Crane

[82] U.S. Department of Army, *Advanced Mobility Concepts Study*, Dec. 2003, pp. 4-19.

[83] Ibid., pp. 4-19 - 4-20.

[84] James Fein et al., op. cit. p. 23.

[85] Ibid., p. ES-3.

[86] See CRS Report RS21886, *Potential Use of Airships and Aerostats*, by Christopher Bolkcom, for more information on lighter-than-air (LTA) platforms.

The CTOL variant, also called a hybrid lifting body airship, combines static lift (buoyancy) with aerodynamic lift. The aerodynamic lift is intended to allow a ship of the same size as an ellipsoidal airship to have greater lift and thus carry more cargo. The hybrid shape should also allow for a higher cruising speed for the same power. The hybrid airship may require a takeoff run that will exceed 10,000 feet in some cases. An unimproved field or water may be used for the takeoff run, but it must be relatively flat. The field must also be clear of trees, power lines, and other obstacles. The CTOL variant had a design goal of 500 short tons.

Figure 9: CTOL Variant

Source: [http://www.globalsecurity.org/military/systems/aircraft/skycat.htm].

The Advanced Mobility Capability Study (AMCS) examined a "blended" (or combined) variant of the CTOL and the VTOL Crane ULAs. The "blended" ULA had a design goal of 338 short tons at a speed of 76 knots for a range of 5,600 nautical miles.[87] AMCS participants believed this type of modeling "provided a solid, measurable means to apply professional judgment and compare various platforms."[88]

Potential advantages for the ULA included:[89]

- Could bypass the traditional ports (APODs and SPODs) to mitigate an enemy's access denial strategies.
- Designed to offload cargo in flat open areas, thus possibly delivering cargo direct to the battlespace.
- Hybrid advocates have proposed that the CTOL variant could land on, and operate from, bodies of water (rivers or bays).
- Proposed cargo capacity could be approximately three to eight times the tonnage capacity of a C-5 (C-5 planning factor is 61.3 short tons).

- Testing by the manufacturer on Lighter-Than-Air vehicles showed limited radar signature and significant survivability to direct fire.

Potential disadvantages of the ULA include:[90]

- At 76 knots, it is roughly 1/5 the speed of a C-5/C-17, though it can maintain this speed for 24 hours per day for multiple days.[91]

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[87] U.S. Department of Army, *Advanced Mobility Concepts Study,* Dec. 2003, pp. 4-8.

[88] Michael Woodgerd, LTC, USA, Center for Army Analysis, interview by author, Washington, Feb. 15, 2005.

[89] U.S. Department of Army, *Advanced Mobility Concepts Study,* Dec. 2003, pp. 4-9.

[90] Ibid.

[91] Michael Woodgerd, LTC, USA, Center for Army Analysis, interview by author, (continued...)

- The maximum projected altitude for the ULA is 6,000 feet. This altitude will limit access and transition in higher mountain areas of the world.

- The "blended" variant carried 76 passengers to simulate support personnel for carried equipment. More passengers could be carried at the expense of cargo. If passengers are carried, life support and safety requirements would need to be further examined, as well as human factors for long duration flights.

- If airports are used, ULA arrivals and departures could limit or shutdown aircraft operations, effect airflow, and decrease throughput.

AMCS analysts have stated the following as issues for the ULA:[92]

- **Ballast.** Both variants of the airships need ballast to keep themselves within weight limits. As cargo is offloaded, either ballast must be added or helium must be vented into the air. The most common type of ballast is water. In an austere environment, it may be difficult to find water or other material that can be used as ballast.

- **Offload.** For the prototype variant of the ULA, the "offload" and "expedited offload" times of 6 and 5 hours, respectively, may be somewhat optimistic.

- **Landing Zones.** The CTOL variant of the ULA requires a large landing zone. Due to this fact, the number of ULAs in one area may be limited. It is estimated that the largest potential landing zone would be the equivalent of 109 football fields. The VTOL variant would require significantly less space, approximately three football fields.

One of the strengths of the ULA is its advertised capability to operate from unimproved landing sites. Critics of the ULA's CTOL variant often mention the landing zone or footprint requirement needed for it to operate. As a minimum, it would appear that at least 3,500 feet would be required for the CTOL variant to land. In an 80,000 square mile survey across the planet, Boeing analysis found that on average only 1% of this area allowed a feasible landing zone of approximately 3,500 feet or longer. On the other hand, it was found that almost 50% of this area allowed a feasible landing zone of 1,000 feet. This data would appear to give more credence to the VTOL crane variant, which proponents have said would require a landing zone of approximately 1,000 feet.

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[91] (...continued)
Washington, Feb.15, 2005.

[92] *Advanced Mobility Concepts Study*, Department of Defense, Dec. 2003, pp. 4-10.

The IDA study only examined the CTOL variant, but some of its conclusions and technical issues may pertain to both variants. The study mentioned the following ULA issues:[93]

- The airships size will be limited by the strength of the available fabrics, joining methods, and facilities. Research needs to be done in fibers, yarns, weaves, and bonding technology.[94] Even if seaming for large airships is feasible, faster seaming machines will need to be developed that can seam thick fabrics. For final vehicle assembly and envelope fabrication, a covered expanse, similar in size to a football stadium, will be needed.

- Further study of the aerodynamics of the lifting body is required near the ground and in free air.

- Further study of ballast is required to offset fuel expenditure and discharge of cargo.

- IDA recommended that the design be done in steps. First, design a 30-ton introductory version, then move to larger capacity craft as the design matures.[95]

The IDA study stated that the ULA was "Infeasible" in the Near Term (FY2006), "Marginally Feasible" in the Far Term (FY2016), and "Feasible" in the Far Term (FY2016) with oriented technology investment.[96]

Advocates for the ULA feel that the VTOL Crane variant with approximately 200 short tons of capacity is feasible today with current technology.[97]

Unmanned Aerial Vehicles (UAVs). In 2001, Northrop Grumman's Global Hawk flew 7,500 nautical miles nonstop from the U.S. West Coast to Australia. It had no pilot in the cockpit or on the ground to remotely guide it. It was a totally

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[93] James Fein et al., *Technical Capabilities Assessments of the Phase II Advanced Mobility Concepts Study (AMCS) Concepts,* Institute for Defense Analyses (IDA), IDA Document D-2996, June 2004, pp. 31-33.

[94] With current fabric technology, a fabric of three plies would allow an envelope volume of 5.3 million cubic feet. To reach a capability similar to that of the "prototype" variant (338 tons), an envelope volume of at least 24.4 million cubic feet would be needed, or a fabric that is about 5 times as strong as current fabrics.

[95] DARPA is funding research on the WALRUS program. The program is a design and development effort where the primary objective is to demonstrate the feasibility and viability of a large airship to transport a Unit of Action from 'Fort to Fight.' The ultimate goal is for the WALRUS to be able to lift 500 tons or more across intercontinental distances and that it will be capable of operating from unimproved landing sites.

[96] James Fein et al., op. cit., p. ES-3.

[97] Michael Woodgerd, LTC, USA, Center for Army Analysis, interview by author, Washington, Feb. 15, 2005.

computer-controlled, automatic flight. The UAV took off, performed a tight spiral climb to the cruise altitude of 65,000 feet, traveled enroute at more than 350 knots, performed a steep, spiral descent, and then executed a fully automatic landing to a full stop.

Some proponents of the UAV maintain that this mission proves that the technology exists to manufacture a UAV cargo-only transport. Though the technology may exist, there currently does not appear to be any immediate plans to develop such a UAV. Upon reviewing the DOD's Roadmap for developing and employing UAVs through the year 2027, it does not show any introduction of a UAV cargo transport until the 2025 - 2030 timeframe.[98]

The DOD Roadmap does state that there are many advantages offered by UAVs to military commanders, most notably in the mission areas categorized as "the dull, the dirty, and the dangerous." For now, this seems to be the DOD's focus. For example, it mentions that one UAV with multiple sensors could survey the same area as ten or more human sentries ("the dull"). UAVs could survey areas contaminated with chemical, biological, or radiological agents without risk to human life ("the dirty"). Also, UAVs could perform the duty of suppression of enemy air defenses (SEAD) that F-16s and EA-6s currently perform ("the dangerous"), with less need for supporting aircraft.[99] The next DOD Roadmap is due for release in Spring 2005.

If 2025 is indeed a target for a UAV cargo transport, then this timeframe is only 20 years away. If the development spans for current weapon systems are any indicator (e.g. the F/A-22 started development in 1986), then some observers have noted that now may be the time to examine the UAV cargo transport. The first hurdle commonly mentioned is access to the National Airspace System (NAS). In particular, if a UAV cargo transport is to fly, it would most likely need access to the 18,000 feet to 40,000 feet flight levels. To operate freely in the NAS, UAVs are going to be expected to operate identically to manned aircraft. An air traffic controller should not even know whether or not an aircraft is manned.

A thorough UAV assessment was undertaken by a combined Joint Aviation Authority/Eurocontrol UAV Task Force over a 18-month period during 2003 - 2004.

> The critical yardstick that the task force used in assessing UAV operations was whether they met an equivalent level of safety, compared with conventionally manned aircraft. In discussing airworthiness, therefore, the report stated that a civil certificate of airworthiness (or its military equivalent) would be mandatory to enter civil controlled airspace.[100]

This would mean that UAV cargo transports intended to be operated in the NAS would have to be built in certified aircraft manufacturing plants, that they would have to use approved aeronautical standards and materials, be subject to all aviation

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[98] U.S. Department of Defense, *UAV Roadmap 2002*, p. 58.

[99] U.S. Department of Defense, *UAV Roadmap 2002*, p. iv.

[100] William Reynish, "UAVs Entering the NAS," *Aviation Today*, Feb.10, 2005.

inspection processes and procedures, and pass rigorous flight test certification. The UAVs would be also subject to an approved maintenance program, which would have to be performed by licensed personnel in airframe, engines, electronics, etc.

For a transport UAV to fly in the NAS, it would be expected to file and fly Instrument Flight Rule (IFR) flight plans . . . just like manned flights. The airlift UAV will most likely need to rely on a variety of communication, navigation, and surveillance (CNS) technologies to safely and efficiently operate in civil airspace. Some analysts have noted that current manned cargo transports already rely heavily on automation in all areas of flight, to include take-off, cruise, and landing. As long as the UAV cargo transport is equipped with the normal avionics associated with manned flight, then the navigation and surveillance technologies would not appear to present any significant challenges. Equipment such as an onboard Traffic Alert Collision Avoidance System (TCAS), inertial navigation and global positioning systems (INS and GPS), real-time weather avoidance radars, Automated Dependent Surveillance - Broadcast (ADS-B), Traffic Information Service (TIS), a flight control guidance system, an Enhanced Ground Proximity Warning System (EGPWS), and non-cooperative sensors are some of the systems that may be required. These are essential for the safe, secure, and reliable integration of the UAV into the NAS.

UAV CNS issues were recently examined at the 2004 NASA Integrated CNS Conference and Workshop held from April 26 - 30, 2004.[101] The one area this conference highlighted throughout was the area of communication. There are two communication links required for remotely piloted UAV operations: (1) the interface between the UAV pilot and Air Traffic Control; (2) the interface between the UAV pilot and the aerial vehicle. Both of these have a need for Line of Sight (LOS) and Beyond LOS capability. The specific challenges for this type of communication are:

- Latency - how much of a delay is acceptable?
- Security - prevention of unauthorized seizure of UAV and to ensure protection from jamming/spoofing/sabotage.
- Availability/Reliability - a lost link problem.
- Link Quality - the need to provide sufficient voice quality and limited data degradation.
- Sufficient Bandwidth - potential for saturation of available bandwidth in a given geographical area.

These issues will need to be addressed if the future UAV cargo transport is remotely piloted. But what if the UAV is not remotely piloted? The other alternative may be a totally computer-controlled, automatic flight such as the Global Hawk.[102]

To develop this type of UAV, observers commonly mention a couple of options. One, the DOD could develop a brand new UAV cargo transport. At a minimum, the

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[101] John S. Walker, *Enabling America's Next Generation of Aviation Vehicles*, briefing given at 2004 NASA ICNS Conference & Workshop, April 26-30, 2004. [http://spacecom.grc.nasa.gov/icnsconf/2004/agenda.shtml].

[102] See CRS Report RL31872, *Unmanned Aerial Vehicles: Background and Issues for Congress,* by Christopher Bolkcom, for more information on UAVs.

typical development span is about 12 years. Another idea that some analysts have mentioned is to modify existing aircraft.

Though no UAV cargo transports are currently being developed by the DOD, there does appear to be commercial interest in the idea. "Don Barber, senior vice president at FedEx, told ATCA (Air Traffic Controllers Association) attendees he believes that, though unmanned air freighters "may not be ubiquitous soon," UAV cargo transport "will be a demonstrated reality" in the near future."[103] For the air freight industry, two of the biggest expenses are fuel and pilot salaries. If the pilot could be removed, significant savings may be achieved. Though this type of technology could possibly be utilized in the airline industry, many analysts have stated that it will be some time before passengers will permit the removal of the pilot from the cockpit.

Wing-In-Ground Effect Aircraft. The wing-in ground effect (WIG) aircraft is designed as a long-range, transoceanic transport. It is intended to fly as low as 20 feet above the sea and take advantage of an aerodynamic phenomenon called ground effect that reduces drag and fuel burn. The aircraft's size and efficiency could allow it to carry the equivalent of current day cargo container ships, but at ten times the speed. It is intended to be capable of flying at the same speed and altitude as most turboprop aircraft — 300 mph and up to 20,000 feet, but most of its flight pattern it will be hugging the water's surface and taking advantage of the ground effect. The WIG would be designed for a range of 10,000 nautical miles over the water.

Figure 10: WIG Aircraft

Source: Boeing Phantom Works

The WIG aircraft would be 400 feet long, have a wing span of 500 feet, and be powered by four pairs of 80,000-hp turbine engines. If built, it would be the largest aircraft ever flown. Designs indicate it would weigh 3.2 million pounds, with a potential to carry 2.8 million pounds of cargo. It would carry the same amount of cargo as a Large, Medium Speed Roll-on/Roll-off ship at ten times the speed.[104]

Potential issues with the WIG aircraft are as follows:

- Extensive weather flight planning could be required to exploit tailwinds and avoid storms.

[103] David Jensen, "Steering Clear of a Perfect Storm," *Aviation Today*, Feb. 10, 2005.

[104] Bill Sweetman, "Monster at 20 Ft.," *Popular Science*, [http://www.popsci.com/popsci/aviation/article/0,12543,410266,00.html].

- Flight characteristics at low altitude may make it hard to control. One of the WIG designers states the controls will need to be highly automated.
- The size of the aircraft may make maneuvering it on the ground difficult.
- The weight of the WIG may exceed the weight limits of most runways and taxiways around the world
- Some critics of the WIG, have said that cruising altitude would be so low that the aircraft would be at risk from rogue waves.[105]
- The vast size of the aircraft would mean a tremendous investment to develop an operational product. Since it is very large, the WIG would require more power for takeoff than for cruise. This would increase the mass of the engines, thus reducing payload and aircraft efficiency.[106]

Seaplanes. The Office of Naval Research tasked the Center for Innovation in Ship Design (CISD) to conduct a study on the utility of seaplanes in supporting the Navy's offshore Sea Base concept. It is thought that seaplanes with heavy lift capability may be simpler to integrate with the Sea Base concept than conventional aircraft. One of the potential missions would be bringing troops inter-theater to meet up with their pre-deployed equipment.

Production of seaplanes has been very limited since the 1960s. Examples of some modern era seaplanes are the Canadair CL-214 waterbomber, the Japanese Shin Meiwa US-1A search and rescue aircraft, and the Russian large multi-purpose seaplanes — the Be-200 and A-40.

Some of the issues addressed in the CISD final report, titled "Use of Seaplanes & Integration within a Sea Base" are:

- **Rough water operations**. It is pointed out that rough water operations are crucial during takeoff, landing, taxiing, cargo transfer, and aircraft survival. Based on open ocean wave data, the report states that a desirable goal for a Sea Based seaplane will be to have full operational capability in sea state 4 (below 8 feet in significant wave height), with limited operation in sea state 5 (below 13 feet in significant wave height).

- **Rapid takeoff and landing**. The report suggests that rapid takeoff and landing are important for high sea state performance to allow a seaplane to rapidly leave or enter the water while avoiding adverse motions and high fuselage loads.

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[105] Committee on Aeronautics Research and Technology for Vision 2050. Securing the Future of U.S. Air Transportation: A System in Peril," (National Academies Press: Washington, 2003), p. 33.

[106] Ibid.

- **Mooring and docking.** Ideally, most seaplanes are designed to be physically lifted from the water when not in use. This is done to protect the aircraft and reduce maintenance. As aircraft size increases this becomes progressively more difficult. The alternative is to have the seaplane "live" in the water. Even then, mooring and docking capabilities will be needed.

- **Ability to transfer a seaplane's payload to a ship in various sea states.** A CISD innovation cell recommended a new method of transferring payload using the Intermediate Transfer Station (ITS) concept. This concept utilizes a large platform deck area for cargo transfer. There is a high side and a low side to this deck. The deck would become a floating seaplane ramp, which would allow seaplanes to come onboard from the low side.

In a recent Massachusetts Institute of Technology project, a team designed a "heavy lift amphibious seaplane" that was specifically designed to meet the requirements for the Sea Basing concept.[107] Their final design allowed a payload of 40,000 pounds and a cruise range of 3,000 nautical miles. The seaplane is amphibious so it could transport cargo from remote land bases and land in the water to deliver its payload. One of the unique design features of this seaplane was the way it would deliver its payload. The seaplane was designed to deliver its payload through a "well deck" on existing amphibious warfare ships. The seaplane would land, taxi to the ship, insert its nose into a cushioned opening (called the auxiliary delivery system) on the well deck. The cargo would then be extracted through its "clam shell" doors in the nose of the seaplane. The report states that there are currently 54 naval vessels over 7 ship classes that use well decks. The seaplane could also dock with a floating platform and deliver cargo on beaches that are suitable for seaplane delivery. It had one other unique feature - the ability to deploy its landing gear in water. This feature could possibly allow the seaplane to do coastal delivery by driving up a water ramp.

Another design that some analysts feel may have merit is Lockheed Martin's Surface Effect Aircraft (SEA). It is primarily a seaplane, but uses two technologies to enhance its capabilities. The concept uses wing-in-ground effect technology, as well as, surface effect ship principles. The WIG technology would assist in increasing its range capability by approximately 25% if utilized. The surface effect ship technology would assist in getting the vehicle out of the water faster, thus shortening the takeoff distance and lessening propulsion requirements.

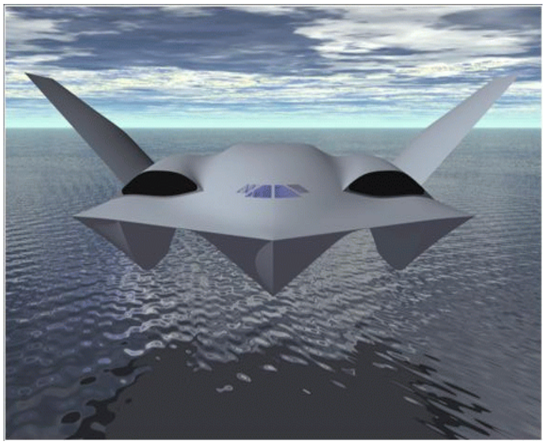

Figure 11: SEA

Source: Lockheed Martin

[107] Omar Bashir, Jean-Marc Freuler, David Smith, Matt Theis, Josh Walton, Brady Young. *Heavy-Lift Amphibious Seaplane for Enhancement of Seabasing*, Massachusetts Institute of Technology, Dec. 14, 2004.

Another innovation for the SEA is a modular concept. The designers believe that different modules could be used depending on the type of mission. The two different examples used were a Conventional Air-Launched Cruise Missile/Unmanned Aerial Vehicle Launcher Module and a Cargo Module.

The SEA is designed to carry the same payload as a C-5, about 270,000 pounds, with a range of 7,500 to 10,000 nautical miles depending on whether it is operating in or out of surface effect. It has an operational goal of 300 - 400 knots at less than 200 feet, but can also fly at normal deployment altitudes. Lockheed Martin also believes that the design may have potential for signature reduction, or "stealth".

Critics of the seaplane have said that they require more propulsion than similarly sized conventional aircraft to takeoff. There was also a concern in the takeoff and landing phase due to floating debris.[108]

Summary of Potential Strategic Mobility Platforms

The table below (Table 2) summarizes the main characteristics of each of the potential strategic mobility platforms. For comparison purposes, the Fast Sealift Ship (FSS), the Large, Medium Speed, Roll-on/Roll-off (LMSR) ship, the C-17, and the C-5 are shown. They are also lightly shaded.

Table 2: Summary of Potential Strategic Mobility Platforms

Platform	Range (nm)[4]	Payload[6] & Passengers	Speed (knots)	Takeoff and Landing Zones	Draft	Feasibility[1]		
						FY 06	FY16	FY16[3] w/tech investment
Fast Sealift Ship	12,200 at 27 knots	200,000 sq. ft. / 200 C-17 loads	33		36' 7"	In Service		
Large Medium Speed Roll-on/Roll-off	12,000 at 24 knots	300,000 sq. ft. / 400 C-17 loads	24		34'	In Service		
Shallow Draft High Speed Sealift	4,500	84,489 sq. ft. / 4,400 stons / 1,000 passengers	75		10'4"			Marginally Feasible[2]
Fast Sealift - Monohull	6,000	158,000 sq. ft. / 8,000 stons / no passengers	38		35'	Marginally Feasible[2]	Marginally Feasible[2]	Feasible
Trimaran High Speed Sealift	8,700	88,500 sq. ft. / 4,500 stons / 1,000 passengers	55		28'	Feasible at 40 knots	Marginally Feasible[2]	Marginally Feasible[2]

[108] Committee on Aeronautics Research and Technology for Vision 2050, *Securing the Future of U.S. Air Transportation: A System in Peril*, (National Academies Press: Washington, 2003), p. 33.

Platform	Range (nm)[4]	Payload[6] & Passengers	Speed (knots)	Takeoff and Landing Zones	Draft	Feasibility[1]		
						FY 06	FY16	FY16[3] w/tech investment
Surface Effects Ship High Speed Sealift	8,700	97,700 sq. ft. / 4,500 stons / 1,000 passengers	60		[5]9.8' /24.7'			Marginally Feasible[2]
C-17	2,400	170,900 lbs / 85.45 stons / 102 passengers	450	3,000'		In Service		
C-5	2,150	270,000 lbs / 135 stons / 76 passengers	518 mph	8,300/ 4,900		In Service		
Global Range Transport	3,860	459,000 lbs / 229.5 stons / 584 passengers	489	7,000'			Marginally Feasible[2]	Feasible
Super Short Take-Off and Land Aircraft	3,100	72,000 lbs / 36 stons or 80 passengers	380	1,000'			Marginally Feasible[2]	Feasible
C-17 Payload and Range Expansion Program	6,300 max ferry	98,000 lbs (avg payload) / 49 stons / 102 passengers	450	3,000'		Marginally Feasible[2]	Marginally Feasible[2]	Feasible
Ultra Large Airlifters	5,600	676,000 lbs / 338 stons / 76 passengers	76	CTOL - >3,500' VTOL - 1,000"			Marginally Feasible[2]	Feasible
Unmanned Aerial Vehicles - Cargo							Feasible[7]	
Wing-in-Ground Effect Aircraft	10,000	2.8 million lbs / 1,400 stons	300 mph	No Data				Marginally Feasible[7]
Seaplane - Surface Effects Aircraft	7,500 - 10,000	270,000 lbs / 135 stons	300 - 400	N/A				Marginally Feasible[7]
Seaplane - MIT	3,000	40,000 lbs / 20 stons	450	N/A				Feasible[7]

Notes:
(1) IDA feasibility assessments are based upon judgements that technology capabilities can be achieved with no more than medium risk.
(2) Marginally feasible indicates that the assessed performance "nearly meets" the AMCS performance in the judgement of the IDA analyst and/or may be feasible but at high risk.
(3) FY2016 w/tech investment - Fiscal Year 2016 with oriented technology investment.
(4) nm - nautical miles
(5) 9.8' of draft is with the air cushion on. 24.7' of draft is with the air cushion off.
(6) stons = short tons
(7) Based on assessment of the author using Technology Readiness Levels (TRLs). Achieving TRL5 should be feasible for all medium and some high risk technologies. The scale of the WIG and SEA made them marginally feasible. Both also use high risk technologies.

Congressional Oversight Issues

Strategic mobility innovation raises potential oversight issues for Congress in the following areas:

- Does Congress have sufficient information about the DOD's plans for lift, and potential lift platforms, to adequately assess investment options?
- To what degree, if any, should government funding be used to develop new lift platforms?
- What mix of lift platforms might be appropriate to both meet future U.S. commercial lift needs and potentially assist in meeting future military strategic lift requirements?
- Should any of these lift platforms be developed and procured in part to support the defense industrial base?
- Should procurement of airlift be expanded beyond current DOD plans, and if so, by how much, and with what platforms?

Further Study of Investment Options

- Does Congress have sufficient information about the DOD's plans for lift, and potential lift platforms, to adequately assess investment options?

Some analysts have noted that the following areas may require further study to adequately assess investment options:

- **High Speed Ships.** Some analysts have stated that speeds in excess of 50 knots may be detrimental to passengers on the open ocean. Further open ocean study may be needed to examine the effects on passengers in various sea states.

- **Fast Sealift - Monohull.** Further study may be required on "med-mooring" to determine how many ports this type of ship can access. Med-mooring is where the ship is perpendicular to the shore or pier. Without dedicated terminal facilities, what ports would the Monohull be able to access worldwide?

- **Double stacking aircraft cargo** may be one way to increase DOD airlift capability. For many of the DOD's current strategic assets, analysts have found that platforms run out of floor space before actually exceeding aircraft weight limits. To increase the current airlift capacity, further study may be needed in bilevel cargo loading(double stacking cargo). There currently are two Air Expeditionary Force Battlelab initiatives addressing this idea. The Bilevel Aircraft Loading System (BALS) and the Tactical Integrated

Packaging System (TIPS) are being examined as ways to increase airlift capacity.[109]

- **Ultra-Large Airlifters (ULAs).** Further ULA studies may be required in three areas: (1) The "foot print" required to support operations for the CTOL and VTOL Crane variants. Analysts have estimated that it may take up to the equivalent of 109 football fields for the landing zone of the CTOL ULA and the equivalent of 3 football fields for the VTOL Crane. This could be a significant issue if the desire is to land these ULAs in unimproved fields. (2) The ballast required to offset fuel expenditure and cargo discharge. Currently, the primary way of offsetting fuel expenditure and cargo discharge is with water. Other ways may include the venting of a lifting gas, vectored thrust, and onboard buoyancy control. (3) The fabrics, yarns, weaves, and bonding technology for the ULA. The size of the ULA is limited by the strength of the fabric. Bigger envelopes require more plies of fabric. Faster seaming machines are needed to bond (with heat) the thick fabrics.

- **Seaplanes and Intermediate Transfer Station (ITS) concept.** If the Navy continues to pursue the Sea Base concept, then some analysts have remarked that seaplanes (or even the wing-in-ground effect aircraft), as well as the Intermediate Transfer Station (ITS) concept may need further study. The feasibility of seaplanes that will be designed to have heavy lift capability and operate in sea states 4 and 5 may require further study. The ITS concept represents one way of getting the seaplanes out of the water and being able to offload cargo/personnel. Is the ITS concept feasible? Other forms of mooring and docking may also require further study.

Future Government Funding

Some of these future concepts appear to have little or no current commercial attraction and consequently are likely to require substantial government funding, unless ways are found to encourage commercial involvement. A potential oversight question for Congress is as follows:

- To what degree, if any, should government funding be used to develop new lift platforms?

Some analysts have highlighted these platforms or areas as possibly requiring future government funding:

- **Ship Research and Development (R&D).** At this time, IDA analysts have noted that no commercial or other R&D efforts are

[109] For more on these initiatives, see [http://www.mountainhome.af.mil/AWB].

expected in the next 10 years for high-speed sealift issues.[110] Without targeted investment in high speed ship technology, the feasibilities of the proposed future sealift platforms may not improve significantly. IDA believed that further R&D was needed in three areas: (1) installed propulsion systems; (2) impact of drag at high speeds (spray drag, appendage drag, and interference drag); (3) challenges of operating ships over 50 knots (e.g. controlling dangerous rolling motions and accelerations).

- **Shallow Draft, High Speed Sealift (SDHSS).** Many sources have noted the desirability of a shallow draft, high speed ship. Proponents of this ship have said that the high speed and shallow draft are requirements for future wartime engagements, in order to provide options when confronted with anti-access or area denial scenarios. On the other hand, critics of the ship have stated that the cavity catamaran technology has never been proven on a large scale. To date, the Florida-based ship designer, Howard Harley, has only manufactured vessels with this design on a much smaller scale. The High Speed Sealift Innovation Cell, a joint effort funded by the Navy and OSD, published a Technical Development Plan that identified $1.2 billion in potential R&D efforts, with the preponderance going to gas turbine research ($700 million).

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- **Global Range Transport (GRT).** There is a limited commercial interest in this blended wing body concept. If this concept is to become reality, then the majority of the funding for the GRT would need to come from the government. The technology from the B-2 stealth bomber program could be leveraged to possibly decrease costs. Also, if there is an industry demand, the government could seek agreement to recoup RDT&E costs.

- **Super-Short Take-Off and Landing (SSTOL) Aircraft.** There is again a limited commercial application for this concept. If this concept is to become a reality, then future government funding would most likely be required. The technology from the V-22 Osprey could be leveraged to reduce RDT&E costs. For this system to become achievable, analysts maintain that research would be required in high-lift technology, flight control integration, propulsion, and composite structures.

- **Ultra-Large Airlifter (ULA).** In April 2004, the Defense Advanced Research Projects Agency initiated a program to develop a 500-ton ULA that can fly 6,000 miles in four days. Phase I, which included system studies and development of a notional concept of the objective vehicle, has been completed, and Phase II, which will cost $50 million, will produce a 30-ton Advanced Technology Demonstrator by 2007, which the U.S. military will use to evaluate the concept. If

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[110] James Fein et al., op. cit., p. 7.

all goes well, a full-scale Phase III vehicle could then be developed and evaluated for potential production. Congress appropriated $10 million dollars to the Walrus program in the FY2005 budget. It's Program Element (PE) number is PE 0603285E, R-1 #32. The Walrus program falls under the Advanced Aerospace Systems project.[111]

- **Seaplanes.** The sea-based aircraft program may require extensive technology maturation. No significant seaplane technology advances have really occurred since the 1960s.

Commercial Applicability

Some of these future lift platforms may have direct commercial applicability. The potential oversight question for Congress is as follows:

- What mix of lift platforms might be appropriate to both meet future U.S. commercial lift needs and potentially assist in meeting future military strategic lift requirements?

Some analysts have noted that the following platforms may have some future commercial applicability:

- **Mobilus Initiative.** The Center for Army Analysis (CAA) is studying ways to develop a commercial Ultra Large Airlifter (ULA) capacity, which then could be accessed for military and/or government use (similar to the Civil Reserve Air Fleet). The "Mobilus Initiative"[112] seeks to use a balanced, cost sharing public/private partnership. The idea is to create a broad and deep mobility capability in the private sector that would be available for military use. The Mobilus Initiative will determine what would be required to bolster the lighter-than-air industry, which will be complementary to the current aerospace industry.[113]

- **Unmanned Aerial Vehicles (UAVs).** There does appear to be a commercial interest in an airlift UAV (e.g. FedEx). Once the national airspace system (NAS) concerns are addressed, then a joint DOD/commercial venture may be feasible. "Access 5" is a government/industry partnership made up of NASA, DOD, the FAA, along with UAV builders Boeing, Northrop, Grumman, Lockheed Martin, General Atomics, Aerovironment, and Aurora Flight

[111] For more on the budget activity of the Walrus program, see [http://www.dtic.mil/descriptivesum/Y2005/DARPA/0603285E.pdf].

[112] Michael Woodgerd, LTC, USA, Center for Army Analysis, interview by author, Washington, Feb. 15, 2005.

[113] For more info on the Mobilus Initiative, see [http://www.sddc.army.mil/frontDoor/0,1865,OID=5 — 180 — -13061,00.html].

Sciences. Access 5 was formally launched in Fiscal Year 2004 under a $101 million NASA grant[114]. The organization's goal is unrestricted UAV "file and fly" access to civil airspace within five years (or 2009). A detailed national plan outlines 1,400 tasks required to develop and integrate technologies, policies and procedures, and aviation infrastructure.[115]

- **Fast Sealift - Monohull.** The Fast Sealift - Monohull is being developed for commercial application. This technology could be leveraged for military application with little cost to the DOD. Currently, FastShip Atlantic, Inc., is the lead for this technology. Spanish ship builder IZAR is due to begin construction once financing is in place. FastShip Atlantic is hoping to begin commercial service in 2008.[116]

- **Blended-wing-body (BWB) aircraft.** According to a National Research Council study, two airlines have expressed interest in purchasing blended-wing-body (BWB) aircraft if they are developed. Some of the concerns that the BWB aircraft will have to overcome are: passenger acceptance of cabins with few or no windows; how to handle emergency evacuation of the large passenger cabins; how to incorporate such a large aircraft into the existing airport environment.[117]

Industrial Base

The potential oversight question for Congress is as follows:

- Should any of these lift platforms be developed and procured in part to support the defense industrial base?

The following points address the defense industrial base question:

- The Navy's FY2006 - FY2011 ship-procurement plan would procure 49 ships over these six years. The Littoral Combat Ship (LCS) accounts for 21 of these 49 ships. The LCS will be built by yards other than the six ship yards that have built the Navy's major war

[114] William Reynish, "UAVs Entering the NAS," *Aviation Today*, Feb. 10, 2005.

[115] For more information on Access 5, see [http://www.access5.aero].

[116] For more info on FastShip Atlantic, see [http://www.fastshipatlantic.com/content_aboutfastship.html].

[117] Committee on Aeronautics Research and Technology for Vision 2050, *Securing the Future of U.S. Air Transportation: A System in Peril*, (National Academies Press: Washington, 2003), p. 33.

ships in recent years.[118] That means that the "big six" ship yards will have to compete for the remaining 28 ships over those six years, which accounts for an average procurement rate of 4.7 ships per year. For these six ship yards, this average procurement rate could result in relatively low work loads, revenues, and employment levels.[119] The high speed ships examined in this report, if procured, may be helpful in maintaining the U.S. industrial capabilities needed for development and production of advanced sealift.

- All of the strategic mobility concepts examined in this report represent future innovation. Some observers have noted that if the U.S. is to maintain a competitive lead in the development and production of airlift and sealift, while also possibly creating new industries (e.g., an Ultra Large Airlifter industry), new jobs, and new marketable skills (e.g., in the blended wing body technology), then future investments in these types of platforms may be required.

Future Procurement

The potential oversight question for Congress is as follows:

- Should procurement of airlift/sealift be expanded beyond current DOD plans, and if so, by how much, and with what platforms?

Some of the areas that may affect this question are as follows:

- **Million-Ton-Mile per Day (MTM/D) Airlift Gap.** In the Mobility Requirements Study 2005 (MRS-05), it stated that a 48.3 million-ton-mile per day (MTM/D) capability should exist with 120 C-17s, a C-5 mission capable (MC) rate of 65% (for all 106 C-5s), and a Civil Reserve Air Fleet contribution of 20.5 MTM/D. Air Mobility Command currently has 119 C-17s and the C-5 MC rate seems to be hovering around 68% for FY2005, but the DOD's current airlift capability is estimated to be approximately 45 MTM/D, leaving an estimated gap of 3.3 MTM/D from the projected capability. If the current projected requirement is approaching 60 MTM/D (as some analysts have estimated), then there is indeed an even larger gap in the U.S. military airlift capability. MRS-05 stated that 176 C-17s were required, with a C-5 mission capable rate of 65%, to achieve a MTM/D capability of 54.5. Thus, even when the Air Force gets ownership of all 180 C-17s on contract, there could be a projected

[118] These six yards include Bath Iron Works of Bath, ME, the Electric Boat Division of Groton, CT, and Quonset Point, RI, National Steel and Shipbuilding Company of San Diego, CA, Avondale Shipyards near New Orleans, LA, Ingalls Shipbuilding of Pascagoula, MS, and Newport News Shipbuilding of Newport News, VA.

[119] See CRS Report RL32814, *Navy Force Architecture and Ship Acquisition: Selected FY2006 Issues for Congress,* by Ronald O'Rourke, for more information on industrial base implications.

gap of at least 5.5 MTM/D. The C-17 production line is currently planned to close in 2008. If this airlift gap is to be filled, then some observers have noted that it can either be filled by procuring more C-17s or by procuring some mix of future strategic airlift platforms.[120]

- **Potential Platforms.** In the Office of Force Transformation's 2004 Strategic Transformation Appraisal, it listed three pertinent "issues of regret," which are key technologies that — if not explored — could be in the future viewed as significant lost opportunities: (1) a super short takeoff and vertical landing platform; (2) a heavy-lift vertical takeoff and landing aircraft (3) a shallow draft high-speed vessel with strategic reach.[121] In the Executive Summary of the Advanced Mobility Concepts Study (AMCS), the Executive Committee recommended that OSD include appropriate direction in POM Strategic Planning Guidance to initiate RDT&E on the following strategic platforms: Shallow Draft High Speed Vessels, Super Short Takeoff and Landing aircraft, and the Global Range Transport. It also recommended that the ULA continue as a platform for further related studies.[122]

- **Future Requirements.** No matter what future platforms are selected, the AMCS identified the following requirements for future mobility assets: (1) reduced dependency on fixed infrastructure; (2) the ability to enter through multiple, unimproved entry points; (3) the ability to swiftly move forces in combat-ready configurations; (4) the ability to conduct vertical maneuver; (5) the ability to close the gap between deployment and employment momentum.[123]

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[120] It is estimated that for every 10 additional C-17s that Air Mobility Command procures that they would get roughly one MTM/D more of capability. The 42 C-17s that the Air Force is currently requesting would provide an estimated 4.2 MTM/D of capability.

[121] Amy Butler, "Pentagon Transformation Analysis Outlines Military Capability Gaps," *Defense Daily*, Nov. 19, 2004.

[122] U.S. Department of Army, *Advanced Mobility Concepts Study,* Dec. 2003, p. vii.

[123] Ibid., p. iii.