

Report of the  
Defense Science Board Task Force  
on  
ENABLING JOINT FORCE CAPABILITIES



AUGUST 2003

Office of the Under Secretary of Defense  
for Acquisition, Technology, and Logistics  
Washington, D.C. 20301-3140

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14 August 2003

MEMORANDUM FOR ACTING UNDER SECRETARY OF DEFENSE  
(ACQUISITION, TECHNOLOGY, & LOGISTICS)

SUBJECT: Phase I Final Report of the Defense Science Board Task Force on Enabling  
Joint Force Capabilities

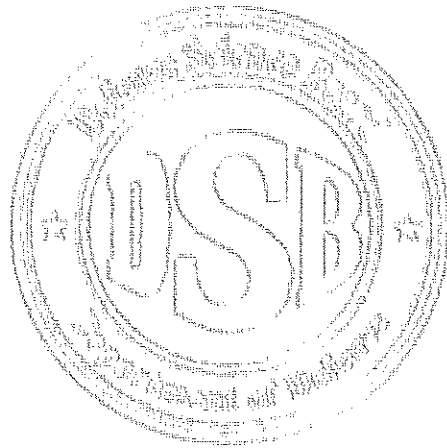
I am pleased to forward the final report of the first phase of the DSB Task Force on Enabling Joint Force Capabilities. The effort, chaired by Gen. Larry Welch (Ret) and Dr. Robert Hermann, carefully considered the challenge of ensuring that our forces are structured, trained, and equipped for effective joint force operations.

Among the several key recommendations proposed by the task force is the suggestion to develop and enforce a meaningful and comprehensive DoD business plan. This plan, to be updated annually, would direct Defense resources to provide the needed forces and interfaces to ensure effective joint force mission capabilities across the spectrum of contingency needs. The report describes the metrics associated with the business plan and the steps required to implement it.

Given the timeliness of this task force's work and the continuing need to enhance our joint effectiveness, I endorse all the task force recommendations and propose that you review them.

A handwritten signature in black ink that reads "William Schneider, Jr." with a stylized flourish at the end.

William Schneider, Jr.  
DSB Chairman





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MEMORANDUM FOR THE CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Phase I Final Report Defense Science Board Task Force on Enabling Joint Force Capabilities

Attached is the Phase I report of the DSB Task Force on Enabling Joint Force Capabilities. For the current effort, the Task Force was charged with recommending ways to enhance the capabilities of our joint forces as quickly as the component forces can respond. The central theme of the task force is the challenge of ensuring that our forces are structured, equipped, and trained to come together quickly for effective joint force operations.

Given the magnitude of this challenge, we divided our effort into two phases: Phase I concentrates on the following main points:

1. Helping identify specific characteristics and examples of organizations that could be capable of accepting responsibility and accountability for delivering the capability with needed responsiveness, and
2. Reviewing and understanding the current state of assigned responsibilities and accountability for joint capabilities to quickly bring combat forces together and focus them on joint objectives across a wide spectrum of possible contingencies.

Phase II will concentrate on recommending further steps to strengthen the joint structure ability to quickly respond with effective joint force operations with integrated Service- and Agency-provided force capabilities.

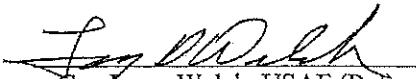
The following five points summarize the task force's Phase I findings and recommendations:

1. Assign and enforce clear responsibilities and accountability for force capabilities among the Joint World (Joint Chiefs, Joint Staff, combatant commands); force providers (military departments and defense agencies); and the Office of the Secretary of Defense (OSD).
2. Strengthen the influence of the combatant commanders in identifying joint force needs and setting priorities for filling those needs.
3. Provide the necessary C2, networks and information integration (NII), and systems engineering support for Joint Forces Command (JFCOM) and the regional combatant commanders.
4. Provide a process for linking resources and priorities to combatant command missions—the basic business of the Department of Defense (DoD).

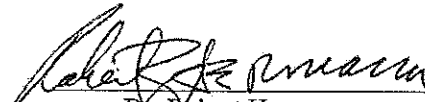
5. Provide a Secretary of Defense (SecDef) Business Plan that directs defense resources to provide the needed forces and interfaces to ensure effective joint force mission capabilities across the spectrum of contingencies.

In addition, the task force found that DoD, as currently structured, is capable of achieving these objectives, although some new relationships will be required. It can also be done within the current framework of laws.

We appreciate the opportunity we have had to work with the task force members and government advisors and look forward to the second phase of work.



Gen. Larry Welch, USAF (Ret)  
Task Force Co-Chair



Dr. Robert Hermann  
Task Force Co-Chair

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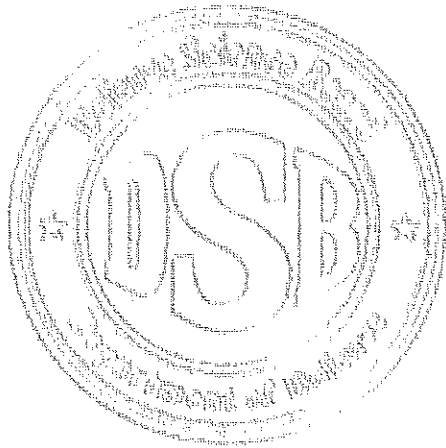
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## 1.0 INTRODUCTION

### 1.1 The Challenge

U.S. national security leaders face a complex, dynamic set of demands in protecting the interests of the United States and its allies. Three key trends shape the nature and capability of the military forces required to meet these demands:

1. The limited ability to predict when, where, and under what conditions we will need to commit U.S. military forces, particularly for smaller-scale contingencies;
2. The need for forces that enjoy dominant superiority over potential adversaries, not simply an incremental advantage over an aggregate set of threats; and
3. The rapid development and global availability of information technology (IT).

Taken together, these trends underscore the need for enhanced joint capabilities.

To achieve such capabilities, we need to address systemic barriers and identify solutions. A platform-centric legacy acquisition system, for example, prevents us from quickly moving information technology into the field to support network-centric military operations. Yet a network-centric approach based on a jointly developed network architecture remains essential if we are to field forces that can (1) respond quickly to a wide range of contingency demands and (2) act decisively from the outset against adaptive and resourceful adversaries. This requires full-capability, highly integrated joint land, sea, air, and space forces.

The need for enhanced joint force capabilities has been and continues to be demonstrated in a nearly continuous set of contingency operations since the end of the Cold War. These operations have consistently been characterized by the need for quick response with effective, integrated joint and coalition forces without the benefit of deliberate planning or standing, in-place, joint command and control (C2) arrangements. In each case, force providers were able to deliver ready forces for deployment quickly. These forces are equipped, constituted, and maintained at a state of readiness needed to meet the needs of joint combatant commands, within resource limits and as understood by the force providers, the military departments, and defense agencies.

A key pacing factor for early operational effectiveness has, in several cases, been the ability to provide the following joint systems capabilities:

- Intelligence preparation of the battlefield;
- Logistics support to the theater;
- Joint command and control; and
- The needed flow of integrated information to the operators, to include the tasking and managing of surveillance and reconnaissance assets and networks.

Innovative ad hoc approaches have, with varying degrees of responsiveness and success, provided the capability to operate with varying degrees of efficiency. These time-consuming processes, however, cannot meet the need for responsive, potent, and agile joint forces against adaptive adversaries.

## 1.2 Terms of Reference

The Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) charged the task force with recommending ways to enhance the capabilities of our joint forces as quickly as the component forces can respond. As defined in the terms of reference (TOR), the specific purposes of the task force are as follows (see appendix A for more detail):

1. Help identify specific characteristics and examples of organizations that could be capable of accepting responsibility and accountability for delivering the capability with needed responsiveness.
2. Review and understand the current state of assigned responsibilities and accountability for joint capabilities to quickly bring combat forces together and focus them on joint objectives across a wide spectrum of possible contingencies.
3. Recommend further steps to strengthen the joint structure ability to quickly respond with effective joint force operations with integrated Service—and Agency—provided force capabilities.

The central theme of the task force is the challenge of ensuring that our forces are structured, equipped, and trained to come together quickly for effective joint force operations. Given the magnitude of this challenge, we have divided our efforts into two phases; Phase I concentrates on the first two purposes, while Phase II (to follow) will concentrate on the third purpose.

## 2.0 THE BOTTOM LINE

The following five points summarize the task force's Phase I recommendations:

1. Assign and enforce clear responsibilities and accountability for force capabilities among the Joint World (Joint Chiefs, Joint Staff, combatant commands); force providers (military departments and defense agencies); and the Office of the Secretary of Defense (OSD).
2. Strengthen the influence of the combatant commanders in identifying joint force needs and setting priorities for filling those needs.
3. Provide the necessary C2, networks and information integration (NII), and systems engineering support for Joint Forces Command (JFCOM) and the regional combatant commanders.
4. Provide a process for linking resources and priorities to combatant command missions—the basic business of the Department of Defense (DoD).
5. Provide a Secretary of Defense (SecDef) Business Plan that directs defense resources to provide the needed forces and interfaces to ensure effective joint force mission capabilities across the spectrum of contingencies.

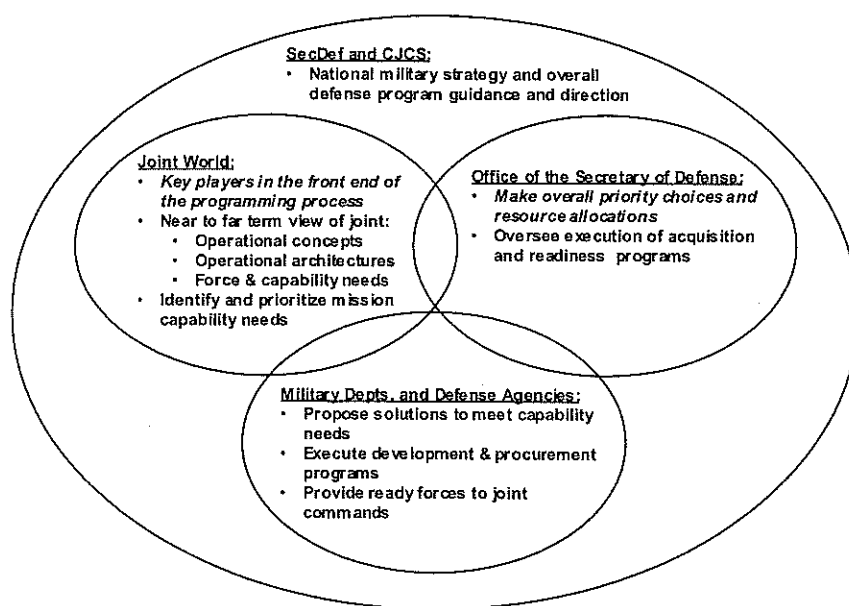
The task force found that DoD, as currently structured, is capable of achieving these objectives, although some new relationships will be required. It can also be done within the current framework of laws. The following sections of the report describe in more detail how to accomplish each of these recommendations.



### 3.0 AUTHORITY AND ACCOUNTABILITY

*Assign and enforce clear authority and accountability.*

Figure 1 is adapted from an earlier DSB report. Two key distortions in the current process are shown in italics and discussed below.



*Figure 1. Defense planning and programming lead responsibilities.*

The figure is intentionally simplified to the most basic definitions of authority and accountability in order to focus on the essential issues. As shown, responsibility and accountability overlap. For example, while it is OSD's responsibility to make overall priority choices and allocate resources, the SecDef and his staff cannot do that competently without full access to the in-depth expertise of the force providers—the Services and defense agencies. Moreover, OSD should also interface closely with the customer for force capabilities: the combatant commands, key players in the Joint World.

As we will discuss more fully in the next section of the report, the military departments and defense agencies—the force providers—dominate the current process for defining the right capabilities. While we suggest in Figure 1 that determining needed capabilities at the front end of the process should be led by the Joint World, the force providers currently collect “requirements;” translate them into recommended individual programs; aggregate the proposed programs into proposed budgets; and work them through the joint, OSD, and congressional communities. During this process, the force providers do consider the combatant commanders' views of their own capability needs and gaps, but those views have a marginal effect and usually are not the direct motivation for most major materiel programs.

Several reasons exist for the modest level of combatant commander influence, but a common complaint of Service planners and programmers is that the combatant

commanders have unconstrained needs; that is, the combatant commanders engage in the process without having to (1) consider the opportunity cost of choices and (2) make the link between value, cost, and schedule for a given capability.

There is some truth to these assertions, but the more complete reason for such limited combatant commander influence is structural. Because the Department's budget is organized by Service and defense agencies, the Services initially adjudicate joint requirements against self-generated (and therefore more familiar and compelling) Service requirements in the important early stages of constructing programs and budgets. The Joint World reenters the process at the end, during program and budget reviews, when its influence is inevitably less and changes are much more difficult to accommodate. For example, the combatant commanders are invited to meet with the Defense Resources Board at the end of the program/budget review process. The result of this process is that Service requirements are filled at a higher level than are the joint requirements, although meeting the joint requirements is essential if combatant commanders are to weld together joint task forces to meet actual and highly unpredictable contingencies.

The military departments and defense agencies are competent in providing balanced Service component forces using this process and have delivered a set of force capabilities that are clearly the best in the world. However, this has been supported by a defense budget and system that tolerates extensive schedule slips and escalating resource demands for individual programs. Further, the task force believes a basic deficiency that severely limits the responsiveness of these best-in-the-world component forces is a less-than-adequate consideration of joint warfighting requirements and the link with value, cost, and schedule. The result is that joint force responsiveness is limited, not by the availability of ready component forces, but by the ability to quickly bring the capabilities of Service component forces together in a highly effective joint force to deal with an unrehearsed and unforeseen operation. Joint deployment; joint battle management; command and control of joint fires; and joint intelligence, surveillance, and reconnaissance (ISR) are some of the areas that have been ad hoc and less effective than they can be and need to be.

ISR coordination with the Intelligence Community is a special case involving OSD, JCS, the Services and defense intelligence agencies, the Director of Central Intelligence and the CIA, and perhaps others. CIA activity is increasingly relevant to the combatant commanders. Still, the processes of the Intelligence Community are compatible with those of DoD and can be integrated with the concepts outlined here, including the Business Plan concept.

Once the Services deliver their programs and budgets, the rest of the process deals on the margins with the Service/defense agency proposed programs and recurring changes in schedules and resource demands. Hence, defined capability needs are not a full response to a disciplined aggregate of inputs from those responsible for employing the capabilities to meet DoD missions. Further, the influence of OSD in making the choices, allocating resources, and overseeing execution is, again, late in the process and on the margin.

It seems clear that the combatant commands need more influence—disciplined by value, cost, and schedule linkage—on the priorities of needed capabilities and associated resources. At the same time, OSD needs to exercise far more authority on resource

allocation and enforcing the Business Plan—that is, ensuring that programs deliver the expected value for the resources expended.

Another important weakness affecting joint force capabilities in the current acquisition system involves the acquisition of information technology. Some core joint warfare areas—joint deployment, joint C2 of joint fires, and joint ISR—depend on integrating Service information technology systems into joint warfighting networks. Commercially developed information technology is developing at a much faster pace than the current DoD program/budget system can handle. As a result, individual Service and joint information technology systems are out of phase and support only limited interoperability and interdependence. A joint task force typically spends weeks building the networks to carry out joint warfare. In several recent operations, the lack of speed and flexibility in joint warfighting networks has been the primary shortfall in the ability of joint commanders to execute missions as rapidly and decisively as force capabilities should have permitted.

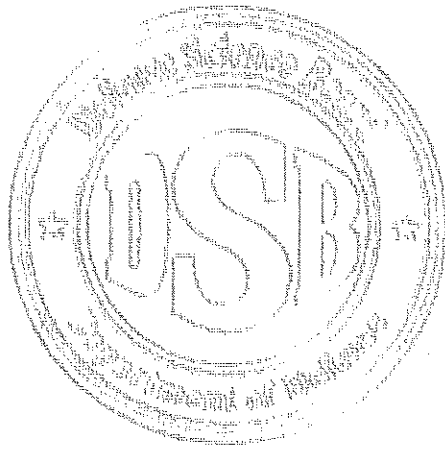
#### FINDINGS ON ASSIGNING AND ENFORCING CLEAR AUTHORITY AND ACCOUNTABILITY

*The Secretary of Defense needs to ensure that the Office of the Secretary of Defense, the Joint World, and the force providers have clear direction on their responsibilities and authorities in the structure and process for defining needed capabilities and acquiring those capabilities.*

*Particular emphasis is needed to ensure that*

- *The Joint World has the lead in identifying capability needs and setting priorities to meet joint mission needs,*
- *Joint warfighting program needs are identified and included at the beginning of the initial build of the Department's programs and budgets—the Business Plan,*
- *There is an enforceable Business Plan that reflects the Office of the Secretary of Defense's decisions on program choices and resource allocations, and*
- *The force providers provide the program management that delivers expected value in programs with OSD oversight.*

Enabling Joint Force Capabilities





#### 4.0 THE ROLE OF THE COMBATANT COMMANDERS

*Strengthen the influence of the commanders charged with conducting joint operations—the combatant commanders—in identifying joint force needs and setting priorities for filling those needs.*

To address the issues of organization/process/structure to identify, prioritize, and approve joint capability needs, it is useful to start with the current process. Figure 2 depicts this process in simplified but conceptually accurate terms.

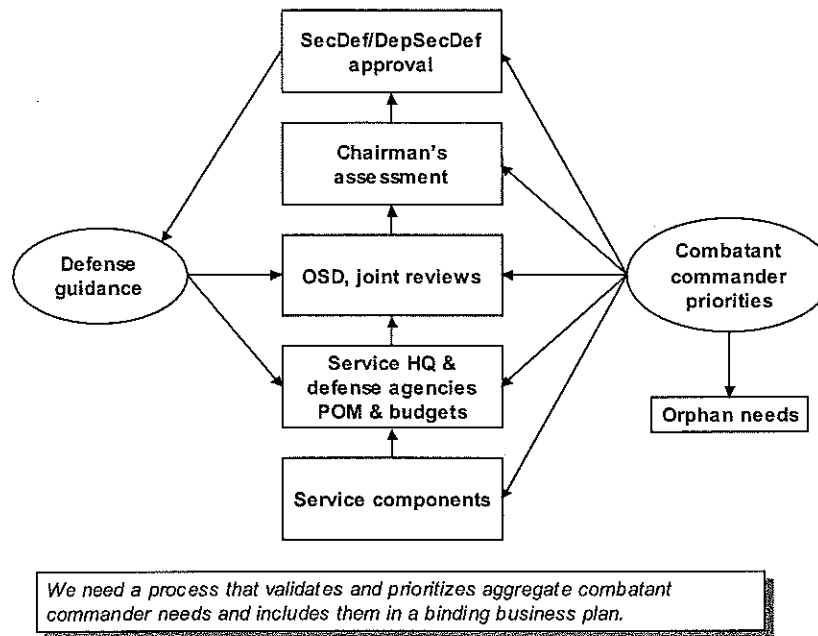


Figure 2. The current process: force provider dominated.

As suggested earlier and shown on the chart, the force providers dominate this process. Over the past two decades, joint influence in defining and pursuing capability needs has increased. In particular, influence over individual weapons system decisions, exercised through the Joint Requirements Oversight Committee (JROC) and supported by J-8, has greatly increased. Still, influence over overall force planning and building remains marginal and highly dependent on how well the Service component commands represent the combatant commanders' priorities. In addition, many joint warfighting needs such as joint battle management and joint ISR (included in the category of "orphan joint needs" in Figure 2) are not developed in coherent programs. They are, instead, either neglected or spread in an uncoordinated fashion across multiple Service and defense agency programs.

The unconstrained nature of the combatant commander's statement of capability needs tends to reduce their credibility. That credibility is further eroded by the commonly declared "near-term focus" of the combatant command. It is true that these commands are properly concerned with ability to meet mission demands on a daily basis, but that is also

true of the military departments and agencies that provide capabilities to combatant commands. To the extent that combatant commands do focus predominantly on the near-term, it is because that is the current expectation. It is not because of any inherent inability to focus on the full spectrum of timeframes from short to long. Further, the best source for understanding future combatant command needs is certainly the leadership of the commands themselves.

However, the long-standing practice is that the military departments and defense agencies build the Program Objective Memoranda (POMs) and the proposed budgets, while the review process is just that—a review process that occurs after the force providers have produced complex, hard-to-change program plans. The Defense Guidance, as currently developed and promulgated, falls far short of being an effective means of strongly influencing the build-up of the force providers' programs.

Further, the current approach increasingly confuses the roles of the joint community and OSD. Over time the Joint Staff has attempted to validate requirements for virtually all the major programs in the Department (development of the Joint Warfighting Capabilities Assessment, or JWCA, process), rather than concentrating on the joint warfighting "seams" based on input and feedback from the combatant commanders. The joint community needs to increase its effectiveness greatly in defining and prioritizing joint capability needs. Supervising the execution of programs to achieve those defined and prioritized joint warfighting capabilities is not necessarily a Joint World role, although the Joint World (primarily the combatant commanders) has to be the authority which determines if these "seam" capabilities are being fielded in a timely, coherent, and fiscally responsible way, just as the individual Services make the same determination for their component forces.

Figure 3 illustrates in simplified terms how a more balanced approach would work.

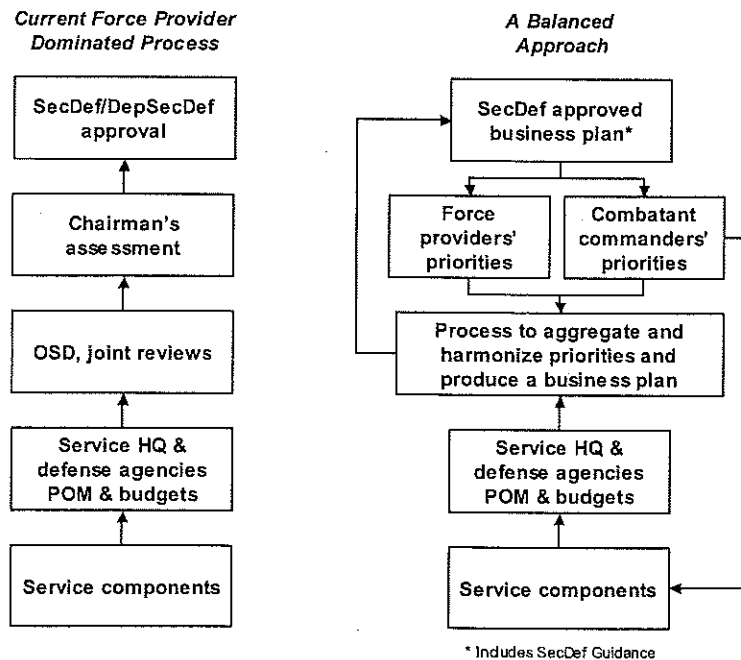


Figure 3. A more balanced approach.

The balanced approach retains the basic responsibility of the force providers to organize, train, and equip forces to provide capabilities for employment by combatant commands. Further, it recognizes the heavy dependence on the expertise, institutional continuity, and focus of the force providers. They remain the principal source of proposed solutions to joint capability needs. As we will note later, the force providers also remain the competent source of delivering the prioritized, approved capabilities. They will also have an increased responsibility for providing information to the combatant commands on rough order costs to fill capability demands so that the combatant commanders' capability priorities include a clear sense of opportunity cost associated with new demands.

Under this more balanced process, however, the joint warfighting capabilities—joint deployment, joint battle management, command and control of joint fires, joint ISR, etc.—will need to be identified separately to ensure that contributing Service and defense agency programs are integrated and that resources are provided to fill gaps in joint warfighting capabilities. An additional reason for retaining the role of the force providers is that they have been a principal source of innovation and experimentation. In times past, OSD has also been a major contributor.

The objective of this process is to make the combatant commands more equal partners with the force providers from the beginning of the process, particularly when identifying capabilities needed to carry out the Department's operational missions. The challenge is to create a process that makes these inputs sufficiently credible to (1) strongly influence force planning at all levels, and (2) identify from the outset the joint warfighting areas in the Department's program and budgets so that the needed capabilities can be compared in value, cost, and schedule with single-Service programs. A later section of this report suggests how that could be done.

A second change is to provide a process for turning combatant command priorities into a set of prioritized capability needs that are relevant to individual and multiple theater and global operations—that is, a process for aggregating and harmonizing joint capability needs and for producing a binding Business Plan that directs the force providers to create and field the approved capabilities. The expanded questions in the TOR suggest the possibility that a new organization or structure might be needed and that may indeed prove to be the case. The task force believes, however, that the current organization—with minimum structural changes—can accommodate the needed process change given adequate direction and support from the senior leadership.

FINDINGS ON STRENGTHENING THE INFLUENCE  
OF COMBATANT COMMANDERS

- *Combatant commanders need to have a driving influence in the program building process from the beginning of each annual cycle of program planning.*
- *Combatant commanders' capability priorities need to be credible, aggregated, and prioritized along with capability priorities from the force provider. Decisions on programs to address those needs should be incorporated into a binding Business Plan.*
- *The Department's program and budget structure needs to include the joint warfighting areas so that combatant commanders' priorities can be applied across joint and Service needs. Among the critical joint warfighting areas are joint command and control, ISR, and connectivity.*
- *The Business Plan, agreed to by the force providers and approved by the Secretary of Defense, should become the single source of defense program guidance.*

## 5.0 OPERATIONAL ARCHITECTURE AND SYSTEMS ENGINEERING SUPPORT

*Provide operational architectures and systems engineering support to combatant commanders for C2 and networks and information integration (NII) needs*

Recent changes in the Unified Command Plan (UCP) should, over time, move the combatant command toward a greater contribution to operational architectures and joint interface systems. For example, Joint Forces Command (JFCOM) has been assigned expanded responsibilities and authorities for overseeing and directing joint battle management and command and control (BMC2) capabilities and joint integration and interoperability. The purpose is to facilitate the creation and development of doctrine, requirements, and integrated architectures for joint BMC2 interoperability and connectivity.

The new Strategic Command (STRATCOM) has a set of global responsibilities for joint forces capabilities, to include global joint command and control services, global information operations, global ballistic missile defense, and an extensive role in global surveillance and reconnaissance. These new assignments will necessitate new relationships with the sources of technical and engineering expertise which will in turn increase both their inclination and capability to contribute to innovative thinking, an attribute not currently characteristic of most combatant commands.

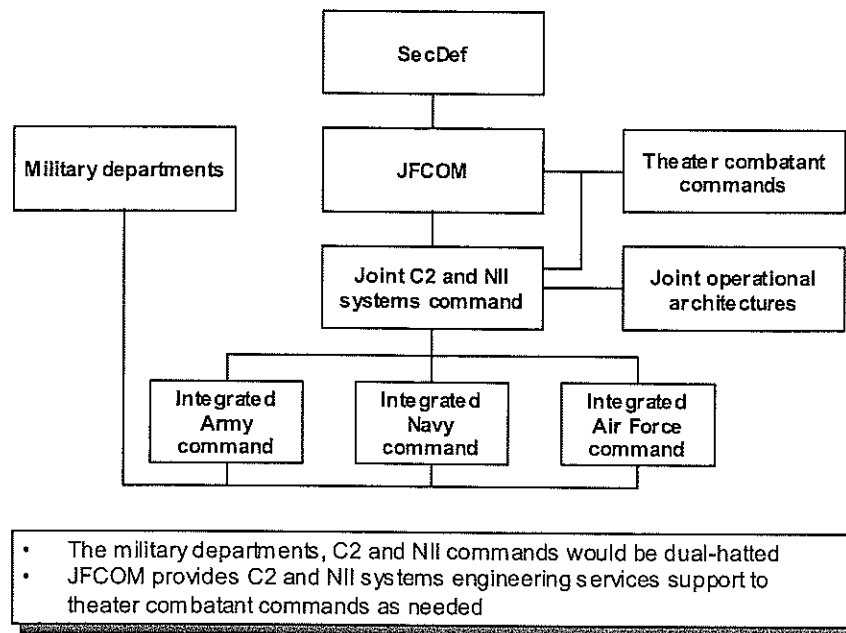
Four fundamental, unfilled needs need to be addressed:

1. An organization and process for providing systems engineering support to combatant commands;
2. A stronger process for creating joint operational architectures so that force providers have a framework into which they fit their programs;
3. Closer and more formal ties with the Service organizations responsible for acquiring and fielding the joint systems; and
4. A means of harmonizing C2 and NII needs across the joint arena, from OSD/JCS, Services/defense agencies (including intelligence), and especially the combatant commands.

The architecture and systems engineering approach should be truly “enterprise”-based, system-of-systems engineering. Figure 4 illustrates an approach to meeting these needs.

A multi-Service organization would be formed in JFCOM to provide mission operational architectures. This organization would need to include people with experience across the operational world. It would report to a new sub-unified command in JFCOM, which would also be the source of systems engineering expertise to JFCOM and the theater combatant commands. Because of the specific global missions assigned to STRATCOM in this area, this command would also have to develop a special relationship with STRATCOM. The organization would be small since the logical source of the expertise would be the Services, in the form of dual-hatted Service NII and ISR organizations, characterized in figure 4 as integrated NII commands.

## Enabling Joint Force Capabilities



*Figure 4. Joint operational architectures and systems engineering support for C2 and networking and information integration (NII)*

Dual-hatting these commands would provide at least three benefits.

1. It would provide the needed level of expertise without duplicating existing capabilities in the Services and defense agencies.
2. It would help ensure that joint needs and systems define integrated C2, NII, and ISR architectures and standards and that Service systems programs conform to these needs and standards.
3. It would provide the acquisition structure to acquire compatible C2 and NII programs and fix existing C2 and NII interoperability problems. Acquisition programs would continue to be assigned to a Service, defense agency, or intelligence community acquisition organization.

In order for the Joint C2 and NII Systems Command to have the needed influence, some part of the overall related programs budget would need to be controlled by the command though acquisition programs would continue to be executed by the Services and defense agencies.

FINDINGS ON PROVIDING OPERATIONAL  
ARCHITECTURE AND SYSTEMS ENGINEERING SUPPORT  
TO COMBATANT COMMANDERS

- *Establish a small Joint Systems Command within Joint Forces Command.*
- *Dual-hat the Service NII and ISR development commands as Service components to the JC2 & NII Command.*
- *Charge the JFCOM JC2 & NII Command with systems engineering support to JFCOM and the regional combatant commands*

Enabling Joint Force Capabilities





## 6.0 RELATING RESOURCE ALLOCATION TO COMBATANT COMMAND MISSIONS

*Provide a process for linking resources and priorities to combatant command missions—the basic business of the Department of Defense.*

The combatant commanders have an essential role in defining new capability needs. This role demands a structure and process that will allow the commanders to provide meaningful inputs regarding the capabilities required to accomplish their missions in the future. These inputs can be meaningful only if based on an understanding of the overall set of capabilities that contribute to a relevant set of missions. This requires that DoD be able to relate resource allocations to combatant command missions. While this may prove to be difficult, it is an essential prerequisite to any meaningful Business Plan. The need for a process to relate resources to combatant command missions is twofold.

- First, the business of the combatant commands is the Department’s core business and inability to relate resource allocations to core business should be regarded as a fundamental failure in how DoD understands its own business.
- Second, it is an essential step in providing the means for combatant commanders to make valid judgments about priorities. Priorities have to be based on choices—often hard choices.

In essence, the combatant commands need to go through a force program decision process that considers the set of capabilities directly relevant to their future missions. As is the case with the military departments, associating program costs with an individual combatant command mission will be an imperfect approach, but it can be sufficient for the need. Even an imperfect allocation will serve the purpose of applying the combatant commanders’ special understanding to the tradeoff of resources within their allocated resource set, just as the military departments have done for decades. Figure 5 illustrates a suggested management approach that associates force capabilities and cost with combatant command missions.

	CC1	CC2	CC3 ...
Army Assigned forces 1 ... n Empirically committed forces 1 ... n Acquisition programs, allocated share 1 ... n Theater infrastructure 1 ... n			
Navy Assigned forces 1 ... n Empirically committed forces 1 ... n Acquisition programs, allocated share 1 ... n Theater infrastructure 1 ... n			
Air Force Assigned forces 1 ... n Empirically committed forces 1 ... n Acquisition programs, allocated share 1 ... n Theater infrastructure 1 ... n			
Defense agencies, etc.			

*Figure 5. A multi-year mission capability/resource matrix to associate defense resources with combatant commands.*

The purpose is to provide combatant commanders the needed information to make credible choices as part of their input to the force programming process. In other words, the purpose is to force the discipline of matching planned capabilities with available resources and to provide visibility into the capability/resource/schedule situation of the Department for all major participants.

While the matrix may appear simplistic, it is, in practice, a complex concept that will work only if all parties understanding its purpose clearly. It is not a budget document, nor does it attempt to account for all defense resources; a significant part of defense spending involves the underlying support for the enterprise, and attempting to associate that part of defense resources with combatant command would complicate the process unnecessarily.

As to the mechanics of allocating resources, the first category shown in Figure 5 is straightforward: it is the total annual cost of sustaining forces assigned to the command. The second category allocates the cost of the forces provided through Joint Forces Command. Here, an empirical allocation based on some past period—perhaps a 5 year running average—will suffice. For acquisition programs, the allocation of a category of programs such as Air Force tactical fighters or Army armor systems could be on the same percentage basis as that part of the force assigned and empirically committed to the combatant command. Other systems such as transportation and global ISR assets—assets that remain high-demand/low-density—will require a different approach. The point is that any reasonable allocation will have arbitrary elements but can suffice for the intended purpose. The first year or two will be the hardest. After that, changes will be incremental, again, as is the case with current allocations to the military departments and defense agencies.

In building and using this management tool, the views of combatant commanders on one hand and military departments and defense agencies on the other are likely to differ; the former will tend to focus on direct mission needs while the latter will likely focus on broader issues. However, there is room for differences in view since, as suggested several times, there needs also to be a structure and process to aggregate a coherent set of capability needs. The purpose of this approach is to discipline the choices and force the needed dialogue to ensure that the customer's unique understanding—emanating from immersion in mission issues—adds a powerful voice to aid in the selection of choices.

FINDINGS ON RELATING RESOURCE ALLOCATION  
TO COMBATANT COMMAND MISSIONS

- *The priorities provided by the combatant commanders need to result from choices that consider the relative value of alternatives to the mission of the command.*
- *To provide the basis for such choices, a means of associating a defined share of defense resources with the command's missions is essential.*

## 7.0 THE BUSINESS PLAN

*Provide a Secretary of Defense Business Plan that directs defense resources to provide the needed forces and the needed interfaces to ensure effective joint force mission capabilities across the spectrum of contingency needs.*

The Business Plan describes agreed upon capability needs and the means of meeting those needs. It portrays and aggregates the military capabilities—joint and component forces—needed to execute the combatant command missions across the range of contingencies covered in the Joint Operational Concept. It explicitly identifies the resources allocated to each mission capability set and to each program within a capability set.

It also provides the metrics in value terms that form the basis for overseeing program execution. The value assessment includes capability provided, resources needed, and schedule. The value assessment will ultimately be expressed in terms of resources allocated to acquire the capability by a certain date.

### 7.1 Buying Capabilities

The value-cost-schedule linkage is the underpinning for a mission-oriented Business Plan, and valid cost and schedule projections are the keys to executing and enforcing the Business Plan. Hence, those who identify capability gaps and advocate filling them will need access to at least rough estimates of the cost and schedule realities for various solutions to their capability needs. This is likely to require a closer interface between the combatant commanders and the force providers. Further, as budget quality estimates of cost and schedule are developed, there needs to be an iterative process to make new value judgments based on the best cost and schedule data available. This iterative process will be especially important for information technology programs. Because of the rapid pace of change common to this technology, programs and budgets require a great deal of flexibility. This does not mean that requirements can be unconstrained; it does mean that engineers and operators need to be tightly connected (with program offices playing a facilitating role) to address the real joint needs in the field with the best developing technology.

To help ensure an enforceable expectation of outcomes, cost and schedule should be commensurate with the need for and value of the capability. As a general rule, cost planning should be based on an 80 percent probability, with a program reserve commensurate with the technical and program risk and the value of the capability.

To provide for realistic expectations, it is essential that spiral development be the standard approach so that a valuable defined increment of capability can be fielded at a predictable cost on a predictable schedule while maintaining the flexibility to exploit learning from experiments and real-world operations. For spiral development to produce expected capabilities at the expected cost on the expected schedule, the process should adhere to the following guidelines:

- There needs to be a careful assessment of technological readiness, with a risk reduction activity outside and preceding the major program activity where significant technical risks exist.
- Each spiral should be an enforced baseline.

- Spiral development provides for spiral experience with the capability providing a highly reliable basis for joint forces judgments about the operational characteristics and value of the next increment and reliable cost and schedule estimates by the providers and OSD.
- Spiral development of incremental capability improvements should be accompanied by spiral testing to ensure that the combat forces can have confidence that the capability will be real in combat.

## 7.2 Measuring Progress and Enforcing Outcomes

The Business Plan defines the responsibilities and accountability for mission execution in the Department and provides the baseline against which performance can be measured. The techniques for evaluation will include exercises, simulation, analysis, program progress reports, management assessment, and, occasionally, real combat.

The Secretary of Defense and Chairman of the JCS will need to establish a formal process for evaluating the performance of each of the combatant commands, military departments, and defense agencies against the assignments defined in the Business Plan. The mechanisms for doing this are largely in place: the JROC process, the Defense Acquisition Board milestone approval process, and some aspects of the proposed Joint Capabilities Integration and Development System, to name a few. Hence the primary weakness in enforcing adherence to the current value-cost-schedule relationship is not due to process. It is due to inadequate discipline and the lack of a guiding Business Plan. Correcting the former will require a new mindset.

Since, the Business Plan is based on a value-cost-schedule linkage (and choices regarding what is to be acquired and what opportunities are to be passed up in favor of these choices), significant changes in cost and schedule beyond that accommodated by reserves constitute a failure of that part of the Business Plan. This would call for a full reassessment of the program experiencing the cost or schedule overrun.

Continuing a program that fails on these counts should be the exception. In contrast, the current practice as a general rule continues programs with multiple cost overruns and schedule slips, and program cancellations based on cost and schedule performance are the exception. Some will argue that failing programs often continue because (1) the requirement still exists, and (2) it is politically too difficult to start over. A primary reason it is too difficult to start over is that we so rarely do so. Hence, the expectation is that even very large cost and schedule overruns will be forgiven. That expectation adversely affects the motivation of both government and contractor program managers. That is not to suggest that even the most vigorous discipline can eliminate the occasional need to continue programs experiencing cost and schedule overruns. It does suggest, however, that the first line of defense should be to adjust program content to fit the program funding and schedule. If that reduces the value to the point that that increment of the spiral program is no longer attractive, that is a very useful thing to understand.

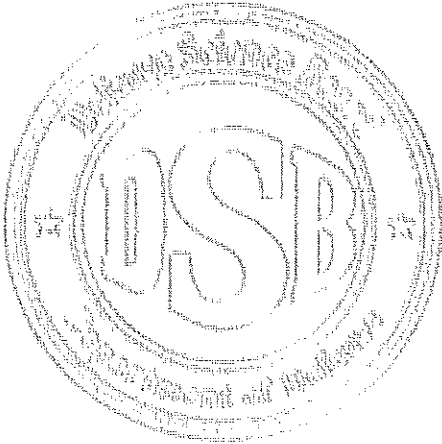
Initial work with the joint community to formulate the Business Plan is likely to result in a long and expensive list of unfilled joint warfighting requirements. To pay the bills, attention will then turn to identifying lower priority needs. Formulating the multi-year mission capability/resource matrix should serve as the basis for identifying lower priority programs. If a combatant commander, Service, or defense agency capability does not appear in the matrix, it becomes an obvious candidate for reduction. If it serves the

joint warfighting needs of several combatant commanders, it should have a high priority. Discipline will be the key to the integrity of the matrix so that it does not become a Christmas tree on which all programs in the department can hang. With discipline in attention to program contributions to joint warfighting capabilities, the matrix can be a valuable tool for making priority decisions.

FINDINGS ON PROVIDING A  
SECRETARY OF DEFENSE BUSINESS PLAN

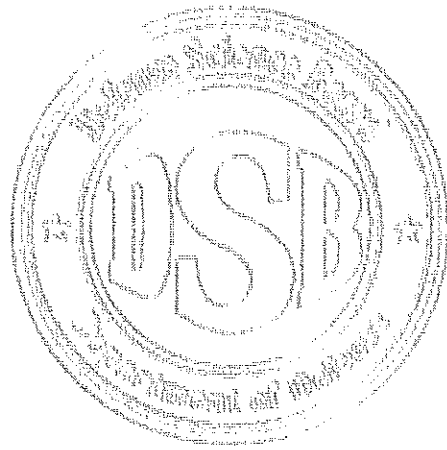
*The structure to produce the Business Plan should be a standing directorate with suitable administrative support, reporting to the Secretary and co-chaired by the DepSecDef and the Vice CJCS.*

- *The directorate would include individuals with backgrounds from the military departments, J-8, the combatant commanders, and relevant offices of the OSD.*
- *It would monitor current execution of the Business Plan and prepare the future years plan.*



## 8.0 RECOMMENDATIONS

1. *Clearly articulate and enforce responsibilities and accountability for force capabilities among the Joint World (CJCS, Joint Staff, and combatant commanders), force providers (Services and defense agencies), and the Office of the Secretary of Defense.*
2. *Implement a process that identifies and prioritizes capability needs based on an aggregation of individual combatant command-identified, resource-constrained, prioritized capability gaps*
3. *To provide for a realistic set of prioritized capability needs and to serve as the basis for a Business Plan, apportion defense resources most directly associated with force building and operations—R&D, system and support procurement, personnel costs, O&M funding for joint operations, and so on—among the individual combatant commands based on their missions and expected operations.*
4. *Task the combatant commands to prioritize their additional capability needs, considering the value to their mission and the cost and schedule linkage. The commands will have to link to the military departments and defense agencies to get rough estimates of the cost and schedules associated with filling capability needs. The combatant commands will then have to make choices within their apportioned resources.*
5. *Establish a small Joint C2, Networks and Information Integration Systems Command in Joint Forces Command with dual-hatted Service components to provide systems engineering support to combatant commands.*
6. *Create a Business Plan, updated annually, that accounts for each increment of capability to be acquired, the cost and schedule for that capability, and a process to measure performance against the plan's objectives.*
7. *Make the Business Plan enforceable by requiring realistic cost and schedule assessments and by providing reserves commensurate with the risk. Use the 80 percent probability cost as the absolute ceiling.*
8. *Force Business Plan discipline with a willingness to (a) terminate programs failing on cost and schedule metrics and (b) start over with new value-cost-schedule assessments. Restructuring a program that is failing on cost and schedule metrics should be the exception, not the rule.*





A. TERMS OF REFERENCE (TOR)



ACQUISITION,  
TECHNOLOGY  
AND LOGISTICS

THE UNDER SECRETARY OF DEFENSE

3010 DEFENSE PENTAGON  
WASHINGTON, DC 20301-3010

February 20, 2003

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Terms of Reference--Defense Science Board Task Force on Enabling Joint Force Capabilities

The Chairman of the Joint Chiefs of Staff has requested that you form a Defense Science Board (DSB) Task Force on Enabling Joint Force Capabilities

Contingency operations since the end of the Cold War have consistently been characterized by the need to quickly integrate joint and coalition force capabilities into an effective operating force without benefit of deliberate planning or standing joint command and control arrangements. In each case, force providers were able to quickly provide ready forces to the joint and coalition operation. These forces are equipped, constituted, and maintained at a state of readiness needed to meet the needs specified by joint Combatant Commands. Further, in each case, a key pacing factor on early operational effectiveness has been the ability to provide the needed joint systems capability – intelligence preparation of the battlefield, logistics support to the theater, joint command and control, connectivity, tasking and managing surveillance and reconnaissance assets and providing the needed flow of information to the operators. Innovative ad hoc approaches have, with varying degrees of responsiveness and success provided the capability to operate with varying degrees of efficiency.

A number of studies and reviews have suggested that at least part of the solution is to identify capability needs and assign responsibility for filling those needs with the same rigor applied to combat forces. Currently ongoing activity is revising the Unified Command Plan to assign previously unassigned joint capability responsibilities and accountability. While this is very positive step, it will lead to additional demands for other new joint force arrangements.

Specific purposes of this task force are to:

- Review and understand the current state of assigned responsibilities and accountability for joint capabilities to quickly bring combat forces together and focus them on joint objectives across a wide spectrum of possible contingencies.



Enabling Joint Force Capabilities

- Help identify unfilled needs and areas where assigned responsibility and accountability calls for further clarification and/or organizational arrangements, e.g.;

DISA support for the new USSTRATCOM's expanded global missions

Interface between USSTRATCOM global operational and support missions and USJFCOM joint development and joint training mission

CNA/CNE STRATCOM/NSA interface

USSTRATCOM/Regional Combatant Command (to include USNORTHCOM) interfaces for missile defense

The need for processes and tools for rapid planning for contingencies for which deliberate plans are not relevant

- Identify specific characteristics and examples of organizations that could be capable of accepting responsibility and accountability for delivering the capability with needed responsiveness.
- Recommend further steps to strengthen the joint structure ability to quickly integrate service-provided force capabilities into effective joint forces.

The study will be co-sponsored by me as the USD (Acquisition, Technology, and Logistics), and the Chairman, Joint Chiefs of Staff. Dr. Robert J. Hermann and General Larry D. Welch, USAF (Ret) will serve as the Task Force Co-Chairmen. RADM Patrick Walsh, USN, Deputy Director for Strategy and Policy, JCS J-5 will serve as the Executive Secretary and LTC Scott Dolgoff, USA, will serve as the DSB Representative.

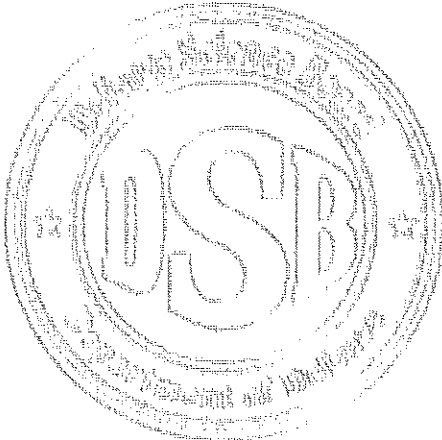
The Task Force will be operated in accordance with the provisions of P.L. 92-463, the "Federal Advisory Committee Act," and DoD Directive 5104.5, "DOD Federal Advisory Committee Management Program." It is not anticipated that this Task Force will need to go into any "particular matters" within the meaning of Section 208 of Title 18, United States Code, nor will it cause any member to be placed in the position of acting as procurement official.



E.C. Aldridge, Jr.

## B. EXPANDED TERMS OF REFERENCE (TOR)

- Help identify specific characteristics and examples of organizations that could be capable of accepting responsibility and accountability for delivering the capability with needed responsiveness
  - What is the organization necessary to establish the future joint needs of DoD? How is this organization's output different from the current outputs of the OSD and Joint Staffs?
  - What are the core competencies of this new organization (or process/structure)? How do they differ from those of the current Joint, OSD or Service staffs?
  - How is this organization populated, managed, and grown?
  - To what does this organization look for guidance?
  - What then is the role in joint needs development of:
    - the Joint and OSD staffs and the combatant commanders and,
    - the Military Services and Defense Agencies and the DoD Intelligence Community.
  - How do the combatant commanders, the Services and the Defense Agencies interact with this new organization (or process/structure)?
  - Should the Services, Defense Agencies and the USG Inter-Agency Organization develop competitive approaches for satisfying joint needs?
  - How does the Secretary of Defense decide among differing competing solutions proffered by the Services and Defense Agencies for meeting joint needs?
  - How does he implement the selected approach?
  - What is the role of the Service Secretaries and their Service Chiefs in this process?
  - What is the role of Service doctrine and futures establishment?
- Review and understand the current state of assigned responsibilities and accountability for joint capabilities to quickly bring combat forces together and focus them on joint objectives across a wide spectrum of possible contingencies.
  - Help identify unfilled needs and areas where assigned responsibility and accountability calls for further clarification and/or organizational arrangements.
- Recommend further steps to strengthen the joint structure ability to quickly integrate Service- and Agency-provided force capabilities into effective joint force operations.



## C. TASK FORCE PARTICIPANTS

### **Task Force Co-Chairs**

Gen Larry Welch, USAF (Ret)

Dr. Robert Hermann

### **Task Force Members**

Mr. Michael Bayer

GEN William Hartzog, USA (Ret)

ADM Dennis Blair, USN (Ret)

Gen James McCarthy, USAF (Ret)

Mr. Denis Bovin

Gen Joseph Ralston, USAF (Ret)

Ms. Mary Margaret Evans

Mr. Michael Rich

Dr. John S. Foster, Jr.

ADM William Studeman, USN (Ret)

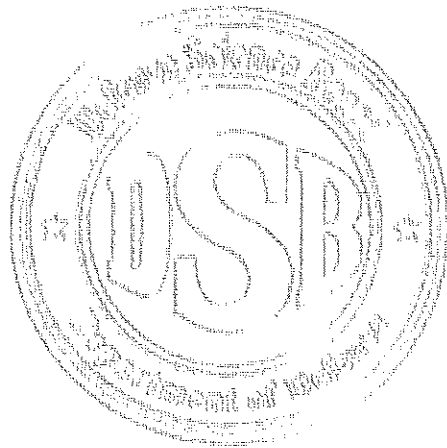
Dr. Ted Gold

### **Executive Secretary**

RADM Patrick Walsh,  
USN, Deputy Director, JCS J-5

### **DSB Secretariat Representative**

LTC Scott Dolgoff, USA,  
USD(AT&L)/DSB



## D. ACRONYMS

BM&C2	Battle Management & Command and Control
C2	Command and Control
CC	Combatant Commands
CIA	Central Intelligence Agency
CJCS	Chief of Joint Chiefs of Staff
DepSecDef	Deputy Secretary of Defense
DoD	Department of Defense
Hq	Headquarters
ISR	Intelligence, Surveillance, and Reconnaissance
IT	Information Technology
JC2	Joint Command and Control
JCS	Joint Chiefs of Staff
JFCOM	Joint Forces Command
JROC	Joint Requirements Oversight Council
JWCA	Joint Warfighting Capabilities Assessment
NII	Networks and Information Integration
O&M	Operations and Maintenance
OSD	Office of the Secretary of Defense
POM	Program Objective Memorandum
R&D	Research and Development
SecDef	Secretary of Defense
STRATCOM	Strategic Command
TOR	Terms of Reference
UCP	Unified Command Plan
USD(AT&L)	Under Secretary of Defense for Acquisition, Technology, and Logistics

Enabling Joint Force Capabilities





Mike Sullivan  
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Mr. Sullivan currently serves as Director, Acquisition and Sourcing Management, at the U.S. Government Accountability Office. This group has responsibility for examining the effectiveness of weapon system acquisition and procurement practices in meeting their mission performance objectives and requirements. His current work includes reviews of program management, the JSF, F/A-22, E-10A, and Global Hawk acquisition programs that generally recommended that more knowledge about requirements, funding, and technology is needed to reduce risk before launching new programs and more knowledge about design and manufacturing processes at appropriate junctures is needed to reduce risk before continued major product development investments are made.

In addition to weapon system acquisition reviews, he has developed and directs a body of work examining how the Department of Defense can apply best practices to the nation's largest and most technically advanced weapon systems acquisitions. This work has spanned a broad range of issues and has focused on creating a knowledge-based, evolutionary process for delivering weapon systems. The group's findings and recommendations often include lessons from some of the world-class commercial developers they have visited, including Bombardier Aerospace, Caterpillar, Ford, Hewlett-Packard, Motorola, Siemens, Toyota, and others. It also recognizes the fundamental role and impact that the requirements-setting and funding processes have on getting better acquisition outcomes. For example, one study assessed the necessary elements for building a sound business case—a match between requirements and resources—necessary for beginning an acquisition with reduced risk. Mr. Sullivan was also part of a GAO team that briefed the task force responsible for DOD's revision of its acquisition policy (the DOD 5000) in May 2003. In addition to reports on major weapon systems acquisitions, he has issued the following:

**Tactical Aircraft: F/A-22 and JSF Acquisition Plans and Implications For Tactical Aircraft Modernization.** GAO-05-519T, April 6, 2005. (Testimony)

**Best Practices: Successful Application to Weapon Acquisitions Requires Changes In DOD's Environment.** GAO/NSIAD-98-56, Feb 1998.

**Best Practices: Better Management of Technology Development Can Improve Weapon System Acquisition Outcomes.** GAO/NSIAD-99-162, July 30, 1999.

**Defense Acquisition: Employing Best Practices Can Shape Better Weapon System Acquisition Decisions.** GAO/T-NSIAD-00-137, April 29, 2000. (Testimony)

**Best Practices: Better Matching of Needs and Resources Will Lead to Better Weapon System Acquisition Outcomes.** GAO-01-288, March 8, 2001.

**Best Practices: Capturing Design and Manufacturing Knowledge Early Improves Acquisition Outcomes.** GAO-02-701, July 15, 2002.



# Model Driven Architecture---Transforming System and Software Design

Noel Longuemare

August 10, 2005

Rev 2

## *Introduction*

Model Driven Architecture (MDA) is a truly revolutionary approach to the way modern systems are specified, designed, implemented, tested, and supported. It affects all aspects of the life cycle of software intensive systems, and promises enormous reductions in both acquisition and life cycle costs, plus orders of magnitude reductions in cycle time. Rarely has such a profound change in methodology emerged, and the full impact of this revolution is just beginning to be realized and appreciated.

## *Description of the Problem*

Today's digitally enabled systems are universally becoming more and more dependent on software in virtually all of their functions. This has resulted in vast improvements in performance, has enabled new capabilities to be implemented, and is driving the trend toward Network Centric Operations as the key discriminator on the battlefield. Software design, development, testing, and support are consuming an ever-larger share of DoD budgets. Model Driven Architecture is about to have a huge impact on this process.

The classical approach to systems design is for a set of paper requirements to be developed that envision the desired system behavior and performance. These are used by the System Designer to formulate the necessary architecture, algorithms, and detailed signal and data flows needed to achieve the desired results. Models and simulations are often used to verify and optimize the detailed system design. Once this process is completed, the system design is provided to the software engineers who actually reduce this to practice, generally employing a high order language such as C++ or the like, and ultimately compile this into executable code for the host computing and processing platforms.

One of the most costly and time-consuming steps in this process is systems integration and test, where the actual operation of the system is verified and compared with the desired behavior. A significant portion of this time is spent in finding and rooting out discrepancies that have been introduced between what the systems designer specified and what was implemented in the actual software design and maintenance processes.

Each of the artifacts of this process is an independent entity: the specifications, architecture, algorithms, signal and data flows, models and simulations, and code---all stand alone. Because of the level of complexity involved, it is nearly impossible to keep all of these entities aligned manually and to correctly deduce the impact of change on each. Thus the perennial integration and test problems.

## *The MDA Process*

Model Driven Architecture changes this entire approach. Instead of paper specifications and requirements, the very first step is the generation of a high-fidelity model of the desired system behavior, utilizing an emerging tool known as Executable Unified Modeling Language (xUML). This model is used to check the completeness and correctness of the specification and to verify and validate the spec against the capability requirements. Further, because the spec (now in model form) is executable, it is possible to measure and optimize performance until the required capability is attained. So far, this is already a significant advance over current practice. However, it is at the next step that the truly spectacular value of MDA emerges.

Once a suitable xUML model has been constructed, a model compiler is then utilized to convert the UML model into actual software code in whichever language is appropriate to the host computing or processing platform chosen for the system. In most cases there are other portions of the system that the computing complex must interface with, and here too the model process is used to specify these details such that a complete and correct description of the software functionality is captured. Once expressed in xUML, the generation of the actual software is totally an automated, machine process.

Several advantages are immediately evident with this approach. Most significantly, the entire step of handing off the system design to a set of software developers and maintainers to redesign and manually convert into software is eliminated. This is not only a huge time and cost saver but also avoids the inevitable introduction not only of errors but also of “software designer’s choice” discrepancies that are inherent to the manual process. Testing is also facilitated, in that performance of the evolving software load can be readily verified using the faithful model representation that is fundamental to this approach. A significant issue in conventional practice is maintaining configuration control between the system designer’s models and the actual system as it evolves. In a design based on MDA, since any modifications are now performed by changing the xUML model itself, one-to-one correspondence is obviously assured.

## *Systems of Systems Networking and Interoperability*

In the case of Netcentric Systems of Systems (SoS), a huge and yet unsolved problem with today’s vast array of military platforms is lack of true interoperability, which ironically is a fundamental tenet of the basic Netcentric concept. The emergence of MDA is the first ray of hope in finally arriving at a method for actually achieving true Netcentric Operations.

Rather than providing paper specifications for each participant in the SoS to individually interpret and implement, an xUML Platform Independent Model (PIM) is first generated that exhibits the desired Netcentric behavior. Once a suitable PIM is derived, it is provided to each participating platform design team, who in turn generate Platform Specific versions applicable to their specific equipment and needs. An Adaptation Layer is generally utilized to adapt the core capability embodied in the PIM to each platform, and that is where unique interface aspects and other platform peculiar needs are addressed. The key factor provided by MDA is that *the same software code* contained in the PIM core is essentially run on every member platform in the SoS network, thus assuring data consistency and true interoperability.

### *Supportability Benefits*

Not only is the initial design process greatly improved---there is an even greater potential benefit in the software support area. Since system configuration control (when using MDA) now revolves around a validated Model rather than the actual software, the impact of software changes and upgrades on overall System and SoS performance can be readily verified at the design stage. Further, so long as interfaces are not affected, changes can be disseminated to participating platforms in the form of changes to the PIM, which can then be incorporated into specific systems using the machine code generation capabilities inherent to MDA. Experience has shown that what previously would take months and often years to manually develop and incorporate can be done in a matter of days for the actual software changes. This is especially important for Netcentric systems, where an entire fleet of platforms can now be modified or upgraded in a synchronized process at comparatively low cost. This has enormous implications for large Total Ownership Cost savings as well.

### *Other Implications of Applying MDA*

MDA is still at an early stage of development, and many of the xUML tools required must be further refined and expanded to cover the needs of the myriad potential applications that are emerging. Industry has already recognized the benefits and is rapidly moving to exploit them. As software design migrates to an MDA approach for the various constituent parts of modern systems, Modeling and Simulation (M&S) will take on a totally different and expanded role. Classically, model generation is a stand-alone effort generally funded as an additional task as an adjunct to the detailed design process, and is often performed by a separate group dedicated to M&S. Issues constantly arise as to how precisely the models represent an actual system, and quite often these models differ in substantive ways due to variations in the assumptions made, simplifications introduced to decrease run time, etc---not to mention the very practical problem of maintaining configuration control synchronization.

Almost all of these issues are avoided by using MDA. Models now move from a side activity to the mainstream, since the basic, detailed designs are fundamentally one-to-one dependent on the models that specify them. No extra funding is required to generate models, since design funds are now directly applied---and with reduced amounts being required at that. Model/System configuration synchronization is also assured at no extra effort.

A powerful new capability is now possible once this process is implemented. Since in the limit every part of the software system is described by high-fidelity, interoperable models, the feasibility of readily putting together combinations of these models to emulate the behavior of a new system becomes practical. Thus it is not unreasonable to anticipate that not too far into the future, detailed behavior of complex new systems can be modeled in an unprecedented short time and with a very high degree of fidelity. This can make possible the rapid fielding of entirely new capabilities, and is a key to attaining true Netcentric operations.

## *Summary*

Model Driven Architecture is clearly an emerging new process that affects virtually every stage of the system life cycle. The benefits in Total Ownership Cost reduction and time to fielding are so significant that both government and industry are rapidly adopting and refining this process as they apply MDA to an increasing number of uses. Suppliers of Unified Modeling Language tools are also rapidly enhancing, broadening, and enriching the required UML tool sets and related compilers as the process is applied to an increasingly wide range of problems and domains. MDA represents a truly revolutionary improvement in the design of future systems, and supplies the key missing interoperability ingredient that will make complex Netcentric Operations possible.