NEGLECTED CAPABILITIES IN THE DOD

USING AGENCY THEORY TO IMPROVE GUIDANCE

Policy Analysis Exercise
4/1/2008

Submitted to:

Mr. Stan Horowitz,
Institute for Defense Analyses

Dr. Ashton B. Carter,
PAE Advisor

Dr. Maurice Kugler,
PAC Seminar Leader

Dr. Monica Toft,
PAC Seminar Leader

Submitted by:

Doug Presley
Anthony Stinton

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To: Mr. Stan Horowitz, Institute for Defense Analyses
Dr. Ashton B. Carter, PAE Advisor
Dr. Maurice Kugler, PAC Seminar Leader
Dr. Monica Toft, PAC Seminar Leader

From: Doug Presley and Anthony Stinton, MPP2

Re: Policy Analysis Exercise Submission

We are pleased to present you with our final Policy Analysis Exercise on Neglected Capabilities in the DoD. In producing this document, we have consulted a variety of print sources and conducted numerous interviews which we have used to inform our analysis. We hope that you will find the recommendations contained in this report both informative and useful.

This report would not have been possible without the help of a great many people. We would like to thank Gen Larry Welch, Dr. Jim Thomason, and Mr. Phil Major at IDA and Dr. Robert Hermann for taking the time to speak with us and discuss our research and recommendations. We would also like to thank Dr. Ashton Carter for his valuable feedback and input throughout the process, and Dr. Maurice Kugler and Dr. Monica Toft for their assistance with structuring our drafts, our research, and our presentation. Lastly, we would like to thank our client Stan Horowitz, for proposing this project, for sharing his ideas and recommendations, for supporting our research, and for his patience and understanding.

Very respectfully,

Doug Presley and Anthony Stinton

EXECUTIVE SUMMARY

Providing effective national defense is one of the fundamental purposes of the U.S. government and the sole purpose of the DoD, and strong, living military services are an essential component of that mission. Yet the strength and culture of the military services can also create agency problems which interfere with the Secretary of Defense's ability to guide the acquisition of necessary capabilities. This report will therefore seek to answer the question:

> **What actions can the Secretary take to improve strategic guidance and conformance with that guidance, to help better allocate resources to inherently joint and neglected capabilities?**

THE SERVICES AND AGENCY PROBLEMS

The agency problem in defense resource allocation creates a system where the services make self interested resource requests, and OSD is unable to objectively evaluate the requests because it relies on service-generated information. To overcome the agency problem, OSD must therefore work to:

- **Better align OSD and Service interests through improved strategic guidance.**
- **Improve transparency to reduce information asymmetries.**

CASE STUDIES

Unmanned Aerial Vehicles: Persistent surveillance capabilities were initially neglected by most services, but after they proved to be highly valuable in the mid 1990s, the services have spent significant resources on them but in a relatively ad hoc manner.

Global Positioning System: After each service started satellite navigation programs, DoD assigned the Air Force as the lead service. The system stalled for decades due to service resistance, but ultimately proved highly successful.

ANALYSIS AND RECOMMENDATIONS

IMPROVING STRATEGIC DIRECTION AND GUIDANCE

DoD needs more involvement by the COCOMs early in the development process to ensure that programs address their most pressing needs, and programs should be "born joint," taking inputs from all the services early on.

- **Improve Joint Warfighter Input into the JROC** by including representatives from JFCOM, STRATCOM, AT&L, and PA&E as statutory members.
- **Strengthen PA&E within OSD** to provide the Secretary with stronger non-biased analysis and help overcome significant asymmetries of information.

GUIDING SYSTEM DEVELOPMENT AND ACQUISITION

It is important that responsibility for joint capabilities be assigned to an appropriate organization with a strong interest in the development of the program as well as the proper time-horizon, expertise, and resources to ensure its success.

- **Increase Management Reserve Funds for OSD** to provide the Secretary with budget flexibility to focus on frequently overlooked joint priorities.
- **Provide Title X Authority for STRATCOM** to lead the acquisition and development of inherently joint capabilities.

ENSURING ACCOUNTABILITY AND COMPLIANCE

Accountability is inseparably tied to strategic guidance, and if DoD does not make clear what it wants, anything the services produce will meet the standards. OSD must improve its guidance and strengthen its analytic workforce to provide better oversight and ensure service compliance with DoD interests.

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INTRODUCTION

With over $180 billion in annual funding for procurement and R&D, the Department of Defense (DoD) spends a tremendous amount of its resources designing and buying the capabilities it uses to fulfill its many national security missions. Yet the complexity and highly technical nature of most defense systems makes the procurement process one of the most difficult management challenges facing the DoD. As the Beyond Goldwater-Nichols report on defense reform for the 21st century aptly points out "If Sisyphus had a job in the Pentagon, it would be acquisition reform."[1] This analysis will focus on only one narrow aspect of acquisition reform, the development of inherently joint and non-traditional capabilities, but many of the recommendations are broadly applicable to other reform efforts as well.

Box 1: Improving Joint Capabilities Development

This report will focus on formulating ways in which the Office of the Secretary of Defense (OSD) can provide managerial guidance and oversight to improve the acquisition of inherently joint and therefore often neglected capabilities.

Here and throughout the paper, we define a neglected capability as one that is under procured (if procured at all) relative to strategic needs, and where procuring more would improve the cost efficiency and/or overall effectiveness of U.S. national defense.

[1] Murdock, Clark A. and Michèle A. Flournoy. "Beyond Goldwater-Nichols: U.S. Government and Defense Reform for a New Strategic Era – Phase 2 Report". Center for Strategic and International Studies, Washington, D.C. July 2005. p. 88.

The focus on capabilities that the services neglect highlights the services' role as the procurement agents for the DoD as a whole. As such, we will use agency theory as a starting point to examine whether the individual services occasionally fail to procure capabilities that would be valuable to the DoD, and if so, how and why these failures occur. In the agency theory framework, the DoD represents the principal whose goal is the efficient and effective achievement of national defense objectives.

To better understand both successes and failures in the procurement of these neglected capabilities, this paper will utilize in-depth case studies of two neglected capabilities: Unmanned Aerial Vehicles (UAVs) and the Global Positioning System (GPS). Obviously, both UAVs and the GPS satellite network are in wide use throughout the DoD, which implies that they have overcome, in full or in part, their original neglect. As such, the case studies of these two capabilities will also examine how these capabilities overcame obstacles to their success. Additionally, the case studies will consider to what extent each of these representative capabilities remains neglected, and what this suggests about the existing DoD and service processes for bringing neglected capabilities into the mainstream.

From the case studies, the analysis will continue to recommend various actions that OSD can take to improve strategic guidance and conformance with that guidance, to help better allocate resources to neglected capabilities. The analysis and recommendations will focus around three issues: improving strategic direction and guidance, guiding system development and acquisition, and ensuring accountability and compliance.

THE SERVICES AND AGENCY PROBLEMS

The military services are the functional arms of the Department of Defense, the agents the DoD uses to carry out its responsibility for national security. The services are also individual, living institutions. Former Assistant Secretary of Defense Ashton Carter made this point in 2000,[2] and defense analyst Carl Builder's 1989 work Masks of War described in depth the institutional personality of each service and sketched how those personalities affect service actions.[3] Neither Carter nor Builder viewed the living natures of the services negatively – on the contrary, the services' individual personalities contribute to the vigor necessary for effective national defense. However, as living entities, the services also have individual interests and preferences which may not always fully align with DoD's, creating the potential for agency problems and internal conflict.

The Goldwater-Nichols Act of 1986 addressed one manifestation of agency problems: inter-service competition in war fighting. Prior to Goldwater-Nichols, the services waged wars through separate Army, Navy, and Air Force campaigns. These separate campaigns gave each service the incentive to take on too many responsibilities or try to win the war with little to no assistance from other services in order to improve service prestige and, potentially, funding. MacArthur and Nimitz's competing campaigns across the Pacific in World War II, disagreements between the Army Air Force and the Army over target prioritization prior to the Normandy invasion, and competition between the Air Force and Navy for targets over Vietnam provide examples of the reoccurring problem of inter-service rivalry throughout the past century. In each case, all services involved wanted to defeat the enemy (which was also the principal's national security goal) but each service wanted to do so in a way that made it most

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[2] Carter, Ashton. "Keeping the Edge: Managing Defense for the Future." Keeping the Edge. Ed. Ashton Carter and John White. Cambridge: MIT Press, 2001. 6-7.

[3] Builder, Carl. Masks of War. Baltimore: Johns Hopkins UP, 1989. 3

responsible for victory. These competing views resulted in the services (agents) pursuing the principal's goal in sub-optimal ways.

Goldwater-Nichols mandated joint war fighting, with a unified theater commander directing all air, land, and sea forces. This unified structure served the U.S. well in the Persian Gulf War and in Operations Enduring Freedom and Iraqi Freedom and has largely reduced the agency problems in war fighting. Yet Goldwater-Nichols also vested the Title X responsibilities to organize, train, and equip the armed forces with the separate services, leading to a situation where operations are joint but force acquisition is separate[4]. Separate acquisition leads to agency problems in Defense resource allocation, the central basis for this paper.

In the example in Box 2, the real estate agent appears dishonest, even though he is merely following his own professional interests. While the services are the agents in defense resource allocation, it is important to note that though individual services may push for what can objectively be called inefficient resource allocations, they usually do so with the sincere believe that those resource allocations are in the best interest of the DoD as a whole. Just as in war fighting where all the services want to defeat the enemy, in acquisition of weapons systems all the services want to effectively defend the U.S.'s strategic interests. Thus, the end, broadly stated, is not the source of conflict, rather, it is disagreement over how to pursue those ends that is the ultimate source of conflict.

[4] Carter 6.

Box 2: A Simple Principal-Agent Example

Agency problems in Defense resource allocation resemble agency problems ordinary people see in their everyday life. For any agency problem to arise there must be both **conflicts of interest** and **asymmetrical information** between the principal and the agent. A very basic example of an agency problem between a homeowner and a real estate agent paid on commission illustrates these requirements. The homeowner wants to maximize his cash flow from the sale of his house. The real estate agent wants to maximize his wealth by selling houses, both this house and others. Because the real estate agent has many houses to sell, he may encourage the homeowner to take a relatively lower offer right away rather than to wait for a higher offer. Taking an offer for $10,000 less than the list price only costs the agent $600 if he earns 6% commission and frees the agent to go out and sell other houses. At the same time, the lower price costs the homeowner $9400, producing a conflict of interest.

However, a conflict of interest without asymmetries of information will not harm the principal. In the above example, if the homeowner knows that he can receive full price if he waits a few weeks, he will reject the low offer today. Unfortunately, the nature of the principal-agent relationship makes asymmetries of information likely: the homeowner would not hire a real estate agent unless he thought he lacked information about the market. Thus, the homeowner will have to trust the real estate agent, who he hired for his superior knowledge, and will therefore make a sub-optimal decision.

There is often very little consensus on the best way to pursue national security ends between the services. As a brief example, consider the U.S. national security end of deterring rogue states from acquiring nuclear weapons. There is wide agreement on this end, but is the best way to achieve it with precision strike capability to target weapons development facilities, with a strong conventional military to threaten regime change, or with naval power to enforce a blockade? A case can be made for each of these options, making it possible to plausibly justify just about any resource request as a non-proliferation capability. As should then be expected, each service makes the case that its means to achieve this and other ends are superior, and so the Air Force argues earnestly for more aircraft, the Navy for more ships, and the Army for more troops and tanks. Even if hindsight shows that one resource strategy is objectively better, the level of uncertainty that accompanies the resource allocation process makes identifying these conflicts as they occur difficult.

Box 3: The Education of an Air Force Officer

The authors graduated from the Air Force Academy. While there, we were steeped in the value of airpower. We heard again and again how Allied air supremacy over the beaches of Normandy allowed D-Day to succeed. We heard it said that, for all the struggles with airpower in Vietnam, sending the B-52s over Hanoi finally brought the North to the peace tables. How the massive and successful air campaign during the Persian Gulf War paved the way for the relatively bloodless 100 hour victory in the ground campaign. And so on. Given this high dose of heritage appreciation, it is unsurprising that the Air Force Academy develops people who believe in the power of airpower. Discussions with friends and colleagues from various services and commissioning sources suggest similar indoctrination for officers in the Army, Navy, and Marine Corps.

Considering the training and education that officers in each service receive, it is not surprising that senior leaders tend to believe that their service's unique strengths are the best way to meet national security challenges. The services go to great lengths to instill a sense of service pride in their soldiers, sailors, marines, and airmen, and officers are naturally inclined to favor capabilities that they are familiar with. By the time officers reach the Pentagon, and certainly by the time they make General or Admiral, they are well versed in the superiority of their own unique service.

As the services cultivate the belief that their core competencies are valuable, there is also a powerful self selection bias, since those who believe in the importance of naval strength or ground combat superiority are more likely to join the Navy or Army, respectively. Once in the organization, the best practitioners of these core competencies usually become the leaders of the organization, further entrenching the belief that what each service does well is important. Though the strong in-service support for each service's core competencies can lead to inefficient resource allocation pressures, it is worth noting that in general, it is good for the nation that the Navy (/Army/Air Force) believes strongly in the value of sea(/land/air) power. At the very least, this is better than the alternative of a service that does not believe in what it is doing.

Though the services' strong support for their core competencies can lead to conflicts of interest, with perfect information OSD could identify conflicted requests and objectively select and fund the best means to achieve national security ends, eliminating resource misallocation resulting from agency problems. However, similar to the homeowner in the real estate example, OSD often lacks adequate information to make the objective decision necessary to identify and sort through conflicting requests. As the real estate agent uses asymmetric information to mislead the homeowner, the services can use asymmetric information to prevent OSD from making objective resource allocation decisions.

At a basic level, the services know best what various weapons systems bring to the table, putting them in position to hold informational advantages over OSD. This problem is only exacerbated by the fact that the services hold the majority of all technical analytic capability. Additionally, service specific analysis often fails to fully consider joint synergies, further contributing to higher estimated force needs.

The services can use their internally generated analysis to create information asymmetries to lead OSD to support the services individual, often inefficient, resource allocation priorities. Builder sites one such example where the Air Force repeatedly changed modeling conditions until it generated systems analysis favorable to producing more manned bombers rather than submarine launched ballistic missiles in the 1960s.[5] The ability to selectively employ only favorable analysis thus is a valuable tool for creating biased information about a service's priority for OSD consumption.

Even when OSD gives strategic guidance on force structure priorities, the services' superior analytic capability often helps them avoid taking action to meet that guidance. Stan Horowitz, assistant director of the Cost Analysis and Research Division at IDA, points out the services are very skilled at using "transformation paint" or "joint paint" to convince OSD that their existing programs meet the OSD-dictated priorities without making any fundamental changes to the programs. Service reluctance to make major program changes to support OSD policies highlight the services' ability to out-wait the administration due to their long time horizons compared with the relatively short tenure of DoD leadership .

The services' use (and at times abuse) of analysis is not necessarily done with malicious intent; rather, the services have deep seated feelings about the value of the core competencies which leads the services to use analysis to highlight the merits of its programs. Put more concretely, the Navy *knows* that having carriers to project American

[5] Builder, 100-101.

power around the globe is important so it is willing to put a coat of transformation paint on its carrier fleet to maintain this important capability.

A total picture of the agency problem in defense resource allocation thus shows a system where the services as agents make self interested but not malicious resource requests which are inefficient from the standpoint of the DoD as principal. OSD is unable to objectively separate the conflicted requests from the efficient requests because it is forced to rely on service-generated and often equally self-interested information chosen to support preconceptions of the right resource choices rather than objective, efficient resource allocation. This framework clearly squares with the idea that the services spend too much on their traditional areas of expertise. However, it is also a useful framework to consider why the services may under-spend on joint and/or non-traditional capabilities, as demonstrated by the case studies below.

CASE STUDIES

The following case studies detail the acquisition of two neglected capabilities, UAVs and GPS, from their early stages until the present. These two capabilities are not the only neglected capabilities in this time frame, but our study focuses on them because they are excellent examples, respectively, of a capability which does not fit any services' core and a capability which must be joint in all facets of its use.

UAV PROCUREMENT IN THE U.S.

The UAV (now alternatively called a UAS) is not a new concept in aviation. The U.S. Air Force used air launched reconnaissance drones extensively during the Vietnam War and the U.S. Navy fielded a remotely piloted anti-submarine helicopter in the same time period. However, the Vietnam-era UAVs had serious performance limitations with reliability, flexibility, and the timeliness of information collected.[6]

Israeli use of UAVs in their 1982 conflict with Syria better foreshadowed the potential of modern UAVs. The Israelis flew a fleet of propeller driven UAVs equipped with real-time video surveillance equipment over Syrian troops and air defense equipment in the Bekka Valley. In addition to providing information about Syrian troop movements, these UAVs drew fire from radar guided Syrian surface to air missiles. This allowed the Israelis to pinpoint and destroy the missile batteries and gain air superiority. In this engagement, the Israelis destroyed 54 Syrian aircraft and 19 missile batteries while losing just one aircraft.[7]

As Israeli UAVs proved their utility, the U.S. Army was developing its own real-time reconnaissance UAV. This Army program, code-named Aquila, saw its costs spiral out of control, largely due to the common acquisition problem of requirements creep.

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[6] Newcome, Laurence. Unmanned Aviation: A brief history of Unmanned Aerial Vehicles. Reston: American Institute of Aeronautics and Astronautics, 2004. 80-88.

[7] Piore, Adam. "Expensive Tastes." Washington Monthly, June 1997, Vol. 29, Issue 6.

An Army Combat Development officer familiar with the Aquila program says that the proliferation of missions requested of the Aquila caused the program to lose focus. As a result, after $1 billion in costs, the Army cancelled the Aquila program in 1987[8]. While the problem of requirements creep is not specific to UAVs, this incident suggests that inherently joint programs may be more likely to attract an excess of requirements because they do not have a traditional base of support within the service (whether Army, Air Force, or Navy) to shepherd the program through development and ward off excess requirements. Stated another way, because UAV programs are not on anyone's turf, they are vulnerable to everyone's turf wars.

While the Army attempted to develop its own UAV, the Navy also recognized the utility of modern UAVs systems but took a different route to procure one. Because the Navy wanted to get a UAV in service quickly, rather than develop its own platform for initial use, it purchased Pioneer UAVs from Israel in 1985 as a temporary measure until U.S. built UAVs would be available[9]. The Pioneer UAV was a slightly updated version of the same aircraft the Israelis used in the Bekka Valley, but the Navy struggled to adapt the Pioneer for use at sea, incurring unexpected costs for re-engineering the aircraft. Additionally, because the Pioneer was purchased as a stopgap, the Navy faced substantial maintenance costs to extend the service life of the aircraft when expected U.S.-made UAVs did not materialize[10]. The Army and Navy's problems with UAV procurement contributed to the U.S. Congress's decision to freeze all funding for UAV programs in 1988 and to set up a UAV Joint Program Office in 1989 as the DoD office with management responsibility for UAVs. Congress made these decisions because UAV development at this time lacked priorities and often pursued redundant capabilities.[11]

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[8] Ibid.
[9] Ibid.
[10] Ibid.
[11] Anthony, David A & Sterste-Perkins, Dagnija. "CRS Report for Congress." Aug 18 1999.

Due to the programmatic problems discussed above, Pioneer was the only operational U.S. UAV during the Persian Gulf War. Though it carried outdated technology and struggled to keep up with fast moving mechanized units and operate in bad weather, the Pioneer generally performed well in this conflict. In fact, its good performance caused Adam Piore, a harsh critic of DoD efforts to procure UAVs, to declare in 1997 that the Pioneer was one of the few bright spots in the American military's long involvement with UAVs[12]. It is notable that due to continued problems with UAV procurement, the Pioneer, which was outdated in 1991, is still in service today with the Marine Corps.[13]

UAVs' successes in the Persian Gulf War led the DoD to emphasize the use of UAVs in military doctrine and to devote more resources to UAV acquisition[14]. As a result, UAV programs received roughly $3 billion for research and development and procurement in the 1990s.[15] However, even with substantial funding, UAV development and acquisition struggled through the 1990s due to a proliferation of vehicles and poor cost control.[16] Mainstream procurement through the UAV JPO performed especially badly, as it failed to independently develop a single operationally fielded UAV in the 1990s.

While mainstream procurement foundered, DARPA developed two successful UAVs, the Predator and the Global Hawk, through the Advanced Concepts Technology Demonstrator (ACTD) program.[17] The Predator, widely considered the most well known UAV[18], first flew in 1994. Because the original Predator is just an extension of the Israeli technology used in the Pioneer and earlier UAVs, it was able to contribute to U.S.

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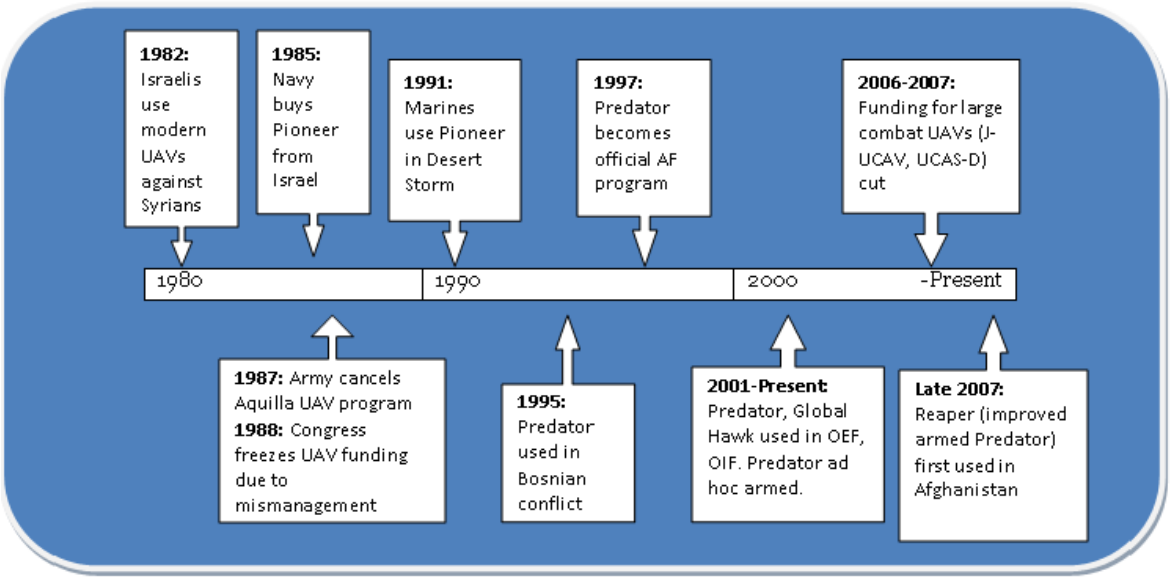
[12] Piore, Adam. "Expensive Tastes." Washington Monthly, June 1997, Vol. 29, Issue 6.
[13] United States. Dept. of Defense. UAS Roadmap 2005-2030. Washington: 2005. 5.
[14] Fulgham, David. "Gulf War Successes Push UAVs Into Military Doctrine Forefront." Aviation Week & Space Technology, Dec1991 Vol. 135, No. 23; Pg. 38.
[15] Tirpak, John. "Will we have an unmanned armada?" Air Force Magazine Nov 05. 54-59.
[16] Kosiak, Steven, and Hunter, Elizabeth. "Unmanned Aerial Vehicles – Current Plans and Prospects for the Future." Center for Strategic and Budgetary Analysis, Washington: July 1997.
[17] United States. Dept. of Defense. UAS Roadmap 2005-2030. Washington: 2005. 4.
[18] "Unmanned and dangerous." Economist 8 Dec 2007: 22-24.

operations in Bosnia in 1995 even before it transitioned to become an official Air Force procurement program in 1997.[19] The development of the Predator through ACTD channels shows one way a useful non-traditional capability can be fielded. However, the ACTD route is only designed for proving the military utility of mature technology, and is not well suited for large scale procurement once the design has been validated. The Predator fit well here because it is almost entirely commercial off the shelf technology[20] but this route is not as useful for developing new technologies. The relatively longer and more expensive development of the Global Hawk in the ACTD process demonstrates this process' limitations.

Figure 1: Timeline of UAV Development



The ease with which DARPA was able to turn the Predator into a useable capability working outside the normal service acquisition system reinforces the argument that it was service management rather than monetary or technological

[19] United States. Dept. of Defense. UAS Roadmap 2005-2030. Washington: 2005. 4.
[20] United States. Cong. House Subcommittee on Tactical Air and Land Forces. Hearings on FY2004 Budget Requests for Unmanned Combat Aerial Vehicles and Unmanned Aerial Vehicle Programs. 26 March 2003.

barriers which hindered UAV development in the 1990s. The agency problem framework developed earlier provides one explanation for why the services had difficulties managing UAV programs. UAVs do not fit into the core of any service, as even the Air Force has long considered reconnaissance, the primary UAV mission, a less important job. Former Chief of Staff of the Air Force and current IDA President Gen (ret.) Larry Welch underlines this point, saying "The fact that certain systems have been 'low density high demand' since I was a lieutenant [pre-Vietnam] should tell you something about the services' priorities". Considered in this light, the UAVs failure to attract top-level management oversight or institutional support necessary to succeed is unsurprising. Similarly, the Navy and Army have their core functions that prevent them from giving managerial attention or institutional support to UAVs.

The events of 9/11 and the subsequent Operations Enduring Freedom and Iraqi Freedom provided an external shock which motivated fresh support for UAVs. In these conflicts, the Air Force fielded both Predator and Global Hawks —though neither had technically achieved initial operational capability when OEF began. The Marine Corps also continued to operate its venerable Pioneer. The UAVs proved highly successful in the field and garnered substantial media coverage. The Predator was even armed, ad-hoc, with Hellfire missiles to eliminate the sometimes frustratingly long sensor to shooter chain. From the ad-hoc armed MQ-1 Predators, the Air Force moved on to develop a larger, improved, MQ-9 Predator, later renamed "Reaper" which began serving in Afghanistan in December 2007.[21]

Though U.S. forces used UAVs widely in both OEF and OIF, they remained "low density, high demand assets," a euphemism meaning that U.S. forces faced a UAV shortage. This empirical determination is a frustrating critique of U.S. UAV procurement and development efforts in the more than ten years between the end Persian Gulf War and September 11, 2001. The Persian Gulf War (and subsequent minor operations in the

[21] Howard, Courtney. "Reaper unmanned vehicle joins warfighters in Afghanistan." Military Aerospace and Electronics.December 2007, Vol. 18, no. 12, P 1,4.

Balkans) showed UAVs as useful platforms and yet most UAV programs languished or fell victim to management neglect, leaving U.S. forces short of a valuable, proven capability in wartime. While this fact is frustrating, it should not be surprising giving Gen. Welch's observation about problems with persistently "low density, high demand assets".

The continued wartime footing from 2001 to the present has seen both some successes and continued struggles in UAV procurement. As mentioned above, the Air Force successfully developed and fielded a larger, more capable, armed medium range UAV to augment the Predator fleet. Additionally, Global Hawk capability has expanded, providing more theater level persistent surveillance. In all, the DoD as a whole went from operating 127 UAVs (excluding small battlefield UAVs) in five major types in 2002 to operating 520 UAVs in 16 major types in 2006. [22] As could be expected, with greater numbers came a greater share of the budget; the 2005 six year FYDP projected $13 billion in spending on UAVs through 2011, a major increase considering that spending on UAVs totaled only $3 billion through the entire 1990s.[23]

However, the current UAV funding picture is less rosy than projected in 2005. Specifically, further efforts to develop larger, armed UAVs have stalled. The Joint (Air Force and Navy) Unarmed Combat Aerial Vehicle (J-UCAV) was defunded in 2006 for the FY07 defense budget[24]. The Air Force used the funds freed up by the cancellation to accelerate development of a new long range bomber which may or may not be manned. The Navy continued the project under the new acronym UCAS-D, which saw its funding request reduced by the President and subsequently cut by $139 million by Congress in 2007. These cuts delayed the UCAS-D's planned initial carrier flight test from 2011 until 2013.

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[22] Ehrhard, Thomas, & Work, Robert. "The Unmanned Combat Air System Carrier Demonstration Program: A New Dawn for Naval Aviation?" Center for Strategic and Budgetary Assessments May 2007.
[23] Tirpak, John. "Will we have an unmanned armada?" Air Force Magazine Nov 05: 54-59.
[24] McKenna, Ted. "J-UCAS Cancelled, But Not for Naught." Journal of Electronic Defense April 2006: 16-17.

Fragmented program management is a major factor that continues to impede UAV development in the post-9/11 environment. In an attempt to better avoid duplicative UAV development and improve interoperability, the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD/AT&L) created the UAV Planning Task Force[25]. However, this task force has only an advisory role, and both Congress[26] and the GAO[27] have pointed out that this advisory-only role reduces OSD's ability to affect UAV development. In turn, OSD's lack of influence has led the neglect of some priority UAV missions as well as duplicative efforts in other areas. More recently, in September 2007, Deputy Secretary of Defense Gordon England directed the office of the USD/AT&L to create a new task force to foster cross-service collaboration. The new task force was selected over the alternative of naming the Air Force executive agent for medium and high altitude UAVs. While it is too early to determine whether this new collaboration-fostering task force will improve UAV development, it does not appear to be vastly different from the previously UAV Planning Task Force, so expectations for much improved results are not warranted.

The main takeaway from UAV procurement and development in the post 9/11 wartime environment is that even as UAVs demonstrate value in both traditional UAV missions like reconnaissance and surveillance and new missions like air-to-ground attack, UAV procurement programs struggle. Though some struggles arise from larger acquisition problems like excess technological risk, the fact that UAV programs infringe on core service missions makes their development and procurement all the more difficult. Service reluctance to pursue greater use of UAVs in these missions likely stems both from concerns about the capabilities of UAVs as well as concerns about displacing

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[25] United States. Govt. Accountability Office. Unmanned Aerial Vehicles: Major Management Issues Facing DOD's Development and Fielding Efforts. Neil P Curtain, Paul L Francis. 17 March 2004.

[26] United States. Cong. House Subcommittee on Tactical Air and Land Forces. Hearings on FY2004 Budget Requests for Unmanned Combat Aerial Vehicles and Unmanned Aerial Vehicle Programs. 26 March 2003.

[27] United States. Govt. Accountability Office. Unmanned Aerial Vehicles: Major Management Issues Facing DOD's Development and Fielding Efforts. Neil P Curtain, Paul L Francis. 17 March 2004.

cherished service missions. Air Force Chief of Staff Gen. John Jumper seemed to represent both these concerns when he said in 2005 he would be reluctant to support UAVs for air-to-air combat missions until he can be sure that doing so "doesn't give up any of the quality we now have by having the greatest trained pilots in the world."[28] Of course, determining how much Gen. Jumper (and others like him) is concerned about avoiding legitimate capability gaps versus loss of service prestige is a difficult question. That the Air Force controls much of the information about possible UAV capabilities and the need for air-to-air capability in the future only makes unraveling this question more difficult.

[28] Tirpak, John. "Will we have an unmanned armada?" Air Force Magazine Nov 05. 54-59.

NAVSTAR GLOBAL POSITIONING SYSTEM

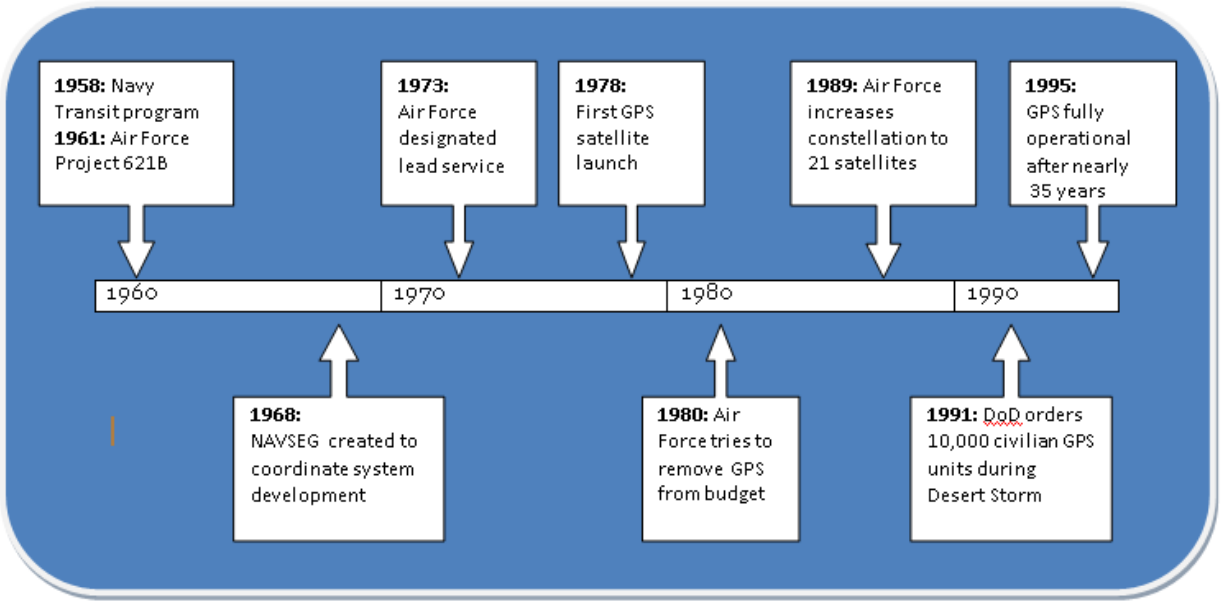
The Navstar Global Positioning System is often cited as a prime example of a public good. The constellation serves not just the US military, but is available to anyone with a simple GPS receiver, and one person's use in no way interferes with other users. Though it was initially developed and is maintained by the Air Force, civilian uses of the GPS signal now dwarf its military purposes, from surveying to commercial aviation to automobile navigation. Yet while the current system may look like a model of effective compromise between the services and the civilian sector, such cooperation was by no means a foregone conclusion. In fact, before the development of GPS, each service was working on its own satellite navigation system and development eventually stalled for decades as the components refused to budge from their service-specific requirements. The history of how the GPS became one of the most widely utilized joint systems is therefore instructive in the benefits, and possible pitfalls, of developing inherently joint capabilities.

The earliest US satellite navigation system, named Transit, was a ten satellite constellation designed by the Navy. The program began initial development in 1958, launched its first satellite by 1960, and was fully operational by 1964.[29] The constellation, which relied upon measuring the Doppler shift of the different satellite signals, had significant limitations due to its small size and the low accuracy of the Doppler method. Transit could only provide two-dimensional positioning with an accuracy of 450m, receivers required up to fifteen minutes to pick up the signal, and often experienced frequent periods without any coverage at all, lasting hours at a time.[30] Additionally, the system could only work for slow-moving ships, and couldn't

[29] Johnson, Dana J. "Overcoming Challenges to Transformational Space Systems: The Global Positioning System (GPS)." Northrop Grumman Analysis Center, Los Angeles, CA, October 2006. 6.
[30] Pace, Scott, et.al. "The Global Positioning System: Assessing National Policies" RAND Critical Technologies Institute, Santa Monica, CA, 1995. 238;
See also Turner, David A. and Marcia S. Smith. "GPS: Satellite Navigation and Positioning and the DoD's Navstar Global Positioning System." Congressional Research Service, Washington, D.C., 1994. 3.

provide tracking for high velocity jets or missiles. Nevertheless, the program was highly successful for nautical purposes, with ships having ample opportunity to pick up the signal and not requiring 3-dimensional positioning. In fact, the Transit system was so successful that the Navy continued to operate the system for civilian navigational purposes until 1996.

Figure 2. Timeline of GPS Development



After Transit had demonstrated the feasibility and utility of satellite navigation, the Navy began development in 1964 of a new system called Timation to test methods of providing increased accuracy. Using highly accurate quartz clocks, and later atomic clocks, the system could reduce the error in the position signal significantly, while also requiring fewer ground-station updates for the satellites. The satellites were primarily used as technology demonstrators, and were never developed into a full navigation system, despite support from the Naval Research Laboratory.[31]

[31] Pace, 239

At the same time, the Army and Air Force were also working to develop satellite navigation systems of their own. The Army's system, titled Sequential Correlation of Range (SECOR), was a small geodetic satellite and four ground stations used to provide highly accurate positioning data for maps and scientific study.[32] The Air Force had started work on a system called MOSAIC in 1960 to track movable ballistic missiles, but cancelled the program when the idea for the mobile ICBMs was scrapped. In 1963, the Aerospace Corporation proposed a new system for the Air Force officially called Project 621B, but commonly referred to simply as GPS. The system was designed to provide accurate tracking of aircraft rather than ships, and therefore had to be significantly more robust than the Navy's systems. GPS would allow for continuous, three-dimensional positioning for fast-moving targets, and use a new pseudo-random noise signal that would be much more resistant to jamming.[33]

In an effort to try and consolidate the multiple satellite navigation programs, DoD established a tri-service committee, called the Navigation Satellite Executive Committee (NAVSEG) to share technological advances and establish joint requirements. Yet rather than combining programs, the sharing of new technological developments only spurred each service into further research to refine its own system. In fact, the NAVSEG allowed the Navy to continually improve its Timation designs based upon new innovations in the Air Force Project 621B and vice versa, so while the committee certainly helped improve both programs, it made the competition for resources that much more fierce.[34]

The competing systems both stood fast for the next five years until the Deputy Secretary of Defense appointed the Air Force as the lead agency for the development of a single, joint satellite navigation system in April of 1973. The program would be run out of a Joint Program Office at the Air Force's Space and Missile Organization, with

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[32] Johnson, 6.
[33] Johnson, 6.
[34] Getting, Ivan A. All in a Lifetime. New York: Vantage Press, 1989. 588.

participation by all four services as well as inputs from NATO, the Defense Mapping Agency, and the Department of Transportation. The Air Force initially took its lead role as an endorsement of its GPS design, and submitted a basically unmodified version to the Defense Systems Acquisition and Review Council in August 1973. Yet the DSARC rejected the proposal precisely because it had not taken into account the requirements and concerns of the other services, particularly the Navy.[35] After the decision of the DSARC, the senior leaders of the JPO met over Labor Day weekend, and having come to accept the need for a compromise solution, hammered out an agreement that was acceptable to all the services.[36]

The Navy entered the discussion with a host of concerns. Foremost among them, the Navy viewed navigation and positioning as one of their traditional roles, and were reluctant to hand over control of the mission to another service. The Air Force, and particularly the JPO program manager Col. Brad Parkinson, made every effort to convince the Navy to sign off on a truly joint system. Since the Navy's Timation atomic clocks were the most advanced of all the services, the new system would use the Navy designed clocks. The Navy also objected to the orbits of the Air Force constellation, in which each cluster of satellites only covered part of the globe using geosynchronous orbits, starting with the first demonstration cluster over North and South America. The Navy worried that if the program funding were cut, the Air Force would never add the additional satellites necessary for coverage of the Indian and South Pacific Oceans, and therefore insisted on 12-hour orbits that would inherently provide global coverage. Additionally, to help co-opt the support of all the services, the JPO team agreed to use the Army's Yuma Proving Grounds for transmitter testing and the Navy's satellite tracking facility at Dahlgren, Virginia rather than the more robust Air Force one in

[35] Johnson, 7.
[36] Johnson, 7.

Colorado Springs.[37] At the time, the Air Force had more robust transmission capabilities, so it was decided to use the frequencies and signals of the Air Force system. With the technical specifications finally agreed upon by the services, the program officially changed its name to Navstar, and was approved by the DSARC in December, 1973 and funded with $150m for 1974.

Unfortunately, even with joint specifications that met the needs of all the services, the GPS still faced significant hurdles. In fact, the greatest threats to the Navstar system were not from inter-service rivalry, but actually from disinterest from the combat units and senior leaders within each service. Even though the Air Force was designated as the lead service, many senior officers were still more concerned with procuring aircraft and weapons systems than they were with supporting an unproven navigation system. The Air Force did not consider improved navigation a pressing need, and the commander of SAC even cancelled orders for 600 GPS receivers in the late 1970s.[38] The JPO tried to emphasize the other benefits of the GPS system, particularly the improved accuracy of munitions, and the engineers at Aerospace demonstrated, on paper, how a bomber equipped with a GPS receiver and "dumb" gravity bombs could achieve the same accuracy as "smart-bombs" at a much lower price.[39] Yet despite the tremendous potential of the GPS, combat units within the Air Force were very slow to accept the new system.

GPS suffered another major setback in 1979, when funding guidance forced DoD to make across the board cuts in research and development programs. The GPS program was therefore faced with a $500m budget cut over the years 1980-85, nearly 30% of its total budget, and the planned constellation was reduced from twenty-four satellites to eighteen. Yet rather than work through the funding cuts, the Air Force instead decided to essentially kill the program, and its June 1980 POM requested only $16.3m instead of

[37] Getting, 591; Johnson, 7.
[38] Johnson, 10, see footnote #32.
[39] Getting, 585.

the JPO's stated need of $234.5m.[40] While OSD was willing to lower R&D funding, it was not willing to see the GPS program killed, and it restored the full funding for GPS in the subsequent budget. Even with OSD backing the program was not safe however, and while the Senate fully supported the program and actually increased its funding over the President's budget, the House voted to cancel all funding for GPS in 1981. The result in conference was that the Air Force received $200m for R&D, but no funding for procurement, and DoD had to reprogram $20m from other priorities to actually begin purchasing the satellites. It was not until the next year that the full procurement of the constellation was approved.[41]

Only after the Persian Gulf War did GPS finally become widely accepted as a tremendous force multiplier and a top defense priority. In fact, the system was so highly successful that DoD purchased 10,000 commercial GPS receivers during the war to supplement the limited supply of military receivers available. By the end of Desert Storm, the GPS had become an integral part of military operations, and has been used widely by every service and many other government agencies since. The tremendous success of GPS in Desert Storm provided significant news coverage and publicity to the two primary civilian GPS manufacturers at the time, Trimble Navigation and Magellan Systems, and helped to propel civilian demand for GPS as well. In turn, the profits generated in the civilian sector have allowed the GPS industry to produce smaller, lighter, more accurate, and less expensive receivers, which in turn benefitted military users. All told, the history of GPS since the Gulf war has been nothing less than a tremendous success.

The development of the Navstar GPS constellation provides a valuable case study, both for its successes and for its difficulties. Though from a budgetary standpoint there was some "waste" in the overlapping service-specific navigation efforts, the

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[40] Johnson, 10.
[41] Johnson, 11.

competing Transit, Timation, SECOR, and Project 621B programs all produced valuable technological developments that ultimately contributed to the success of the final GPS constellation and satellite design. Though the redundancy carried some costs it ultimately proved a worthwhile investment. Once the programs began to grow however, and began competing for funds to pay for demonstrator constellations, the DoD was well served by combining the competing programs into a single design. In fact, OSD probably waited slightly too long to decide on a design and appoint the Air Force as the lead service, as the development slowed between 1968 and 1973. Yet while the competition may have slowed the deployment somewhat, the JPO was still created early enough in the development process that the final GPS system was a truly joint platform that was successfully integrated across all the services. Though the initial impetus for combining the programs may have been financial, the biggest payoff from the early joint collaboration has been a navigation system that is fully interoperable across all military and civilian users. One key lesson, therefore, is that while there was some benefit to competing research in the early development stages, DoD was ultimately best served by early and sustained joint input into the design process.

Yet while there were tremendous benefits to receiving joint inputs early in the development process, there were also benefits to giving a single service the authority as the lead agency for the development of the system. Ivan Getting, the president of the Aerospace Corporation and one of the leading proponents of the GPS, first believed that the system was so important, that it would be a mistake to leave its development to any single service or even any single government agency. After Getting asked White House Science Advisor Lee DuBridge for help in building interagency support for the system, DuBridge responded that he should “forget the polemics of public debate and interminable interagency fights… [and instead] find a military customer who has the greatest need (requirements) and who therefore has money and who also has the

management experience and then run with the ball."[42] Ultimately, Getting concluded that DuBridge was completely right, and that letting the Air Force take the lead, with help from the JPO, helped cut through many of the interagency hassles and funding disagreements while still achieving a system that ultimately suited users across all the military and into the civilian sector.

Another important lesson illustrated by the GPS system is that operational commanders and warfighters may not have the time-horizon or the technical knowledge to understand the tremendous potential benefits of new concepts and systems. Even Air Force leadership, with the expressed mission of equipping future combat forces, was ready and willing to cancel the GPS program had it not been for the insistence by OSD. At the time, the concept of the GPS and its true potential was too vague and ill-defined to appeal to people used to fighting battles and flying airplanes, and it was only from the engineers and the think tanks that true support for GPS arose. Therefore, while it is important to give operational commanders and warfighters a significant input into resourcing decisions, the DoD must be careful not to let near-term concerns overshadow long-term projects that are not as tangible as aircraft and bombs.

The GPS has been a hugely successful program for the Air Force, DoD, and the entire civilian sector. Yet such a success was not predetermined, and the program stalled for years before it was fully accepted as a top priority mission by any of the services. Ultimately, GPS provides both a model and a warning about the process of joint capabilities development.

[42] Getting, 589.

ANALYSIS AND RECOMMENDATIONS:

The previous case studies provide two examples of capabilities that simply do not fit neatly into the traditional service responsibilities and missions. In each case, the military services were reluctant to fully embrace an emerging technology, and the development languished due to lack of interest or disagreements. Both cases demonstrate that the development of joint capabilities is more than a one-time decision of who is in charge; rather, it is an iterative process of defining requirements, assigning responsibilities, and following up on implementation. OSD must have a detailed understanding of the information asymmetries and institutional resistance it faces, as well as a range of tools to implement inherently joint programs. Otherwise capabilities that fall outside the traditional service responsibilities are bound to languish for years, or even worse, ultimately fail to provide the necessary capabilities to the warfighters.

The goal of providing better joint capabilities to the COCOMs is not new, but it remains one of the most difficult challenges facing military leadership today. Numerous studies have proposed extensive lists of acquisitions reforms to help DoD better prepare for the wars of the future, yet while DoD has acted on many of the recommendations, they are often not as effective as initially expected, and more work remains to be done. This report frames the problem in an agency theory context, and seeks to advance previous studies by highlighting traditional principal-agent tensions and providing a framework for how to overcome some of the most common conflicts. Generally, to mitigate principal-agent problems, the principal can realign the agent's incentives to reduce conflicts of interest, or can improve transparency to reduce information asymmetries. We consider recommendations using both remedies because the defense resource allocation agency problem is such a wide ranging, hard to solve problem.

This report uses a three-part framework to analyze DoD acquisitions and resourcing as it relates to inherently joint, and therefore often neglected, capabilities. The first stage, upon which there is significant agreement on the need for reform, is improving the strategic guidance and requirements definitions for joint programs.

Numerous studies detail the need for more involvement by the COCOMs early in the development process to ensure that programs in the pipeline are designed to address the most pressing needs experienced by field commanders. Additionally, programs should be "born joint," taking inputs from all the services early on, so that joint functions are not forced upon an already establish program later in the lifecycle. These reform efforts focus on improving the inputs to the JROC, as well as the ultimate specifications and requirements passed to acquisition managers. DoD has already begun many of these efforts, but due to limited time and resources of the COCOMs, the reforms have not all been easily implemented.

The second stage of the process is the actual system development, usually handled by the acquisition staffs of the individual services. While some analysts assume that better guidance and recommendations will allow the services to seamlessly develop joint capabilities, history demonstrates that this is not always the case, and frequently joint requirements are given lower priority than service requirements when faced with budgetary constraints. It is therefore necessary not only to strengthen requirements and guidance, but also to ensure that and appropriate organization handles the capability development, be that a lead service, a joint task force, a separate defense agency, or even a major command. No one solution is consistently better than the other, and it is therefore necessary to compare the strengths and weaknesses of each solution to the specific characteristics of the desired capability.

The final stage in the process must be to compare the procurement agents ultimate outcomes to the initial requirements and needs of the COCOMs and other services. While it is simple enough to expect "accountability," designing the appropriate system of metrics and measurements is often the most difficult part in the reform process. The metrics must ensure that the appropriate outcomes are being generated, while also allowing flexibility for unforeseen technical hurdles that are bound to occur. The metrics should therefore act as a feedback mechanism to ensure that the final

product effectively fills the needs of the war fighter. These metrics should also and encourage new research and development in any areas where the final product fails to fully meet war fighter needs.

IMPROVING STRATEGIC DIRECTION AND GUIDANCE

Perhaps the most common theme among all recent studies of DoD resourcing is the need for better alignment of the budgeting process with the strategic environment. While it would seem obvious that the DoD should allocate its large but nevertheless constrained resources towards the current and future threat environment, aligning budgeting and program decisions with accurate threat assessments is no simple task. Even given the same information, defense leaders can often come to different conclusions about the likelihood or severity of many of the current threats to US interests. Even more difficult is the task of preparing for threats twenty or thirty years into the future, where even the best predictions offer only a rough guide of the strategic environment and possible adversaries' capabilities. The required Quadrennial Defense Reviews are intended to provide this guidance, but in practice even the vast resources of the Defense Department are woefully insufficient to meet the host of missions and requirements dictated by the QDR. With such vague guidance on strategic priorities, the services can justify whatever priorities they desire, usually those that fall into their traditional mission areas. Without more realistic priorities and guidance, overly broad QDRs abdicate their role and leave the real resourcing decision to the services.

Box 4: Strategic Guidance Recommendations

- **Improve Joint Warfighter Input into the JROC**
- **Strengthen PA&E within OSD**

One method for improving the assessment of risk that has been developed at IDA is the Integrated Cross-Capability Assessment and Risk-Management tool. The ICCARM asks senior defense leaders to rate both the severity and probability of a set of six (or more) "challenge areas" that have the potential to threaten American interests. By forcing senior leadership to compare and rank different threats, the ICCARM then helps prioritize different threats in an objective and measurable manner. IDA personnel administered the ICCARM to over twenty senior defense leaders in 2004, and the results indicate that there is significant agreement on some high-priority threats, as well as disagreement on others. If adopted and put into more widespread and institutionalized use, the ICCARM could therefore serve as a quantitative baseline to help inform resource decisions by directly relating them to the perceived risk of senior defense leaders.

While the ICCARM provides an objective measurement of strategic risks, many recommendations for improving strategic guidance have focused on increasing the input of the COCOMs, both regional and functional, in guiding funding and resource allocation. Though a consolidated strategic risk assessment is desirable, increasing COCOM input into resourcing decisions seeks to capture much of the same underlying expertise and knowledge, but without a formal risk assessment process. The Beyond-Goldwater Nichols Phase II Report describes the ideal relationship between the COCOMs and the services as a supplier-consumer relationship, with the COCOMs

needing some additional capability (demand) and the services competing to provide that capability (supply) at the lowest cost to the DoD. The supply-demand analogy is not only designed to help find the lowest cost solution for any given need, but it also seeks to focus the suppliers towards meeting the demands of the COCOMs, while reducing programs that do not fit any specific operational need. As BGN-II clearly states, "only the Combatant Commanders have operational requirements; joint-capability requirements, both near- and far-term, must drive DoD resource allocation and acquisition policies and decisions."[43]

Linking strategy and threats to resource decisions is a much larger issue than just improving joint capabilities. Even single service platforms must ultimately be tied to the threat environment and the needs of the COCOMs if they are to serve any purpose, and improved strategic guidance will therefore benefit nearly all decision-making within the resource allocation chain. The Defense Science Board has consistently advocated developing a DoD-wide business plan as one way to strengthen and monitor the link between forces provided and strategic force needs[44]. Yet while inherently joint capabilities are only a small part of the problem, they are perhaps the most susceptible to being overlooked by the services and would benefit the most from the improved requirements guidance, particularly that from the COCOMs.

It is important to note that it will not be possible to completely avoid all conflicts of interest in making strategic decisions on funding and development of new capabilities. First, COCOMs are still a product of their services, and having spent thirty years in one branch they are unlikely to completely change their priorities and strategic outlook in a two-year tour as a joint commander. Additionally, each COCOM has their own set of requirements and priorities that are often very different from each other, and increased COCOM input might simply result in trading the conflicting interests of

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[43] Murdock, Clark A. and Michèle A. Flournoy. "Beyond Goldwater-Nichols: U.S. Government and Defense Reform for a New Strategic Era – Phase 2 Report". Center for Strategic and International Studies, Washington, D.C. July 2005. 78.
[44] Hermann, Robert. Telephone Interview. 7 March 2008.

one group of flag officers for the influence of another.[45] However, the generals and admirals at the regional and functional commands are much closer to actual use of forces. While they may still carry some service-specific resourcing biases, their proximity to the warfighters makes it more likely that their interests will be better aligned with the strategic national defense interests.

Though the COCOMs are the end users of military capabilities and all programs should ultimately serve their operational needs, the commanders do not always have the appropriate mindset or analytic resources to determine what their future needs will be. COCOMs, under constant operational pressures and daily deadlines, are often more concerned with short-term programs that can help them deal with their most immediate concerns. This has resulted, in the words of the BGN study group, in "inadequate advocacy of mid- to long-term needs of the regional commanders."[46] While this "short-term opportunity horizon"[47] may be beneficial in highlighting current capability shortfalls, it leaves long-term planning as a secondary concern.

COCOMs are also limited in their ability to determine long-term operational requirements because they lack the analytical resources and expertise that is often necessary to visualize groundbreaking technology developments. New capabilities and developments are most often first conceptualized by experts who have a tremendous understanding of the potential benefits, and limitations, of emerging new technologies, and most ground breaking programs are therefore developed within the highly specialized service structure. The GPS, mentioned earlier, is precisely one such example, where operational commanders were leery of satellite based technologies and could not foresee the tremendous benefits that such a capability would provide. It took highly

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[45] Shalikashvili, John M. "Keeping the Edge in Joint Operations." Keeping the Edge. Ed. Ashton Carter and John White. Cambridge: MIT Press, 2001. 45-6.
[46] Scruggs, David. "Beyond Goldwater Nichols: An Annotated Brief" Center for Strategic and International Studies, Washington, D.C. August 2006. 6.
[47] Shalikashvili, 43.

specialized engineers, guided by a general understanding of the needs of the COCOMs and what was technically feasible, to push through one of the most useful technological developments in the past decades. Breakthrough developments often require the vision to imagine a program twenty years in the future, and the patience to follow through on the long developmental process. Therefore, while the COCOMs certainly can provide critical insights into current capability gaps, they are often not well suited to predict the capabilities that will be needed, or possible, well into the future.

Recent initiatives by the DoD have sought to improve strategic guidance and joint requirements determination early in the resource allocation process, but many of the reforms have not been as successful as initially hoped. Two particularly important initiatives have been the use of Integrated Priority Lists (IPLs) and the Joint Capabilities Integration and Development System (JCIDS) to help identify the short- and long-term operational needs of the COCOMs. The IPLs, submitted annually by the COCOMs to the JROC, seek to identify current joint capability gaps that need immediate resourcing attention, and have helped guide the allocation of a few billion dollars each year in defense spending. Yet as pointed out in the Beyond Goldwater Nichols Phase II report, such funding is minimal when compared to overall acquisition totals, and the IPLs should likely be strengthened to influence funding an order of magnitude greater than currently occurs.[48]

The JCIDS program, designed to address mid- and long-term joint capabilities requirements, has achieved even less success in guiding resource allocation. Consisting of telescoping concept documents in a variety of mission areas, so far the JCIDS have remained too general to effectively guide resourcing decisions. COCOMs do not have expansive staffs devoted to program analysis and evaluation, and therefore often have trouble predicting the costs and feasibility of their capability needs. Additionally, producing each JCIDS document is a time-consuming process, estimated at roughly

[48] Murdock, 78-9.

5,000 man-hours, which places significant demands on the limited staffs of the COCOMs and distracts them from the main mission of supporting the warfighter.[49] The COCOMs do not have the sufficient time or resources to successfully navigate the complicated and laborious JCIDS process, and the system therefore continues to be dominated by the individual services.[50]

In the agency framework, the key difficulty is how to get the services as agents to act in the interests of OSD as the principal. As long as OSD guidance is vague and unspecific, the services will continue to play the dominant role in deciding the required capabilities. Ultimately, OSD must improve its process of defining required capabilities, with help from the COCOMs, and then asking the services to provide those (and only those) capabilities. By providing better, more specific guidance that is aligned with national priorities, OSD can reduce the services' ability to follow their own interests while claiming to be supporting the national strategy.

There have been numerous studies over the past five to ten years that recommend a variety of reforms to improve strategic guidance from OSD. In the context of the agency framework, two key themes stand out as particularly important to help align service incentives with national goals and overcome the large asymmetries of information. First, OSD needs to strengthen warfighter input into the JROC to better link its planning and resourcing to national priorities to overcome misplaced service incentives. Second, OSD must strengthen its own analytical capability to put itself on a more even footing with the services in budgetary and resourcing debates.

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[49] Murdock, 80.
[50] Hermann, Robert and Larry Welch. "Transformation: A Progress Assessment, Volume I." Defense Science Board Summer Study, Washington, D.C., February, 2006. 19.

IMPROVE JOINT WARFIGHTER INPUT INTO THE JROC

The Joint Requirements Oversight Council is the primary body for ensuring that resources are allocated towards national priorities, particularly for joint programs. Yet the current membership, composed of the vice-chiefs of staff of each service, only reinforces the services' dominant role in acquisitions. The Beyond Goldwater-Nichols II study recommends replacing the vice-chiefs with the Deputy COCOMs of the functional (and possibly the regional) commands, which would drastically increase the voice of the warfighter in the resourcing process. Yet as discussed above, the COCOMs and their staffs are not ideally suited for making long-term strategic resourcing decisions, and such a solution might just trade the competing interests of the services for the competing interests of the COCOMs. Instead, this report draws upon recommendations made by other studies[51] and recommends strengthening joint input by including key civilian and military representation on the JROC. OSD should therefore work with Congress to update the JROC membership to include USD(AT&L) and a representative from PA&E. JFCOM and STRATCOM also play a unique role as major commands with both long- and short-term responsibilities, and the Deputy Commander of each should also be included on the JROC to provide long-term joint inputs. While recent efforts by OSD have allowed COCOMs and civilian leadership to sit in on JROC meetings – either in person or via teleconference – inclusion of additional members is unlikely to have a significant effect unless they are permanent additions to the council.

[51] Defense Science Board Studies, Keeping The Edge, and Kadish, Ronald "Defense Acquisition Performance Assessment." Defense Acquisition Performance Assessment Project, January, 2006.

STRENGTHEN PA&E WITHIN OSD

The other primary principal-agent problem faced by OSD is a drastic asymmetry of information in making resource decisions. The services hold nearly all of the technical and analytic capability, and OSD is therefore reliant upon the services to evaluate their own programs and recommendations. OSD therefore needs to increase its staffing, expertise, and funding for program analysis to better evaluate service programs. While the strengthened PA&E will always be at an informational disadvantage, it will provide senior civilian leaders with a much better picture of the likely trade-offs between competing systems.

GUIDING SYSTEM DEVELOPMENT AND ACQUISITION

Even if OSD and the services were able to precisely define a prioritized list of required defense capabilities, some organization would still have to procure those capabilities. For the majority of capabilities, the appropriate procuring agent is obvious—the Navy should lead aircraft carrier procurement, the Army tank procurement, and so on. However, for inherently joint capabilities, a lead service is often less than optimal, frequently resulting in under-resourcing or neglect. It is therefore important that responsibility for joint capabilities be assigned to an appropriate organization with a strong interest in the development of the program as well as the proper time-horizon, expertise, and resources to ensure its success. This section looks at the strengths and weaknesses of four different procurement agents available to DoD for the development and acquisition of joint systems, but ultimately concludes that none is optimally suited for joint systems development as they currently exist. OSD therefore needs to choose which procurement agent is best suited for any given program, and work to overcome its weaknesses or create a new type of program development organization.

Box 5: System Development and Acquisition Recommendations

- **Increase management Reserve Funds for OSD**
- **Title X Authorities for STRATCOM**

Figure 3 below presents a matrix of different options that OSD has to lead the procurement and development of new joint capabilities. Each of these options – a lead service, a defense agency, a joint task force, or a major command – is arrayed against six

different characteristics that will affect its ability and willingness to lead the development process.

Figure 3. Procurement Agent Analysis Matrix

	Ownership	Jointness	Time Horizon	Resources	Expertise	Setup Costs
Lead Service	Low	Low	Long	High	High	Low
Defense Agency	High	Moderate	Long	Moderate	High	Moderate
Joint Task Force	High	High	Moderate	None	Low/High	Low
Major Command	Moderate	High	Short	Low	Low	High

While each dimension of the matrix is important, certain characteristics will be more important for some programs than for other. However, one more constant factor is the relative importance of *ownership* and *jointness* for the development of joint capabilities.

> *Ownership* refers specifically to the organization's commitment to the neglected capability in question. Organizations established with the development of a new capability as their core mission are much more willing to devote resources to that program, and become strong advocates for the desired capability. Assigning a neglected capability to an organization which is highly committed to its development helps guarantee that the organization's interests are well aligned with OSD's, sharply reducing potential conflicts of interest. Achieving organizational buy-in to a program is therefore one of the most important aspects of ensuring long-term success without repeated OSD interventions.

Jointness is the organizations willingness and ability to incorporate other services/agencies considerations in its programs. Some capabilities merely need to be interoperable between the services, while others must be fully joint in concept, design, and development.

Time horizon refers to the ability of the organization to consider long term needs, plans, and goals. Organizations with a daily operational mission are more likely to have a shorter time horizon, focusing on near-term deadlines rather than long range strategic planning, though this can sometimes be overcome through a dedicated long-range planning office. An appropriate time-horizon is especially important for highly technical projects with long development times.

Resources are a measure of the money each organization can deploy to support its priorities. Additionally, it refers to the institutional power of the organization, and how much influence they have with key decision makers. The organization must have resources that are commensurate with the magnitude of the capability in development.

Expertise refers to both engineering and acquisition skills in the organization. Some programs are above all a technical challenge, and will require greater engineering resources and expertise for successful development.

Setup costs consider both the financial and administrative costs of either assigning a new capability to an existing organization or creating a new organization to acquire that capability.

A quick scan of the above matrix shows that no agent scores well across all dimensions.

Lead services have the time horizon, resources, and expertise to effectively develop joint capabilities and these capabilities can be assigned to a lead service for relatively little cost. However, the lead service frequently displays little commitment to the joint capability and struggles to consider other services' needs in the program. This was apparent in the case of GPS, where the Air Force tried to cancel the program even though it had been assigned as the lead service.

Defense agencies are one traditional location for neglected capabilities. These agencies are widely variable in both capabilities provided and performance in meeting those capabilities. They generally bring sufficient time perspective, expertise, and ownership but can struggle to compete for resources against services, which tend to resent funds diverted towards defense agencies. Additionally, these agencies can be expensive to set up and staff initially and have varying performance considering joint outcomes.

Joint task forces are highly committed to their assigned capabilities and easy to set up. Depending on the personnel assigned, they can also have significant levels of expertise. However, in practice these task forces have no resources or authority, meaning their only role is to make recommendations and give advice which they have no means to enforce or support. This dynamic is well illustrated by the UAV case in general and specifically by examining congressional testimony from the director of the UAV Planning Task Force and reports about that task force[52],[53].

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[52] United States. Cong. House Subcommittee on Tactical Air and Land Forces. Hearings on FY2004 Budget Requests for Unmanned Combat Aerial Vehicles and Unmanned Aerial Vehicle Programs. 26 March 2003.

[53] United States. Govt. Accountability Office. Unmanned Aerial Vehicles: Major Management Issues Facing DOD's Development and Fielding Efforts. Neil P Curtain, Paul L Francis. 17 March 2004.

Major commands, as the ultimate force users, are well positioned to consider joint force needs. However, as discussed at length above, these entities traditionally lack the long term time horizon, resources, and engineering and acquisition expertise necessary to act as procurement agents. Here JFCOM and STRATCOM have begun to emerge as an exception, and their long-term requirements have encouraged them to start developing and advocating for long-term joint capabilities. Additionally, developing these capabilities within the COCOMs could be expensive. While all COCOMs are not well suited to be procurement agents, this does not subtract from the value they could add to the process of defining required capabilities.

Confronted with the above group of suboptimal procurement options for joint and neglected capabilities it is useful to both consider how the existing options could be strengthened to improve outcomes and to consider other organizations which could serve as procurement agents.

Regional Combatant Commands and joint task forces have so many weaknesses as procurement agents that costs to make them viable force providers simply outweigh the likely benefits. However, lead services, defense agencies, and functional commands can all be effective procurement agents at times. Lead services are weak on both ownership and jointness, and this is a major problem because these are important dimensions. However, jointness at the first order, interoperability level, can be achieved with tightly tailored requirements—for example, a radio which is capable of transmitting on certain frequencies, across certain distances, such that it can be used by Air Force, Army, Navy, and Marine Corps forces. This solution may not be effective for programs requiring higher levels of joint consideration, but it is one way to make lead services more viable for some projects.

The other major problem with lead services is their lack of ownership of inherently joint and neglected capabilities. If a service does not care about a certain capability, or that capability is at odds with its traditional core, the service will give the

capability as little of its attention as it can get away with and hope it goes away. However, there is some history of services overcoming, at least in part, reluctance towards certain assets. The Navy never really wanted ballistic missile submarines, but these forces are an available and important part of U.S. nuclear deterrence strategy[54]. The Air Force has been reluctant to embrace space operations, but does so now and has tried through cultural changes to better embed space functions in the service[55]. OSD has primarily generated this commitment over time by funding specific projects and browbeating services to perform these projects. Naturally, this is a suboptimal solution, as it requires continued involvement by senior leadership and is often less effective than internally motivated performance. In spite of these limitations, top down direction to force services to own some neglected capabilities has worked at times, and might be the only option for high priority capabilities that continually fail to meet joint requirements.

Defense Agencies have proven most successful when given direction to provide a well-defined capability, such as the Missile Defense Agency and the Defense Logistics Agency. Others have struggled to accomplish their mission, due to low budgets, poor guidance, or service resistance. In general however, defense agencies serve an important role, and while admitting that they have wildly variable performance as a group, Gen. (ret) Larry Welch holds that many defense agencies do useful things that would not otherwise get done.[56] The largest obstacle to successful use of defense agencies is service resistance, as the services try to prevent funds for the agencies from being diverted away from their own budgets. Another potential obstacle for some defense agencies is what to do with the agency after it meets its primary mission. The MDA was created to rapidly field missile defense against North Korea. Having done so, it

[54] Builder 200.
[55] Recent Air Force slogans have emphasized space operations, insignia for space personnel was recently changed to include “Space wings” more similar in appearance to pilot wings, and the authors can personally report that the Air Force Academy schedules frequent space awareness events for its cadets.
[56] Welch, Larry. Telephone interview. 11 February 2008.

faces questions about what to do next[57]. In these cases, the time-horizon of the agency may be too long, as the organization begins to look for a mission to save itself from obsolescence.

Given the strengths and weakness of the different procurement agents for joint capabilities, OSD should seek to choose the most appropriate option given the needs of each specific capability, as well as work to overcome as many of the agency problems as possible.

INCREASE MANAGEMENT RESERVE FUNDS FOR OSD

Building ownership of a capability within an organization takes times, and the services have been particularly resistant to accepting new missions and capabilities in addition to their traditional roles. A lead service is therefore likely to try and reallocate funding away from the development of the new capability and towards other service priorities unless OSD intervenes. In some cases, OSD simply needs to exert its authority and insist that the services restore adequate funding to the new capability in its budget, and let the service make trade-offs somewhere else. Rather than always being engaged in budget battles however, OSD should also have the option of simply adding more funding to a service budget to pay for the new capability, particularly towards the end of the budget process when changes would be particularly disruptive. OSD currently has some discretionary funds that it keeps in reserve for just such an occasion, but they have historically been too low to fund any significant capability development and acquisition programs. While a funding work-around is less than ideal, as it essentially sidesteps the PPBS process, giving OSD a larger management reserve to allocate directly to programs will help mitigate some of the problems which arise from the services' incentives to cut funding.

[57] Welch, Larry. Telephone interview. 11 February 2008.

PROVIDE TITLE X AUTHORITIES FOR STRATCOM

Though there are some modifications that can help improve current procurement options on the margins, the limitations of each organization demonstrate the need for more flexible and integrated process. One alternative, with some track record, is giving procurement authority to a functional major command, such as the Title X authorities that Special Operations Command (SOCOM) has had since its inception in 1987.[58] While SOCOM faced some initial struggles manning its acquisition element[59] and integrating its budgeting process with the PPBS[60], SOCOM procurement became reasonably effective by the late 1990s. In fact, SOCOM's acquisition arm won some DoD acquisition awards in this time frame[61]. Even despite manpower limitations and its early struggles, assigning Title X responsibilities to SOCOM has been an overall success that can serve as a model for the development of other inherently joint systems and capabilities.

This report therefore recommends that DoD work with the Congress to provide STRATCOM with Title X authority to develop and procure inherently joint capabilities, as well as the necessary manpower and funding resources to support the new programs. Just as with SOCOM, the procurement agency within

[58] Demarines, Victor. "Exploiting the Internet Revolution". Keeping the Edge. Ed. Ashton Carter and John White. Cambridge: MIT Press, 2001. 74.
[59] United States. Department of Defense. Special Operations Command. U.S. Special Operations Command History 1987-2007. 2007. 20.
[60] Lewis, Leslie., James Coggin, and C. Robert Roll. The United States Special Operations Command Resource Management Process. Santa Monica: Rand, 1994.
[61] SOCOM History, 23-24.

STRATCOM would have the option of developing a capability completely in-house or of retaining decision-making authority over service-led programs.[62]

This recommendation goes beyond the proposals of Beyond Goldwater-Nichols Phase II Report, which recommends developing a Joint Task Force specifically for C3 under either JFCOM or STRATCOM. Instead, it would develop an acquisition organization with responsibility for a spectrum of neglected capabilities, leveraging the experiences of SOCOM to help smooth the development process and overcome service resistance. While the authors considered JFCOM as another option to lead the joint development programs, the long time-horizon required of many of the STRATCOM missions makes it less likely to prioritize its short-term needs at the expense of its long term requirements. STRATCOM also appears to be taking steps towards becoming an institutional champion of joint needs[63], and is currently responsible for the joint and non-traditional missions of cyberspace operations and strategic C3. As is stressed in BGN-II however, while either STRATCOM of JFCOM may be an appropriate choice, procurement authorities should not be given to both organizations to avoid conflicting programs and inefficient use of resources.

Figure 4. STRATCOM as Procurement Agent

	Ownership	Jointness	Time Horizon	Resources	Expertise	Setup Costs
STRATCOM w/ Title X	High	High	Long	Moderate	Moderate	Moderate

[62] Transcript of interview with Dale G. Uhler, conducted by Jeff McKaughan. *Special Operations Technology – Online Edition*. www.special-operations-technology.com/print_article.cfm?DocID=801
[63] Welch, Larry. Telephone interview. 11 Feb 2007.

It is useful to consider where these desired changes to STRATCOM would place it on the procurement agent analysis matrix developed above in Figure 3. As the ultimate user of the joint capabilities it would be developing, STRATCOM would feel significant ownership of the capability and have a large stake in the project succeeding. The new Title X authorities would also ensure high levels of "jointness" in new capabilities, as STRATCOM would bring its long history of joint cooperation and integration to the development process. Due to the global and ongoing nature of its missions, STRATCOM is also less likely than any other major commands to over-emphasize short-term necessities to the detriment of long-term planning and development, and should have no problem adopting a long-term time horizon when necessary. In providing Title X authority, DoD and the Congress would also need to provide STRATCOM with at least moderate funding and resources to develop and acquire its new capabilities. As demonstrated by the example of SOCOM, these changes will incur significant setup costs and will pose challenges in developing the necessary expertise in engineering and acquisitions. Nevertheless, the benefits of a creating a procurement agent with significant *ownership, resources,* and the appropriate *time-horizon* outweighs the costs, and could provide a new and effective option to better acquire and develop new joint capabilities.

ENSURING ACCOUNTABILITY AND COMPLIANCE

The fundamental question that OSD's accountability system should address is whether the forces provided to the warfighters have improved national security. One of the reoccurring weaknesses in OSD's control of the acquisition process is its inability to ensure that the services, as the primary force providers, are actually supplying the capabilities that the warfighters need and have requested.

There are two necessary subordinate questions to ask when answering the fundamental accountability question. The first is: did the DoD get the capabilities it wanted, in an efficient and relatively cost-effective manner? Phrased this way, the question of accountability is inseparably tied to the issue of initial strategic guidance and requirements. If the DoD does not make clear what it wants, or even worse, if it does not know what it wants, then anything the services produce will meet the standards. As discussed earlier, the current JCIDS products and IPLs are often too vague or broad to measure outputs against, and until they provide more specific and feasible requirements they will not provide a very useful measure of accountability. Compounding the problem is that with vague or non-existent requirements to procure neglected capabilities, there is frequently no organization which can be held accountable for failing to procure these capabilities. Given the deep linkages between better guidance and improved accountability, the above stated recommendations about improving the strategic requirements will substantially bolster end-of-cycle accountability for the acquisition of neglected capabilities. Strengthening PA&E within OSD will also greatly improve accountability by providing OSD with the ability to independently judge the extent to which the services have met the initial guidance. Finally, assigning neglected capabilities to an organization that willingly accepts ownership and responsibility for the new capability creates a channel to utilize existing accountability processes.

The second necessary question is: did the capabilities the DoD acquired reduce national security risks? If initial guidance is clear and well developed, it is likely that

programs designed to meet those requirements will improve national security. Yet when viewed across decades, it is a given that the national security environment will have changed, and it is also important to ensure that the provided capabilities are appropriate to address new security risks that may have emerged. OSD must therefore walk a difficult line between ensuring that guidance is specific enough to be actionable, while also being flexible enough to stay relevant in a changing security environment. Frequent reviews which examine increases and decreases in defense capabilities compared with corresponding increases and decreases in national security risk would therefore be a useful step to ensure that even well specified desired capabilities reduce security risks. This risk review process has the added advantage that, even if strategic requirement guidance is not clear and DoD gets only those capabilities that the services wanted (as is largely the situation now), OSD could still use a risk review process to see how services' desired capabilities mitigated security risks. As discussed above, the IDA-developed ICCARM can be an extremely useful tool in helping to align strategic guidance and requirements with current and anticipated risks.

Any accountability program should take care not to demand overly rigid compliance to initial guidance, as engineering setbacks or the changing strategic environment can drastically change the feasibility or desirability of any given program. An iterative accountability system should gauge whether past acquisition efforts have reduced security risks, and whether current programs meet anticipated future risks while allowing for strategic and technical realities to inform both the desirability and feasibility of various capabilities.

CONCLUSION

Providing effective national defense is one of the fundamental purposes of the U.S. government and the sole purpose of the DoD, and strong, living military services are an essential component of that mission. Yet the strength and culture of the military services can also create agency problems which interfere with OSD's ability to effectively guide the acquisition of necessary defense capabilities. There is no magic bullet to solve these problems, but we believe that the recommendations contained in this report will improve the DoD's ability to procure the neglected and inherently joint capabilities which are more important than ever in the current volatile and fast changing national security environment.

IMPROVING STRATEGIC DIRECTION AND GUIDANCE

Improve Joint Warfighter Input into the JROC by including representatives from JFCOM, STRATCOM, AT&L, and PA&E as statutory members.

Strengthen PA&E within OSD to provide the Secretary with stronger non-biased analysis and help overcome significant asymmetries of information.

In addition to improving guidance, these recommendations will improve end-of-cycle accountability by providing clearer standards against which capabilities can be judged.

GUIDING SYSTEM DEVELOPMENT AND ACQUISITION

Increase Management Reserve Funds for OSD to provide the Secretary with budget flexibility to focus on frequently overlooked joint priorities.

Provide Title X Authority for STRATCOM to lead the acquisition and development of inherently joint capabilities.

Improving guidance alone is not enough, as even with perfect guidance, OSD must still select or develop the appropriate force provider to procure the desired capabilities.

APPENDIX A – SELECTED WORKS CITED

Builder, Carl. Masks of War. Baltimore: Johns Hopkins UP, 1989.

Carter, Ashton and John White, Eds. "Keeping the Edge: Managing Defense for the Future." Keeping the Edge. Cambridge: MIT Press, 2001.

Fulgham, David. "Gulf War Successes Push UAVs Into Military Doctrine Forefront." Aviation Week & Space Technology, Dec1991 Vol. 135, No. 23;

Hermann, Robert and Larry Welch. "Transformation: A Progress Assessment, Volume I." Defense Science Board Summer Study, Washington, D.C., February, 2006. 19.

Johnson, Dana J. "Overcoming Challenges to Transformational Space Systems: The Global Positioning System (GPS)." Northrop Grumman Analysis Center, Los Angeles, CA, October 2006.

Kadish, Ronald "Defense Acquisition Performance Assessment." Defense Acquisition Performance Assessment Project, January, 2006.

Murdock, Clark A. and Michèle A. Flournoy. "Beyond Goldwater-Nichols: U.S. Government and Defense Reform for a New Strategic Era – Phase 2 Report". Center for Strategic and International Studies, Washington, D.C. July 2005.

Pace, Scott, et.al. "The Global Positioning System: Assessing National Policies" RAND Critical Technologies Institute, Santa Monica, CA, 1995. 238;

Scruggs, David. "Beyond Goldwater Nichols: An Annotated Brief" Center for Strategic and International Studies, Washington, D.C. August 2006.

United States. Dept. of Defense. UAS Roadmap 2005-2030. Washington: 2005. 5.