Report
of the
Defense Science Board
Task Force on

COMMAND AND CONTROL SYSTEMS MANAGEMENT

JULY 1987

Office of the Under Secretary of Defense for Acquisition
Washington, D.C. 20301

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

AD-A188 811

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188
Exp Date Jun 30, 1986

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS N/A
2a. SECURITY CLASSIFICATION AUTHORITY N/A	3. DISTRIBUTION/AVAILABILITY OF REPORT Distribution Statement A Approved for Public Release: Distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) N/A	5. MONITORING ORGANIZATION REPORT NUMBER(S) N/A
6a. NAME OF PERFORMING ORGANIZATION Defense Science Board, Ofc of the Under Secy of Def (A)	6b. OFFICE SYMBOL (If applicable) DSB/OUSD(A)
6c. ADDRESS (City, State, and ZIP Code) The Pentagon, Room 3D1020 Washington, D.C. 20301-3140	7a. NAME OF MONITORING ORGANIZATION N/A 7b. ADDRESS (City, State, and ZIP Code) N/A
8a. NAME OF FUNDING/SPONSORING ORGANIZATION Defense Science Board/OUSD(A)	8b. OFFICE SYMBOL (If applicable) DSB/OUSD(A)
8c. ADDRESS (City, State, and ZIP Code) The Pentagon, Room 3D1020 Washington, D.C. 20301-3140	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER N/A 10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO	TASK NO	WORK UNIT ACCESSION NO
N/A	N/A	N/A	N/A

11. TITLE (Include Security Classification)
Report of the Defense Science Board Task Force on Command and Control Systems Management, Unclassified.

12. PERSONAL AUTHOR(S)
N/A

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM N/A TO N/A	1987 July	86

16. SUPPLEMENTARY NOTATION
N/A

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION
22a. NAME OF RESPONSIBLE INDIVIDUAL Diane L.H. Evans	22b. TELEPHONE (Include Area Code) (202) 695-4158/6463 22c. OFFICE SYMBOL DSB/OUSD(A)

DD FORM 1473, 84 MAR

83 APR edition may be used until exhausted
All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301-3140

DEFENSE SCIENCE BOARD

June 9, 1987

MEMORANDUM FOR SECRETARY OF DEFENSE
THROUGH: UNDER SECRETARY OF DEFENSE FOR ACQUISITION

SUBJECT: Report of the Defense Science Board Task Force on Command and Control Systems Management

I am pleased to forward the final report of the Defense Science Board Task Force on Command and Control Systems Management. The task force was asked to review progress made since 1978 when a similar Defense Science Board Task Force assessed the status of command and control systems management. The task force was chaired by Dr. Solomon J. Buchsbaum, who also chaired the 1978 effort. In 1978, the situation was not good. Today, the task force concludes that as a result of actions taken by the Department of Defense, especially during the past six years, the command and control infrastructure is much more extensive and resilient than that of a decade ago.

Nevertheless, the task force concludes that more needs to be done to speed up and to make more effective the process of deciding what command and control systems are needed and what they should do, then to develop and deploy the systems, test and exercise them and continue to evolve them. This is especially true of tactical and theater command and control systems.

To this end, the task force has made recommendations in the following areas:

- how to assure the operational effectiveness of systems for the support of command and control;
- how to enable military commands to upgrade and evolve their own command-unique systems within standards and specifications stemming from an overarching architectural framework to fit the specific needs of the commands;
- how to strengthen the capabilities of the Joint Chiefs, the Services and the Unified and Specified Commands for testing and exercising as well as evaluating and specifying functions to be performed by the command and control systems;

- o how to make sure that the acquisition of command and control systems takes into account the special attributes of these systems, especially the need for evolution;
- o how to develop a coordinated program of research on command and control concepts to provide the intellectual base needed to guide the evolution of improved command and control systems;
- o how to provide education and training as well as career pathing to command and control specialists.

The actions recommended are particularly propitious because of the ongoing reorganization in the Department of Defense.

I recommend that you read Dr. Buchsbaum's letter and the Executive Summary. An implementation recommendation is being staffed through OSD and will be submitted for your consideration through the proper channels.

Charles A. Fowler

Charles A. Fowler
Chairman

Attachment

OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

'ENSE SCIENCE
BOARD

June 3, 1987

Memorandum for the Chairman,
Defense Science Board

Subject: Report of the Task Force on Command and Control Systems Management

I transmit herewith the report of the DSB Task Force on Command and Control Systems Management. The Task Force concludes that considerable progress has been made since a similar DSB Task Force reviewed this topic in 1978. As a result of action taken by the Department of Defense, the command and control infrastructure today is more extensive as well as more resilient than that of a decade ago. This is particularly so in strategic command and control. We document that progress in the report.

Nevertheless, the Task Force concludes that more needs to be done to speed up and to make more effective the process of deciding what command and control systems are needed and what they should do, then to develop and deploy the systems, test and exercise them and continue to evolve them. This is especially true of tactical and theater command and control systems.

To that end, the Task Force makes six recommendations which are summarized in the Executive Summary. The actions recommended are particularly propitious because of the ongoing reorganization in the Department of Defense.

Our emphasis is on the commander -- the commander at any level -- helping the commander acquire and evolve the command and control system that fits his needs. This approach is, of course, fundamentally different from the standard acquisition process wherein evolution is not the central driver and in which the commander's involvement is limited to participation in the establishment of requirements.

I recommend that you transmit this report to the Defense Science Board and then to the Secretary of Defense.

S. J. Buchsbaum
Chairman
Defense Science Board Task Force
on Command and Control Systems
Management

Att.
As above

I. Executive Summary

"The nation is failing to deploy command and control systems commensurate with the nature of likely future warfare, with modern weapons systems, or with our available technological or industrial base."

The above quotation was the opening statement in a report on Command and Control Systems Management issued nearly a decade ago by a Task Force of the Defense Science Board. The present Task Force was constituted to review the progress made in the intervening years in command and control and to assess how we are faring today.

We conclude that, indeed, outstanding progress has been made in the past decade, especially in strategic command and control. The present command and control infrastructure is more extensive as well as more resilient than that of a decade ago. In the body of the report we summarize the reasons for this conclusion.

Nevertheless, we conclude that a gap exists between the command and control systems we should be fielding and those we are fielding, especially in the tactical/theater areas worldwide.

We present six sets of recommendations aimed at increasing the speed and the efficiency of the existing process for deciding upon and then developing, deploying as well as testing, exercising, evolving and operating command and control systems.

1. To assure the operational effectiveness of systems for the support of command and control, we recommend that a strong institutionalized process be put in place to:

   - establish and maintain an architecture for the command and control of US forces operating under either national or allied command that links all elements of the command and control structure from both top-down and bottom-up;

   - establish and maintain the standards needed to achieve interoperability and operational effectiveness in the field and enforce adherence thereto;

   - provide conceptual guidance and technical support to field commands as they evolve their command and control systems within the overall architecture and interoperability standards;

   - identify and approve Required Operational Capabilities (ROCs) that are timely and responsive to the inputs and needs of the CINCs.

An approach to achieving the "strong institutionalized process" is presented in pages 15 through 17 of the report.

2. To strengthen the capabilities for testing and exercising as well as evaluating and specifying functions performed by command and control systems, we recommend:

   - that the capabilities of the JCS, CINCs, and Services for operationally testing, exercising, evaluating and specifying functions to be performed by command and control systems should be fostered and increased throughout the life cycle of the command and control system.

3. To strengthen the capabilities of the Commands and to upgrade and evolve their command unique system, we recommend:

   - that each CINC's involvement in the planning, funding, and acquisition of command and control systems relevant to his command be increased and that each CINC have resources organic to that command to evolve, upgrade, and maintain his own command-unique command and control system under the overarching architecture established centrally by DoD. The DoD should institutionalize this process of incremental evolutionary acquisition of command-unique systems under CINC management and with Service support of the required technical infrastructure;

   - that each CINC have access to his own small architecture capability to help provide the information needed for interoperability, for inputs to the CJCS on JROCs and priorities for command and control funding and for the design of the Command's unique command and control needs.

   - that a modest increase in CINC initiative funds be made to provide the means to meet time-sensitive command and control needs of the CINC.

4. To improve the regulations for the acquisition of command and control systems we repeat the recommendation of the 1978 Task Force:

   - "that the Department of Defense issue new directives to govern the acquisition of command and control systems that recognize the special characteristic of those systems. These directives should recognize that the various stages of the development of command and control systems overlap; recognize that user participation in the conception, evolution testing and development of command and control

systems is a strong requirement; and provide flexibility and adaptability to meet the wide variations in the needs of commands,"

- urge that the acquisition policies and oversight processes for command and control now being developed take into account the thrust of this recommendation, and

- specifically, recommend that DoD regulation 2167 reinforce and enlarge the guidelines contained in the Defense Acquisition Circular, dated February 28, 1983, pages 16-17, and that compliance with such guidelines be assured.

5. To strengthen the intellectual base for command and control we recommend:

   - that a comprehensive program devoted to research on command and control be defined and implemented. The research program should delve into all aspects of command and control, not just the technological aspects. It should form close linkages to the several research and graduate education programs in command and control in Service and Defense educational institutions and should exploit and foster related research programs in our universities. DARPA should play a key role in this endeavor.

6. To strengthen education and training as well as career pathing of command and control specialists we recommend:

   - that the Director for command and control systems on the Joint Staff identify the requirements for command and control specialists in the Services; the Joint Staffs; the Unified and Specified Commands; and with the Services develop the internal Service manpower requirements to include those needed to ensure viable R&D programs;

   - that the Services develop command and control career patterns that ensure adequate personnel are assigned to and developed in the command and control specialty, that those assigned are trained, developed and managed in a career progression that provides adequate incentives for their continued service in this specialty;

   - that the JCS and the Services develop an educational and training system that fully supports the command and control needs of the military forces; and

- that embedded training and programs be developed on operational command and control systems to enable training to proceed in most realistic environments and to provide improved feedback to developers.

The time is propitious to build further upon the progress already made during the past decade in command and control systems management and the ongoing reorganization of the Department of Defense.

II. Introduction

"The nation is failing to deploy command and control systems commensurate with the nature of likely future warfare, with modern weapons systems, or with our available technological or industrial base."

This quotation was the opening statement in a report on Command and Control Systems Management issued nearly a decade ago by a Task Force of the Defense Science Board.* To correct the then perceived failings, that Task Force addressed itself to the following areas:

- how to assure the operational effectiveness of systems for the support of command and control;**
- how to enable the military commands to upgrade and evolve their command and control systems within standards and specifications stemming from an overarching architectural framework to fit the specific needs of the commands;
- how to strengthen the capabilities of the Joint Chiefs, the Services and the Unified and Specified Commands for testing and exercising as well as evaluating and specifying functions to be performed by the command and control systems;
- how to modify the regulations for the acquisition of command and control systems in order to recognize the special attributes of

---

* Report of Defense Science Board Task Force on Command and Control Systems Management, July 1978. The report is reproduced in its entirety in Appendix A. It should be read in conjunction with the present report.

** Command and Control is defined in JCS Pub 1 as "the exercise of authority and direction by properly designated commander over assigned forces in the accomplishment of his mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities and procedures which are employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of his mission."

In essence, it is the process of making, disseminating, and implementing informed command decisions in order to obtain optimum effectiveness of the nation's military forces in peace time, crisis, conflict or war.

these systems, especially the need for evolution, and finally;

- how to develop a coordinated program of research on command and control concepts to provide the intellectual base needed to guide the evolution of improved command and control systems.

How are we faring today? What changes or improvements have ensued since the 1978 DSB report? Have its recommendations been implemented? If so, to what extent and with what effect; if not, why not?

To help answer these questions, the present Task Force was chartered (see Appendix C) with membership that overlaps that of its predecessor Task Force (see Appendix B). The Task Force held seven meetings and has been briefed by both users and developers of command and control systems. A list of those who participated in our reviews is in Appendix D.

Our broad conclusion is nearly as straightforward as that of the 1978 Task Force. While the situation is much improved over that of a decade ago in that the present command and control infrastructure is more extensive, as well as more resilient than that of a decade ago, the needs and the opportunities have grown over the years so that there still is a gap between the command and control systems we should be fielding and those we are fielding.

To put this conclusion in a proper perspective, we hasten to point out that the "gap" we perceive today was a chasm a decade ago. Truly, outstanding progress is evident.

It includes the following:

- command and control is no longer the neglected orphan of a decade ago. Guided by policies and directives issued by the White House, there is now greater appreciation of the importance of command and control and of the leverage it can provide in conflict or war, in the Congress, among the public and within the DoD (but not yet among the allies).

- The budget for command, control and communications has grown from $6.2B in 1978 to $22.0B in 1987. Most of this growth has occurred during the past six years ably managed by the strengthened Office of the Assistant Secretary for Command, Control, Communications and Intelligence;

- the overall management structure for command and control has been greatly strengthened. An OJCS organization has been established at the O-9 level (C^3S Directorate now J-6) that has worked to bring command and control systems planning in line

with the elements of US military strategy such as nuclear deterrence, forward deployed forces, sea control, alliances, and arms control. This organization has been involved in the evolution of dozens of command and control programs to various stages of development, deployment and use;

- the importance of an overarching command and control architecture including the setting of standards, well defined interfaces and specifications among and between subsystems has been recognized and the work to that end is proceeding, especially in the new Joint Tactical Command, Control and Communications Agency, and within the Center for Command, Control and Communications Systems within DCA. The consolidation of JTC3A with DCA is a welcome step as well;

- the establishment of the Command, Control and Communications Review Council has provided an effective means for the senior Command, Control and Communications managers within the Services to influence decisions especially as they affect interoperability. In this regard, the record of MILSATCOM Panel has been especially impressive;

- the ability of the Unified and Specified Commands to upgrade their own command and control systems has been boosted by entrusting to the CINC limited, but not insignificant, resources to modify and evolve their own command unique systems to fit the specific needs of their commands and providing to them technical support;

- career pathing, as well as education and training of command and control professionals has been improved;

- a large number of new command and control systems has been fielded and existing ones upgraded especially in strategic command and control, with emphasis on surveillance, reliability and robustness which, as we said above, in the aggregate make the command and control infrastructure much more extensive and more resilient than it was a decade ago; and

- further improvements in the interoperability and robustness of the command and control infrastructure will be forthcoming as systems now in development - such as MILSTAR, Mobile Subscriber Equipment, etc. - will begin to be deployed.

What do we mean then when we say there exists a "gap" between what we should be and what we are fielding? It is simply this: We believe that the process of determining and acting on command and control needs is not working as effectively and speedily as it must, especially for tactical and theater command and control systems

worldwide. This, in turn, is partly because of: i) an acquisition process in need of strengthening; ii) tight resources; iii) the continuing absence of an agreed-upon, well-understood DoD architectural framework with its well-defined interfaces and standards to guide the evolution of command and control systems; and iv) the dearth of personnel skilled in command and control.

The procurement and fielding of truly effective command and control systems - support systems that aid the commander in the exercise of his command - is not an easy matter. The 1978 Task Force described the nature of command and control systems. Here, we merely restate that a command and control system supporting a commander is not just a computer with its associated software and displays; it is not just communications links; and it is not even just all the information processing and fusion that must go in any well-designed and well-operating command and control system. It is all of the above and much more. The ideal command and control system supporting a commander is such that the commander knows what goes on, that he receives what is intended for him and that what he transmits is delivered to the intended addressee, so that the command decisions are made with confidence and are based on information that is complete, true and up-to-date. The purpose of a command and control system is, in the end, to provide assurance that orders are received as originally intended with follow-up in a timely fashion, which can make the difference between winning and losing wars.

Deploying command and control systems that work well, or even very well, in peacetime, is far from sufficient. The systems must also function well during times of stress and during a conflict. However, experience in times of crisis and war indicates that few systems are as reliable as their designers had intended. A viable system for use in time of war or crisis must therefore embody robustness and the potential for graceful degradation. This consideration must be paramount in the design and the acquisition of command and control systems.

A commander has powerful operational incentives to improve his command and control system. He should be able to do this more easily and quickly than he can today. The main purpose of this report is, indeed, to suggest ways of helping the commander - the commander at any level - acquire the command and control system that fits his needs. These ways fall into the five areas covered by the 1978 Task Force which were listed earlier in this Introduction. To these, we add one more: education and training and career pathing of command and control professionals. The subsequent sections of this report are keyed to these six areas.

The Task Force addressed itself to broad issues of command and control systems management. Our emphasis has been on tactical and

theater command and control. We did not delve into the details of command and control associated with nuclear release or intimately associated with sensor or weapons systems.

The work of this Task Force comes at a propitious time. The Department of Defense is undergoing a reorganization, and it is important to determine and assign clearly and unambiguously roles and responsibilities on issues of command and control. We address this issue as well in the sections that follow.

III. Findings, Conclusions and Recommendations

1. Assuring the Operational Effectiveness of Systems for Command and Control

A. Military Command and Control

The substantial investment in command and control since 1978 has laid the basis for improved command and control. Still, our review indicates that interoperability and operational effectiveness in the field remain as serious deficiencies.

The Task Force believes that these deficiencies can be reduced by strengthening and institutionalizing the process for:

- establishing and maintaining an architecture for the command and control of U.S. forces operating under either national or allied command that links elements of the command and control structure from both top-down and bottom-up.

- continuing to establish and maintain the standards needed to achieve interoperability and operational effectiveness in the field and enforcing adherence thereto through timely acquisition and continual purging of old hardware and procedures;

- providing technical support to the CINCs as they evolve their command and control systems within the overall architecture and interoperability standards;

- formulating and approving Required Operational Capabilities (ROCs) that are timely and responsive to the inputs and needs of the CINCs.

We believe that there would be important and positive results from creating such a process. The existence of a sustaining institutional process for establishing and maintaining an architectural framework would provide a dependable guide to the necessarily diverse procurement activities which acquire the new equipment, purge the old and provide the people that make up our command and control system. Each service or agency which has a functional support responsibility to the operating forces would know the framework and standards within which they must fit or with whom they must negotiate changes. Thus, those charged with logistics, intelligence, communications security, information security, navigation

systems, administration, or diplomatic communications, to cite some examples, would be able to develop these capabilities with confidence in their ability to serve the forces; and the operating commands would have the guidelines and change processes within which they could evolve their procedures and fielded systems.

To achieve these objectives, a greater focus of authority must be created and provided with enough skilled people to carry out the function. It must also be influential enough in the planning, programming and budgeting process to provide competent and dependable advocacy on behalf of these important objectives. The primary conclusions of the Task Force in this regard are:

- The combination of the DCA [subsuming the Center for C^3 Systems (C^3S) and the Joint Tactical C^3 Agency (JTC^3A)] and the new office of the Vice Chairman of the JCS form a sound starting basis for the centralized institutional responsibility. Skilled personnel, experienced in the needs of top-down and bottoms-up participants, is key to the success of this effort.

- The architectural framework must necessarily be broken down into manageable parts. We believe the first division should be along command lines so that the primary subordinate entity within a national framework should be the CINC's architecture. Supporting functions, such as intelligence, comsec, logistics, etc., and their architectures, should be subordinate to the CINC's architecture if compatibility conflicts must be resolved at that point. Avoiding such conflicts must be a primary objective of the overarching architectural framework but, in principle, the coherence of the operating force should take precedence over the coherence of a supporting function. This places new and increased importance on the ability of the CINCs to control, evolve, and maintain the configuration of their command and control systems and their interfaces and processes. They will need technical resources to do this job.

- Much could be achieved through modification and adaptation of equipment, systems. and procedures already fielded. While some new systems are required, we believe that there has been too much emphasis on the development of completely new

systems over the evolution of the very comprehensive already in-place systems. Since a command and control system manifests itself only when it is embedded in the operating command it serves, that operating command must have the central role in evolving its own command and control system. This also will require strengthening the system and technical competence of the operating command and increasing the command's access to and influence over resources, including external technical support. We discuss this point in greater detail in section II.3 below.

- The ingredients needed to establish and maintain the architectures and standards for our operating forces necessarily include operational experience and competence as well as resource judgment and responsibility. Thus, both the military and civilian parts of the Department of Defense are embraced by these functions. It is the view of the Task Force that a single institutional structure can best satisfy the technical needs of the two parts of the Department of Defense.

Thus, there needs to be established an integrated command and control support activity with responsibility for architecture, interoperability standards, and technical support for all aspects of command and control including exercises, doctrine and training. Although we recognize that there are many ways to implement such a concept, the following elements display one approach which would satisfy the judgment of the Task Force.

- For command and control systems management, the VCJCS would be the principal spokesman for the CINCs and the arbiter among the Services and CINCs on operational matters relating to command and control systems. The VCJCS should recommend to the Under Secretary of Defense for Acquisition command and control systems and supporting communications suitably prioritized among all Service and CINC claimants. His should be the definitive recommendation on these matters, it being understood, however, that the CINCs and Service Chiefs can raise any objections to his proposals at the various resource and acquisition boards and reviews conducted by the Secretary of Defense. We note with pleasure that the Chairman of the Joint Chiefs of Staff has already assigned these responsibilities to the VCJCS.

- The DCA would be the entity providing the requisite technical support for command and control. Thus we envision that the DCA, (perhaps suitably renamed), in addition to their present operational responsibility, would have the responsibility and authority for the integrated command control support activity. This would combine the work of the JTC^{3}A, C^{4}S, and the needed technical support to the CINCs. We envision that, as today, the DCA commander would report to both the Chairman of the Joint Chiefs of Staff and the Assistant Secretary of Defense (C^{3}I). The CJCS would be responsible for overseeing matters pertaining to operations, training, exercises, doctrine, architectural support and employment. The ASD(C^{3}I) would be responsible for system planning activities and for overseeing matters pertaining to acquisition policies established by the OSD.

  The success the DCA will enjoy in providing the integrated command and control support will rest, ultimately, on people. The DCA must be able to attract and retain the requisite human talent - military and civilian - to carry out the ambitious tasks outlined above. That's a very tall order even under the best of circumstances made more difficult by the existing civil-service personnel policies. We urge that the Director DCA be given all the help he needs to ensure the availability of or access to the requisite technical talent.

B. Allied and Interagency Command and Control

The development of our current command and control systems have focused on the integration of US military systems with those of other agencies of our own government and with the military systems of existing alliances at the very highest levels of interface. The National Communication System (NCS) has focused on integration of interagency telecommunications capabilities. Where this focus has occurred the redundancy, connectivity, interoperability, restorability and security of our emergency telecommunications systems has shown significant improvement. It is our opinion that the same focus has not been applied at the lower end of the infrastructure. US command and control systems required in this milieu show significant need for improvement. Based on our review it appears that the greatest near-term national improvement in command and control is possible through increased effort at this

vital lower level of interface.

How well our DoD command and control systems are integrated with other US and allied command systems is becoming of increasing importance in this interdependent world. At the low end of the spectrum of warfare, one of our principal weaknesses in conducting effective Low Intensity Conflict (LIC) is our lack of an integrated command and control system in areas in which such conflicts are or might be fought. Such a system must tie together all of the US and allied intelligence and other information nodes within the region. Lacking such a command and control system our efforts will lack focus and tend to be uncoordinated. Differences in language, culture, style and doctrine represent particular challenges to effective coordination.

In most of the regions of the world where we must be prepared for conventional (mid-intensity) conflict we have existing alliances. In those alliances the separate national command and control systems are seldom developed to maximize the capabilities of the combined forces in the region to conduct coalition warfare, if required. Where US commanders are dual-hatted as Allied Commanders (e.g., SACEUR, SACLANT) the capability of the alliance is better coordinated but not maximized. At the apex of the spectrum of warfare are the command and control systems required to manage a US strategic nuclear response. While it can be argued that this command and control capability needs to be predominately US, it must also take into account the capabilities of our allies in both the pre and post exchange regimes. As we consider reductions in US/USSR nuclear forces, the nuclear forces of our allies play a more significant role and an integrated command and control system becomes more critical. The national resources of the US and its allies applied to command and control is quite impressive. The total effectiveness of the command and control systems realized by these resources is degraded significantly by the lack of integrated capabilities that have been developed.

We conclude that the military command and control systems that are being developed have focused on the interoperability of Allied and Interagency command and control systems at the highest level. Information, intelligence, and other critical data flows quite well horizontally at the top most levels. It flows well vertically to the discrete elements of the various

agencies in the field. It does not flow as well among the agencies in the field. We recommend that the DoD plan for command and control enhancements be made with all of the players in mind. As a first step, CJCS should task US CINCS to develop overarching command and control requirements to improve the interface with allies and other US agencies. Based on these requirements, consideration should be given to funding through US resources those that can be the most significant effect on correcting the command and control interface shortcomings. We believe that significant progress can be made within two years.

2. Strengthening the Capabilities for Testing and Exercising as well as Evaluating and Specifying Functions Performed by Command and Control Systems

The 1978 DSB report on command and control systems management emphasized the important role of operationally-oriented tests and exercises to help evaluate the performance of current command and control systems, and to train operational personnel.

Frequent use and realistic training exercises of the command and control systems of a command are essential to confidence in and reliability of the system. Commanders who have their command and control systems adapted to all essential operational and support requirements of the command are able to conduct such exercises and make routine use of their systems as an adjunct of normal day-to-day operations. Those who have not made such adaptations should. Frequent use and simulated system degradation through both jamming and system losses generates familiarity and confidence; it enables both the operator and the supporting specialist to detect and eliminate weaknesses and to accommodate partial system degradation and interoperability. And, of course, lessons learned from real crises and conflicts must be widely disseminated and put to use as well.

Since 1978, there have been significant improvements in the training-oriented Command Post Exercises (CPX) and the field tests and exercises conducted by the JCS, Services, and the major commands. Rigorous tests and exercises to improve readiness have continued at a level of over 100 exercises per year conducted under JCS purview and many others under CINC and Component Command purview. Further, battle simulation capabilities are appearing as an enrichment of tactical-level CPXs (for example, The Warrior Preparation center in Europe). Traditional exercises have been used selectively for operational tests of new capabilities (for example, the Joint Deployment System development at MacDill AFB by the Joint Deployment Agency). Success can be identified in other areas as well (for example, the NORAD warning-system tests and exercise program and the Eucom nuclear-force communications test program).

Major improvements have resulted from the JCS-directed joint exercises and contingency operations held in the past decade. Short-notice exercises are now executed routinely at the CINC level. They have provided for dramatic improvement of our theater command and control readiness posture. We are also encouraged by the recently developed series of no-notice

interoperability command post exercises focusing on a single theater of operations. These exercises should highlight the current shortcomings and permit the commanders in the field to prioritize their critical command and control requirements.

These successes in evaluating and upgrading command and control systems as a result of lessons learned in the exercises also offer new opportunities. Too much artificiality still exists resulting in false conclusions. Exercises should be conducted on as realistic basis as possible with equipment on hand and no short cuts permitted that would skew the ability to command and control the forces involved. More can and should be done to greatly improve the operational performance and readiness of current command and control systems through test, fix, and test-again evaluation exercises. Second, user-oriented test beds that are closely coupled to the acquisition process are needed to maximize the operational effectiveness and utility of programs to upgrade command and control. These exercises and tests to assess command and control performance and to help specify new capabilities are needed at all levels of the command structure -- NCA/JCS, CINCS, and Service component commands.

The JCS-sponsored, DCA-supported strategic connectivity test and exercise program stands out as an example of the opportunities to evaluate and then improve readiness and command and control performance. In this case, a long-term test-fix-test again program called POLO HAT has made a substantial contribution to strategic nuclear command and control readiness. The key ingredients of the program's success involve its strong emphasis on issue-oriented evaluation and its programmed test and fix cycle; a mission focus that deals with operational capabilities rather than hard/software performance per se; and an attempt to achieve the maximum practical degree of realism, including the repeated introduction or simulation of degradation and disruption.

Other factors in conducting substantive evaluation include not only focused objectives, but a structured approach to data collection and analysis. The employment of trained, experienced observers and technical experts who are deployed to the field and bring back diagnostic insights as well as raw data can be a high-value investment. One noteworthy activity is the development of a Headquarters Effectiveness Assessment Tool (HEAT) by DCA to provide a quantitative basis for collecting and evaluating exercise data. A long-term continuing commitment among the key commands involved in joint exercises is also needed. Most important, the people and funds for technical support that are needed to conduct and analyze

tests and exercises must be furnished to the Commands by DoD.

Several million dollars per year in addition to organic Command resources has been required to support the POLO HAT program. About four to five times this amount may be be needed to support testing of all strategic missions worldwide. Similar amounts are needed to support joint tactical tests and exercises. Specific high priority areas for realistic tests and exercises include NATO processes and procedures for crisis management and transition to war (for example, alert levels) and air/land/sea battle coordination and interoperability at commands worldwide.

Operational tests and exercises can also serve as a unique test bed for new capabilities. New capabilities should be tested once, or at most a few at a time; otherwise the origin of failures becomes difficult to pinpoint. The evolutionary development of what is now the Joint Deployment System by the Joint Deployment Agency (JDA) is probably the most significant testimonial to the command and control test-bed potential of an on-going operational exercise program. This program started with the 1978 Nifty Nugget exercise whose results led to a combined evolutionary development and operational exercise program by the JCS, JDA, and the appropriate CINCs. This program was conducted from 1980 to 1985 and cost about $60 million. Evaluation resources were embedded within the evolutionary development program conducted by JDA that yielded fundamental lessons and new capabilities for the CINCs to formulate operational contingency plans and options, including force deployment options.

We conclude from all this experience that operational testing and exercising at all levels of the command structure worldwide should be fostered and strengthened throughout the life cycle of the command and control system life cycle. The combination of operational exercises and user-oriented test-bed activities represent major opportunities to maximize current-system readiness and to assess command and control performance. This assessment can be applied to specify new functions that will further upgrade command and control capabilities as well as maximize the utility of command and control systems being developed and acquired by DoD. The resources needed to implement and use these test and exercise capabilities are modest -- less than 1% -- compared to the investments needed to develop, acquire, and field command and control systems.

We therefore recommend that the capabilities of the JCS, CINCs, and Services for operationally testing, exercising, evaluating, and specifying functions to be performed by command and control

systems should be fostered and strengthened throughout the life cycle of the command and control system. The cost of demonstrating and testing must, of course, be kept in line, but the monies needed for improvements be absorbed by an overly ambitious test program. However, increased testing and system exercise is essential.

3. Strengthening the Capabilities of the Commands to Upgrade and Evolve Their Command Unique Systems

The 1978 DSB report on command and control management concluded that the need for a centralized focus within DoD for command and control architecture and interoperability must be balanced with the need for adaptability and evolutionary change in deployed systems at using commands. We conclude also that the using commands must have the primary responsibility for exercising, operating and maintaining their command unique systems. They should also have the capability and freedom to evolve and upgrade these systems within the overarching architecture established centrally by DoD. These capabilities are necessary to permit each command to tailor the command-unique parts of these systems to its own mission, geography, and commander's approach to decision-making. The acquisition process must recognize that such command systems must be designed from the outset to facilitate future evolution.

The 1978 DSB report also recognized that the CINCs have not played an adequate role in the command and control planning process. Within the last decade, the role of the CINC in command and control system planning and management has changed significantly. Institutional roles have been redefined recently in the areas of planning (the establishment of CINC Command and Control Master Plans and the JCS Global Assessment); programming (increased participation by the CINCs in the POM review process); requirements generation (the establishment of the Joint Requirements and Management Board); and development and acquisition (the establishment of the CINCs Command and Control Initiatives Program). Although all these opportunities are there, the CINCs generally do not have the resources that are needed to capitalize on them. Their staffs are committed to near-term operational issues and they lack the necessary databases and resources. Thus, if the CINCs are to play an appropriate role in command and control management, they must have access to the necessary architectural and technical support and the funds that role requires.

These resource shortfalls are not experienced equally by all the commands. Several CINCs are closely aligned with a Service or a Defense Agency (for example, CINCSAC with the Air Force; CINCLANT with the Navy; CINCEUCOM and CINCPACOM with DCA). However, these are cases (for example, CINCSOUTH) where organic and external resources are very limited. These observations suggest that each CINC must be analyzed individually to identify the specific resources needed for exercising, testing, and upgrading command and control systems.

To assure interoperability and information security in command and control worldwide, each CINC must be constrained to upgrading and maintaining only the command-unique parts of his command and control system. CINC initiatives for command and control upgrades should be used only for time-urgent needs where Service acquisition procedures are slow or unresponsive. The Services should support the normal evolutionary development of command and control systems by providing, under streamlined procedures, the technical infrastructure and resources to the CINC, who should guide and manage the overall effort under the overarching DoD architectural framework for command and control.

To accomplish these objectives for evolutionary development, the CINCs require: 1) a modest increase in initiative funds from present levels to provide greater access to non-developmental items, including the capability for rapid prototyping to help establish new requirements and to test and evaluate them; ii) the establishment of small architecture teams at each CINC headquarters; iii) validated information to make timely and more extensive inputs to the CJCS for joint required operational capabilities (JROCs) and the priorities for command and control funding; iv) the institutionalization within DoD of a process for incremental evolutionary acquisition of command-unique systems under CINC management; and v) the resources that are necessary to carry out these responsibilities.

We recognize that some roles and responsibilities in these proposed activities are now unclear between the CINCs, Services, JCS, and OSD agencies. We conclude that new organizational arrangements and procedures are needed to implement them successfully along the lines suggested in Section II,1. above and Section II, 4. below.

We therefore recommend that:

- Each CINC's involvement in the planning, programming, and acquisition of command and control systems relevant to his command be increased and that each CINC have resources organic to that command to evolve, upgrade, and maintain his own command-unique command and control system under the overarching architecture established centrally by DoD. The DoD should institutionalize this process of incremental evolutionary acquisition of command-unique systems under CINC management and with Service support of the required technical infrastructure.

- A modest increase in CINC initiative funds should be made to provide the means to meet time-sensitive command and control needs of the CINC.

- Each CINC should have access to his own small architecture capability to help provide the information needed for interoperability, for inputs to the CJCS on JROCs and priorities for command and control funding and for the design of the Command's unique command and control needs. These architectural staffs should coordinate their efforts to share methodologies and tools and to help identify cross-CINC issues and needs.

4. Improving the Regulation for the Acquisition of Command and Control System

The 1978 DSB report placed considerable emphasis on the fact that the regulation for one acquisition of command and control systems must take into account the special attributes of these systems, especially the need for evolution. It wrote as follows:

"The command and control system acquisition process needs to reflect the special characteristics of those systems. Most importantly, it must recognize that command and control systems must be designed from the outset to facilitate future evolution and that most systems developments will, in fact, be evolutionary adaptations of existing systems, unlike weapon system development where change is usually highly discrete. It also must assure that the user's contribution is present from the very beginning of system design through acquisition and deployment."

The 1978 Task Force then recommended that:

"The Department of Defense issue new directives to govern the acquisition of command and control systems that recognize the special characteristics of those systems. These directives should recognize that the various stages of the development of command and control systems overlap; recognize that user participation in the conception, testing and development of command and control systems is a strong requirement; and provide flexibility and adaptability to meet the wide variations in the needs of commanders."

The 1978 Task Force included a draft of such a directive as a "strawman" to help OSD to implement that recommendation.

We are pleased that the thrust of this recommendation has been embodied in the Defense Acquisition Circular, dated February 28, 1983, pages 16-17. We find, however, that the acquisition process does not uniformly follow these guidelines. Consequently, we repeat the recommendation and urge that the acquisition policies and oversight processes for command and control now being developed, including DoD oversight regulation 2167, reinforce and enlarge on these guidelines and assure compliance with the guidelines.

It is noteworthy that the Joint Logistics Commanders recently issued guidance for the use of an Evolutionary Acquisition strategy in acquiring C^2 systems. Effort will be required to assist the user in implementing this guidance.

5. Strengthening the Intellectual Base for Command and Control Through Coordinated Program of Research in Command and Control

The 1978 Task Force highlighted one of the largest problems in the command and control milieu as "...deciding what the system should and should not do..." and traced this problem to a lack of a "...useful conceptual framework for evaluating or specifying command and control systems...". This lack is still with us today.

Command and control is a multidisciplinary endeavor entailing technological, economic, organizational and cognitive aspects. Progress in understanding of command and control has been (at best) slow largely because there has not been a well-structured research program specifically aimed at gaining such understanding. The 1978 Task Force had recommended that such a research program be developed.

We have reviewed the research being conducted on command and control. While we are pleased that the amount of research has grown since the 1978 DSB report, we find that the research is unfocussed and largely technology oriented. Such research is useful, but it does not address the important and challenging operational problems command and control faces.

The hard job of looking deeply into all aspects of command and control in a coordinated, disciplined manner has not yet been undertaken. Put another way, there is need to do research on the structure and capability of command and control.

Specifically, we recommend that a comprehensive program devoted to research on command and control be defined and implemented. The research program should delve into all aspects of command and control, not just the technological aspects. It should form close linkages to the several research and graduate education programs in command and control in Service and Defense educational institutions and should exploit and foster similar research programs in our universities. DARPA should play a key role in this endeavor.

6. Strengthening Education and Training as well as Career Pathing of Command and Control Specialists

A recurrent theme throughout our study was the need for a stronger personnel base for improvements in command and control. One of the likely reasons for the failure to reflect in the acquisition process the special characteristics of equipment to be procured to facilitate command and control of forces can probably be traced to an inadequate supply of personnel trained in the subtleties of this non-hardware area. Though the officers with whom we interacted at the higher levels expressed understanding of their own needs, translation of these needs/desires into effective action requires participation of large numbers of people at many levels. Such people do not exist in the numbers needed. Even for those who are trained, the technology in this area moves rapidly, and a single officer's career, some decades long, can span several generations of technical capability.

The 1978 Task Force did not study the training and career pattern problems but opined that the Services should play the major role in training command and control specialists. The reports we received from the Services and the CINCs concerning the effectiveness of the current system to train, develop and manage the essential civilians and military (officers, warrant officers and NCO's) needed for command and control activities indicate that much remains to be done.

The training courses that have been developed within the Joint schooling system (e.g., the Joint command and control courses at the Naval Post Graduate School and Armed Forces Staff College) are considered to be excellent training mechanisms. However, the output is considered inadequate to meet the needs of the Commands and the means for tracking the graduates of the command and control Schools varies significantly among the Services. The result is that adequate command and control professionals are not available in the command headquarters to provide the staff support necessary to ensure that command and control capabilities are maximized throughout our military command structures. One of the shortcomings that contributes to the inadequacy of command and control professionals is the lack of a coordinated, combined Joint and Service needs document. We were satisfied that the Services have developed internal Service manpower requirements documents for command control personnel. However, the needs of the Joints Staffs and Unified and Combined Commands are less precise or non-existent. Two additional areas have not been given sufficient consideration in developing manpower requirements documents - Research and Development Specialists and Allied command and

control experts.

If we are to develop our command and control capabilities to their fullest, we must be willing to develop the research specialists necessary to ensure that we are at the leading edge of command and control technology. We must also ensure that we have developed sufficient command and control professionals who are knowledgeable about the command and control activities of our allies. The integration of US command and control with Allied command and control is as important as our own national integration. We need professionals well versed in this command and control milieu.

We found repeated instances, in all Services, of personnel working in command and control specialities who considered themselves deprived of promotion, bonuses or recognition -- in "the backwater" of service career progression or promotion. This is a classic complaint of those who, for real or perceived reasons, consider that they have been shunted to a side track. On the other hand, there clearly are examples of command and control professionals who seem to have fared reasonably well. In any event, the Task Force considers solutions requiring weighted promotions and priority considerations for people in the command and control areas as counterproductive and unnecessary. Rather, the optimum solution would seem to lie with the focus of the commander on command and control -- his interest areas, his understanding, and his application. We found little or no dissatisfaction with specialty service in command and control in those commands where the commander was directly immersed and concerned with his ability to command; was involved in all facets of his command and control systems and directly interested in his basic command and control staff. In our view, the solution to career pathing in command and control lies in our ability to impress the commanders at all levels with the direct responsibility for his command and control system -- and its people. If the commander can be made to realize the essential contributions of the command and control staff to his vital command function, a healthy solution is feasible; if they fail - he fails.

The Task Force is sympathetic to the legitimate claims of many who have been engaged in command and control specialities and have failed to receive timely promotions or recognition. We urge commanders and personnel specialists to be sensitive to these growing but ill-defined specialty areas involved; however, we find the most viable solution to satisfactory career progress lies in widespread programs that emphasize the vital role of his command and control system to commanders at all levels and requirements that insure frequent command

cognizance of all aspects of the system and those who man and support it. In our view, command and control staff and support requirements draw on all combat and support skills; they do not lend themselves to a single career path, and it would compound the problem to attempt to so channel them.

Since command and control has such a leveraged impact upon our total force capabilities, and since skilled professionals are essential to maximize command and control, we conclude that the following steps are necessary to improve the career patterns of command and control personnel available to the Services. First, the Director for command and control Systems on the Joint Staff should identify the requirements for command and control professionals in the Departments; the Joint Staffs; the Unified and Specified Commands; and with the Services develop the internal Service manpower requirements to include those needed to ensure viable R&D programs. Second, the Services should develop command and control career patterns that ensure adequate personnel are assigned to the command and control specialty, that those assigned are trained, developed and managed in a career progression that provides adequate incentives for their continued service in this specialty. Third, the JCS and the Services should develop an educational and training system that fully supports the command and control needs of the military forces.

In the development of command and control systems for the military forces two other problems have continued to exist. One has been how to train with operational command and control systems and the other has been how to develop an interactive process that permits direct feedback from the command and control System user.

Some commanders have expressed reservations about having their staffs train on the extant command and control systems. They are concerned, among other things, that use of the operational command and control systems for training will degrade the ability of the command and control systems to respond in a timely manner to real threats, or that such use will provide bogus information in the system which cannot be kept separate from real world information during the training session or which cannot be purged from the system when the training is completed. One of the drawbacks of not using operational command and control systems is that the users do not have the opportunity to develop additional skills by training on the real command and control system. A second drawback is that by failing to permit the user to train on the operational system, we are likely to preclude development of user initiated innovations to improve the system and make it more user friendly.

We conclude that the commanders' concerns can be resolved and that the shortcomings identified can be overcome by developing embedded training programs into command and control systems. Such embedded training would permit those involved in command and control activities to conduct training in the most realistic environment possible and would permit the command and control users to provide feedback to the command and control developers that would aid in ensuring that our command and control systems are responsive to the changing needs of our commanders.

APPENDIX A

REPORT OF THE DEFENSE SCIENCE BOARD TASK FORCE ON

COMMAND AND CONTROL SYSTEMS MANAGEMENT

JULY 1978

Report of the

DEFENSE SCIENCE BOARD TASK FORCE

on

COMMAND AND CONTROL SYSTEMS MANAGEMENT

July 1978

Office of the Under Secretary of Defense Research & Engineering
Washington, D.C. 20301

OFFICE OF THE UNDER SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

RESEARCH AND ENGINEERING

2 August 1978

TO: Secretary of Defense

THRU: Under Secretary of Defense for Research and Engineering

SUBJ: Report of Defense Science Board Task Force on Command and Control Systems Management

The final report of the DSB Task Force on Command and Control Systems Management is hereby transmitted.

The Task Force has determined that:

a) our command and control systems have not kept up wither with the changes in the type of warfare or the changes in weapons and available command and control technology;

b) it is important to have procurement procedures for command and control systems that reflect the special nature of such systems. The Task Force recommends that a new procurement directive be issued (Appendix E) that:

1) makes 5000.1 and 5000.2 not applicable to command and control systems; 1/

2) brings the using Commands very deeply and continuously into the development of the command and control systems;

3) emphasizes the evolutionary character of command and control systems. 2/

1/ It is obvious to me that one of the causes of (a) was the misguided attempt to apply directives 5000.1 and 5000.2 to C^3 systems.

2/ I believe that the proposed directive makes insufficient provisions for the continuous changes in software and architecture required by the evolution process during the operational life of the system. However, this need is recognized in the list of findings (p. 10 and 13 of tne report) and recommendations (No. 4, p. 17).

c) there is strong need for a central organization which would essentially:

1) oversee the design and testing of all command and control systems that cut across Service lines;

2) insure that means are available whereby the commands can take the initiative in the evolution of the systems; and

3) insure commonality and interoperability among US and Allied systems.

The Task Force feels strongly that the best course would be to establish a new agency (Defense Command & Control Systems Support Agency - DCCSSA) to fulfill these functions; they have prepared a draft directive (Appendix D) establishing the new agency. However, the Task Force also states that if the establishment of DCCSSA "is not now propitious, the next best approach would be to combine the functions we have identified (for the DCCSSA) with the present DCA to create a new Defense Command, Control & Communication Agency."3/

I recommend this second course and urge that we do expand the DCA by broadening its charter, using Appendix D as a basis, to fulfill the desired functions.

I also recommend the adoption of the other recommendations of the Task Force.

Chairman
Defense Science Board

3/ It is my belief that the Task Force members prefer the DCCSSA to the DC^{3}A because most of them believe that the military communicators (a) have shown historically a serious lack of understanding of command and control; (b) would not permit DC^{3}A to properly fulfill the DCCSSA role; and (c) they further believe that DCA performance in WWMCCS supports their fears. I do not share their concerns.

OFFICE OF THE UNDER SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

RESEARCH AND
ENGINEERING

19 July 1978

Memorandum for the Chairman, Defense Science Board

Subject: Report of the Task Force on Command and Control Systems Management

I transmit herewith the report of the DSB Task Force on Command and Control Systems Management. The Task Force concludes that the nation is failing to deploy command and control systems commensurate with the nature of likely future warfare, with modern weapons systems, or with our available technological and industrial base. A stronger focus on command and control is needed.

To this end we make just five broad recommendations listed in the Executive Summary. These deal with

- The need for a central organization to manage the design and acquisition of command and control systems that cut across Service boundaries and to assure the compatibility and operational effectiveness of all systems for the support of command and control.
- The need of each major military command to be able to adapt, modernize and maintain its command and control system to fit the needs of the command.
- The need to strengthen the capabilities of the Services and of the Unified and Specified Commands for evaluating, operating and specifying functions for command and control systems.
- The need for new directives for the acquisition of command and control systems tailored to the special characteristics of these systems.

- The need for research on all aspects of command and control.

Two new DoD directives are drafted to help implement the recommendations and are included as Appendices D and E.

I urge that you take steps to implement these recommendations.

S. J. Buchsbaum
Chairman
DSB Task Force on
Command and Control
Systems Management

Att.

CONTENTS

I. EXECUTIVE SUMMARY

The nation is failing to deploy command and control systems commensurate with the nature of likely future warfare, with modern weapon systems, or with our available technological and industrial base. Consequently, a much stronger focus on command and control within DoD is needed to assure that improved command and control systems will evolve in a timely fashion to meet our national needs. Some centralization of responsibility for the management command and control systems will help achieve this goal. The role of the Unified and Specified Command in establishing requirements and adapting their command and control systems to their particular circumstances must be strengthened as well.

Command and control systems typically are very complex in their design and behavior, presenting special characteristics that distinguish them from weapons systems and that must, therefore, be reflected in the acquisition process. The most important of these characteristics is the need for adaptability to user needs and for their evolutionary change over time. Significantly, there is almost no commonly understood vocabulary or conceptual framework for analyzing, designing, or evaluating command and control systems.

These considerations take on especial importance in view of the likely future constraints on U. S. defense budgets, putting a great premium on gaining the most effective utilization of our military forces.

To correct these failings, the Department of Defense should revise its organization and procedures for the acquisition and management of command and control systems in the following ways:

1. There should be within the Department of Defense a strong central organization to manage the design and acquisition of command and control systems, designated by the Secretary of Defense, which cut across Service boundaries or are of major concern to OSD, JCS, or the National Command Authority and to assure the compatability and operational effectiveness of all systems for the support of of command and control.

2. Each major military command should have funding and manpower resources organic to that command to adapt, modernize and maintain its command and control systems, within established standards and specifications, to fit the needs of the command.

3. The capabilities of the Services and Unified and Specified Commands for exercising and evaluating, operating, and specifying functions to be performed by command and control systems should be strengthened.

4. The DoD should issue new regulations for the acquisition of command and control systems which would provide flexibility and which are specifically tailored to the special properties of these systems.

5. The DoD should develop a coordinated program of research and testing on command and control concepts, design, and system performance to provide the intellectual base to guide the evolution of improved Command and Control systems.

II. INTRODUCTION

The Defense Science Board Task Force on the Management of Command and Control Systems was commissioned by the Under Secretary, Defense Research and Engineering, during December 1977 to determine if the nation is acquiring command and control capabilities commensurate with the weapons systems that we are deploying or with the technology that is available.* The Task Force was urged to develop recommendations that, if implemented, would help improve the design, acquisition, operation, and evolution of command and control systems. This Report is in response to this charter.

*Command and control is defined in JCS Pub 1 as "the exercise of authority and direction by properly designated commander over assigned forces in the accomplishment of his mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities and procedures which are employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of his mission."

The Under Secretary's direction to the Task Force is reproduced in Appendix A. The Task Force membership is listed in Appendix B.

The Task Force held discussions with numerous managers and operators of command and control systems in the OSD and in the Services (listed in Appendix C) and has examined several command and control systems presently in development. We are grateful for the cooperation we have received.

It is clear that the nation needs command and control systems which would provide substantially better service to our national leaders and our military commanders than the ones we have in place. Our opponents in many circumstances are likely to have forces larger than ours over which we can prevail only with superior coordination and battle management, and the potential damage and rapid pace of likely future warfare make command and control even more essential than ever before.

It is also clear that we could have the improved command and control systems needed. The United States has a strong lead in the technologies of computers and communications upon which modern command and control systems must be built, and we have better knowledge of how to manage complex man-machine organizations than any of our potential adversaries.

There are, of course, real difficulties in achieving the needed and possible command and control system improvements. Some of the problems are technical; the design, installation and utilization of command and

control systems present one of the most complex challenges of modern technology. Some of the problems are managerial and organizational; it is difficult to reach agreement on who should do what in command and control systems design and acquisition and how to work around the constraints of acquisition directives designed for weapon systems that do not allow for the special characteristics of command and control systems. Some of the problems are conceptual: there is little explicit and shared understanding within the Defense community as to what command and control concepts are most important and how these concepts should be reflected in the design of command and control systems.

The Task Force has focused on management and organizational issues because we feel that changes in these areas are possible and are necessary antecedents to improvement of our national capability to field workable command and control systems. We confirm the view, widely held in DoD, that new procedures and new institutions are needed for the design and acquisition of command and control systems, for both our strategic and tactical forces. This report sets forth our findings, conclusions, and recommendations.

III. FINDINGS AND CONCLUSIONS

One of our most important findings is that there is an important need for fundamental change and improvement in our military command and control capability. This need arises primarily from significant changes over the last decade in the technology of American military

forces and in the nature of the control needed in likely future applications of those forces. The awareness of this need is widespread within DoD, albeit from different perspectives and with differing priorities.

Probably the most basic reason for new and better command and control capability is the changing nature of circumstances in which American military power may need to be applied. Our political and security interests around the world are likely to mandate carefully controlled use of force with precise understanding at all levels of command as to what is and is not happening, and what is -- or is not -- to be done. Especially in a major NATO-Warsaw Pact war or in general nuclear war with the Soviet Union, it will be important for commanders and national leaders to have a kind of control over the forces they command that is appropriate to the situations they will face.

A second reason for needing better command and control capability is that our ability to deter military aggression is dependent upon our ability to respond appropriately. Command and control systems that deny important options, are too complex to be used effectively, or are too slow, can cause aggressors to discount our will or ability to respond. They also can force us into excessive retaliation which may cause a military situation to escalate unnecessarily.

Third, U.S. intelligence collection and reporting systems have become highly rich in the information they provide. It is important

that this information be available to the appropriate level of command in the proper context and that the command and control systems permit commanders to utilize that information in controlling their forces. This information-rich character of the modern strategic and tactical battlefield is compounded by the advent of "smart" weapons which depend critically on timing and placement for their effectiveness.

Finally, the likelihood of future constraints on U.S. defense spending puts a great premium on gaining the most effective use of our limited forces. Although quantitative measures are lacking, it seems clear that improved command and control systems can multiply the effectiveness of U.S. forces in many of the possible confrontations we may face with the Soviet Union and other adversaries. (History provides some striking examples of such leverage - Midway, Pearl Harbor, Battle of Bulge, Gallipoli, etc.)

Fortunately, these reasons for more emphasis on improving our command and control capability are matched by the availability of technology and systems expertise to make such improvement a real, not futuristic, possibility. Early on in our study it became clear that the major difficulties in developing, acquiring, and deploying command and control systems are not primarily technical, but conceptual (What should the system do?) or administrative (How do we organize the required resources?).

Therefore, we have focused our effort and this report principally on the special charactristics and problems of command and control systems, as distinct from weapons systems or communications systems, and the adequacy of existing organizational and administrative arrangements for the acquisition and management of command and control systems.

The Special Problems of Command and Control

We have found a number of characteristics of command and control systems that distinguish them from other types of systems developed and procured by the DoD. Broadly, those characteristics can be categorized as technical, managerial, organizational, and conceptual. In the following discussion of these characteristics, we do not intend to imply that each is totally unique to command and control; we recognize that some are differences in degree and some are shared with certain other kinds of systems. Rather, we have attempted to describe an overall pattern that has led us to conclude that special arrangements are required for the management and acquisition of command and control systems.

Technical:

The most basic technical characteristic of command and control systems is that they are highly "information rich." That is to say, the behavior of the system is highly dependent in a very complex way on the information in it and the demands put upon it. Most weapon

systems by contrast have relatively simple behavior and control characteristics (although they may be highly sophisticated engineering accomplishments).

Also, command and control systems must be highly adaptable to meet the many demands a commander may place upon them in the myriad of circumstances that can arise in a battle. They must perform acceptably with imperfect information, and their performance should degrade gradually, rather than fail catastrophically under damage and stress. These kinds of requirements make it very difficult to specify performance criteria to guide technical developments that are much related to actual system usefulness. This is compounded by the fact that the range of technical choices, together with often subjective performance criteria, presents a complexity that is unique to command and control system development.

Then too, command and control systems differ from other defense systems in that a very large fraction of the development cost is in software rather than hardware and considerable hardware already is available commercially, at least for R&D use. Therefore, acquisition procedures based on hardware have little a priori applicability to command and control systems.

Managerial:

Each of the technical characteristics just described affects the management of command and control system development and acquisition.

This management is further complicated by the need to integrate the command user's diverse needs and perspectives with the wide range of technical options presented by system engineering designers. Since neither of these groups is likely to share a common vocabulary, expertise, experience, or priorities, the management problem of achieving the required capability at reasonable cost is yet more difficult.

Organizational:

Organizational factors add another layer of unique characteristics. Most command and control systems cut across Service lines, at their interface, if not in actual deployment. Key users may be Service unit commanders, CINCs, or the National Command Authority. Systems typically must be interoperable with many other systems designed at different times with different emphases. Researchers, designers, and users are likely to be in different organizations and in different locations. Commands, Service staffs, OSD and JCS all have important roles in generating command and control system specifications.

Command and control systems require easy adaptation to the changing and often unique situation facing each command and its personnel. They must be maintained and modified on a regular basis and yet remain interoperable and reasonably standardized so that military operations and manpower training programs can be operated across unit lines.

Conceptual:

As already mentioned, one of the biggest problems in designing, developing, and acquiring command and control systems is the problem of deciding what the system performance criteria should be -- i.e., what the system should and should not do. The absence of commonly understood concepts of command and control system performance and the existence of language barriers among technologists, policy analysts, planners, and commanders all underlie the fact that we lack in DoD any very useful conceptual framework for evaluating or specifying command and control systems. Terms like fail-soft, adaptability, robustness, and so forth are hard to translate into specific indices for the system designer.

The performance of command and control systems depends on factors such as damage, staff degradation, commander stress, weapon capabilities, intelligence inputs, and so forth, most of which involve considerations of organizational psychology, combat experience, decision theory, and the like, which typically are not in the realm of system designers and yet must be part of any sound command and control system design concept. Similarly, we have yet to learn how to separate the operational function of command and control from the design of command and control concepts and systems. It is significant that we found considerable system development within DoD, but almost no research in the command and control field is underway within or funded by DoD. Neither the Services, ASD/PA&E, nor ASD/C^3I have any significant capability to study the effects of

alternative command and control capabilities and vulnerabilities on military effectiveness or overall force posture, even though it is widely recognized that command and control is a major determinant of the strength and usefulness of our military forces.

Conclusions:

Our conclusions as a result of our study are simple. First, there are important long-term reasons for establishing a strong focus in DoD for command and control matters. DoD budget constraints seem likely to put a growing premium on enhancing the effectiveness of those weapon systems we can afford to include in our force structure. The lead of the U.S. over the Soviet Union in command and control technology is an area that should be exploited to gain the leverage of a superior command and control. Growing interdependence of political and military considerations in applications of U.S. force put a premium on precise and timely command and control capabilities at all levels, and the growth of real-time intelligence reporting systems has created an information-rich environment for both tactical and strategic military encounters which requires new command and control systems and procedures to sort out and utilize that information for application in the command and control function. A centralized focus within DoD on the management of command and control systems design, development, and acquisition can help foster research, assure proper funding, facilitate interoperability of systems and compatability of systems planning with overall force posture and doctrine development -- all of which will contribute to the growth of a

stable interface environment within which improved command and control systems will take root and grow.

Second, the need for standardization and central control must be balanced with the need for adaptability and evolutionary change in deployed systems. Using commands must have the primary responsibility for deploying, operating, and exercising their command and control systems. They also should have capability and freedom to modify those systems within specified limits. This is necessary to permit each military command to tailor its command and control systems to its own mission, geography, and commander's style. It also would help bridge the language barrier between users and designers.

Third, the command and control system acquisition process needs to reflect the special characteristics of those systems. Most importantly, it must recognize that command and control systems must be designed from the outset to facilitate future evolution and that most systems developments will, in fact, be evolutionary adaptations of existing systems, unlike weapon system development where change is usually highly discrete. It also must assure that the user's contribution is present from the very beginning of system design through acquisition and deployment.

Fourth, the capabilities and the roles of the Services and Unified and Specified Commands should be strengthened to accommodate a DoD-wide effort to upgrade command and control capabilities and proficiency.

Fifth, a new long-term DoD-wide emphasis on research on command and control system technology and concepts should be formulated and funded to provide the broad professional and intellectual base necessary for improving our command and control capabilities.

IV Recommendations

Based on our review and analysis, as described above, we have identified five recommendations for change that we believe will strengthen the ability of the Department of Defense to devise and implement command and control systems that will enhance the effectiveness of our military forces.

1. The Department of Defense should charter an agency that will:

   - o assist the Unified and Specified Commands and JCS in the development of command and control system requirements and specifications;

   - o establish technical standards for interfacing specifications;

   - o perform development planning including alternative concept, trade-off studies;

   - o develop master plans for programming and budgeting of various command and control developments and procurements;

- and act as system architect and integrator on command and control systems, designated by the Secretary of Defense, which cut across Service boundaries or are of major concern to OSD, JCS or the National Command Authority.*

---

*The organization should be responsible for the following functions:

- Assuring the integrity, compatibility, evolutionary capability, and technical efficiency of all communications, data, and information systems employed in support of command and control requirements designated by the Secretary.

- Coordinating with the Chairman, JCS and OSD elements to assure that all validated command and control requirements are considered in planning of systems and that systems constraints and opportunities are fully considered in the formulation and validation of requirements.

- Establishing standards and requirements for interface specifications, systems interoperability, evolutionary constraints, and system architecture for command and control systems, including both hardware and software.

- Developing, coordinating and, as appropriate, executing, a cohesive DoD program of research, analysis and other studies on command and control system design and operation.

- Assisting the ASD/C^3I in review, analysis, and comment on all DoD budgets pertaining to command and control systems.

- Assuring appropriate tests of command and control systems in realistic operational exercises, including vulnerability to damage and disruption.

- Assuring the adequacy of developmental and operational testing to provide compatibility, interoperability, and evolutionary growth capability in command and control systems, and, where appropriate, administering such testing.

- Participating in the development and validation of command and control concepts and requirements.

By contrast, this organization should not be responsible for the operation or maintenance of command and control systems, or the validation of command and control requirements.

This central command and control organization should report to the Secretary of Defense through the appropriate Under Secretary or Assistant Secretary. With regard to military command and control doctrine operational requirements and operating policies and procedures, it should be responsible to the Chairman, JCS.

We feel that it would be best to establish this central command and control organization as a new separate entity, which might be called the Defense Command and Control Systems Support Agency (DCCSSA). Reporting to the Secretary of Defense, the DCCSSA would have reporting and coordinating relationships within DoD much like DCA and NSA. Our reasons for preferring this arrangement are principally that the functions and professions of command and control systems design, development, and acquisition require high level support and visibility in DoD. We have included in Appendix D a draft of a DoD directive which would implement this recommendation. (This draft is provided as a "strawman"; it should be recognized that it must be reviewed by the OSD staff for consistency and completeness.)

If it is determined that establishment of a new DoD agency is not propitious, we feel that the next best option would be to combine the functions we have identified with the present DCA to create a new Defense Command, Control and Communications Agency (DC^3A). In this event, the present responsibilities of the Director, DCA, would have to be realigned to encompass the new command and control functions. Moreover, care would have to be taken to assure that sufficient funds,

manpower and management capability are assigned to the DC^3A so that command and control would not be lost or dominated by the communications professionals in the combined agency.

2. Each major military command should have funds and manpower sufficient to operate, maintain, modernize, and adapt its command and control systems within the architectural guidelines and constraints established by DCCSSA. The funding for maintenance, modernization and adaptation should be a significant fraction perhaps 10%, per annum of the invested value of systems.

We expect that there would be considerable assignment of people back and forth between the commands and the DCCSSA so that command and control professionals will acquire both perspectives and provide an important communication mechanism between the commands and the DCCSSA.

3. The very considerable capability for acquiring and operating command and control systems which currently resides in the Services and the Unified and Specified Commands should be reinforced to work with the new DCCSSA so as to strengthen the overall DoD command and control capability.

4. The Department of Defense should issue new directives to govern the acquisition of command and control systems that recognize the special characteristics of those systems. These directives should recognize that the various stages of the development of command and control systems

overlap; recognize that user participation in the conception, testing and development of command and control systems is a strong requirement; and provide flexibility and adaptability to meet the wide variations in the needs of commanders. A draft of such a directive is attached as Appendix E. (This draft is provided as a "strawman"; it should be recognized that it must be reviewed by the OSD staff for consistency and completeness.)

5. The DCCSSA (or DC^3A) should be directed to develop a broad research program on command and control encompassing technological, economic, organizational, cognitive, and other aspects of command and control system design and performance. This research program should be coordinated with DARPA and the Services and should include support for research by DARPA, the Services and contractors.

In making its recommendations, the Task Force has not studied the training and career pattern problems that may arise. We do believe, however, that the Services should play the major role in training command and control professionals and should have significant funding for command and control research. Innovative training programs, like the new command and control program at the Naval Postgraduate School, should be strongly supported.

APPENDIX A

TERMS OF REFERENCE

DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D C 20301

20 SEP 1977

MEMORANDUM FOR THE CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Command and Control System Management

Please establish a task force to reexamine the process by which OSD and the Services specify, plan and procure C^3I systems.

I would like to have the DSB examine:

1. To what extent procurement of C^3I systems should require multi-Service cooperation as contrasted with the present procedure of separate procurement in each Service (accompanied by a distinct set of actions to insure interoperability).

2. To what extent have existing procedures and organizations proven their effectiveness in the procurement of joint systems for combined operations such as close Air Support Systems, Battlefield interdiction and the like.

3. To what extent the existing procedures and directives designed to regulate weapon system procurement are applicable to C^3I systems.

4. To what extent the existing management organizations deal satisfactorily with C^3I systems and, if changes are desirable, what alternatives exist.

5. In view of the existence of DCA, the WWMCCS Council, and the joint interoperability Council for Tactical C^2 systems, what type of relation should be established among these entities.

I would like to have your final report by 15 May 1978, and it would be most useful to have an interim report by 1 February 1978 to provide a preliminary view of the approaches being considered.

William J. Perry

William J. Perry

APPENDIX B

TASK FORCE MEMBERS

Dr. Solomon J. Buchsbaum, Chairman
Vice President, Bell Laboratories

Dr. Harold W. Lewis, Co-Chairman
University of California

General John R. Deane, Jr. (Ret.)
Consultant

General Russell Dougherty, USAF (Ret.)
Consultant

Dr. Richard D. DeLauer
Executive Vice President, TRW

Mr. Bob O. Evans, Vice President,
IBM

Dr. Ivan E. Sutherland
California Institute of Technology

Dr. Clay T. Whitehead
Allison Technical Services

VADM Levering Smith (Ret.)
Consultant

Mr. Charles A. Zraket, Executive Vice President
MITRE Corp.

Dr. Robert J. Hermann, Cognizant
Deputy Under Secretary of Defense
for Research & Engineering (C^3I)

Mr. Everett D. Greinke,
Cognizant Director

Mr. John C. Cittadino
Executive Secretary

APPENDIX C

PARTICIPANTS IN TASK FORCE MEETINGS ON COMMAND AND CONTROL SYSTEMS MANAGEMENT

PARTICIPANT	DATE	SUBJECT AREA
Dr. W. Perry, USDRE	12/8/77	Under Secretary's overview
Dr. R. Hermann, DUSDRE(C^3I)	12/8/77	Deputy Under Secretary's (C^3I) overview
LTG L. M. Paschall, Director, DCA	12/8/77	Defense Communications Agency
MG J. Hoover, Director, Joint Tactical Communications Office	12/8/77	TRI-TAC Program
COL F. Maffett, Systems Engineer, JINTACCS	12/8/77	Joint Interoperability of Tactical C^2 Systems
Dr. E. Fubini, Chairman, DSB	1/11/78	Chairman's perspective
LTG C. J. LeVan, Director, Operations, OJCS	1/11/78	JCS perspective and the Joint Tactical C^3 System Council
ADM D. J. Murphy (Ret), DUSD(P)	1/11/78	Policy/Requirements viewpoint
VADM R. V. Kaufman, USN	1/11/78	Navy Command and Control
MG C. R. Myer, Director, Army Telecommunications and MG H. Dickinson, Commander, CORADCOM	1/11/78	Army Command and Control
BG J. S. Creedon, USAF and COL T. Thompson, Tactical Air Command	1/12/78	Air Force Tactical Command and Control
COL Fred Clark, Dep. Dir. C^4, USMC	1/12/78	Marine Corps Command and Control
COL B. Parkinson	1/12/78	NAVSTAR/GPS Program
Dr. P. Dickinson	1/12/78	BETA Program

PARTICIPANT	DATE	SUBJECT AREA
Mr. A. Marshall, Director, Net Assessment	2/7/78	Net Assessment views
CDR J. Dunn, OD, Net Assessment	2/7/78	Counter-C^3
Mr. M. Lockerd, Texas Instrument Corp.	2/7/78	Army Scientific Advisory Panel views of Army C^2
MG R. Edge, USAF (Ret)	2/8/78	C^2 Management
Dr. A. Babbitt, WWMCCS, Systems Engineer	2/8/78	WWMCCS program and lessons learned
Dr. D. Signori, IDA	2/8/78	Tactical C^3I Framework Study
RADM Myers, Deputy Chief of Staff, CINCLANT	3/23/78	CINCLANT C^2 organization and operations
Mr. Vince Cook, IBM	3/23/78	Experiences in working WWMCCS architecture

APPENDIX D

DEPARTMENT OF DEFENSE DIRECTIVE

SUBJECT: Defense Command and Control Systems Support Agency (DCCSSA)

References: (a) Title 10, United States Code, Section 125

(b) DoD Directive 5000.XX, "Acquisition of Support Systems for Command and Control Systems"

A. PURPOSE

This directives establishes and defines the mission, responsibilities and command relationships of the Defense Command and Control Systems Support Agency (DCCSSA).

B. GENERAL

Pursuant to the authority vested in the Secretary of Defense and the provisions of reference (a), the DCCSSA is established as an Agency of the DoD reporting to the Secretary of Defense through the _____ (Appropriate Staff level to be added) _____.

With regard to military command and control doctrine, operational requirement and operating policies and procedures, he shall be responsible to the Chairman, Joint Chiefs of Staff. Additional guidance with regard to operational doctrine and procedures shall be furnished to the Director, DCCSSA, by the JCS, the Unified and Specified Commands and the Military Departments. The purpose of the DCCSSA is to assist the Unified and Specified Commands and the JCS in the development of command and control system requirements and specifications; to establish technical standards for interfacing specifications; to perform development planning including alternative concept trade-off studies; to develop master plans for programming and budgeting of various command and control developments and procurements; and to act as system architect and integrator for command and control systems designated by the Secretary of Defense, which cut across Service boundries or are of major concern to OSD, JCS or the National Command Authority. Management policy for command and control systems acquisition is established in reference (b).

C. DEFINITIONS

Terms used in this Directive are defined in enclosure 1.[1]

D. MISSION

The mission of the DCCSSA is to:

1. Perform studies and system engineering analyses, establish standards, conduct other technical activities on a continuing basis and establish an overall command and control support systems plan which will ensure the technical adequacy, systems compatibility, and operational effectiveness of all US and allied communications data and sensor systems required to support the validated command and control requirements for unilateral, joint or combined operations of US forces in peace, contingency or war.

2. Provide for orderly evolution and interoperability of future command and control support systems through continuing analysis of long range operational needs and management of the system configuration.

3. Provide programming and budgeting for and direction of developments and procurements of designated command and control systems.

4. Provide to the Secretary of Defense a consolidated program and budget for the Command and Control Systems of the Services and Commands.

E. ORGANIZATION

The DCCSSA shall consist of a Director, a headquarters establishment and such subordinate units and facilities as established by the Director to accomplish his mission of other activities assigned to the agency by the Secretary of Defense or by the Chairman, Joint Chiefs of Staff, acting by authority and direction of the Secretary of Defense.

F. RESPONSIBILITIES

1. Director of DCCSSA shall:

a. Command, organize, direct, and manage the DCCSSA and its field organizations in accordance with assigned missions and within the resources to be made available.

b. Participate with the Organization of the Joint Chiefs of Staff, the Unified and Specified Commands, and the Military Departments and applicable allied agencies in the development and formulation of operational concepts and requirements for the employment of US forces in order to understand the scope of command and control systems support needed to implement such concepts.

c. Establish standards and interface specifications and serve as the DoD intersystems architect/engineer/integrator for both hardware and software of US command and control systems.

d. Provide programming and budgeting data for, and manage all programs for which he is assigned responsibility and funded.

e. Establish technical specifications, interface standards and configuration control procedures of US systems and interfacing allied systems which provide command and control support in the employment of US forces.

f. Manage the technical and interface standards and the configuration of the DoD command and control systems throughout their service life.

g. Serve as the US representative in international/allied negotiations concerning cooperative research development, acquisition, interoperability and international configuration management of command and control support systems.

h. Develop, maintain, and update an overall technical and budgetary plan for research, development, acquisition, and integration of command and control systems to meet identified needs.

i. Make recommendations to the Office of the Secretary of Defense concerning research and development program approval, service funding, and acquisition of intra-service command and control systems; and the service assignment of program management, acquisition, and logistics support of inter-service command and control systems.

j. Provide for the conduct of intersystem developmental and operational testing (DT&E/IOT&E) to develop and demonstrate the compatibility, interoperability, and effectiveness required by employment concepts.

2. The Director, DCCSSA is not responsible for but will maintain an awareness of:

a. The operation, maintenance, and logistic support for command and control support systems.

b. The requirements for or management and acquisition of intra-service command and control support systems.

3. The Director, DCCSSA is assigned responsibilities for and, in conjunction with other DoD components and Agencies, will plan for the orderly incorporation into DCCSSA of the following programs/organizations:

a. Joint Tactical Communications Program (TRITAC).

b. Joint Interoperability of Tactical Command and Control Systems (JINTACCS).

c. Joint Tactical Information Distribution System (JTIDS).

d. WWMCCS System Engineering Office (WSEO).

e. Military Satellite Office (MSO).

f. Defense Communications Engineering Center (DCEC).

g. Command and Control Technical Center (CCTC).

4. The Deputy Under Secretary of Defense for Policy shall provide policy guidance to the ASD (C3I) with regard to the prioritization and confirmation of command and control requirements, as required.

5. The Chairman, Joint Chiefs of Staff shall:

a. Provide guidance, to the Director, DCCSSA on military and command and control doctrine and operational policies and procedures with regard to the development of command and control support systems.

b. Review and provide recommendations to the ASD (C3I) or the Director, DCCSSA, as appropriate, on the overall command and control support systems plan, other project and programming plans prepared by DCCSSA and on the allocation of military and civilian manpower to DCCSSA.

c. Provide advice to the ASD (C3I) regarding changes and modifications in the functions and responsibilities of the Director, DCCSSA.

d. Provide guidance concerning the relationships between the commanders of the Unified and Specified Commands and the DCCSSA.

c. Provide direction and guidance to the Director, DCCSSA on matters related to the development of improved command and control support to the NCA.

6. The Secretaries of the Military Department shall:

a. Provide, within the limitation of available resources, full support and assistance to the Director, DCCSSA in accomplishing his mission.

b. Accept tasking from the Director, DCCSSA to conduct acquisition programs for command and control support systems with funds provided by DCCSSA.

c. Accomplish related functions in support of planning, programing, budgeting, detailed engineering, training of operating and support personnel and other functions as may be required.

d. Consult with and obtain coordination of DCCSSA on the development of intraservice command and control support systems to ensure that potential interface requirements are not overlooked. Request DCCSSA representation on source selection advisory councils and evaluation boards for interservice command and control support systems.

e. Insure compliance with the technical specifications, interface standards and configuration control procedures established by Director, DCCSSA for command and control systems under his cognizance.

7. The Commanders of the Unified and Specified Commands shall:

a. Develop, with the participation of DCCSSA, the JCS, the Military Departments, and other DoD agencies, as appropriate, requirements for command and control support appropriate to their theatre, function, and threat.

b. Conduct, with the participation of the JCS, DCCSSA, and the Military Departments, field exercises/tests to aid in validating of command and control requirements and in the development of effective and efficient command and control support systems.

c. In conjunction with the Military Departments, provide for logistics and maintenance support of command and control support systems employed in exercises and military operations conducted within their Commands. This provision shall include employment of assigned personnel qualified to maintain, modify, and upgrade command and control systems to adapt to the specific operational needs of the Command, within established standards and specifications.

d. In conjunction with the Chairman, JCS, develop agreements with DCCSSA to delineate clearly the Command relationships with the DCCSSA field organizations to insure mutual responsiveness and coordination of effort.

8. Other Defense Agencies within their assigned areas of responsibilities shall:

a. Provide, within the limitation of available resources, full support and assistance to the Director, DCCSSA in accomplishing his mission.

b. Accept tasking from the Director, DCCSSA to conduct acquisition programs for command and control support systems with funds provided by DCCSSA.

G. AUTHORITY

The Director, DCCSSA, or his designee, is specifically delegated authority to:

1. Command the DCCSSA and its field organizations.

2. Establish DCCSSA headquarters and field organizations, and within overall authorized manpower, allocate military and civilian

spaces amoung such organizations in accordance with the policy of the Secretary of Defense.

3. Have free and unrestricted communications with all elements of DoD, as well as with other organizations having national command, control, and communications and intelligence responsibilities.

4. As system architect, engineer, and integrator, exercise technical control of subsystem/project management of the Military Departments, Unified and Specified Commands, other DoD Agencies, in those areas which support directly the development, acquisition, and evolution of interservice command and control support systems under his cognizance.

5. Prescribe technical specifications, interface standards and configuration procedures and monitor the installation status of new command and control support systems. In those cases where resource implications prevail, exercise of this technical systems authority could require agreement with the Military Department or Defense Agency concerned, and the Assistant Secretary of Defense to determine resource authority or availability.

6. Obtain, in coordination with the appropriate DoD components, such plans, reports, and information as are required to accomplish the DCCSSA mission.

H. ADMINISTRATION

1. The Director and Deputy Director, DCCSSA, shall be commissioned officers of suitable general or flag rank appointed by the Secretary of Defense from officers of the Armed Forces on active duty or qualified civilians of equivalent rank.

2. The appointment of other military personnel, and the selection of civilian personnel, for the DCCSSA will be subject to the approval of the Director, DCCSSA.

3. The DCCSSA will be authorized such personnel spaces, facilities, funds, and other administrative support as deemed necessary by the Secretary of Defense.

4. The Military Departments and other DoD components shall, within available resources, provide support as necessary to the DCCSSA.

5. Personnel, facilities, equipment, and other support required to maintain and operate specific elements of the DCCSSA shall be provided from resources available to DoD components as directed by the Office of the Secretary of Defense.

APPENDIX E

DoD Directive 5000.XX

ACQUISITION OF SUPPORT SYSTEMS FOR

COMMAND AND CONTROL

References: (a) Report of the Defense Science Board Task Force on Command and Control Systems Management

(b) DoD Directive 5000.1 "Major Systems Acquisition"

(c) DoD Directive 5000.2 "Major Systems Acquisition" Process"

(d) Charter for the Defense Command and Control Support Agency (DCCSSA)

A. PURPOSE

This Directive is based upon the following underlying principles.

1. The process designed for acquiring weapons systems is not completely applicable to command and control systems. ADP, communications, and intelligence systems which support command and control needs are by their nature highly interdependent. When aggregated into command and control systems they must evolve during their entire lifetime in order to be able to fulfill a wide variety of operational needs.

2. Development and continuing evolution of command and control systems requires the direct participation of the users (unified and specified command and subordinate operating units as appropriate). This participation is required from the original identification of the of the need, through system development, evaluation and deployment and finally, in the evolutionary growth and adaptation of the system in the field.

3. Effective command and control support systems in the field depends on the ability to adapt/modify a given system to meet the needs of various commanders in changing military situations which may be encountered in different theaters.

4. Interoperability of command and control systems at various command echelons is essential for effective command and control. Interoperability must be achieved and maintained while simultaneously providing the user with a capability for modifying and adapting a system to meet his particular needs.

B. APPLICABILITY AND SCOPE

1. The provisions of this Directive apply to the Office of the Secretary of Defense and the Organization of the Joint Chiefs of Staff and to the Military Departments and the Defense Agencies (hereinafter referred to as "DoD components"). As used herein the term "Services"

refers to the Army, the Navy, the Air Force, and the Marine Corps.

2. The provisions of the Directive apply to all command and control systems.

3. Command and control support systems which support all levels of command are included under this Directive.

4. References (b) and (c) are not applicable for command and control systems.

5. In the event of a conflict between this Directive and prior system acquisition Directives of OSD, the Services and DoD agencies, the provisions of this Directive shall apply.

C. DEFINITIONS

A definition of the terms used in this Directive is shown in Enclosure 2. (to be provided)

D. ACQUISITION GUIDANCE

1. Management of the acquisition of command and control systems will be in accordance with a Command and Control Systems Plan which incorporates the needs the various using commands and provides for the

evolution, material support and interoperability of the systems. Responsibility for the development and continuing evolution and maintenance of this plan is with the Defense Command and Control Systems Support Agency (DCCSSA) (see reference d) in corporation with the operational units, using commands, services and agencies.

2. Using commands and agencies are responsible for continuing analysis of mission areas to identify command and control support needs. Such analysis may employ the use of test beds where appropriate.

3. For DCCSSA managed programs the Services are responsible, as required, for providing facilities, technical and logistics support for the test bed and field operations described in paragraph D.

4. The acquisition of command and control systems under Command and Control Systems Plan shall normally be conducted in two phases.

a. Phase I, entitled "Design and Development" is initiated with the identification of a need by an appropriate using command or DoD component. The strucutre of Phase I will normally consist of three steps.

(1) Step 1 "Concept Formulation" consists of: (1) analysis of the identified operational needs and deficiencies of the existing capabilities in comparison to the Counter-Communications,

Command and Control projected threat, (2) an assessment of fiscal, timing, interoperability, standarization, etc., constraints, and (3) a program plan.

Laboratory test bed operations may be initiated during Step 1 if required to aid formulation of the initial concept. Step 1 shall result in a Command and Control Systems Needs Statement. The content of the Systems Needs Statement is shown in Enclosure 3 (to be provided).

(2) Step 2 "Test Bed Operations" is to refine the requirement, assess the technical approach and validate the concept. The using command or DoD component shall participate directly in this step. Maximum us shall be made of existing military and commercial hardware and software which is functionally acceptable to the using command or agency for subsequent Field Evaluation trails.

(3) Step 3 "Field Evaluation" transfers the system developed in Step 2 to the using command or DoD component for further evolution and evaluation in an operational environment. Evolution of the system shall be directed at tailoring the system to meet the identified need under the stresses of field operations when operated by personnel from the using command or DoD component.

Step 3 shall result in a detailed definition of the command and control system specification including operational software.

b. Phase II, entitled the "Implementation" phase is initiated by decision of the Secretary of Defense based on the results of Phase I. Phase II encompasses, to the extent required, modification of an existing systems, the full scale engineering development, production and deployment of the system for operational use. The structure of this may take one of four possible forms depending upon the availability of appropriate hardware and software at the Phase II initiation. The four possible forms are:

(1) Modification

It is to be anticipated that the needs for, and employment of, command and control systems will change in an evolutionary way over the lifetime of the systems. If the operational circumstances permit, changes will be made in the field by using personnel augmented as necessary by DCCSSA. Field changes should be made with due consideration of any possible impact on the interoperability with other systems and should be further evaluated for potential adverse impact on other command and control support systems as well as for possible wider application to other systems. DCCSSA will be responsible for overall interoperability standards.

(2) Deployment

The conditions are: sufficient hardware exists in either military or suitable commercial form and the software has been developed on this equipment during the design and development phase. The system may already be deployed in Phase I or all that remains to be done is to deploy the hardware to the using command or agency, supply replications of the software and conduct functional checkouts.

(3) Production and Deployment

The conditions are: suitable system hardware designs exist in either military or commercial form and the software has been developed during the design and development phase. Additional hardware must be produced to meet the anticipated operational usage.

(4) Engineering Development, Production, and Deployment

The conditions are: the design and development phase was conducted with modified or brassboard equipment (either military or commercial) which is not operationally suitable for the intended application. Thus full scale engineering development is required. This may also include revisions to the prototype software used in the design and development phase. In the event of a conflict or breach of cost

or performance thresholds reflected in the Command and Control Systems Plan the matter shall be referred to the Under Secretary of Defense for Research and Engineering (USDR&E) for resolution. The decision to employ either forms a,b,or c shall be made integral with the decision to enter Phase II. The decision to deploy the system for operational use rests with the using command or DoD component in consultation with the DCCSSA.

5. The foregoing methodology applies equally to those Command and Control Systems acquired by the Services for intra-service use.

APPENDIX B

THE UNDER SECRETARY OF DEFENSE

WASHINGTON, DC 20301-3010

RESEARCH AND
ENGINEERING

15 SEP 1986

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Defense Science Board Task Force on Command and Control Management

You are requested to form a Task Force to review progress made on selected aspects of the 1978 Defense Science Board Task Force on Command and Control Management. The review should focus, in particular, on those study recommendations addressing testing and exercises, the role of the Unified and Specified Commands, and C2 Research.

Your report should be available by April 1987. It is not anticipated that your inquiry will need to go into any "particular matters" within the meaning of Section 208 of Title 18, U.S. Code.

Mr. Donald C. Latham, ASD(C3I), and I will jointly sponsor this Task Force. Dr. Solomon J. Buchsbaum has agreed to serve as Chairman of this study, which will include members of the 1978 Task Force. Mr. Hallie B. Henry of the OASD(C3I) staff will serve as Executive Secretary. CDR Hugh N. McWilliams, USN, will be the DSB Secretariat representative.

Donald A. Hicks

APPENDIX C

DSB TASK FORCE ON COMMAND AND CONTROL SYSTEMS MANAGEMENT MEMBERS

DR. SOLOMON J. BUCHSBAUM
Executive Vice President
Customer Systems
AT&T Bell Laboratories

GENERAL RUSSELL E. DOUGHERTY (USAF, Ret.)
Consultant

DR. EUGENE G. FUBINI
E. G. Fubini Consultants, Ltd.

DR. ROBERT J. HERMANN
Vice President, Science and Technology
United Technologies Corporation

ADMIRAL ISAAC C. KIDD, JR. (USN, Ret.)
Consultant

DR. HAROLD W. LEWIS
University of California, Santa Barbara, CA

GENERAL E. C. MEYER (USA, Ret.)
Consultant

MR. CHARLES A. ZRAKET
President and Chief Executive Officer
The MITRE Corporation

COMMANDER HUGH N. McWILLIAMS, USN
Military Assistant to Defense Science Board

LIEUTENANT COMMANDER GEORGE A. MIKOLAI, USN
DSB Military Assistant

DR. HAL B. HENRY
Executive Secretary

APPENDIX D

	TIME	LOCATION	BRIEFERS/PARTICIPANTS
1.	3 Nov 86	THE PENTAGON Room 5C1040	Dr. Quinn, OSD Mr. Mabius, Information Systems Command, Ft Huachuca, AZ RADM Holland, Navy Staff Maj Gen Brandt, ESD, Hanscom AFB, MA Capt Howe, ESD Lt Gen McKnight, JCS Col Essig, JCS RADM Paulson, DCA Dr. Signori, DCA
2.	18 Dec 86	THE PENTAGON Room 5D1027	Lt Gen Rodgers, Army Staff Brig Gen Leffler, Army Staff Brig Gen Granrud, Army Staff Col Dacunto, Army Staff Col McKinney, Army Staff Lt Col(P) Grippe, Army Staff Lt Col Smith, Army Staff Lt Col Chamberlain, Army Staff Lt Col Cloore, Army Staff Maj(P) Tatum, Army Staff Mr. Weber, Army Staff Mr. Fairbanks, Army Staff RADM Holland, Navy Staff RADM Chesbrough, Navy Staff Brig Gen Ludwig, Air Staff Lt Gen McKnight, JCS Col Essig, JCS Lt Gen Powers, DCA RADM Paulson, DCA Maj Gen Lynn, CINCPAC Col Gaddis, EUCOM Col Martinson, EUCOM Maj Gen Cassity, NORAD/SPACE Lt Gen Lang, OSD Capt Sample, CINCLANT Mr. Buckles, CINCSAC Col Eastman, OSD Col McSweeney, OSD
3.	19 Jan 87	The Hayes Bldg.	Brig Gen Leffler, Army Staff

		The MITRE Corp. McLean, VA	Maj(P) Tatum, Army Staff RADM Holland, Navy Staff Brig Gen Brown, Air Staff Col Burke, Air Staff Mr. Lubarsky, OSD Col Eastman, OSD Lt Gen McKnight, JCS Col Essig, JCS Mr. Fallon, JCS Mr. O'Connor, NSA Dr. Perry, DARPA Dr. Waks, The MITRE Corp. Mr. O'Donohue, The BDM Corp. Mr. Kapas, Kapas Associates RADM Myers, Kapas Associates Brig Gen Kirby, AFCEA
4.	24 Feb 87	The Pentagon Room 5C1040	Mr. Latham, ASD(C^3I) Maj Gen Donahue, Army Staff Maj(P) Tatum, Army RADM Holland, Navy Staff Brig Gen Brown, Air Staff Col Burke, Air Staff Lt Gen McKnight, JCS Mr. Toma, JCS Col Essig, JCS Mr. Israel, DCA Lt Gen Lang, OSD Col McSweeney, OSD Capt Raebel, OSD Brig Gen Bombel, JTC3A Col Pons, JTC3A Lt Col Stewart, JTC3A
5.	16 Mar 87	The Pentagon Room 5D1039	Gen Herres, VCJCS Mr. Latham, ASD(C3I) Brig Gen Brown, Air Staff Col Burke, Air Staff Lt Gen Lang, OSD Col McSweeney, OSD Dr. Milburn, DSB Lt Gen McKnight, JCS Mr. Toma, JCS
6.	17 Mar 87	The Hayes Bldg. The MITRE Corp. McLean, VA	Executive Session
7.	21 Apr 87	The Hayes Bldg. The MITRE Corp. McLean, VA	Executive Session