

**REPORT OF THE
DEFENSE SCIENCE BOARD
TASK FORCE
ON
Command, Control, Communications,
Computers, Intelligence, Surveillance and
Reconnaissance (C4ISR) Integration**

February 1997



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**OFFICE OF THE UNDER SECRETARY OF DEFENSE
FOR ACQUISITION & TECHNOLOGY
WASHINGTON, D.C. 20301-3140**

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MEMORANDUM FOR UNDER SECRETARY OF DEFENSE (ACQUISITION &
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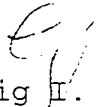
SUBJECT: Report of the DSB Task Force on C4ISR Integration

I am please to forward the final report of the DSB Task Force on C4ISR Integration, which was co-chaired by Dr. Robert Hermann and Gen Larry Welch, USAF (Ret). You asked the Task Force to provide advice to the Department's C4ISR Integration Task Force (ITF) and a review of its final report.

The Task Force concluded that the actions recommended in the C4ISR ITF Report may not result in greater integration. Specifically, joint force commanders might not have a strong enough influence on decisions regarding what increased (or decreased) C4ISR capabilities are needed for them to carry out their assigned missions. Improvement is needed in two areas:

- A joint process for determining C4ISR needs in systems and support capabilities, and
- A military systems engineering capability for C4ISR integration.

The Task Force recommends that SECDEF and the Chairman continue evolve the joint process for determining what a joint commander needs for C4ISR capabilities. Given its inherent joint character, C4ISR integration is a logical aspect of warfare for this joint process to focus on early. Once such a joint structure is created, it should be used in the Joint Theater Air and Missile Defense program as a pilot program for demonstrating C4ISR integration, with focus on refining the responsibilities and missions of the warfighting CINCs.


Craig I. Fields
Chairman



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Dr. Craig I Fields
Chairman
Defense Science Board
The Pentagon
Washington, DC

Attached is the final report of the 1996 Defense Science Board Task Force on C⁴ISR Integration. This Task Force was tasked to assist the DoD by providing advice to the Department's Integration Task Force on all aspects of C⁴ISR integration as well as separate reports of its judgments on these matters.

The Task Force worked closely with the Integration Task Force to assess the adequacy of DoD-wide C⁴ISR integration activities. Despite many excellent recommendations, this DSB Task Force was not comfortable that the work and vision of the Integration Task Force were adequately formulated to drive DoD C⁴ISR integration. It is unclear to this Task Force whether the cumulative impact of the actions recommended by the ITF will, in fact, move DoD C⁴ISR toward greater integration. This Task Force believes that, at this time in the Department's history, and with the revolution that is going on in related technical and industrial fields, there is a need to provide a compelling vision of what must be done, why it must be done, a more simplified process to accomplish this, and the serious consequences of inaction.

This Task Force then focused its attention on its concern that joint force commanders do not have a strong enough influence on decisions regarding what increased (or decreased) C⁴ISR capabilities are needed for them to carry out their assigned missions. The Task Force achieved a consensus on the need for improvement in two areas:

- *A joint process for determining what a joint force commander needs in C⁴ISR systems and related weapon systems and support capabilities in order to operate effectively.* The Task Force sees the need for a more formal joint process on the front end of the programming and budgeting cycle. The Task Force does not yet see a comprehensive, institutionalized process that provides:
 - Adequate support to enable the CINCs to stay abreast of ongoing and potential development of capabilities that can significantly influence the CINC's ability to perform their missions
 - Ways to test new concepts and systems and an exercise and training environment that helps assure continuing C⁴ISR competence
 - An effective formal process which allows the Joint elements of DoD to influence the organization, training and equipping allocations that produce capabilities to support the CINC's assigned missions

- *A military systems engineering capability for C⁴ISR integration.* The Task Force believes that DoD lacks a joint mechanism for the design and improvement of the C⁴ISR system. The Service Components develop their own C⁴ISR systems and subsystems based on their own operational concepts and view of the operational need. These several systems are brought together in a theater when needed and great time and effort is then expended to make them work together well enough for the forces to operate jointly in an adequate manner. Some progress is being made, but too slowly to meet immediate needs and seize the opportunities for improvement. DoD must do better in the planning, design and execution of joint C⁴ISR integration. The part of DoD that is responsible for joint activities consists of the CJCS, the Joint Staff and the CINCs. Up until now, the CINCs have been operating organizations and joint activities are not responsible for the systems engineering and design of the CINC's military capability. To take on C⁴ISR integration responsibilities, not only must some joint entity be given the formal responsibility, but it must be provided with the resources needed to carry out this job.

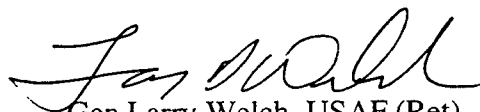
This Task Force developed a conceptual approach for addressing both of these needs, a "model." In both cases, the Task Force sees important initiatives aimed in the right direction. The Task Force supports these initiatives and recommends that:

1. SecDef and the Chairman continue to evolve the joint process for determining what a joint force commander needs in order to operate effectively as recommended in the 1996 DSB Summer Study on Innovative Support Structure for 21st Century Military Operations. Given its inherent joint character, C⁴ISR integration is a logical aspect of warfare for this joint process to focus on early.
2. CJCS use the new structure that was established to provide joint operational architectures and joint system engineering to Joint Theater Air and Missile Defense as a pilot program for the broader C⁴ISR area, with focus on the refining the responsibilities and missions of warfighting CINCs.

I recommend that the Department consider the models provided within this report as a basis for judging the progress from these ongoing DoD initiatives. I would like to thank the members and government advisors of this Task Force for their hard work on this important subject and for their dedication to improving the Department.



Dr. Robert Hermann
Co-Chairman



Gen Larry Welch, USAF (Ret)
Co-Chairman

Defense Science Board Task Force on Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C⁴ISR) Integration Final Report

1.0 INTRODUCTION

The Deputy Secretary of Defense, in an effort to accelerate the development of Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C⁴ISR) integration and architecture efforts in the Department of Defense, directed that a DoD-wide Integration Task Force (ITF) be created. He designated Assistant Secretary of Defense (C³I) to sponsor, organize and manage this effort. The Defense Science Board (DSB) was requested then to establish a Task Force on C⁴ISR Integration to assist this internal DoD process by providing:

- Advice to the ITF chairman on all aspects of C⁴ISR integration.
- Separate reports of its judgments on these matters to the Department

The Terms of Reference for this Task Force are attached as Appendix A and the list of members as Appendix B.

The DSB Task Force met four times with the leaders of the ITF. During each meeting, the ITF leaders described the process, organization and results of the ITF efforts to date. Based on these interactions, the DSB Task Force formulated a set of inputs for consideration by the ITF. Two letter reports were submitted by the DSB Task Force during the course of its deliberations.

The Task Force discussed the Department's ITF efforts with regard to DoD-wide C⁴ISR integration. Although the Task Force was impressed by the size and scope of the ITF effort and the dedication and quality of people involved, the Task Force concluded that the Department's ITF efforts were overly broad and complex. The ITF tasks were made very difficult to accomplish by the fractionated and "stovepiped" nature of the C⁴ISR stakeholder community, particularly with regard to programmatic and fiscal responsibilities.

Despite many excellent recommendations, this DSB Task Force was not comfortable that the work and vision were sufficiently focused to drive DoD C⁴ISR activities toward the required level of integration. The recommendations of the ITF speak to generalized Pentagon processes which the Task Force does not believe will result in leveraged progress in achieving important new levels of C⁴ISR integration. This Task Force believes that, at this time in the Department's history, and with the revolution that is going on in related technical and industrial fields, there is a need to provide a compelling vision of what must be done, why it must be done, a more simplified process to accomplish this vision, and the serious consequences of inaction.

All elements of the DoD are aware of the need to create a joint C⁴ISR system to support the military commanders in combat. Over many years, the Services, as a part of their responsibility to equip and train the forces, have created organizations and processes to provide the C⁴ISR that

they believe to be needed for their own forces. In today's world of combined, smaller forces for almost all military operations, the need for and difficulty of combining the C⁴ISR equipment and procedures supplied by the Services have grown substantially. The lack of an established process for carrying out that task has become evident and great efforts are being made by everyone concerned to solve the problem, which is by no means limited to C⁴ISR but extends across all joint military capabilities. The approach of the DoD has been gradual and evolutionary consisting of joint committees of various sorts, joint tests and exercises, assignments of primary responsibility for various pieces to particular Services and Agencies, and the creation of new organizations such as the Joint Requirements Oversight Council (JROC).

The Task Force applauds these efforts but does not believe they are adequate to deal with the Joint C⁴ISR problem. The Task Force believes that a much clearer assignment of responsibility is needed and, since it does not seem workable to assign the task to one of the Services or to the OSD staff, this assignment should be made to the joint world itself, which already has the fundamental responsibility for the assembly and command of the combined Military Force. The Task Force sees the fundamental responsibility as belonging to the Chairman JCS and the CINCs.

The Task Force is not advocating that any of the responsibilities of the Services and Agencies be transferred to the CJCS/CINCs. Rather, it sees a responsibility that no organization has at the moment, the creation of a joint C⁴ISR capability. The vast majority of the work will continue to be done by the Services and Agencies.

The Task Force sees two fundamental needs: improving the joint process for determining what a joint force commander needs in order to operate effectively, and the creation of a joint system engineering organization, under the direction of CJCS, both to assist the CJCS and the CINCs in determining their needs, and to assist the CINCs in making the many components and subsystems supplied to them work together effectively in joint operations.

These two needs are closely related but are, to a considerable extent, different and separable. The body of this report describes in greater detail just what the Task Force recommends.

The Task Force is well aware of the recent creation of a new management structure for Theater Air and Missile Defense. The TAMD structure creates a Joint Theater Air and Missile Defense Organization (JTAMDO) within the Chairman's staff to "define the required system interoperabilities and operations architectures, and to validate developing Joint Theater Air and Missile Defense capabilities through both simulation and technology demonstrations." The structure assigns the responsibility for systems engineering to BMDO. This new structure is consistent with this Task Force's recommendations and is an appropriate, although partial step in the direction needed for the broader joint C⁴ISR area.

2.0 JOINT PROCESS FOR DETERMINING WHAT A JOINT FORCE COMMANDER NEEDS IN ORDER TO OPERATE EFFECTIVELY

The Task Force sees the need for a more formal joint process on the front end of the programming and budgeting cycle that gives joint force commanders stronger influence on decisions regarding what increased (or decreased) capabilities are needed for them to carry out

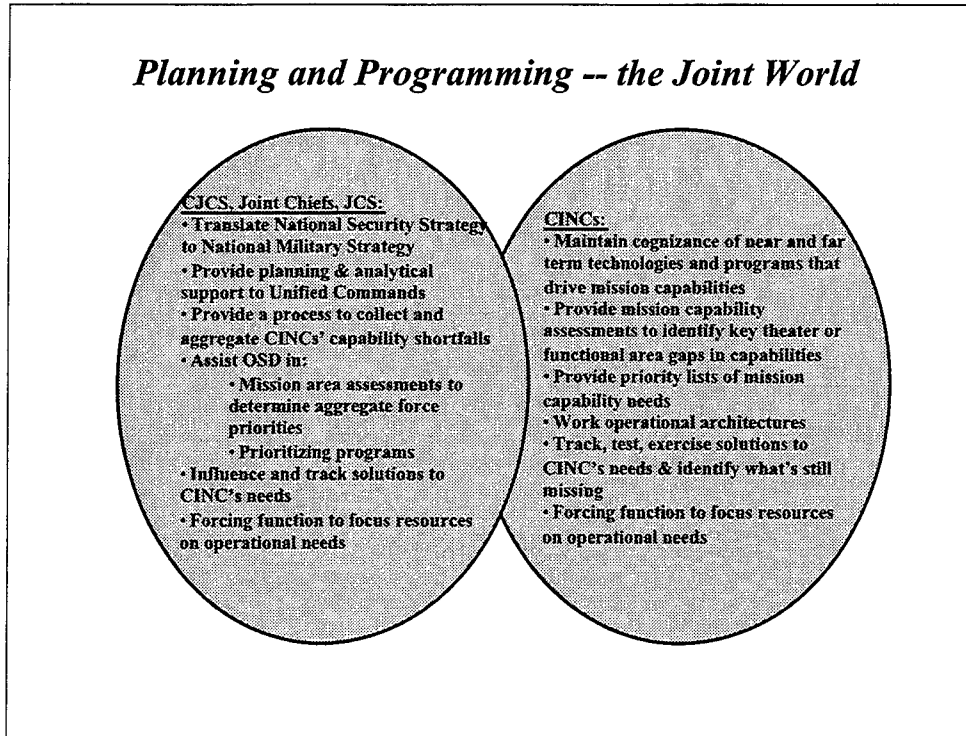
their assigned missions. Such a process should encompass the full range of needed capabilities. However, C⁴ISR integration is particularly in need of the joint attention since many other capabilities – weapons, platforms, etc. receive intense attention through Service initiatives. Further, C⁴ISR includes an inherently joint set of capabilities that can evolve only from a powerful joint process. Progress has been made since the mid-1980s in strengthening the involvement of the CINCs and the Joint Staff in decisions that provide capabilities to joint commanders for joint operations. Still, the Services are far more effective in pursuing their initiatives to develop Service-unique capabilities than is the joint world in pursuing those joint capabilities essential to effective joint operations. The Task Force does not yet see a comprehensive, institutionalized process that provides:

- Adequate support to enable the CINCs to stay abreast of ongoing and potential development of capabilities that can significantly influence the CINC's ability to perform their missions. The CINCs need regular, assured-access to technical expertise to insure currency.
- Ways to test new concepts and systems and an exercise and training environment that helps assure continuing C⁴ISR competence. The Advanced Concept Technology Demonstration program is intended to help provide such a capability in selected areas. However, the CINCs need continuing access to a simulation environment that specifically addresses C⁴ISR capabilities, concepts and training. Such an environment is important to trying out new systems as well as maintaining competence with existing systems and concepts. Exercises, whether live, simulated, or combinations of both, need to employ the same assets and processes that will be used during actual operations.
- An effective formal process which allows the joint elements of DoD to influence the organization, training and equipping allocations that produce capabilities to support the CINC's assigned missions. The JROC/JWCA process is intended to help serve this purpose, but it is not well suited to making tough resource and priority decisions, based on the collection of CINC user and Service provider inputs. In particular, C⁴ISR decisions need to be conceived and born joint rather than being integrated after the fact into joint capabilities.

Customer-Based, Output-Oriented Planning and Programming There has been important progress in involving the warfighting customer in the process of identifying the gaps between tasking and capabilities for the joint operational commands - the combatant commands. For example, with the current Joint Chiefs approach, the CINCs are being consulted and informed to an unprecedented level.

Still, making the ultimate customer a stronger influence in resource allocation priorities remains ad hoc and personality dependent, while the role of the providers of forces and services (the Military Departments and Defense Agencies) is institutionalized and codified, and dominates the planning and budgeting process.

Planning and Programming -- the Joint World



This Task Force sees the need for a formal, lasting role for the joint operational customer in formulating joint operational concepts and joint operational architectures, as well as in ensuring appropriate input to resource allocation priorities to produce effective joint operational forces. There needs to be a fundamental change in culture such that the providers are clearly serving the joint customer as a first priority.

This Task Force sees different lead roles for the three C⁴ISR integration communities within the Department of Defense.

1. Joint World:

- Become key players in the front end of the programming process
- Address both near and longer-term views of joint:
 - Operational concepts
 - Operational architectures
 - Force and capability needs
- Identify and prioritize mission capability gaps within constrained resources and under SecDef guidance on strategy

2. OSD:

- Make overall priority choice and resource allocation recommendations
- Oversee execution of acquisition and readiness programs

3. Military Departments and Defense Agencies

- Propose solutions to meet the highest priority capability needs
- Execute development and procurement programs
- Provide ready forces to joint commands

Given the SecDef and CJCS formulation of the national defense strategy and overall defense guidance, a primary responsibility of the joint world is to match available force capabilities to tasks and to identify gaps in capabilities. While this process has evolved in positive directions in recent years, it depends heavily on the emphasis accorded this role by the incumbent CJCS. Further, the planning and budgeting process can and does continue apace whether or not the individual or collective CINCs participate in any meaningful way.

Only OSD can fill the role of resource choice arbitrator and allocator. This role is less institutionalized and codified than the Services organizing, training, and equipping role, but is clearly an essential part of the planning and budgeting process. Still, at present, the choice arbitrator and resource allocator role is severely hampered by lack of visible connectivity of resource allocation to mission output--that is to the capabilities of the CINCs to carry out their assigned operational missions.

Since the role of the joint world is less defined, institutionalized, and codified than the other two entities in the Department, this Task Force expanded on the needed joint role in the planning and budgeting process. Much of what is suggested as the planning and budgeting role of the CJCS, Joint Chiefs and JCS is underway and becoming institutionalized. First, the CJCS, the Joint Chiefs and the JCS have key roles in:

- Translating national security strategy to national military strategy,
- Providing planning and analytical support to Unified Commands,
- Providing a process to collect and aggregate CINCs' capability shortfalls ,
- Assisting OSD in mission area assessments to determine aggregate force priorities and in prioritizing programs,
- Influencing and tracking solutions to CINC's needs, and
- Providing a necessary forcing function to focus resources on operational needs.

In contrast, the role of the CINCs is not widely accepted within either the civilian or the military leadership of the Department. Instead, there is frequently active opposition from some in the JCS, OSD, and Military Departments to such a role. Among the common arguments against more CINC involvement are that:

- The CINC is too busy with day-to-day duties to give meaningful attention to the longer term demands of the operational mission in his theater. To avoid distracting the CINC from his day-to-day duties, this matter is best left to Washington. That argument assumes

that everything else the theater commander does is more important than focusing on the longer term needs of his theater of operations.

- More CINC involvement would infringe on the Military Department Title 10 responsibilities and would require a large plus-up in the CINC's staff.

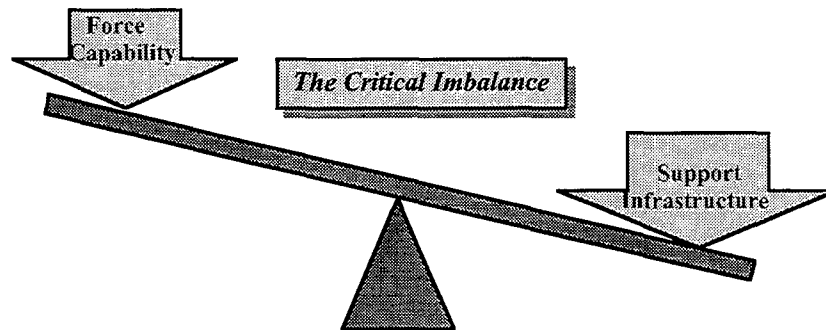
The conceptual "model" suggested by this Task Force is not that the Military Departments should do less organizing, training, and equipping. It is that the joint world should do more in identifying the needs of the joint customer that are to be satisfied by the providers of organized, trained, and equipped forces. In order to undertake this role, the CINCs would require a part of their staffs focused on the duties listed below:

- Maintaining cognizance of near and far term technologies and programs that drive mission capabilities
- Providing mission capability assessments to identify key theater or functional area gaps in capabilities
- Providing priority lists of mission capability needs
- Working operational architectures
- Tracking, testing, and exercising solutions to CINC's needs and identifying what is still missing
- Providing an additional forcing function to focus resources on operational needs

It does not follow that the CINCs would necessarily need a larger overall staff. Instead, the highest priority tasks should get manned first and this role should be among the highest priority for CINCs.

The Joint Customer Role in Motivating a Shift of Resources from Support Infrastructure to Force Capabilities Budget reductions have shrunk investment in the R&D and procurement that sustains and modernizes force capabilities much more than support infrastructure. The support infrastructure constituency has exerted more influence than the combat force capability constituency (Joint Chiefs and CINCs). The joint world is the natural constituency most strongly favoring resources for operational capabilities vs. support infrastructure and needs to play a leading role as a forcing function.

*The Joint Customer Role in Pushing Resources from
Support Infrastructure to Force Capabilities*

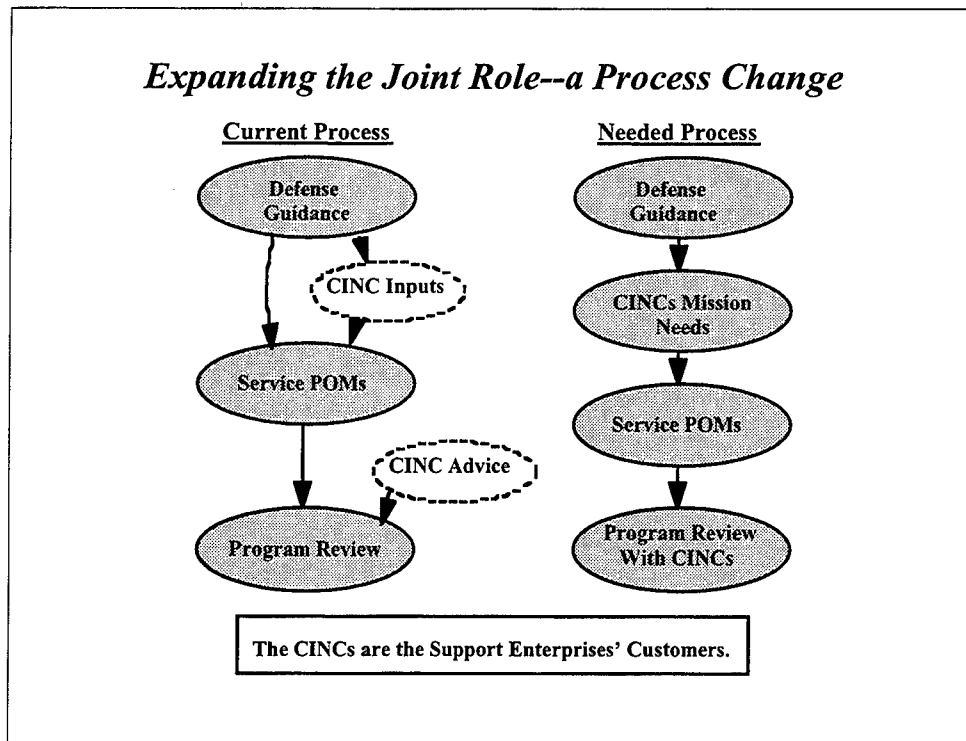


Budget reductions have shrunk investment in the R&D and procurement that sustains and modernizes force capabilities much more than support infrastructure. The support infrastructure constituency has exerted more influence than the natural force capability constituency (Joint Chiefs and CINCs)

It is apparent that the joint world has not been as effective as needed in maintaining and modernizing force capabilities. With budget reductions, the total amount of the budget dedicated to support infrastructure has grown to more than one half the total budget (55-60%). It seems clear that a strong joint forcing function is needed to redress this imbalance.

The figure below depicts an important element of the Task Force's "model" for planning and resource allocation decision making -- that of insuring that the joint elements of the Department fulfill their responsibilities and that the joint operational needs become paramount from the outset in the planning and budgeting process. As mentioned earlier, the Chairman's Program Assessment and the JROC deliberations are now more focused on ensuring that the CINCs needs to carry out their assigned operational missions play a more influential role. Still, this emphasis needs to be as firmly institutionalized in the process as the Services roles in building POMs.

Expanding the Joint Role--a Process Change



The current role of the CINC's, as shown on the above, still needs to become a more integral, required part of the process. There are any number of possible approaches to the mechanics of making the CINC's role an integral part of the process, as shown on the right. The cultural change is far more important than the mechanics. The cultural change is to treat the CINC's as the "customers." As such, the CINC's should not be expected to define the solutions offered by the suppliers — that is the role of the Services and Agencies. However, the entire system should evaluate results based on satisfying the customer's needs. Any other approach will inevitably lead to inadequate focus on the enterprise purpose and allow supplier interests to overshadow customer needs. The Chairman's Program Review is evolving such that it will be the vehicle for the CINC's mission needs step. The Chairman's Program Assessment could serve the purpose of the Program Review step on this chart.

Allowing support infrastructure to become a larger consumer of resources than operational forces is compelling evidence of the need for rebalancing the DoD investment portfolio. The final report of the DSB Task Force on Innovative Support Structure for 21st Century Operations provides a detailed overview of current DoD investments plans and makes recommendations on how to motivate increases in the investment in warfighting while at the same time enhancing support.

Joint Planning and Programming -- What's Missing? The Task Force sees the need to focus the process more intensely on the main business of the defense enterprise --providing the right set of capabilities for the CINC's to carry out their operational missions. The following summarizes what is needed:

1. A formal front end joint process for assessing mission capabilities and identifying gaps in mission capability, with the joint world accountable for the result.

- This process should be influential, timely and accountable as the Military Departments' front end processes for evaluating Service-unique solutions to joint needs
 - Specific responsibility and accountability should be assigned within the JCS and to the CINCs
 - The front end process should precede the Services POM exercises and DRB activities
2. Technical and program expertise for the CINCs--a mechanism for providing the technical and program expertise to geographic and functional CINCs to allow them to provide more meaningful inputs to prioritizing needs and influencing solutions
 3. A way for the CINCs to try things out--simulation and exercise capabilities where CINCs can experiment as part of the concept development process in areas of particular interest to them, particularly things that have to do with the joint connections that CINCs need to bring Service provided units together in an effective joint force
 4. Joint operational doctrine, joint operational architectures and joint technical architectures-- a mechanism to develop and promulgate needed joint connectivity (the glue) that brings service provided combat units together in an effective joint force. This is a particularly important requirement for theater air and missile defenses, C⁴ISR, etc.

The CINCs Planning and Programming Role The Chairman's input to Defense Guidance and the Services' POM process should be heavily and directly influenced by the CINCs' inputs on gaps in their capability to meet assigned mission needs. After the fact review of Service POMs by CINCs helps with process discipline but is relatively ineffective in shaping the overall defense program to meet joint force operational needs. To fill the essential front end role, CINCs have individual short and long term needs. Some in common with other CINCs, some unique.

- The CINCs need to focus some resident technical and program expertise on this need (CINCUSACOM has already expanded such expertise out-of-hide).
- Individual CINC sources of expertise also need to be closely connected.
- The CINC's staff must identify unique theater needs in defining and adapting joint operational doctrine and architectures to meet individual CINCs needs.

Each functional and geographic CINC should form resident technical expertise and a program tracking unit at its headquarters. These units should have on-line connectivity to similar functions at other CINCs, Component headquarters, Service headquarters, the Joint Staff, and OSD (including DARPA, DISA, NSA, NIMA and NRO).

The CJCS and SecDef should ensure that CINCs have full continuous access to program information with needs for access determined by the individual CINC. The size and complexity of such units is dependent on the individual CINC needs.

As noted earlier, this Task Force does not necessarily see the need for a substantially increased CINC staff size, but it does see the need for increased access to technical and analytical resources. This activity should drive the CINC's planning for future warfighting capability and

should be manned well ahead of most other priorities. This activity should be supplemented by and closely connected with other functions in the headquarters in order to represent the CINC in ensuring that joint doctrines and joint warfighting architectures take account of the CINC's unique needs.

Joint Operational Doctrine, Joint Operational Architectures and Joint System and Technical Architectures Joint operational doctrine and architectures are essential to guide development of the connectivity required for an effective joint force C⁴ISR integration. At present, there is not an effective process for providing such guidance, hence the ability to respond rapidly with effective joint forces is seriously compromised. There is a lack of continuing attention to such connectivity essentials as deployable C⁴I and access to overhead services. This inevitably leads to a lack of adequate connectivity between Service-provided components of theater wide functions such as theater air and missile defense.

The first need is for a process to develop joint operational doctrine with enough specificity to guide joint operational architectures (what connects with what for what purposes under whose control, etc.) Joint operational architectures must be specific enough to guide the system and technical architectures, (i.e., how are things actually connected, with what ground rules). Doctrine and architectures must fill the twin needs of adaptability to CINC unique needs and structuring deployable capabilities to fit a variety of CINC's needs

The lead for developing joint operational doctrine and joint operational architectures should be shared between the CJCS/Joint Staff and USACOM. USACOM should be involved because of its unique role in training the CONUS-based force. Additionally, the JTASC (Joint Training, Analysis and Simulation Center) and the JBC (Joint Battle Center) are located near USACOM. The CJCS/Joint Staff provides the authoritative tasking. USACOM provides:

- The operational expertise and serves as the conduit to ensure that individual CINC's needs are accommodated to the CINC's satisfaction.
- The connectivity to joint training, exercising doctrine and architectures through the Joint Simulation and Assessment Center during development, testing and continuing training.

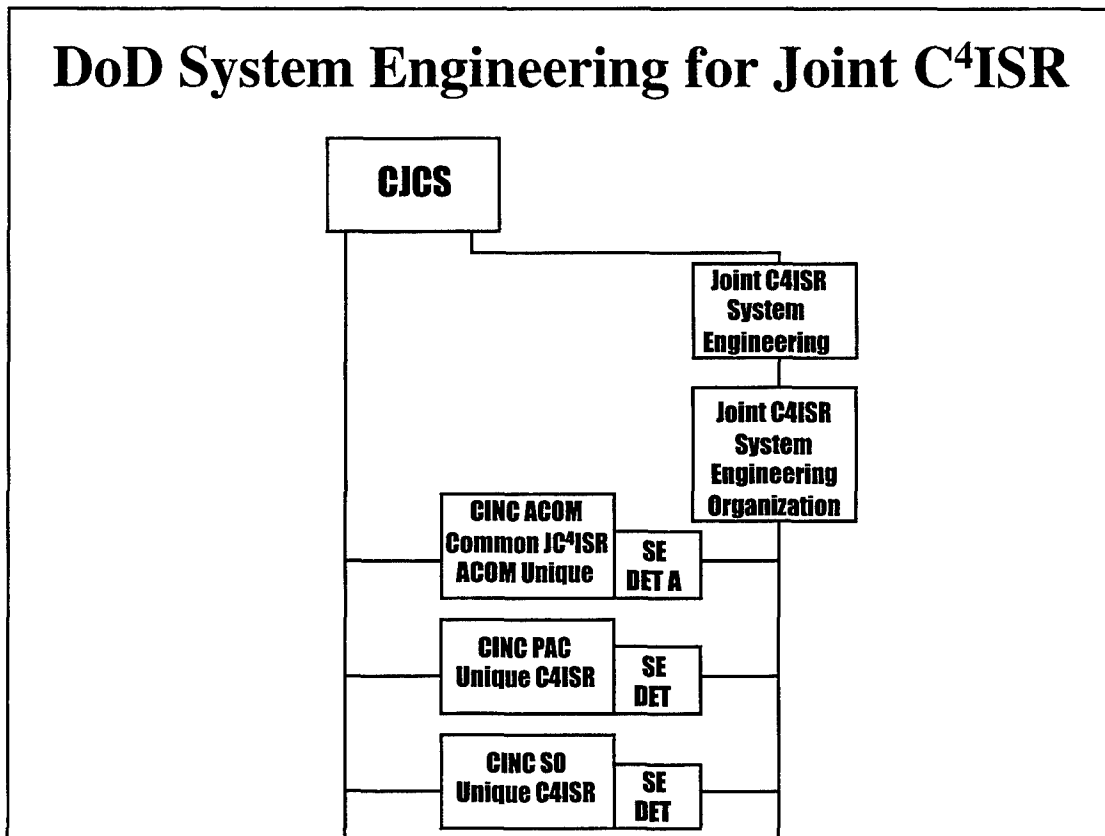
The key implementing principle must be that the CINC's part of the front end process become an essential prerequisite to the follow-on planning and budgeting process. This will require fundamental change in demands and expectations. The CINC's inputs must be specific enough to form the basis for mission needs statements leading to executable programs. The SecDef and CJCS will need to insist that the CINC's work precede other steps in the process. There should be a formal process to review the responses to the CINC identified capability gaps, the JCS aggregate evaluation of the gaps, and guidance to the Services on priorities. The full proposed Defense program should be examined in mission output terms with the entire program depicted as allocated to the individual CINC missions.

RECOMMENDATION: Task Force recommends that SecDef and the Chairman continue to evolve the joint process for determining what a joint force commander needs in order to operate effectively as recommended in the 1996 DSB Summer Study on Innovative Support Structure for

21st Century Military Operations. Given its inherent joint character, C⁴ISR integration is a logical aspect of warfare for this joint process to focus on early

3.0 A MILITARY SYSTEMS ENGINEERING ORGANIZATION FOR C⁴ISR INTEGRATION

A Military Systems Engineering Organization for C⁴ISR Integration The Task Force sees the need for a “military systems engineering organization to support CJCS and the CINCs in their role in joint C⁴ISR.” The figure below provides an overview of such an organization:



In order to carry out their responsibilities for the design of the joint operational architecture, the CJCS and the CINCs must:

- 1) Gather together a description of the joint operational architecture including descriptions of the components, how they are used and how they are supposed to work together. This systems description must be kept up to date and include descriptions of new component systems under development.
- 2) Bring together the components, forces, people, equipment, software and procedures, and find out if they will work, separately and together. There are a very large number of interfaces to

be considered, ranging all the way from cable connectors to common vocabularies. Everyone knows that if you don't actually try something out, it won't work. The joint C⁴ISR system is one of the most complex systems ever built. DoD would never ship a relatively simple system like a surveillance radar without extensive testing beforehand. This same standard must be applied to joint C⁴ISR.

- 3) Work with the system developers and their contractors to fix the obvious troubles so that the joint system will work well enough that the CINCs can be confident that the system will perform in a battlefield environment. The working joint system can then form a basis for improvement of existing capabilities and the addition of new ones.
- 4) Run extensive joint exercises, demonstrations, tests, simulations, and stimulations in as realistic and stressful a manner as possible. These exercises should use real forces and equipment, and be suitably instrumented to permit finding out how well the system works and provide immediate feedback for short term improvements in equipment and software and in the ways in which the system is actually used. Exercises are the foundation on which system improvements are based, as well as providing assurance that the existing joint system will work effectively when needed.
- 5) Back up the exercises with simulations. Simulations provide the opportunity for much more extensive system exercising because they are much less expensive and much more flexible than real exercises. Simulations must be consistent with exercises, however, if their results are to be trusted and useful. Presumably, simulations of component systems can be obtained from the component suppliers. The job of the joint system designer is much the same as with the real system: maintain a description, try things out, deal with interfaces, fix problems (or see they are fixed) and then plan for, and run, joint system level simulations. Based on the results of the above, work with the system program office to negotiate and oversee short term fixes and improvements.
- 6) Based on the results of the above, determine, negotiate and oversee short term fixes and improvements by the component designers.
- 7) Further, based on these results, work with the Services and acquisition agents to design major improvements and new component systems. This is not simply a manner of writing "Requirements" that others may ignore or change, but of participating throughout the processes of development, decision and tracking program acquisition management activities. New subsystems should be tried out in the system designer's real system.
- 8) Participate in the mission planning and resource allocation at the highest level of DoD, both to be sure that the joint system needs and recommendations are understood and taken into account, and to assure that he knows what is going on and what he can expect in the future to guide him in his design activities.

In addition to technical skills, the design of a military system involves tactics and doctrine, training, defense against adversary information warfare attacks, logistics and other skills of the military professional. This paper does not attempt to estimate these needs either in total or in

addition to resources already available to the CINCs. The following is a description of technical staff needs only.

Organization of and Resources for Such a Systems Engineering Capability for C⁴ISR Integration The Task Force assumes that the "Military C⁴ISR System Engineer" will be a flag officer reporting directly to CJCS. The System Engineer will have a modest military staff but will need access to technical resources to carry out his responsibilities.

The bulk of these technical resources are needed to test, modify and specify components, and to work with the Services and Agencies to design major improvements. A formal arrangement must be established between the CJCS/CINCs and the Services/Agencies covering their several responsibilities, including the responsibility of the Services/Agencies to support CJCS/CINCs in system integration activities, especially test and fix. This paper assumes the Services (and other agencies) will support the integration activities related to their respective components; participating in the tests, exercises and simulations; and in the definition of troubles and fixes. Beyond this, however, the system engineer needs his own technical resources under his direct control and dedicated to his interests only. The major focus of this activity is to ensure integration of systems and their resulting effective performance to support warfighting.

Because the problem is to create a joint, unified, consistent C⁴ISR system, dedicated support to the Military System Engineer should come from a single unified organization. Only a unified organization can provide the needed flexibility, quality control, internal communications and corporate memory.

However, the bulk of the work will take place at the CINC level and not in the office of the CJCS. The Task Force assumes that the work will be delegated to specific CINCs, primarily to CINCUSACOM who will have responsibility for common architectural and interoperability issues. The other CINCs will participate in CINCUSACOM's activities, take responsibility for their unique problems, and may be assigned separable general problems on occasion. Therefore, there should be a common systems engineering capability at some convenient location, as well as elements distributed to each of the warfighting CINCs. This capability will not only carry out centralized functions, but supply technical support to individual CINCs and to the CJCS as required.

The basic cadre of technical support at each CINC would be perhaps ten to twenty professionals permanently assigned from a central source, augmented as needed. Thus, approximately 100 people will be needed to support the various regional CINCs.

If CINCUSACOM becomes the integrator for the common systems, he will need a substantial resident system engineering support group, at least 100 staff and perhaps more.

The central group will also number at least 100 staff. A wide range of expertise will be required -- equipment and software engineers, sensor and communications experts, information system engineers, analysts, test and simulation experts, planners, cost analysts, etc. The size and makeup of the organization may vary with time, especially after the initial transient of getting on top of the existing system is over. Flexibility is extremely important.

Putting this all together, the Task Force sees a technical capability of about 300 technical experts. This organization would report to the Military System Engineer and be led by a very senior and experienced system engineer with a background in C⁴ISR. In view of the need to build a highly capable organization quickly, and to stay flexible over the long haul, the Task Force recommends that DoD tap the private sector for much of this capability. Due to the nature of the job, the need to be intimately familiar both with the government's needs and plans and with the details of the design work of a great many military contractors, the Task Force suggests consideration be given to the establishment of a long-term contractual arrangement. It should be noted that the NRO and others have had such a system engineering group for many years. They have been key to both operational architecture design and the integration of individual systems and subsystems. The Task Force suggests consideration of the use of an FFRDC.

The cost of such a system engineering capability is estimated to be at least \$50 million per year. This is a significant amount of money, but a very small percentage of the annual investment in building and maintaining a joint C⁴ISR integration capability. The Task Force believes that such an organization is necessary for attaining an effective C⁴ISR investment and will pay for itself many times over in savings accruing from better informed management and more carefully planned developments.

RECOMMENDATION: The Task Force recommends that the SECDEF and the Chairman create a military systems engineering organization to support the CINCs in their evolving responsibility for the operational design of joint C⁴ISR. The DoD initiative in Joint Theater Air and Missile Defense assigns the responsibility for systems engineering to BMDO. This new structure is consistent with this recommendation and is an appropriate, although partial step in the direction needed for the broader joint C⁴ISR area. This Task Force endorses this step, particularly in its apparent effort to involve the CINCs in a "military systems engineering" effort. The Task Force recommends that CJCS use the new structure that was established to provide joint operational architectures and joint system engineering to Joint Theater Air and Missile Defense as a pilot program for the broader C⁴ISR area, with focus on the refining the responsibilities and missions of warfighting CINCs.

4.0 OTHER ISSUES

The DSB Task Force identified a several other issues regarding the Department's management of C⁴ISR integration:

1. Intelligence Support to Military Operations The Task Force believes that national intelligence support for joint force commanders needs to be strengthened and regularized. For example, there is a need for effective mechanisms to ensure continuing mutual understanding of the CINC's needs and the capabilities provided by the national community. While there have been improvements in these mechanisms, unless they are solidly institutionalized, the improvements are likely to be transitory.

The nation is paying dearly for very capable resources which have been shown to be of critical importance to military operations; but changes are needed in the systems and processes if they are going to serve the forces as they should. At the combat force level, intelligence has many of

the same qualities as other information and needs to be integrated into the command of the combat unit by the command process. The information provided must be made natural to the combat unit. The "Intelligence Institutions" cannot do this job; it must be integrated into the combat unit by the operational military institutions. This, as with many other aspects of a modern military force, will require some changes in how the forces train and practice.

The Task Force believes that users of C⁴ISR capabilities still do not have the understanding and control of capabilities needed to have confidence in assured access to needed information. In some cases, the concern is about reliable commitment of the information source in the face of other collection priorities. In other cases, the perceived problem is information glut that masks the important. Again, to leverage the enormous potential of modern information systems, joint force commanders need a solid understanding of capabilities and adequate control over the priorities.

RECOMMENDATION: The Task Force recommends that the Department work with the DCI and the broader Intelligence Community to develop new ways of providing information support for operational commanders which effectively and efficiently integrate the rich array of assets available within the United States. As a mechanism to facilitate identification and implementation of good ideas for C⁴ISR integration, the DoD might consider the creation of a C⁴ISR Integration Review Board, similar to the newly formed Space Management Board and at the same level (DASD chair in the name of the SecDef/DepSecDef with the VCJCS, DDCI and other actors represented). Today's information technology can support revolutionary changes in how support is provided to military operators. DoD needs mechanisms that facilitate the introduction of such revolutionary changes into warfighting capability.

2. Vulnerability, Security and Protection The Task Force is concerned about the adequacy of DoD attention to protection of critical systems. The move to ever greater reliance on interconnected information and information capabilities makes their protection both challenging and crucial. Open architectures and commercial standards bring important benefits but also make adequate protection inherently more difficult. DoD should ensure that protection of C⁴ISR systems from information attacks is a primary consideration.

A corollary issue of concern to the Task Force is that the Department's continues to differentiate between intelligence people and operators, and organize for warfighting with this differentiation as a basis. As US warfighting elements learn more about and operate in "information warfare," this differentiation will become extremely difficult and perhaps even counter-productive to maintain. The separation of intelligence and operations functions has been a root cause for problems in providing real-time, high quality intelligence support to military operations.

RECOMMENDATION: The Department should closely evaluate whether the separation of intelligence and operations functions within warfighting elements continues to serve the nation well.

3. How to Acquire C4ISR Capabilities The Task Force noted at least two fundamentally unique characteristics of C4ISR systems relevant to the acquisition process. First, the inherently joint aspects of C4ISR are critical to the overall utility of C⁴ISR. However, the Services focus on C⁴ISR tends to be internal to the weapons system or internal to a defined segment of the

Service's responsibility (e.g., carrier battle groups, army corps or division, Air Force (AF) control of air operations, etc.). Hence, a major part of the responsibilities for C⁴ISR integration is distributed throughout various weapon system, platform, and Service-controlled systems of systems programs. This Service focus on embedded C⁴ISR also leads to defense contractor solutions. In contrast, the broader aspects of C⁴ISR need to be far more rooted in the more responsive commercial information industry sector. Again, the Department needs to focus on the joint aspects of C⁴ISR in its acquisition organization. This will require a joint organization with clear responsibility and authority for joint C⁴ISR and with a heavy propensity to exploit the rapidly changing technologies common to the commercial sector. The second key characteristic is the pace of technological change in the field of information systems that form the basis for much of C⁴ISR. The pace of this change is totally incompatible with normal DoD procurement practices and DoD's seeming preference for ownership of things rather than reliable access to leased services and capabilities.

DoD needs to push even harder on acquisition reform. There are a host of reasons why the C⁴ISR area is a natural one for the introduction of changes in the acquisition process and increased reliance on commercial industry and business practices. The commercial sector is the driving force in many key information technologies. The Department has made important progress in embracing commercial standards and products. Still, the acquisition process and continuing proclivity towards detailed specifications stifles innovation and delays use of commercial "best practices." The Task Force sees the need for far more progress in cultural change and practices to allow DoD to take advantage of the most current commercial and government-developed information technologies in support of C⁴ISR mission needs.

Appendix A
Terms of Reference



THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, D.C. 20301-3010



ACQUISITION AND
TECHNOLOGY

DEC 11 1995

MEMORANDUM FOR THE CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Terms of Reference -- Defense Science Board
Task Force on C4ISR Integration

In an effort to accelerate the development of Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) integration and architecture efforts in the Department of Defense, the Deputy Secretary of Defense directed the creation of a DoD-wide C4I Integrated Product Team (IPT). He designated the Assistant Secretary of Defense (C3I) to sponsor, organize and manage this effort. To assist the internal DoD process, you are requested to form a Task Force on C4ISR Integration to:

- Provide advice to the IPT chairman on all aspects of C4ISR integration.
- Provide separate reports of its judgments on these matters to the Department.

The Principal Deputy Assistant Secretary of Defense (C3I) will sponsor this Task Force and arrange for the funding and other support as may be necessary. Dr. Robert J. Hermann will serve as the Chairman of the Task Force and Gen. Larry D. Welch, USAF (Ret) will serve as the Vice Chairman. COL Barry Miner, USA will serve as the Task Force Executive Secretary and Col Scott Hammell, USAF will serve as his Deputy. CDR Robert C. Hardee, USN will serve as the Defense Science Board secretariat representative.

The Task Force will operate in accordance with the provisions of P.L. 92-463, the "Federal Advisory Committee Act," and DoD Directive 5105.4, the "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, U.S. Code, nor will it cause any member to be placed in the position of acting as a procurement official.

This Task Force should provide an interim report by July 1996 and a final report by the end of 1996.

Paul S. Kaminski
Paul G. Kaminski



Appendix B

Membership

MEMBERSHIP LIST

**DEFENSE SCIENCE BOARD TASK FORCE ON
C4ISR INTEGRATION**

Task Force Chairman

Dr. Robert J. Hermann

Task Force Vice Chairman

Gen Larry D. Welch,
USAF (Ret)

Task Force Members

Mr. Edward C. Aldridge, Jr.	MG John F. Stewart, USA (Ret)
Mr. Robert R. Everett	ADM William O. Studeman, USN (Ret)
Mr. Charles A. Fowler	VADM Jerry O. Tuttle, USN (Ret)
Mr. Donald C. Latham	
LtGen Carl G. O'Berry, USAF (Ret)	Gen John W. Vessey, Jr., USA (Ret)

Executive Secretary

COL Barry Miner, USA
Mr. Richard DuChateau

DSB Secretariat Representative

CDR Dave Norris, USN

Appendix C

Glossary

Appendix C

Glossary

BMDO	Ballistic Missile Defense Office
C3I	Command, Control, Communications and Intelligence
C4I	Command, Control, Communications, Computers and Intelligence
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CINC	Commander-in-Chief
CONUS	Continental United States
DARPA	Defense Advanced Research Projects Agency
DoD	Department of Defense
DRB	Defense Resources Board
DSB	Defense Science Board
DISA	Defense Information Systems Agency
FFRDC	Federally Funded Research and Development Centers
ITF	Integration Task Force
JBC	Joint Battle Center
JCS	Joint Chiefs of Staff
JROC	Joint Requirements Overnight Council
JTAMDO	Joint Theater Air and Missile Defense Office
JTASC	Joint Training, Analysis and Simulation Center
JWCA	Joint Warfare Capability Assessment
NIMA	National Imagery and Mapping Agency
NRO	National Reconnaissance Office
NSA	National Security Agency
OSD	Office of the Secretary of Defense
POM	Program Objective Memorandum
TAMD	Theater Air and Missile Defense
USACOM	US Atlantic Command