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BY THE COMPTROLLER GENERAL

# Report To The Congress

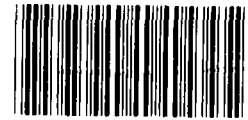
OF THE UNITED STATES

## The World Wide Military Command And Control Information System--Problems In Information Resource Management

GAO's evaluation of the World Wide Military Command and Control Information System modernization effort showed that continuing problems associated with providing automated support for command and control functions are not being properly addressed by DOD.

DOD's efforts are not yet completed; however, the methods employed and progress to date are unlikely to enable the replacement of the World Wide Military Command and Control Information System to meet its intended goals. Further, these efforts are proceeding far too slowly to be considered responsive to the need to improve current system performance. DOD anticipates 10 more years will be necessary to modernize the system.

GAO's evaluation of the modernization program shows that substantial changes are needed in the program's management structure before the system can be fully and effectively modified.



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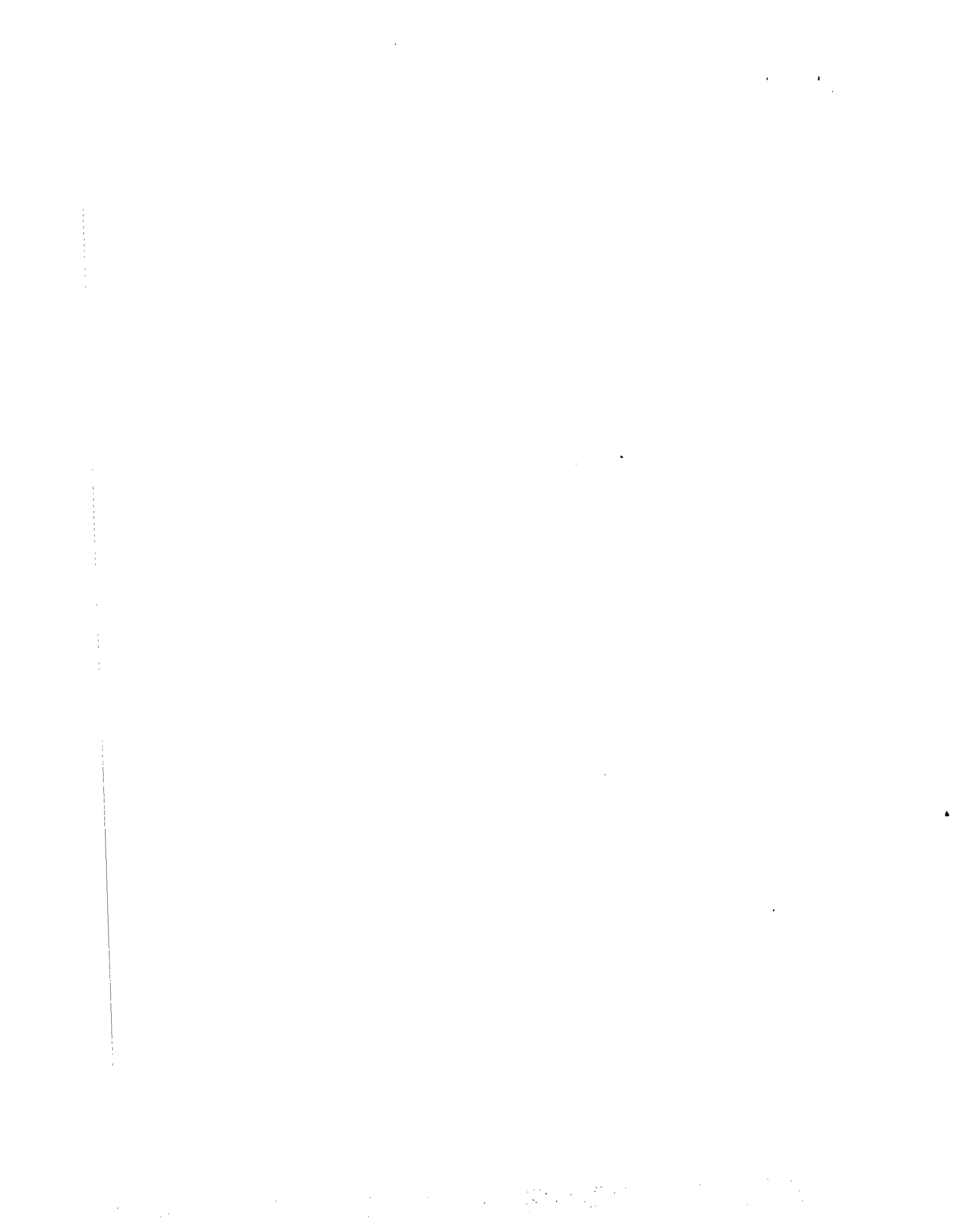
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To the President of the Senate and the  
Speaker of the House of Representatives

This report assesses the Department of Defense's efforts to modernize the computer support of military command and control functions. We made this review at the request of the chairman, Subcommittee on Defense, House Committee on Appropriations.

We are sending copies of this report to the Director, Office of Management and Budget, and to the Secretary of Defense.

  
Acting Comptroller General  
of the United States



D I G E S T

At the request of the chairman, Subcommittee on Defense, House Committee on Appropriations, GAO evaluated the Department of Defense's (DOD's) efforts to modernize the World Wide Military Command and Control Information System (WIS), as the World Wide Military Command and Control System (WWMCCS) automatic data processing (ADP) program is currently termed. GAO evaluated DOD's plan to modernize WIS to determine whether it provided a reasonable and systematic approach to address and resolve known problems associated with WIS. Also, GAO evaluated subsequent modernization efforts, including an analysis of the feasibility of allowing each command the option of developing its own computer configuration for WIS.

WIS is an arrangement of personnel, equipment (including ADP equipment and software), communications, facilities, and procedures employed in planning, directing, coordinating, and controlling the operational activities of U.S. military forces. WIS and its priority component, the National Military Command System, are essential elements of U.S. national security. WIS is intended to provide the President and the Secretary of Defense a means to

- receive early warning and intelligence information,
- apply the resources of the military departments,
- assign military missions, and
- give direction to the Unified and Specified Commands while supporting the Joint Chiefs of Staff in carrying out their responsibilities.

WIS consists of data communications lines, an intercomputer network, computers, and software, and is an essential resource in providing command and control for U.S. military forces. To properly support the President, the Secretary of Defense, and the Joint Chiefs of Staff, the equipment must provide a direct connection (or real-time relay)

whenever necessary, computerized data formats must be common, and all components of the system configuration and operation must be as efficient as possible.

Beginning in 1970, GAO and various DOD study groups began reporting to the Congress and DOD that the present-day WIS was not accomplishing its intended goals. DOD has not fully implemented the recommendations in those reports. As a result, DOD has experienced serious degradation in its command and control capabilities during the past 11 years. DOD's inability or unwillingness to resolve problems involved with information resource management in a command and control environment are the real issues degrading WIS performance.

On April 23, 1979, GAO testified before the Subcommittee on Research and Development, House Committee on Armed Services, on WIS problems. On the basis of this testimony and findings of previous investigations, the committee (1) concluded that DOD urgently needed to modernize WIS and (2) directed DOD to submit an acceptable integrated modernization plan with the fiscal year 1981 budget request.

GAO's evaluation of the plan showed that:

- The present day WIS has a very limited capability to provide timely, accurate, and complete information to commanders, particularly during times of crisis. (See p. 7.)
- Current conditions dictate a need to accelerate the modernization schedule. It is undesirable to wait another 10 years before the system is modernized. (See p. 8.)
- Operational concepts for WIS have been inadequately developed and are so broad, general in nature, and self-evident that they make little or no contribution toward providing a foundation for resolving known problems. (See p. 11.)
- Too much emphasis is being placed on the selection of a system architecture before defining information requirements. (See p. 13.)
- Centralized management of the current WIS is necessary but unattainable. (See p. 15.)
- The existing state of the art in computer technology makes it entirely feasible for each

command to develop its own computer configuration to support its assigned missions, the President, and the Secretary of Defense. (See p. 17.)

GAO's evaluation of DOD's subsequent WIS modernization efforts shows that these efforts are slow, do not address the fundamental issues, and will not lead to a timely responsive solution to known WIS problems.

DOD, despite dozens of large-scale studies, has failed to make meaningful progress toward implementing a responsive, reliable, and survivable WIS. The performance of the current WIS suggests that rapid improvements are necessary to minimize shortfalls in capability, particularly during times of crisis. However, WIS modernization planning is proceeding far too slowly to be responsive to these deficiencies. Although an unnecessarily long acquisition process is not scheduled for completion until 1989, it may slip repeatedly because DOD's efforts are inadequate to achieve the desired results. Specifically, after more than 2 years since the start of the WIS modernization effort, DOD

- has only recently approved a concept of operations for WIS on which detailed information requirements must be based (see p. 23),
- does not plan to properly define the detailed information requirements necessary as a cornerstone for successful system acquisition (see p. 25),
- has prematurely selected a computer architecture before defining requirements which relies on advances in computer technology beyond the existing state of the art (see p. 29), and
- has neither established an effective central manager for WIS nor recognized its inability to do so and establish an effective alternative.

#### RECOMMENDATIONS

DOD must recognize the magnitude of the problems in WIS due to shortfalls in capability and resolve to deal with them properly. All efforts must be directed toward realizing systemwide objectives in the shortest possible time frame to minimize the potential for serious operational problems, particularly during times of crisis.

Because DOD's plan to modernize WIS has a fragile foundation and does not provide a timely solution to current WIS problems, substantial changes are required to WIS modernization efforts.

We recommend that the Secretary of Defense redirect the modernization of WIS in the following manner:

- Replace those computer systems having immediate shortfalls with modern upward compatible computers where a comparative cost analysis justifies such action.
- Complete the detailed information requirements to support command and control decisionmaking.
- Develop an architecture and computer system design that can satisfy detailed information requirements specifically incorporating the following actions:
  - Employ life-cycle management practices, including life-cycle costing, as presented in DOD Directive 7920.1 Life Cycle Management of Automated Information Systems (Oct. 17, 1978).
  - Follow other sound management practices such as establishing measurable system performance and effectiveness goals and objectives, including periodic evaluation, providing cost-effective growth potential, and clearly delineating responsibilities and coupling them with needed authority and control of resources.
  - Employ proven state-of-the-art computer technology in the WIS design to ensure the development of reliable systems.
  - Specify standard network protocols, terminology, data elements, data formats, and data retrieval techniques for horizontal (between commands) and vertical (command to national military command centers) communications.
  - Decentralize decisionmaking to allow individual WWMCCS sites to develop their own computer systems to meet command needs in compliance with the above standards.
  - Centralize management and control of resources for the intercomputer network to ensure that



local command needs do not preempt network operations.

AGENCY COMMENTS

DOD's written comments with GAO's detailed evaluation are presented in appendix IV. DOD generally disagreed with GAO's conclusions and recommendations but did not provide any new or convincing evidence to support its objections. DOD believes its approach to modernizing WIS is a systematic, planned, and incremental effort to develop a responsive and reliable system. GAO believes DOD's WIS modernization effort cannot lead to a timely, efficient, and effective solution to known WIS problems.

MATTERS FOR CONSIDERATION  
BY THE CONGRESS

We recommend that the Congress consider requiring DOD to submit a plan for carrying out GAO's recommendations with the fiscal year 1983 budget. The Congress may wish to defer selected items in the fiscal year 1982 budget until the revised plan is accepted. (See p. 36.)



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ABBREVIATIONS

ADP	automatic data processing
DOD	Department of Defense
GAO	General Accounting Office
JCS	Joint Chiefs of Staff
NCA	National Command Authorities
OJCS	Organization of the Joint Chiefs of Staff
WIN	WWMCCS Intercomputer Network
WINA	WWMCCS Information Needs Analysis
WIS	WWMCCS Information System
WSE	WWMCCS System Engineer
WSEO	WWMCCS System Engineering Organization
WWMCCS	World Wide Military Command and Control System

## CHAPTER 1

### WHAT IS THE WORLD WIDE MILITARY

#### COMMAND AND CONTROL INFORMATION SYSTEM?

The World Wide Military Command and Control Information System (WIS) is an arrangement of personnel, equipment (including automatic data processing (ADP) equipment and software), communications, facilities, and procedures employed in planning, directing, coordinating, and controlling the operational activities of U.S. military forces. WIS is the current term for the World Wide Military Command and Control System (WWMCCS) ADP program.

WIS includes the existing command and control systems of the Unified and Specified Commands, the command and control and related management information systems used by the headquarters of the military departments, the command and control systems of the headquarters of the service component commands, and the command and control support systems of Department of Defense (DOD) agencies.

WIS is intended to provide the National Command Authorities (NCA) (the President and the Secretary of Defense) a capability to

- receive early warning and intelligence information,
- apply the resources of the military departments,
- assign military missions, and
- provide direction to the Unified and Specified Commands while supporting the Joint Chiefs of Staff (JCS) in carrying out their responsibilities.

WIS' success requires that effective coordination and liaison also be maintained with activities outside DOD. Some of these activities include the White House Situation Room, the State Department Operations Center, the Central Intelligence Agency Indications Office, the U.S. Intelligence Board National Indications Center, the U.N. Military Mission, the Office of Emergency Preparedness National Warning Center, the U.S. Coast Guard Operations Center, the Federal Aviation Administration Executive Communications Control Center, and the North Atlantic Treaty Organization.

The National Military Command System, the priority component of WIS, must be capable of exchanging information either directly or indirectly between or among these differing activities. The quick and efficient exchange of information is essential if the NCA is to make appropriate and timely responses to potential or real threats to our national security. Both the communication of warning and intelligence information from all sources and the communication of decisions and commands to our military forces

require that the National Military Command System be the most responsive, reliable, and survivable system that can be provided. To meet such requirements, equipment must operate compatibly, communication links must provide a direct connection (or real-time relay) whenever necessary, computerized data formats must be common, and all details of system configuration and operation must be as efficient as possible.

The NCA's ability to make appropriate and timely responses to potential or real threats also requires that all command and control systems within DOD be configured and operated for the effective support of the National Military Command System as well as their specifically assigned missions. For these reasons, the National Military Command System is an essential element of our national security.

An ADP program capable of fulfilling NCA's requirements is integral to the National Military Command System's ability to be responsive.

#### PROBLEMS WITH WIS

In the early 1960s, WIS capabilities consisted of a loosely knit federation of approximately 158 different computer systems, using 30 different general purpose software systems at 81 separate locations. These systems

- were not responsive to national level requirements;
- were not true systems because they were developed separately without fully considering the information requirements of other commands with which they had to exchange information;
- lacked growth potential;
- used incompatible hardware, software, and data base structures;
- could not transfer data and information efficiently;
- made it extremely difficult to exploit ADP technology because of the vast differences in equipment and software systems;
- involved very costly independent or decentralized system development efforts;
- resulted from multiple equipment procurements made at single unit prices, usually at General Services Administration contract prices, instead of consolidating procurements to obtain discount prices;

- forced commands to make an excessive number of sole-source procurements to try to keep software conversion costs down; and
- caused commands to experience multiple (similar) software development costs, maintenance costs, and logistical support costs because equipment and software had not been standardized.

The present-day WIS, established in 1966, was intended to resolve these problems.

Beginning in 1970, we and various DOD study groups began reporting to the Congress and DOD that the present-day WIS was not accomplishing its intended goals. DOD has not fully carried out the recommendations in those reports. During the past 11 years, DOD has experienced shortfalls in its command and control capabilities. Many DOD officials believe that shortfalls in WIS support capabilities contribute to decreased military readiness. Recent false nuclear alerts at the North American Air Defense Command Headquarters and the ADP support provided during recent crisis situations highlight these weaknesses.

The inability or unwillingness of DOD to resolve problems involved with information resource management in a command and control environment are the real issues degrading WIS performance. Due to the current status of the program and its importance to the Nation's security, it is imperative the system be modernized as quickly as possible.

THE CONGRESS DIRECTS THAT  
WIS BE MODERNIZED

The Congress has repeatedly expressed concern with the shortcomings in WIS. Several committees have focused on the deficiencies of the present operational system, the inevitability of the need for new hardware, and the wastefulness of adding additional hardware to the present operational system.

On April 23, 1979, we testified before the Subcommittee on Research and Development, House Committee on Armed Services, on WIS problems. On the basis of this testimony and findings of previous investigations, the committee concluded that DOD urgently needed to modernize WIS. The committee agreed with our recommendation that further funding for WIS improvements be restricted until DOD presents an acceptable integrated modernization plan. This plan was to clearly indicate the type of ADP capability required by the various commands in support of their command and control functions and how DOD planned to modernize both computer hardware and software elements of WIS in response to those requirements. The committee requested this plan be submitted with the fiscal year 1981 budget request.

On February 7, 1980, DOD responded to congressional direction and submitted a document titled "Planning for the Modernization

of the WWMCCS Information System (WIS)." However, according to the House Committee on Armed Services, the plan did not comply with congressional intent. Specifically, the plan was vague and failed to address measures DOD would take to correct current deficiencies in WIS. Milestones and funding requirements were not established. The WWMCCS System Engineer (WSE) said that DOD was unable to present a firm and detailed plan at that time, and given the scope of the WIS problem, could not produce one until July 1982. Thus, the Congress will not have an opportunity to formally comment and act on the plan until the fiscal year 1984 budget is submitted.

Therefore, the House Committee on Armed Services requested that DOD submit a detailed WIS modernization plan with the fiscal year 1982 budget request. This January 1981 report provided a more detailed assessment of the problems with the current WIS, a statement of the general requirements for a new WIS system, and DOD's preferred approach to modernization. Cost and schedule estimates were also included.

Considering the importance and cost of the WWMCCS ADP program, on September 3, 1980, the chairman, Subcommittee on Defense, House Committee on Appropriations, requested us to evaluate the modernization plan and report the results of our evaluation to the committee.

#### OBJECTIVES, SCOPE, AND METHODOLOGY

Based on the request from the chairman, Subcommittee on Defense, House Committee on Appropriations, we evaluated DOD's WIS modernization effort. (See app. II for a copy of the request.) The chairman requested that we evaluate the plan submitted to the Congress in February 1980 to determine whether it provided a reasonable and systematic approach to address and resolve known problems with WIS. The chairman also requested that we monitor the development of the modernization program and include in our evaluation an analysis of the feasibility of allowing each command the option of developing its own computer configuration for WIS.

To accomplish our objectives, we (1) examined the modernization plan including the January 1981 version and evaluated its contents, including the underlying assumptions and supportive studies, (2) examined numerous studies and held discussions with DOD officials to determine whether modernization efforts were adequately responsive to the plan and presented a realistic approach to solving known WIS deficiencies, and (3) evaluated the advantages and disadvantages of various alternative approaches to solving known WIS problems. We relied heavily on our prior reviews of WIS and other DOD computer system development programs when evaluating the modernization plan and when developing our conclusions and recommendations.

We analyzed documents, contracts, records, reports, and related information. Also, we interviewed DOD officials (1) in the WWMCCS System Engineering Organization (WSEO) part of the Defense



Communications Agency which has responsibility for collecting requirements and designing the future WIS to meet these requirements, (2) in the Organization of the Joint Chiefs of Staff (OJCS) who must define the concept of operations for WIS and validate the requirements gathered by WSEO, and (3) in the Command and Control Technical Center, also part of the Defense Communications Agency. The center's WWMCCS ADP Technical Support Directorate is responsible for monitoring changes to the current computer configurations and the development and changes to the WWMCCS Intercomputer Network (WIN).

Discussions were also held with officials and other responsible personnel of the Office of the Secretary of Defense and the National Bureau of Standards. We also talked with contractor personnel responsible for maintaining the current systems and those assisting in the development of the modernization program, as appropriate.

## CHAPTER 2

### EVALUATION OF THE WIS MODERNIZATION PLAN

On February 7, 1980, DOD responded to congressional direction and submitted a plan for modernizing WIS. The WIS modernization plan was evaluated to determine whether it provided a reasonable and systematic approach to solve known problems and assessed the feasibility of allowing each command the option of developing its own computer configuration for WIS. On January 19, 1981, DOD submitted a more detailed version of this plan which we considered in our evaluation.

Our evaluation showed that:

- The present-day WIS has a very limited capability to provide timely, accurate, and complete information to commanders, particularly during times of crisis.
- Current conditions dictate a need to accelerate the modernization schedule. It is undesirable to wait another 10 years before the system is modernized.
- Operational concepts for WIS have been inadequately developed and are so broad, general in nature, and self-evident that they make little or no contribution toward providing a foundation for resolving known problems.
- Too much emphasis is being placed on the selection of a system architecture before defining information requirements.
- Centralized management of WIS is necessary but unattainable.
- The existing state of the art in computer technology makes it entirely feasible for each command to develop its own computer configuration to support its assigned missions and NCA.

The problems with current WIS performance and efforts to modernize WIS are the result of DOD's failure to properly apply existing information resource management procedures and techniques. Information resource management takes the complex, seemingly overwhelming problems of massive system development programs and breaks them down into manageable components to be accomplished incrementally.

The information life cycle is composed of three phases-- initiation, development, and operations. Each phase contains a number of steps to be accomplished in succession. For example, during the development phase information requirements must be first identified and then placed in order of priority, after which short- and long-range plans to meet these requirements

can be developed. The system analysis and design stage can be entered after which programming, component testing, and system testing can be accomplished in succession. The information requirements serve as a guide in system analysis, design, and programming stages, and can be used as benchmarks in the testing stages.

Skipping any of these steps substantially increases the risk of failure. This risk increases with the complexity of the system being developed. With massive, complex systems such as WIS, it is imperative to properly apply information resource management throughout the entire information life cycle. DOD's failure to apply proper information resource management procedures and techniques is the underlying cause of current WIS problems and the basis of our criticisms of the modernization plan and subsequent DOD efforts.

The results of our evaluation are explained in more detail in the following sections.

#### WIS HAS A LIMITED CAPABILITY TO PROVIDE NEEDED INFORMATION

During the summer and early fall of 1979, WSE conducted a survey of users to obtain their views on the operational performance of WIS. The survey information was gathered through interviews with 272 WIS users. Four levels of users were interviewed--commanders in chief; functional area deputies, such as intelligence and operations; functional area staff officers and noncommissioned officers; and the ADP managers at 27 WIS sites.

The survey showed that despite its imperfections, users perceive WIS as providing useful support for day-to-day operations, particularly for long-term advanced planning for joint military operations. However, for time-constrained crisis or conflict, they did not view WIS support as adequate or responsive to their needs. Users gave the following reasons for the system's limited ability to provide responsive support during time-constrained situations.

- The system lacks a state-of-the-art online query/response information retrieval capability. With a more modern capability, information can be retrieved more rapidly.
- The circuitry of the main computer is not designed to function in an online, highly interactive mode such as command and control. Therefore, the system requires modernization or replacement.
- Source information is not timely, accurate, or complete enough for managing time-constrained situations. This condition is partially attributable to the cumbersome procedures used to collect, process, and transmit the information.

--Experienced and well-trained personnel are not always available at several WIS sites. This condition impairs the ability to provide timely, accurate, and responsive information, particularly during times of crisis.

--Command facilities and supporting information systems, including WIS, are not considered to be survivable against acts of civil strife, sabotage, or war. Thus, users do not believe WIS will always be available when needed.

One concern of ours is the characterization in the modernization plan that WIS support is adequate for day-to-day situations. The plan stated that more than 80 percent of the users rated WIS support as moderately effective or better. However, because the user study supporting this claim classified responses only as "very effective," "moderately effective," or "ineffective," it only showed that more than 80 percent of the users felt WIS support deserved a better rating than ineffective; not that it is adequate for day-to-day situations. Less than half of those surveyed gave WIS support a rating of very effective. The point is that even in day-to-day situations, WIS needs to be made more effective and comprehensive in its ability to provide needed ADP support. Users were concerned about inadequate response time and other deficiencies in the timeliness and accuracy of data which could be improved through better hardware and more flexible and responsive software.

#### WIS MODERNIZATION SCHEDULE NEEDS TO BE ACCELERATED

The basic objective of the WIS modernization effort is to provide a truly integrated, reliable, and responsive system to support the NCA and military commanders and their staffs throughout all levels of conflict.

The modernization effort is presently planned to be accomplished in three phases over a 12-year period. The system concepts and alternatives are to be defined during the period 1978-81. Equipment will be acquired from 1982 to 1989, and the system is not expected to be placed into operation and continue to evolve until 1990.

According to the modernization plan, significant modernization or replacement of the current computers will be required over the next decade to ensure an adequate supply of spare parts and to avoid further technical obsolescence, both of which constrain operational performance. Hardware modernization/replacement must be accomplished incrementally and in a way which maintains critical operational support. WSE is concerned that any abrupt replacement of the current hardware would cause an unacceptable level of disruption.

WSE's concern can be eliminated by taking advantage of the existing state of the art in computer technology. Computers

designed to operate in an online interactive environment are available which can process the current WIS application software with virtually no changes or redesign necessary. The use of these upward compatible computers would solve many of the problems due to the batch processing orientation of the circuitry of the current WIS computers, a major factor in WIS' limited ability to provide ADP support to military commanders in time-constrained situations. The abrupt replacement of the current computers is a necessity.

Properly planned, the replacement of the current computers could be accomplished in a few days or over a weekend at a site. For example, the Tennessee Valley Authority recently upgraded two large-scale processors with compatible equipment on two successive weekends. Only one processor could be installed on each weekend because the only access to the computer room was through a second story window. The new machines were available for normal processing the Monday morning after installation. In Washington, D.C., a commercial time-sharing service installed two upward compatible processors to replace two aging systems over a weekend with only 72 hours advanced site preparation. The systems were fully operational and serving customers on Monday.

Unsupported assumptions about conversion difficulties are delaying WIS modernization

According to the modernization plan, replacement of the existing hardware will not begin until 1984 and is not scheduled to be completed until 1989. The long-term retention of existing hardware is justified on the basis that software conversion/redesign will dominate costs. Federal regulations (46 FR 1218, Jan. 5, 1981) require a comparative cost analysis of alternatives be performed and the least costly alternative over the system life cycle be selected. However, as noted in the plan, a firm estimate of software conversion/redesign costs has not been made because DOD has not made a detailed examination of each software application. Thus, DOD is uncertain of the magnitude of the problem or the costs involved in converting/redesigning existing WIS software or the availability of less costly alternatives.

Generally, software costs represent 80 percent or more of total costs over the system life cycle. The modernization plan anticipates that software conversion/redesign efforts will be the dominant modernization cost and will significantly influence the time required to provide a satisfactory operational capability with any new system.

Presently, about 460 to 490 WIS software applications exist, including locally developed applications, that could be considered as candidates for conversion or redesign. According to the modernization plan, the magnitude of the conversion and redesign effort depends on the size, condition, projected long-term utility, and degree of hardware dependence of these applications. However,

these factors have not been assessed; and consequently, no useful estimate of conversion/redesign costs has been made.

Commercially available data base management systems can reduce the time necessary for programming nonroutine requests for information. Data base management systems are well suited to the applications used in WIS, which are predominately data storage, updates, and retrievals. Improvements in computer hardware, especially reduced cost, make possible the extensive use of data base management systems which use more machine resources for a given result than high level languages such as COBOL. <sup>1/</sup> Also, the query language capabilities of some data base management systems enable the users to do some of their own programming. Thus, proper employment of data base management systems can reduce the time required to redesign software applications.

The assumption that conversion/redesign efforts will dominate costs may be unnecessarily slowing the pace of the modernization program which is not scheduled to be completed until 1989. Therefore, a detailed examination of the current application software, including an assessment of the full potential of data base management systems, should be made to derive a realistic estimate of software conversion/redesign requirements and costs.

Also, some of the "assumptions" used in the modernization plan to justify an overly elongated schedule are inaccurate. For example, the modernization plan states that operator and programmer retraining can be met for a new system only over a period of several years (and at considerable cost). Our examination of nine Federal computer centers which recently acquired new systems showed that operators do not need extensive training to switch to a new vendor's equipment or to more modern equipment. Application software programmers familiar with high level languages, such as COBOL, can be effective on new systems within several months, not years. We recognize that it may take programmers as long as a year to become equally proficient on new equipment. Since about 70 percent of the WIS application software is written in COBOL, the existing WIS programming support could be effective on a new system in substantially less time than indicated in the plan.

We recently examined conversion costs at eight Federal centers which purchased noncompatible, medium to large replacement computer systems. The results of our examination are described in detail in our report entitled "Conversion: A Costly, Disruptive Process That Must Be Considered When Buying Computers" (FGMSD-80-35, June 3, 1980). The cost of training operators, programmers, and users, including personnel costs, averaged less than 10 percent of all conversion costs (\$5.4 million) and ranged from about \$150,000 to \$1.8 million. The high figure was for a

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<sup>1/</sup>COBOL: Common Business Oriented Language, a standardized business language for programming a computer.

large-scale computer system serving four different administrations within a department and replacing eight separate computers, including five different models from two manufacturers. For comparison, we examined a ninth large-scale computer procurement using compatible equipment from the same manufacturer and found that training costs were only \$9,230. The transition to the new system was so smooth that although the old computer was kept for 6 weeks as a backup, it was not used. As we noted in our report, the use of standard high-level programming languages with judicious use of vendor-unique extensions, coupled with sound programming and documentation practices, can minimize conversion costs and problems.

Until the conversion/redesign effort is completed, DOD plans to retain the existing WIS hardware. However, as noted on page 8, upward compatible hardware can be purchased which will run the current software applications, provide badly needed online capabilities, and can support the extensive use of data base management systems. Then, application programs could be redesigned using comprehensive information requirements according to priority as personnel and funding are available.

While the modernization plan recognizes critical deficiencies in the hardware and system software base, it is not scheduled for completion until 1990. The most critical issue, replacement of the computers, is not scheduled to be completed until 1989. This is a 12-year acquisition cycle for a clearly deficient system. A much shorter replacement cycle is needed to minimize the potential for operating problems, particularly during times of crisis.

The modernization plan continues the DOD tradition of program evolution for WIS without first defining information requirements and then designing expandable systems to meet those needs. The current system is an example of the results of using this evolutionary approach. The modernization plan calls the current system "clearly not up to the state of the art" and recognizes critically needed near-term upgrades "to avoid further technical obsolescence." Continued implementation of the current evolutionary approach will keep WIS far behind the existing state of the art in computer technology. As a result, DOD can expect to experience continuing shortfalls in capability particularly during crises and higher levels of conflict through the 1980s and possibly through the 1990s.

#### OPERATIONAL CONCEPTS ARE STATED TOO ABSTRACTLY

The modernization plan identifies four broad operational concepts and associated considerations and issues driving the modernization process. These concepts involve user support, system attributes, information handling capabilities, and reporting structures and procedures. We found the issues underlying these concepts to be so broad, general in nature, and self-evident that

they are of little or no practical value and make no progress toward providing a foundation for resolving known WIS problems.

The following examples demonstrate the superficial treatment of "important" operational considerations:

- "The WIS must support operational tasks which are (1) WWMCCS-wide (e.g., reporting of force status), (2) common and/or shared among the members of functionally defined and interdependent subcommunities (e.g., deployment planning), and (3) unique to individual WWMCCS commands (e.g., MAC [Military Airlift Command] scheduling of airlift assets)." (User support.) This statement is too broad to constitute progress in resolving the problem of duplicative application software development by WWMCCS sites. Listings of operational tasks that are common, shared, and unique would be the first step toward minimizing costly duplicative application software. This was a major problem the current WIS was intended to resolve.
  
- "Improved responsiveness to remote as well as local information queries/exchanges is a prerequisite to effective support of interactions among WWMCCS sites." (System attributes.) This statement is self-evident because the remote queries/exchanges are the interactions between WIS sites. A statement of the means by which improved interactions will be achieved is needed. For example, items such as the needed data transfer capabilities of the intercomputer network, the size and processing requirements for the main computers, and the extent to which standard data base structures and elements must be used are needed before responsiveness can be improved.
  
- "Assured availability (of the system) and accessibility (of the information) are critical to the individual user." (System attributes.) There is no question availability and accessibility of the system is critical to the user, but how these requirements are to be met is not described in the plan.
  
- "All command elements require a minimum complement of basic storage, retrieval, and display capabilities; these must be designed for ease of use by decisionmakers and their staffs." (Information handling capabilities.) This statement shows that all sites need ADP capability. However, a clear definition of requirements and associated functional capabilities is needed to provide a flexible ADP system that is responsive to a broad range of operational tasks. These requirements must be specified before equipment and software is acquired to meet them.
  
- "Survivability/sustainability is the key WWMCCS attribute at the higher levels of conflict [conventional and nuclear war and post-nuclear attack]." (System attributes.) No



progress toward improving survivability/sustainability is shown such as listing potential methods to improve survivability.

--"Improved information timeliness, accuracy, and completeness have been identified as a prerequisite to substantially improved WWMCCS ADP support." (Reporting structures and procedures.) Our prior report detailed widespread and chronic deficiencies in the timeliness, accuracy, and completeness of data in the software package, Unit Status and Identity Report System (formerly called FORSTAT). During our evaluation we found that these conditions still exist. Real progress toward resolving this problem is not identified or described in the plan. For example, identifying all data elements and the timeliness and accuracy requirements for them would be a major step toward resolving this problem. As a minimum, the identification of a methodology to define comprehensive information requirements should have been described in the plan.

#### PLAN PREMATURELY FOCUSES ON SYSTEM ARCHITECTURE

The modernization plan describes two WIS architectural alternatives. In the first, WIS is viewed as a combination of similar or standard configurations at each site interconnected by a communications network. The second alternative involves the use of individual computer configurations at each site also interconnected by a communications network. The term architecture is used in this report to include the computer configurations at each site and the communications network between sites.

The first alternative is essentially the same as that used in the existing WIS configuration. Such an architecture could have many advantages because standard equipment, standard software, and standard data base management techniques and procedures could be used. Thus, operators and programmers could be reassigned between sites with little or no training required before they became effective.

The second alternative would provide greater flexibility to the individual commander by allowing him to tailor his ADP support to his own needs while also providing needed support to other users, including upper level commands, JCS, and NCA.

For either alternative to be effective and efficient, standard data elements must be identified and agreed on by users. Also, information processing and transfer rates must also be identified to determine the appropriate size and capacity of the computer configurations that must process it and the communications network over which it must be transferred. Yet, after more than 30 years of effort, commanders still cannot agree on these

essential items for providing ADP support in the command and control environment.

Other advantages could accrue if the information processing and transfer rates were identified. For example, one or more sites could serve as a backup to any other site. Computer configurations and network capabilities could be acquired to handle not only the workload at a single WIS site, but also provide a capability to process the workload from another site. Such a backup capability is essential to maintain continuity of operational support, particularly when the existing WIS sites are not considered to be survivable.

The modernization plan recognizes that each WIS site will continue to require ADP support to accomplish its own missions and to satisfy its responsibilities as part of the overall WIS command structure. Consequently, individual site configurations must be

- tailored to the needs of local commands,
- responsive to higher echelon reporting requirements and data interactions with other WIS sites, and
- compatible with related improvement programs.

The modernization plan also recognizes the need to be able to exchange information with the tactical levels, other military networks, and systems operated by our military allies. According to the plan, the way this need will be met is an unresolved issue. An ability to effectively exchange information with the tactical levels, other military networks, and the systems of our allies can only be accomplished by identifying the information required to be transmitted to these other systems from each site and configuring the computer equipment and related communications network to support these requirements. These detailed information requirements are yet to be identified and agreed on by DOD, JCS, and/or U.S. commanders.

We are concerned about the modernization plan's emphasis on easy initial transition and continuing evolution. Given the potential for local internetting, the implication is that the current computer systems will be retained for a long period. Although WSE recognizes the inherent deficiencies of this hardware, the extra costs for maintenance and ineffectiveness due to severely limited online capabilities represent only a fraction of the negative effects of such action. The remaining effect will be the continued retention of inefficient application software--software that is inefficient because it was designed and programmed to exploit a hardware/system software base that was not designed to function in a highly interactive mode, such as the command and control environment, and will not provide significantly better performance on any modern hardware/system software base.

We are also concerned about the architectural approach sketchily outlined in the modernization plan. The architecture has been predetermined through the selection of automatic digital network (Autodin) II as the communications subnet. This occurred before several important issues were fully addressed. For example:

- What data bases will be located where?
- What kinds of data exchanges among the various WWMCCS sites will be requested?
- What would be the effect of consolidating computer support capabilities on a regional or functional basis?
- What access controls will be required?

These are basic questions in the modernization of any system but are not answered or addressed in the plan. In essence, the communications network architecture has been decided on before determining network requirements. Where an architecture is chosen without regard to requirements, the usual result is an ineffective and/or inefficient system. A responsive communications network architecture must be based on comprehensive information requirements including the volume, frequency, accuracy, and timeliness of data that must be transmitted between sites. This task remains undone while WSE continues to study the problem.

CENTRALIZED PROGRAM MANAGEMENT OF THE  
CURRENT WIS IS NECESSARY BUT UNATTAINABLE

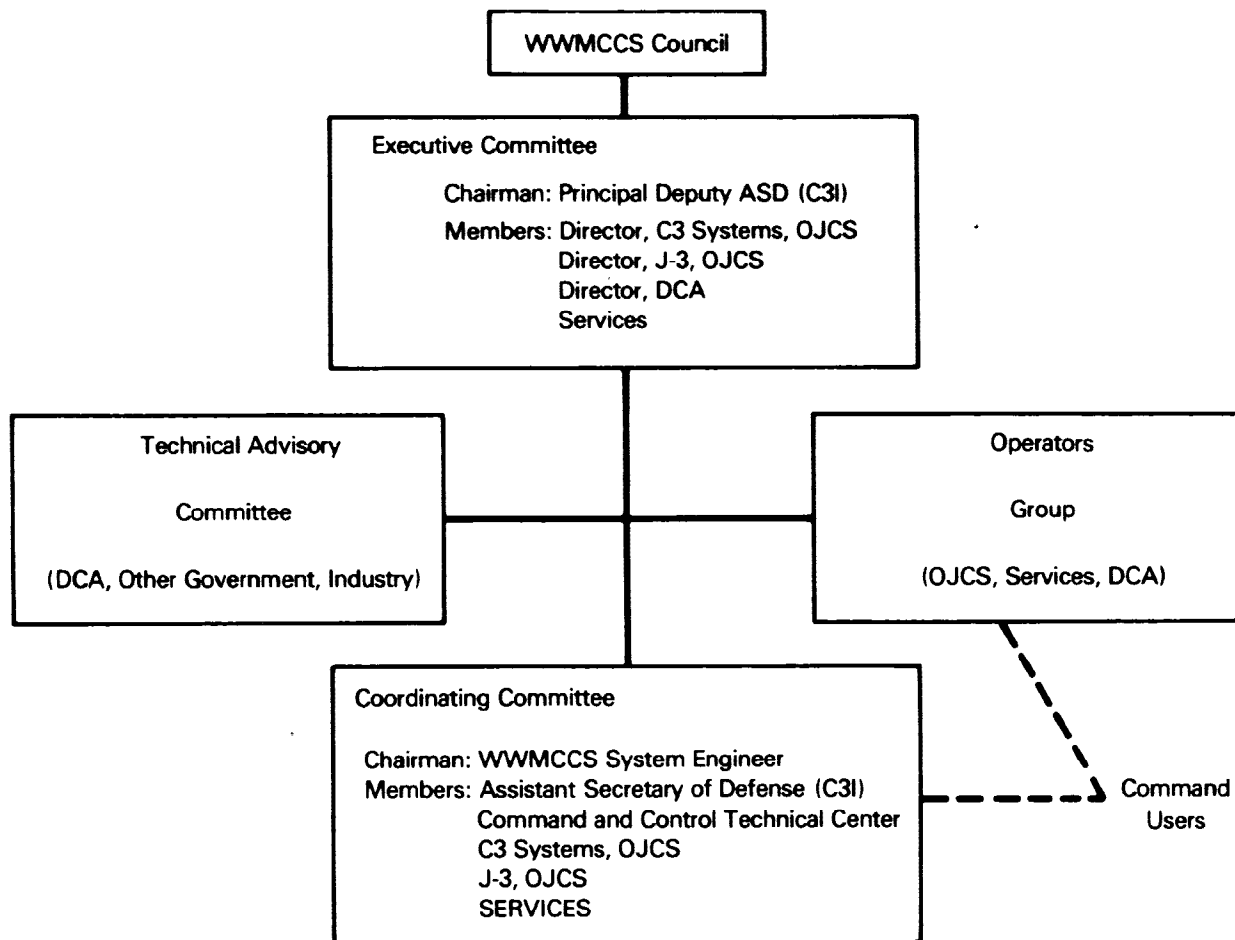
The modernization plan proposes creating a WIS Acquisition Management Office to handle acquisition activities and to provide strong centralized management for WIS. Even along with other recent changes, we believe these actions will not achieve effective centralized management for WIS because the control of resources will not be coupled with the management responsibility.

Recent changes intended to improve the existing institutional arrangements include

- establishing a WWMCCS ADP Coordinating Office to oversee the modernization process within the Office of the Assistant Secretary of Defense and
- establishing a WWMCCS ADP Technical Support Manager to provide a focal point for technical coordination of upgrades to the current systems and a centralized "clearinghouse" of information and knowledge concerning these systems (including fiscal data).

An organization chart illustrating the current management structure is shown in figure 1 on page 16.

**Figure 1**  
**WWMCCS ADP: Committee Structure**



- Current System Upgrading
- WIS Modernization Planning
- WIS Management Planning

The ADP committee structure shown, established earlier to assist WIS modernization planning, has now been formalized. Its objectives are to ensure a strong DOD-wide management focus on the modernization program and current system upgrades.

The modernization plan proposed a WIS Acquisition Management Office be established in July 1981 (as of July 1981, the Secretary of Defense had not approved such an office) to become the central manager with responsibility for WIS implementation including cost accounting and life-cycle management (but excluding locally developed software applications not designed specifically to support joint operations). Eventually, this office would assume technical responsibility for continued upgrading of the then current WWMCCS computer systems. Problems due to fragmented management have existed since the program began and WSE did not indicate where organizationally, the WIS Acquisition Management Office would be located or how it would gain funding and other authority from the services and commands. Thus, we believe the current and proposed actions will not be adequate in resolving WIS management problems. The immediate changes proposed will have little, if any, effect because the necessary resources have not been allocated. The management structure could be effective in establishing policy and providing general guidance and goals, but will be ineffective in providing strong centralized management because the WIS Acquisition Management Office will lack budgeting and funding authority. The proposed WIS Acquisition Management Office can only perpetuate prior and current management problems because the authority and control of resources--fiscal, equipment, and personnel--will remain with the services and commands. Without the authority and control of resources, strong and effective centralized management cannot exist.

These management problems manifest themselves in a variety of ways. The decision process becomes unduly prolonged and is unlikely to result in decisive action. The result has generally been maintenance of the status quo with a recommendation for further study. Matters which require a concerted cooperative effort by all parties, such as life-cycle management including life-cycle costing, are simply not done. For example, no one individual or organization had knowledge of DOD's planned expenditures for maintenance and upgrades to the current WIS. On the basis of service estimates, we calculated that DOD plans to spend \$156.7 million on maintenance and for upgrades to the current WIS for fiscal years 1981-85. It may be less costly to replace the current system than to continue to operate it, but no one in DOD has compiled and analyzed the information necessary to prove or disprove this assertion.

INDIVIDUAL COMPUTER CONFIGURATIONS--  
A FEASIBLE SOLUTION

The use of individual computer configurations at WIS sites could resolve current WIS problems if properly carried out. Existing computer technology is available to interconnect computers

from different manufacturers. Individual sites could develop their own configurations tailored to their specific missions and still support the overall WIS command structure. This arrangement also offers an opportunity to implement an effective management alternative to strong centralized management for WIS.

The use of individual computer configurations at WIS sites can only be effective if standard data elements are employed. Despite 30 years of automated support for command and control, DOD, JCS, and U.S. commanders have been unable to agree on standard data elements. If WSE designated standard data elements and data base retrieval techniques as the new WIS architecture, this problem would be overcome. Individual commands could then develop their own configurations tailored to their specific missions and be assured that the overall WIS command structure was properly supported.

Under this arrangement, WIS would not need strong centralized management, and OJCS would continue to establish information reporting requirements between WWMCCS sites. The exchange of information would be enhanced because the use of standard data elements and data base retrieval techniques would provide remote users ready access to needed data via the intercomputer network. Responsibility for the development, operation, maintenance, and funding for the intercomputer network could then be transferred to the Defense Communications Agency.

#### SUMMARY

The WIS modernization plan does not make meaningful progress toward the development of a responsive, reliable, and survivable WIS. The proposed schedule is unduly prolonged and fails to recognize the full effect of the deficiencies of the current WIS. In addition, it does not fully develop or provide a meaningful foundation for the resolution of known WIS problems. These problems include the technical obsolescence of the data retrieval capabilities of the current system; inadequacies in the timeliness, accuracy, and completeness of information; and the lack of an effective management structure for WIS.

Rapid improvements in WIS are possible without experiencing serious operational problems. Upward compatible replacement computers are available which can process the current WIS software and provide needed online data retrieval capabilities--a major limiting factor in WIS performance. The current computers do not need to be retained until 1989 as planned.

The modernization plan's emphasis on system architecture is improper. DOD guidance and common industry practices dictate the development of comprehensive information requirements before system architectures are designed. The selected architecture should be chosen from those alternatives capable of fulfilling requirements based on cost and growth potential.

Rather than addressing critical management problems effectively, the modernization plan proposes a means by which they will be perpetuated. Strong centralized management for WIS cannot exist because the control of resources--fiscal, equipment, and personnel--will remain with the services and commands.

The use of individual computer configurations at WIS sites is a feasible solution to WIS problems. But this alternative must be properly carried out to be effective. Standard data elements must be identified and agreed on by the WIS community. Also, data base retrieval techniques must be standardized to help the exchange of information through a communications network using standard protocols.

## CHAPTER 3

### DOD'S MODERNIZATION EFFORTS ARE UNLIKELY TO RESOLVE WIS PROBLEMS

DOD, despite dozens of large-scale studies, has failed to make meaningful progress toward developing and using a responsive, reliable, and survivable WIS. The listing of studies dealing with WIS architecture and information requirements is truly awesome. A final concept of operations for WIS was only recently approved for use in developing comprehensive information requirements. Even though detailed information requirements have not been formulated, WSE has designed a system architecture for WIS which is dependent on future technological advances. Any architecture conceived before detailed information requirements are compiled, based on an approved concept of operations, will be premature.

### CONTINUED STUDY OF WIS IS NOT PRODUCTIVE

In 1966 JCS initiated a study to define the major parameters to be used as a basis for selecting new computer equipment for WIS. After 14 years, many hundreds of studies, and the expenditure of more than \$1 billion, DOD has failed to develop a responsive, reliable, and survivable architecture or provide a firm and detailed planning document describing how to achieve such an architecture.

In spite of an over abundance of studies which essentially contain the same or similar information and recommendations, DOD persists in unrelenting pursuit of additional funds to support further studies. This commitment to study at the expense of decisive action prolongs the operation and maintenance of antiquated and dangerously inadequate hardware and software which seriously impairs DOD's ability to provide responsive, reliable support to NCA, JCS, and the Unified and Specified Commands.

### Adequate groundwork for a WIS architecture has never been developed

DOD has been unable to develop an approved concept of operations and comprehensive information requirements--two necessary prerequisites for the development of a sound and effective approach to providing ADP support. Moving ahead with architectural development or hardware acquisition without guiding philosophical principles derived from an approved concept of operations and comprehensive requirements definition has not resulted in a system that completely and effectively addresses the needs of its users. Continuing to move ahead in this fashion will not improve WIS operational capabilities.

A concept of operations establishes boundaries defining the total system's scope of service answering the question "What



should the system provide, how securely, and in what environment?" Information requirements can then be developed listing all the elements comprising each major operational concept.

Identification of information requirements based on a well-thought-out concept of operations logically precedes system acquisition and provides a governing philosophy from which engineering and architectural decisions naturally flow. The Office of Management and Budget Circular A-109, "Major Systems Acquisitions," and DOD Instruction 7920.2, "Major Automated Information Systems Approval Process," specifically direct that procurements be based on valid information requirements.

DOD's approach of continually studying WIS problems without initiating decisive implementation is illustrated by the following chronology of selected DOD activities. (See app. III for a listing of many of the more recent studies.) The chronology demonstrates DOD's repeated failure to develop a concept of operations and associated information requirements. Despite this fact, DOD acquired 35 medium-to-large computer systems in 1971-73, and WIS has cost more than \$1 billion since its inception.

#### Chronological highlights

- 1966 JCS begins study to define major parameters to be used as a basis for an industrywide competition to supply ADP equipment to support the WIS community.
- 1967-68 DOD establishes a Joint Technical Specification Group to prepare specifications and other material required for selection of ADP equipment. Deputy Secretary of Defense approves WWMCCS ADP:
- Logical Support Plan.
  - Management Plan.
  - Technical Support Plan.
  - Selection Plan.
- 1969 The Deputy Secretary of Defense approves a plan to proceed with procuring standardized WIS computers and software.
- 1970 February 6--Secretary of Defense curtails data processing growth until the Assistant Secretary of Defense (Comptroller) develops a comprehensive:
- development, expansion, and implementation plan;
  - economic analysis; and

--system monitoring procedures.

June 4--Deputy Secretary of Defense directs that more specific planning and funding control for WIS be established. OJCS, as manager of the project, had responsibility for further detailed planning. The plan was to include

--hardware and software inventories,

--funding analysis for hardware and software acquisition and maintenance,

--evaluation of alternative programs for introducing new standard ADP equipment,

--procedures for providing common software,

--information requirements,

--functional descriptions of data processing requirements common to all users, and

--data interchange improvement objectives.

Concurrently, the Deputy Secretary of Defense approves competitive procurement of 15 to 35 standard systems.

1971                   October 15--Honeywell Information Systems receives contract award.

1972-73               Numerous JCS memorandums attempt to ensure orderly and systematic progress in the development of WWMCCS ADP systems. For example, a JCS memorandum titled "Worldwide Military Command and Control System Objectives Plan for Fiscal Year 1973-1992," provided objectives to guide the evolutionary development and improvement of WIS.

1973                   DOD completes installation of the 35 WIS standard computer systems.

November 23--After systems are in place, JCS submits a composite list of NCA requirements to the Secretary of Defense for comment. This list was developed because JCS recognized that information requirements of the NCA, necessary for an effective system, were not adequately defined in advance of either system design or procurement.

December 14--Memorandum from Deputy Secretary of Defense acknowledges significant problems in WIS development resulting from lack of specific

and timely definition of NCA information requirements and provides guidance for future work as follows:

- Refinement of information requirements, sources of information, and development of WIS operational concepts.
- Emphasis on "ad hoc" capabilities to provide information in crisis situations.
- Fundamental requirements for the NCA and supporting decisionmakers.
- Planning for an information system that is flexible enough to accommodate future changes as they arise.

1974 IBM begins 2-year study costing in excess of \$10 million to develop requirements and architectural guidelines for a new WWMCCS including WIS.

1976 Because the WWMCCS Council was not convinced that improvements suggested in the IBM study would actually result in significant operational benefits, DOD requests funds to establish a WWMCCS ADP Operational Utility Research and Development Program to assess the operational utility of ADP in a command and control environment.

More recently, in July 1978 the then Assistant Secretary of Defense (Communications, Command, Control, and Intelligence) directed WSEO to develop a plan for modernizing WIS. WSEO commissioned the Mitre Corporation to define alternative architectures and BDM Corporation to analyze WIS information needs. At WSE's request, OJCS was tasked to prepare a "WWMCCS ADP Concept of Operations for Post - 1985." All three efforts are being undertaken concurrently, demonstrating once again DOD's failure to define a concept of operations and to clearly identify information requirements before system design. The current course of action can only lead to the design and acquisition of a system that does not completely and effectively address the needs of its users.

APPROVED CONCEPT OF OPERATIONS NEEDED  
BEFORE WIS CAN BE MODERNIZED

An approved concept of operations for WIS is a prerequisite to identifying the essential information which must be reported, processed, forwarded, stored, and displayed for command and control activities. While an initial "WWMCCS ADP Concept of Operations for Post - 1985" was issued in November 1979, JCS did not approve a final version until February 1981. An approved concept of operations should identify the specific functions and tasks which WIS must support, and thus serve as a basis for defining detailed information requirements.

The final concept of operations outlines 10 functions for which WIS should provide automated support:

- Monitoring the current situation to include the status of U.S. and non-U.S. forces.
- Formulating responses to warning and threat assessment.
- Selecting options, deploying forces, and executing operation plans.
- Performing attack, strike, damage, and residual capability assessments.
- Reconstituting and redirecting forces.
- All levels of conflict, including day-to-day operations, crisis management, the application of conventional and limited nuclear forces, transattack in a general war environment, and postnuclear attack including reconstitution.
- Various command centers--fixed, airborne, seaborne, and land transportable/deployable.
- Various classes of users--command center personnel, operations teams, battle staffs, crisis action teams, operations planners, command and control related action officers, local commanders, reporting organizations, mobile command elements, and daily users/support personnel.
- Functional areas such as crisis action system; force readiness/status monitoring; general and strategic operations planning; emergency actions; force deployments and employments; special operations; electronic warfare; reconnaissance; movement planning, coordination, execution, management, and monitoring; logistics planning; support and resupply of U.S. and Allied forces; nuclear weapons management; and technical administrative support provided by special staff functions relating to command and control, such as medical, civil engineering, communications, personnel, environmental, and intelligence.
- Activities such as test and evaluation, command post exercises, field training exercises, real world operations, and quantitative analyses from day-to-day operations.

Much of the information required for WIS must be collected, processed, stored, and/or displayed in relatively short periods of time. These time periods may vary from a few seconds to several days, depending on the nature of and need for the information. Because the information is essential to decisionmakers, the computer system and related communications must be responsive, reliable, and available as needed. WIS must be able to capture, transmit, process, and display information that is timely,

accurate, and easily understood. Therefore, the system must be secure and easy to use to be effective. Finally, the system must be able to function properly in two modes of operation-- priority and routine.

Progress toward a final concept of operations was slow

As noted earlier, JCS issued the initial concept in November 1979 and sent it to all WIS sites with a request for comments on the document to be delivered by mid-January 1980. OJCS expected to be able to incorporate or resolve all comments and produce a final version by July 1980, 7 years after DOD recognized the need for an approved concept of operations. Some of the commands did not respond formally but gave verbal agreement. An official from OJCS believed that several of the commands had not fully reviewed the document but just agreed due to lack of time. There were several obvious errors and inconsistencies that were noted by almost all of the commands which formally responded.

In February 1981 JCS approved a revised WWMCCS ADP concept that incorporates the 10 elements previously identified and can serve as a basis for defining detailed information requirements and later system architecture efforts.

An approved concept of operations is the cornerstone for designing a computer system. The concept of operations outlines an operational philosophy defining the functions and tasks ADP should perform or assist. As shown by previous DOD experience, any preliminary architectures designed before approving a concept of operations are likely to need substantial changes.

INFORMATION REQUIREMENTS NEED DEFINING

DOD's failure to define information requirements has been a very significant factor in the shortfalls of WIS. Although WSE efforts after the modernization plan have not been completed, we believe the final product will not be an appropriate base for selecting/developing a responsive, reliable WIS architecture. The primary reasons are

- the conduct of poorly executed efforts in requirements analysis, particularly the "WWMCCS Information Needs Analysis (WINA)," which will be used to drive the architectural decision process;
- reliance on analysis of prior studies which do not capture information requirements, but rather describe currently collected information which is not adequately responsive to the needs of command and control, particularly in levels of conflict above day-to-day operations; and

--the failure to identify the essential elements of information which must be collected, processed, stored, displayed, and disseminated.

#### WINA cannot satisfy objectives

WINA had two objectives--the first was to analyze WIS information needs and the second was to identify WIS information flows essential for U.S. military command authorities to exercise direction over assigned forces and resources within a wide range of conflict levels. While the basic nature of this approach is sound, the study results cannot be used because they are based on inaccurate and unrealistic scenarios and lack the required precision for determining processing requirements. OJCS and cognizant Army and Air Force officials expressed their view that little, if any, of the study results would be of practical value. While these deficiencies were recognized within DOD, corrective actions were initiated too late and were not sufficient to salvage the effort.

The WINA study took 11 Government-furnished scenarios selected from the 1976 WWMCCS architecture study. Each contained a series of briefly described events occurring principally within the National Military Command System, the priority WIS component serving NCA. Operations analysts expanded the scenarios by creating subevents describing the command and control activities which presumably would logically occur at WIS sites and interfaces in association with each scenario event. The analysts invented over 8,400 subevents.

This approach is sound to determine system sizing and capacity if the scenarios contain the most pressing processing, reporting, and display requirements that may occur at all WIS sites. The scenarios were chosen by DOD to reflect a range of conflict levels rather than to identify the most stressing situations for computer support of command and control across the WIS environment.

An April 14, 1980, OJCS memorandum expressed these concerns to WSE.

"We have reviewed the documents associated with this analysis and do not believe they adequately cover the full spectrum of the WWMCCS community requirements. Furthermore, there is some question concerning the actual flow of events within the scenarios such as Scenario Seven which should reflect us engaging in a conflict rather than withdrawing from the conflict. Also, the scenario activities are not evenly distributed among the WWMCCS participants."

The memorandum continued:

"Due to the current shortfalls in the project, we do not feel we will be able to validate the findings. Therefore, the data probably cannot be used to determine and validate any operational requirements or capabilities."

Officials of the Army Operations Center and Air Force Headquarters were less charitable. They stated that WINA was of little or no practical value. They were critical of the construction of the subevents in the 11 scenarios and believed that the subevents were invented by retired senior military personnel because they reflected the way military business was conducted several years ago and emphasized the commander's role with inadequate attention to the action officer level. These beliefs were substantiated in discussions with the WSE's staff.

Two related deficiencies in WINA are the lack of precision in defining the qualities of required information and proper validation of these requirements. Because the qualities of required information were defined in broad ranges, they cannot be used to accurately determine processing loads and serve as a sound basis for a request-for-proposal to competitively acquire equipment. Further, the "requirements" developed were not properly validated by the commands to which these requirements were ascribed.

The attributes of required information in the scenarios were not defined with adequate precision to determine processing requirements. For example, the timeliness required for a data retrieval could be given a range of from 1 to 10 minutes. If a system is procured with enough capacity to process the retrieval in 1 minute, then there will be 10 times the essential capacity if the retrieval is not needed until 10 minutes. In the reverse, required capacity would be seriously underestimated.

These WINA requirements were examined by the Army and Air Force. WSEO officials said that the Air Force classified its requirements within one order of magnitude of that chosen by WINA about 95 percent of the time, but the Army disagreed by more than one order of magnitude about one third of the time. These large differences indicate serious disagreement, rendering the results totally inadequate for use in sizing computer systems and supporting communications.

Detailed information requirements  
definition--likely to be inadequate

During our review, WSE had not completed the detailed information requirements necessary to support system design or architecture. However, we believe current efforts after the modernization plan will be inadequate based on the methods being used and the progress made.

In discussions with WSEO and OJCS personnel, we found that there was no detailed description of the methodology to be used to compile detailed information requirements. OJCS had provided WSEO with an extensive number of background documents which address various aspects of the information requirements of NCA, including currently collected information. It should be noted that the detailed information requirements of NCA have never been

accumulated. WSEO officials said that they were in the process of analyzing these documents with the assistance of contractor personnel. A full set of information requirements for NCA/JCS and supporting WIS site information requirements were scheduled to be completed in April 1981 for review and validation but still were incomplete as of July 1981.

This effort will only include NCA/JCS level requirements and not all of the requirements of the individual commands. Individual command requirements will only be included if they directly support the national level requirements. The system to be procured on the basis of these requirements will only be capable of supporting this abbreviated form of WIS, as opposed to the two WIS missions supporting the command and control functions of NCA and the Unified and Specified Commands.

According to WSEO and OJCS personnel, operation plans, exercise results, and other documents which identify the essential elements of information will not be employed. The essential elements of information constitute the basis for detailed information requirements. Once these elements are identified, the requirements for retrieval, currency, and accuracy for each can be established. This data, along with communication requirements between WIS sites, can form the basis for system acquisition. If information requirements are developed without these documents, there will be critical information gaps during exercises or, worse, during the actual execution of a critical operation plan.

WSE believes that a detailed set of information requirements is a prerequisite for procurements established by the Congress and us rather than being a sound practice in developing systems. In a May 1, 1980, memorandum to the Deputy Director for Strategic C3 Systems, OJCS, WSE responding to criticisms of WINA wrote:

"It is clear that Congress and the GAO expect DOD to provide comprehensive descriptions of the future information system requirements of each WWMCCS node before letting DOD proceed with the modernization of WWMCCS ADP. It is also increasingly evident that the inputs from the WWMCCS commands with respect to their future information requirements are likely to be less specific and less detailed than Congress and the GAO will require. Consequently, we must look at all ways of providing the kind and level of detail about WWMCCS information requirements being sought by Congress and the GAO.

"It is doubtful that the ongoing Joint Action will provide the level of detail on information requirements for the WIS by WWMCCS node which is being sought by Congress and GAO."

Because WINA is of questionable value and WSE expects detailed information requirements to be lacking, we believe it is



unlikely that DOD will produce a set of information requirements that can serve as a basis for developing a complete system capable of satisfying all user needs at a minimum of cost. Although all future information requirements cannot be anticipated, selection of an architecture based on anticipated requirements that can be modularly expanded should meet user needs for many years. Detailed information requirements should be compiled because they are essential to building good systems rather than perceived requirements of the Congress or us.

#### WIS ARCHITECTURE EFFORTS ARE PREMATURE

Design and selection of a WIS architecture is premature because the proper foundation for a computer architecture, a comprehensive set of information requirements based on an approved concept of operations, has not been established. Regardless, after the modernization plan, WSE had detailed a WIS architecture. Selection of this architecture, besides being premature, has serious faults, including

- reliance on technical advances in computer technology and
- reliance on WIN improvements that have been repeatedly delayed.

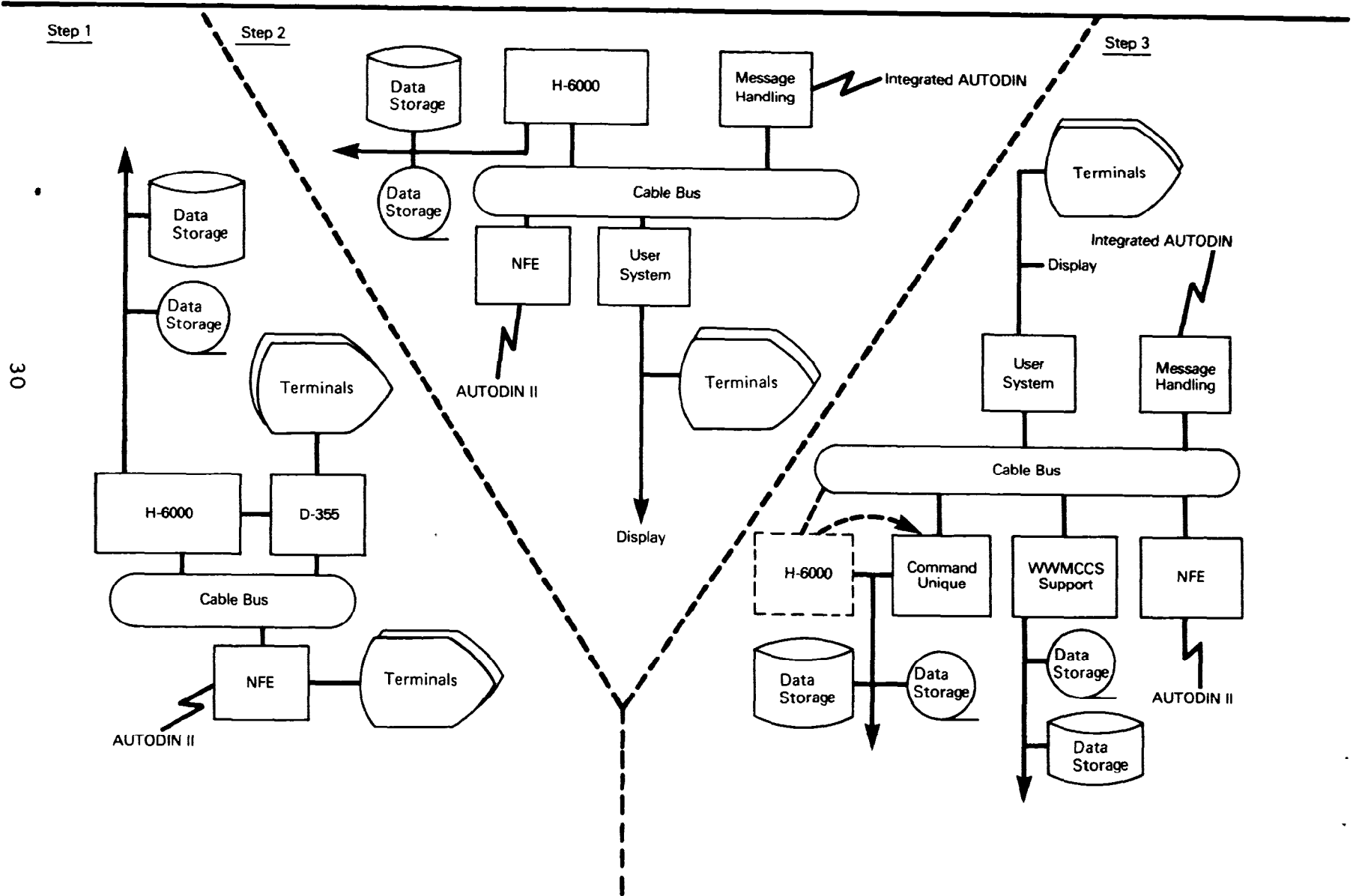
Also, the selected architecture and transition strategy includes the long-term retention of the current computers which we believe should be replaced as quickly as possible to avoid continuing operational problems, particularly during a crisis and other time-constrained situations.

#### Reliance on technological advances is unwise

WSE has selected a WIS architecture employing several computer systems at future WIS sites. The selected architecture employs a cable bus--a combination of coaxial cables and interface units which allow direct exchanges of electronic signals between computers--to allow the direct exchange of information between a number of separate computer systems at a single WIS site. A dominant force in this move has been WSE's desire to avoid disruption during the changeover to a modern architecture and its subsequent actions in defining only the limited information requirements of the NCA/JCS. Cable bus technology provides the possibility of creating an efficient, effective local multicomputer network for WIS. However, the applicability of such an approach cannot be made objectively and requires significant technological advances in the state of the art.

Preliminary architectural diagrams (see fig. 2 on p. 30) employ a cable bus to interface several major computer systems. Among these systems are a new WIS standard computer, the current computer system, a new system for locally developed applications, a data base machine system (or "user system"), plus a network

**Figure 2**  
**Expected Transition Steps Using Cable Bus Technology**



front end, and automated message handling system. WSEO officials said that cable bus technology will allow all these systems to be available to each local user as well as remote users via WIN and that the coexistence of all these systems would allow for modular, flexible growth and enable conversion costs to be absorbed over a number of years.

Analysis of the research and development work in cable bus applications shows that considerable advances are required in the state of the art. A military command center network must support local computer-to-computer communication with data rates of millions of bits per second, according to a Mitre Corporation report on its cable bus research efforts for DOD. However, the current testbed shows that cable bus throughput was found to be less than 30 thousand bits per second. Thus, significant advances will be required before cable bus technology can be of practical worth in the command center. We were unable to determine when this development would occur, if at all. The development may also be superseded by other advances, such as improved message switch architectures, which may become commercially available at significantly reduced costs.

The risks are great if DOD continues to pursue this architecture. Technological advances expanding the state of the art are difficult to predict and may occur later than anticipated. Important systems such as WIS should be designed using proven technology, not conjecture. We believe it is inappropriate for DOD to fund this type of basic research for WIS where requirements can be met with off-the-shelf technology with only minimal adaptation to meet the existing unique needs.

#### WIN--a microcosm of WIS

WIN has performed poorly like the current WIS for many of the same reasons. It features very old equipment, poorly designed and built system software, no requirements analysis, fragmented management, and low levels of reliability and survivability. Furthermore, WIN relies on the current WIS computers to conduct network business. The majority of these network problems have been well known for years, but instead of replacing the network immediately, including offloading the WIS computers, WIN has been expanded from 3 to 6 to 20 sites. Meanwhile, the replacement network, WIN/network front end, has been delayed for several years.

WIN has been plagued with severe reliability/availability problems over the last several years. WIN failures are due to deficiencies in the network design, obsolete and poorly maintained hardware, and poorly designed and built software. A compounding limitation in WIN reliability/availability has been the reliance on the WIS computers to run the Network Control Program. Due to the network's complexity and design weaknesses, the specific cause of network outages has been difficult to identify, and very limited corrective actions have been made. These severe reliability problems, which are compounded by expanding the network,

apparently did not influence the decision to add 14 additional WIN nodes or sites.

Several organizational deficiencies affecting WIN operations and reliability were identified during a recent contractor study of WIN. The contractor made these observations:

--"No one showed us on an organization chart, or otherwise identified a position directly responsible for operations and maintenance of the WIN communications subnetwork.

--"\* \* \* we never met any person who said he was specifically responsible for solving the subnetwork's problems.

--"\* \* \* the IMPs [interface message processors-network hardware] are the property of the host organizations and these organizations seem, at least as we were told, to view them as such, not responding to direction from the NCC [Network Control Center] staff.

--"\* \* \* the contractor hardware maintenance organization is not well oriented to maintaining the IMPs."

The contractor recommended several changes to the hardware used in the current WIN design. Specifically, these included replacing interface message processors with new hardware and adding a minicomputer to properly monitor the network, thus providing useful diagnostics. The contractor noted that the new message processors could be purchased for less than \$30,000 each and that maintenance charges would be much lower (approximately \$5,000 vs \$12,000 yearly per unit). Replacing these devices with new equipment could pay for itself in a few years and could provide greater reliability because the upgraded WIN would essentially duplicate an existing and more reliable network. The contractor estimated the cost to provide an adequate network monitoring capability to be about \$115,000 for hardware, \$100,000 for software, and \$82,000 for annual maintenance of hardware and software.

The Defense Communications Agency estimates that it will spend \$9.9 million in fiscal years 1980-85 to maintain and operate the current WIN design. Only \$7 million over the same period will be spent to develop the improved WIN/network front end. Since our earlier review, the scheduled date for WIN/network front end has slipped from October 1980 to October 1983. Defense Communications Agency officials attributed some of the slippage to the requirement that they design a standard network front end for Autodin II, a new packet-switching communications subnet intended to replace the current dedicated circuits used in WIN. Much of the remaining slippage was attributed to a requirement to competitively procure minicomputers to serve as network front ends which would allow use of the network independent of the local WIS standard computer system because all network software would reside on it.

## SUMMARY

DOD is repeating the same critical error in the current WIS modernization effort that was made during the 1971 WIS standard buy. Despite all of the studies completed and underway, DOD has failed to select a system architecture based on a comprehensive set of information requirements.

Without first identifying the critical data elements needed to carry out assigned missions, the usual result is a system design that does not completely or efficiently meet the needs of all its users.

Identifying these data elements before system design and acquisition is essential to ensure proper system sizing and capacity, and hence responsiveness, as well as providing clear guidance to software developers. For these reasons, identification of detailed information requirements--the essential data elements and their associated qualities of timeliness, accuracy, and currency--is incorporated in both DOD and the Office of Management and Budget directives on developing automated systems.

## CHAPTER 4

### CONCLUSIONS AND RECOMMENDATIONS

#### CONCLUSIONS

WIS is a massive, complex ADP system, but its problems can be resolved by properly applying existing information resource management procedures and techniques. The art of information resource management takes the complex, seemingly overwhelming problems of massive system development programs, like the WIS modernization, and breaks them down into manageable components to be accomplished incrementally. There is no panacea, shortcut, or painless cure for WIS' problems. Instead, a steady journeyman-like method must be applied to resolve these problems.

WIS and its priority component, the National Military Command System, are essential elements of our national security. WIS is intended to provide NCA a means to receive warning and intelligence information and to provide direction to our military forces while supporting JCS in carrying out their responsibilities. Also, WIS must support the command and control needs of the Unified and Specified Commands. Consequently, WIS must be the most responsive, reliable, secure, and survivable system that can be made available within established resources. Data communications and ADP capabilities are two of the essential resources that can enable WIS to achieve these objectives. To meet such requirements, the equipment must operate compatibly, communication links must provide a direct connection or real-time relay whenever necessary, computerized data formats must be common, and all components of the system configuration and operation must be as efficient as possible in terms of both effectiveness and in the use of resources.

Our 1979 evaluation of WIS (LCD-80-22) showed that these objectives, recognized by DOD in 1966, had yet to be achieved although it had spent \$1 billion for this purpose since the start of the program. Despite hundreds of studies, DOD has not prepared a firm and detailed planning document describing how to develop such a system.

The performance of the current WIS is so poor that rapid improvements are necessary to minimize continuing critical shortfalls in capability, particularly during times of crisis. A major cause of these problems is the continued use of computers whose circuitry was not designed to function in an online environment required by the command and control function. However, WIS modernization planning is proceeding too slowly to be responsive to these deficiencies. Even though an unnecessarily long replacement process is not scheduled for completion until 1989, we believe it will slip repeatedly because the DOD's efforts lack the required quality. Specifically, we found that after more than 2 years since the start of the WIS modernization effort, DOD

- had only recently approved a concept of operations for WIS on which detailed information requirements must be based,
- does not plan to properly define the detailed information requirements necessary as a cornerstone for successful system acquisition,
- has prematurely selected a computer architecture before defining requirements which relies on advances in computer technology beyond the existing state of the art, and
- has neither established an effective central manager for WIS nor recognized its inability to do so and establish an effective alternative.

### RECOMMENDATIONS

DOD must recognize the magnitude of the problems in WIS due to shortfalls in capability and resolve to deal with them properly. All efforts must be directed toward realizing systemwide objectives in the shortest possible time frame to minimize the potential for serious operational problems, particularly during times of crisis. Because DOD's plan to modernize WIS has a fragile foundation and does not provide a timely solution to current WIS problems, substantial changes are immediately required to modernize WIS.

We recommend that the Secretary of Defense redirect the modernization of WIS in the following manner:

- Replace those computer systems having immediate shortfalls with modern upward compatible computers where a comparative cost analysis justifies such action.
- Complete the detailed information requirements to support command and control decisionmaking.
- Develop an architecture and computer system design that can satisfy detailed information requirements specifically incorporating the following actions.
  - Employ life-cycle management practices, including life-cycle costing, as presented in DOD Directive 7920.1 Life Cycle Management of Automated Information Systems (Oct. 17, 1978).
  - Follow other sound management practices such as establishing measurable system performance and effectiveness goals and objectives, including periodic evaluation, providing cost-effective growth potential, and clearly delineating responsibilities and coupling them with needed authority and control of resources.

- Employ proven state-of-the-art computer technology in the WIS design to ensure the development of reliable systems.
- Specify standard network protocols, terminology, data elements, data formats, and data retrieval techniques for horizontal (between commands) and vertical (command to national military command centers) communications.
- Decentralize decisionmaking to allow individual WWMCCS sites to develop their own computer systems to meet command needs in compliance with the above standards.
- Centralize management and control of resources for the communications network and equipment interconnecting WWMCCS sites to ensure that local command needs do not preempt network operations.

AGENCY COMMENTS

DOD's written comments with our detailed evaluation are presented in appendix IV. DOD generally disagreed with our conclusions and recommendations but did not provide any new or convincing evidence to support its objections.

MATTERS FOR CONSIDERATION  
BY THE CONGRESS

The Congress may wish to direct DOD to provide a revised plan to modernize WIS that incorporates our recommendations with the fiscal year 1983 budget. Consideration should be given to deferring selected items in the fiscal year 1982 budget until the revised plan is accepted by the Congress. The following currently budgeted items could be deferred:

<u>Program element number and title</u>	<u>Amount to be deferred</u> (millions)
32019K - WSE	a/\$ 3.3 R&D (out of \$4.3)
33152K - Joint Program Management Office	3.9 R&D
32017K - Joint Technical Support Activity	7.4 R&D (out of \$12.8)
32018K - National Military Command System ADP Support	<u>4.1 Procurement</u>
	<u>\$18.7</u>

a/R&D--research and development.



LIST OF OUR PREVIOUS REPORTSON WIS

"Problems in the Acquisition of Standard Computers for the World Wide Military Command and Control System." Report to the House Committee on Appropriations (B-163074, Dec. 29, 1970).

Letter report on the World Wide Military Command and Control System to the chairman, Subcommittee on Government Activities, House Committee on Government Operations (B-163074, May 6, 1971).

Letter report on the World Wide Military Command and Control System to the Secretary of Defense (LCD-75-116, July 21, 1975).

Letter report on the World Wide Military Command and Control System to the Secretary of Defense (LCD-78-106, Apr. 5, 1978).

"NORAD's Information Processing Improvement Program--Will It Enhance Mission Capability?" Report to the Congress (LCD-78-117, Sept. 21, 1978).

"The World Wide Military Command and Control System--Major Changes Needed in Its Automated Data Processing Management and Direction." Report to the Congress (LCD-80-22, Dec. 14, 1979).

"NORAD's Missile Warning System: What Went Wrong?" Report to the chairman, House Committee on Government Operations (MASAD-81-30, May 15, 1981).

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**House of Representatives**  
**Committee on Appropriations**  
**Washington, D.C. 20515**

September 3, 1980

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Honorable Elmer Staats  
 Comptroller General of the  
 United States  
 General Accounting Office  
 Washington, D. C. 20548

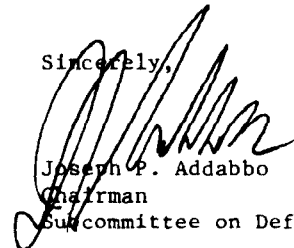
Dear Mr. Staats:

Recently, the General Accounting Office issued a report on a Department of Defense program entitled, "World Wide Military Command and Control-Automated Data Processing (WWMCCS-ADP)."

Presently, the DoD is planning to eventually deploy a "follow-on" WWMCCS-ADP system. Considering the cost and importance of this program, I believe the GAO should monitor the development of the program and provide my Committee a periodic update in areas such as cost, concurrence with guidelines in Congressional reports, and timeliness of implementation. Also, your evaluation should include an analysis of the feasibility of allowing each command the option to develop its own computer configuration for purposes of command and control as long as that configuration is inter-operable with each node in the system.

It would be appreciated if the initial update, including a briefing, be provided to the Committee by February 15, 1981. Due to the time constraints involved, official comments by the Department of Defense need not be included.

Sincerely,



Joseph P. Addabbo  
 Chairman  
 Subcommittee on Defense

CHRONOLOGY OF SELECTED DOCUMENTSON WIS

We collected many of the more recent studies, reports, and plans prepared internally by DOD and by contractors which demonstrate the expense and scope of DOD's continuing examination of WIS.

We classified these documents into three general categories--development of architectural alternatives; concepts, analysis, and requirements definition; and current system description, development, and alternatives. Several documents contained substantial material relevant to more than one category, and we classified them into the more dominant category. The following table summarizes these documents by category, number, and cost.

Selected Documents Summary Table

<u>Category</u>	<u>Selected studies</u>		<u>Contracted</u>	
	<u>Number</u>	<u>Number</u>	<u>Number</u>	<u>Cost</u>
				(thousands)
Development of architectural alternatives	15	13	a/	\$1,159
Concepts, analysis, and requirements definition	17	9	b/	1,970
Current system description, development, and alternatives	<u>18</u>	<u>14</u>	a/	<u>1,220</u>
Total	<u>50</u>	<u>36</u>		<u>\$4,349</u>

a/Costs were not available for one study.

b/Costs were not available for four studies.

Although all of DOD's WIS studies are not included, our sample illustrates the vast amounts of time, money, and human resources expended in perpetually studying WWMCCS ADP. DOD's failure to design and implement an effective WWMCCS ADP system is certainly not the result of inadequate study, but a lack of decisive action.

An annotated listing of these 50 studies, including the principal thrust of each, follows.

1. "Worldwide Military Command and Control Objectives Plan for FY 1975-1994." In-house (July 1, 1974).

- Provides a detailed description of WWMCCS; states goals and a hierarchy of objectives to guide the evolutionary development and improvement of WWMCCS; lists operational requirements with their associated priorities that support the objectives; shows the interrelationship of the WWMCCS goals, objectives, and operational requirements; and identifies issues requiring further study.
2. "DOD Data Internet Study Phase II Report." In-house (Dec. 1974).
- Provides a basis for DOD to formulate a policy early in 1975 to guide data network and internetting activities.
3. "Research in Network Data Management and Resource Sharing: Application Summary." Center for Advanced Computation, University of Illinois at Urbana-Champaign (May 19, 1975).
- Assesses needs of the WIS community as perceived by the actual WIN users. Evaluates General Comprehensive Operating System approaches to current prototype WWMCCS intercomputer network problems so that both user needs and current activities can be integrated into the 3-year research plan.
4. "Report on WWMCCS ADP Communication Interface Requirements." Rand Corporation (Mar. 1976).
- Discusses various elements which should be taken into account in considering standard communications interfacing capabilities for the WIS computers. These elements include existing and projected near-term capabilities, major long-range development efforts, and the effect of related developments.
5. "WWMCCS Software Maintenance and Enhancement Study." The Mitre Corporation (June 1976).
- Develops and assesses alternatives to the contractual arrangements which expire in 1979 with the Honeywell Information Systems for maintenance of WIS standard system software. Part of this five-volume study assesses procurement and organizational alternatives. The evolution of the current maintenance environment; the eventual transition to a next generation of WWMCCS; and the effect of arrangements for developments, enhancements, and hardware and firmware maintenance are considered, as well as implications for configuration management and quality assurance.
6. "A Preliminary Analysis of the DBM Concept for WWMCCS ADP." System Development Corporation (Aug. 16, 1976).

--Presents a preliminary analysis of the data base machine concept to determine the usefulness of incorporating such a device in the WIS environment.

7. "Capabilities Baseline for USAREUR Command and Control." TRW/INCO Inc. (Nov. 1976).

--Delineates the baseline capabilities that are currently available or will be available by fiscal year 1978-79 to support intelligence information flows during peace or hostile engagement.

8. "Non TFC/COIC USAFE TAIS Segment Needs Analysis." RCA/Government Systems Division (Mar. 31, 1977).

--Supports U.S. Air Force, Europe, in the definition of the functional needs and system capability requirements of the tactical unit segment. In particular, this document reviews the ADP and communications currently available to support the tactical units, considers the deficiencies and needs of the tactical units, and discusses data outputs and flows associated with their intelligence functions.

9. "WWMCCS Data Base Machine Concepts, Requirements, and Functional Approach." System Development Corporation (May 20, 1977).

--Reviews trends and constraints imposed on current WIS data management requirements and explores alternatives available in a specialized data base machine. The report (1) concludes that the data base machine is a technically attractive option for the WIS community, (2) makes specific recommendations to determine the exact functional requirements for such a machine, and (3) establishes operational concepts required to achieve implementation.

10. "Prototype WWMCCS Intercomputer Network (PWIN) Operational Experiments Program: Final Consolidated Report for Operational Experiments #1 and #2." In-house (June 1, 1977).

--Analyzes and evaluates the effectiveness and operational usefulness of the Prototype WWMCCS Intercomputer Network by obtaining operational experience and performance measures.

11. "USAREUR Command and Control Information System (CCIS) Study." In-house (June 2, 1977).

--Examines the capability of the existing command and control information system in meeting requirements of the commander and staff.

12. "The Impact of the WWMCCS Architecture Study on WWMCCS ADP Communications." Rand Corporation (June 1977).
  - Examines the ADP communications aspect of the IBM WWMCCS architecture planning study and WSE activities in this area. Report concludes that the potential effect of the architecture study on WIS data communications will be minimal.
13. "Report to the Secretary of Defense on the National Military Command Structure." Department of Defense--Richard C. Steadman (July 1977).
  - Presents and evaluates alternatives for making the national military command structure more effective and efficient in carrying out the national security mission.
14. "USAFE Operations Support Center Concept of Operations." In-house (Aug. 10, 1977).
  - Presents an expanded, more detailed concept of operations for the U.S. Air Force, Europe, Operations Support Center. The collection of ideas is the result of appraisals by each Operations Support Center's functional area manager of wartime taskings and the resources needed to accomplish these tasks.
15. "Summary of Findings for WWDMS T-2, 4 Performance Testing Phase 2." Planning Research Corporation (Aug. 29, 1977).
  - Presents the results of tests made comparing the responsiveness of World Wide Data Management System T-2, 4 as compared to COBOL using various data base structures under a variety of conditions.
16. "FMIS Evaluation Phase 3 Report." Planning Research Corporation (Sept. 30, 1977).
  - Compares the features of two data management systems: Force Management Information System and World Wide Data Management System.
17. "Preliminary Examination of WWMCCS Autodin I Traffic." Rand Corporation (Sept. 1977).
  - Analyzes Autodin I traffic data for each of the WWMCCS sites. The data will be used in the development of alternative concepts for a standard communications interface subsystem and the identification of baseline capabilities for the management of WWMCCS operational data.

18. "WWMCCS Operational Data Management: Requirements Baseline and Problems Areas." Rand Corporation (Nov. 1977).
  - Describes initial perceptions of the processing requirements and technical characteristics of the current management environment. Problem areas are described and a set of issues relevant to the development of a concept of operations for WWMCCS data management is considered.
19. "Concepts and Alternatives for a WWMCCS Communications Interface System." Rand Corporation (Nov. 1977).
  - Recommends near-term improvements of communications interfacing capabilities for WWMCCS.
20. "Revised Preliminary WSE Transition Plan." In-house (Jan. 1, 1978).
  - Summarizes current plans for implementing the new capabilities of the selected architecture in support of the 1985 target WIS. Includes updated summaries of technical approaches planned for achieving these capabilities together with associated schedules, costs risks, dependencies, and required actions for program implementation.
21. "INFE Software Functional Description Overview." Digital Technology Incorporated (Mar. 20, 1978).
  - Presents a functional overview of the initial operational capability network front end under development by Digital Technology Incorporated to connect a WWMCCS H6000 host to Autodin II.
22. "USAFE TAIS Data Base Study." RCA/Government Systems Division (Mar. 31, 1978).
  - Contains descriptions of intelligence data pertinent to the development of the USAFE Tactical Air Intelligence System intelligence data base.
23. "Program Definition Plan for Research and Development in the Operational Utility of ADP." In-house (Mar. 1978).
  - Establishes the WWMCCS ADP Operational Utility Research and Development program to identify and demonstrate, ADP applications which offer significant improvements in the operational effectiveness of WIS.
24. "Phase B Experiment Plan." Digital Technology Incorporated (June 19, 1978).

--Describes future initial operational capability network front-end experiments.

25. "FORSTAT--Present Operation and Transition to the WWMCCS Intercomputer Network." Institute for Defense Analysis, Science and Technology Division (June 1978).

--Analyzes some of the major operational characteristics of FORSTAT, a major WIS data base, and presents recommendations for improving the system with a view toward future operation as WIN is phased in.

26. "WWMCCS Data Management Analysis and Data Base Machine Requirements Definition and Functional Description." System Development Corporation (July 18, 1978).

--Presents the results of a study addressing the WWMCCS data base machine concept. Defines criteria for evaluating alternative Data Base Management configurations.

27. "Report of the Defense Science Board Task Force on Command and Control Systems Management." In-house (July 1978).

--Examines the management of command and control systems to determine if the Nation is acquiring command and control capabilities commensurate with the weapon systems being deployed and available technology. Develops recommendations that, if implemented, could improve the design, acquisition, operation, and evolution of command and control systems.

28. "Network Reliability." TRW: Defense and Space Systems Group (Aug. 31, 1978).

--Develops methodology for analyzing the reliability of the Prototype WWMCCS Intercomputer Network.

29. "WWMCCS Information System Engineering Management Plan." The Mitre Corporation (Oct. 1978).

--Provides a framework for the management and coordinated development of a post-1985 WIS--the information collection, processing, and display system that will evolve from the current WIS.

30. "USEUCOM Command and Control Systems Architecture Study." IBM and DOD personnel (Oct. 1978).

--Develops a command and control system architecture which meets emergency/wartime mission requirements of the U.S. European Command. The first report of this study addresses unconstrained requirements, another report presents the deficiencies identified as a result of comparison of requirements and baseline, and the final



report recommends architectural approaches to correcting deficiencies.

31. "Transition Strategies for an Intermediate WWMCCS Communications Interface Subsystem." Rand Corporation (Apr. 1979).
  - Presents alternatives for transitioning from existing communications interfacing facilities at WIS sites to an incrementally improved WIS communication interface subsystem during a 36-month period beginning in April 1978.
32. "Summary Report of Audit, Force Status Report (FORSTAT) and Unit Capability Measurement System (UCMS)." Air Force Audit Agency (June 20, 1979).
  - Presents audit results at 27 locations to determine the accuracy of Force Status Report and Unit Capability Measurement System readiness status information.
33. "FY 1979 Final Report: Cable Bus Applications in Command Centers." The Mitre Corporation (Oct. 1979).
  - Documents fiscal year 1979 activities related to the applicability of a microprocessor-based cable bus local area network for WIS command centers.
34. "WWMCCS ADP Concept of Operations for Post--1985." (Draft) In-house (Nov. 21, 1979).
  - Identifies the major objectives, considerations, and support elements; and establishes the general scope, capabilities, and responsibilities for WIS support in the post-1985 time frame.
35. "The Final Report on the Survey of Users Perceptions of and Opinions About WWMCCS ADP." In-house (Dec. 6, 1979).
  - Presents WIS users' current perceptions and opinions. Results used as input to a plan for modernizing WIS in the post-1985 period.
36. "Planning for the Modernization of the WWMCCS Information System (WIS)." In-house (Jan. 1980).
  - Prepared in response to a congressional request that DOD submit, with the fiscal year 1981 budget, a plan for modernizing the current WIS.
37. "WIN Design Alternative Analysis." Computer Sciences Corporation (Feb. 1980).
  - Addresses WIN software design changes intended to prevent network abnormalities from affecting the user.

It also outlines design changes to those functions that have a known potential for affecting network reliability. In addition to reliability, the changes outlined address design deficiencies of some of the network software.

- 38 and 39. "The WWMCCS ADP Baseline Description." Working paper (May 31, 1980) and "WWMCCS Current System Description 1979 (Partial draft) Annex F, Current WWMCCS ADP Description." (Aug. 4, 1980) TRW; Defense and Space Systems Group.
- Provides WSE and WIS community with a concise definition and description of the major existing WIS system software at all WIS sites. This information will be used to define alternative WIS architectures for WWMCCS Council review and selection in October 1981.
40. "The WWMCCS Information System Architecture." The Mitre Corporation (Working paper).
- This multivolume report describes the results of initial efforts to define alternative WIS architectures. Emphasizes conceptual definition for possible future uses of WIS in terms of strawman applications.
41. "IMP Alternative Analysis Report." Computer Sciences Corporation (Aug. 1980).
- Evaluates near-term software and hardware alternatives for performance and cost improvements in the dedicated WIN Communications Subnet. The report contains an evaluation of the current WIN Communications Subnet interface message processors and a comparative analysis of candidate alternative systems.
42. "WIN Study: Final Report." Bolt, Beranek, and Newman, Inc. (Sept. 1980).
- Provides suggestions for improvements for WIN reliability.
43. "Information Analysis." TRW (Sept. 1980).
- Supports synthesis of architectural alternatives and seeks to determine ADP needs not met by the current WIS by evaluating differences between present and future information flows. The first technical note examines the process feasibility, develops a methodology for comparing these, and follows and applies it to a pair of scenarios. Subsequent reports document comparisons for other similar scenario combinations and identify potential ADP shortfalls.

44. "WIS Baseline Description (Shortfalls)." TRW (Sept. 1980).  
--Identifies WIS shortfalls which are being used as inputs to the WIS requirements efforts.
45. "WIS Preliminary Security Alternatives." Systems Development Corporation (Sept. 1980).  
--Analyzes appropriate security technologies and evaluates and recommends multilevel security operations for development of the WIS security plan.
46. "WWMCCS Information Needs Analysis." The BDM Corporation (Oct. 1980).  
--Analyzes WIS requirements to identify information flows essential to command authorities in directing resources within a range of conflict levels including crisis, theater conventional war, theater nuclear war, and general war.
47. "Honeywell WIN System Evaluation and Performance Audit." Honeywell Information Systems (Oct. 1980).  
--Identifies WIN system performance limitations and isolates bottlenecks within the network.
48. "Topology Model." In-house (Feb. 1981).  
--Studies by means of computer modeling, the WIN Communications Subnet loading as a function of configuration, traffic load, restricted capacities, and alternative routing schemes.
49. "WWMCCS Information Needs Analysis (WINA)." The BDM Corporation (Mar. 1981).  
--A continuation of the initial WINA contract; this effort develops a methodology for verifying the WINA data base.
50. "Information Requirements Definition" and "Information Requirements Collection." Mitre and TRW (Sept. 1981).  
--Provides data for input to specifications for WIS.

DOD COMMENTS AND OUR EVALUATION

DOD's comments are presented below along with our evaluation of them on a section-by-section basis. DOD's comments do not provide any new evidence to support its disagreement with our conclusions and recommendations.



RESEARCH AND  
ENGINEERING

THE UNDER SECRETARY OF DEFENSE

WASHINGTON D C 20301

29 May 1981

Mr. W. H. Sheley, Jr.  
Director  
Mission Analysis and Systems Acquisition Division  
United States General Accounting Office  
Washington, DC 20548

Dear Mr. Sheley:

This is in reply to your letter to the Secretary of Defense regarding your draft report dated April 14, 1981, on "The World Wide Military Command and Control Information System--Problems in Information Resource Management" (OSD Case #5689), (GAO Code 941211).

We have reviewed your draft report and find few conclusions that have not been covered in previous GAO reports on this subject. We find this draft misleading in that it does not acknowledge the progress made over the past year and reflected in the Plan supplied to the Congress in January 1981. We believe that we have in fact developed a comprehensive program for the modernization of WIS, which is responsive to the issues pointed out by Congress and the GAO. Our major concerns with your draft report are contained herein.

**Evaluation:** DOD's comment that it finds "few conclusions that have not been covered in previous GAO reports on this subject" is correct. The primary reason for this is DOD's continuing reluctance to take effective, decisive action. This history is clearly shown in the chronology contained in chapter 3 (See p. 20.) DOD first recognized the need to replace the current WIS in 1974, and yet, the system has remained in use while DOD continues to spend hundreds of millions of dollars to make incremental improvements without correcting the basic flaw of the system (i.e., hardware that was not designed to function in the highly interactive command and control environment).

DOD believes that our report is misleading because it does not "acknowledge the progress made over the past year and reflected in the Plan supplied to the Congress in January 1981." First, DOD has not submitted a "Plan" but rather a report. We believe there is a significant difference which DOD highlights later in its letter. Our report does recognize the activities conducted over the year between the two reports to the Congress. These activities are discussed in some detail (see pp. 23 to 33). However, as we have noted, the first major step toward successfully developing a major ADP system is the identification of detailed information requirements. This step has not been accomplished although a system architecture has been prematurely selected. (See p. 29.)

DOD indicates its belief that the report submitted to the Congress in January 1981 is responsive to the issues pointed out by the Congress and us. DOD's report is not responsive to several issues:

- The need for substantial timely improvements to WIS.
- The need to develop detailed information requirements before system design.
- The need to develop a workable alternative to strong, centralized management which DOD has been unable to achieve.

#### DOD comment

The Department submitted to Congress with the FY 81 Budget a document dated January 1980 titled "Planning for the Modernization of the WWMCCS Information System (WIS)." This report identified the major considerations and issues surrounding modernization of the WIS, outlined a strategy for accomplishing the modernization and presented a schedule of major milestones. Because of the early stage of the modernization process, the report admitted that at that time it was premature to present a firm and detailed plan for WIS development and implementation. In January 1981, a report titled "Modernization of the WWMCCS Information System (WIS)" was submitted to Congress. This report supplements the previous document, further defining the operational and information system requirements of the WIS modernization and presents the basic architectural alternatives for the modernization. Both of these documents are interim reports leading to the final modernization report which will be submitted to Congress with the FY 83 Budget.

Evaluation: DOD is correct that a plan to modernize WIS has not been developed and that its intention is not to produce one until nearly 3 years after congressional direction and 4 years of its own effort. This is far too long to develop just a plan to modernize WIS.

DOD comment

As noted in your April 14, 1981, letter, GAO began its investigation of the DoD's modernization program for WIS on April 18, 1980. This review, subsequently directed by Congressman Addabbo, focused primarily upon our 1980 report to Congress. We feel that most of the concerns expressed in your draft report are addressed in our January 1981 report. Your draft report criticizes our present efforts based upon obsolete data and ignores our most recent, more detailed report to Congress. We feel that the timing of your report is most unfortunate.

Evaluation: DOD is correct that our report addresses deficiencies in the January 1980 DOD report to the Congress. This earlier report, as DOD notes in its comments, was supplemented by the second report submitted in January 1981. It is the very foundation of the WIS modernization effort that we question. Therefore, it is appropriate that we focus on the document which serves as a basis for this effort.

DOD's contention that our report is based on obsolete data is unfounded. In its comments, DOD fails to support this contention by identifying any material differences in the facts. Further, the January 1981 report was used in part to interpret the previous edition and was thoroughly studied by our staff. The purpose of obtaining agency comments is to obtain additional viewpoints and to correct material differences in the facts. On the basis of our evaluation of DOD's detailed comments, no new data or evidence that facts contained in our report are obsolete or incorrect has been supplied.

DOD comment

We have several other concerns with your draft report. You recommend (on pp. v and 53) that we abandon the evolutionary approach . . . and resolve to build on an . . . incremental basis. We believe that the approach detailed in our January 1981 report is indeed a systematic, planned and incremental approach to a responsive, reliable, secure and survivable system. You indicated (on pp. v and vi) the WSE should stop redundant studies of WWMCCS problems and encourage us to replace the current computers before continuing the modernization process, but then you recommend that we not make any architectural decisions until detailed requirements studies are completed. We believe that the current mix of requirements analysis and architectural alternatives review is the proper balance to achieve the timely and effective modernization of WIS. Your criticism of the lack of information flow requirements ignores the fact (alluded to on p. iv) that in February 1981 the JCS approved a WWMCCS ADP Concept of Operations and General Requirements for Post-1985. (See GAO note on p. 67.)

Evaluation: The approach detailed in DOD's January 1981 report does not outline a systematic, planned, and incremental approach to building a responsive, reliable, secure, and survivable system. First, DOD's efforts have not been systematic but are haphazard. The system architecture was decided on before the concept of

operations was approved. A concept of operations establishes boundaries defining the total system's scope of service, answering the question, "what should the system provide, how securely, and in what environment?" This step logically precedes the identification of information requirements elaborating each operational concept. Together, a well-thought-out concept of operations and associated detailed information requirements provides a governing philosophy from which engineering and architectural decisions naturally flow. To reverse the process will almost surely lead, as it has in the past, to a system that does not efficiently and effectively meet the needs of its users.

Second, the approach proposed by DOD is not planned. For example, current ADP procurement regulations (46FR1218) require a comparative cost analysis to determine which alternative will meet user needs at the lowest overall cost over the system life. Lowest overall costs include purchase price, lease or rental cost, or services cost of the contract actions involved; other factors; and other identifiable and quantifiable costs that are directly related to the acquisition and use of the system, such as personnel, maintenance and operation, site preparation, energy consumption, installation, conversion, system startup, contract support, and the applicable present value discount factor. Alternatives which must be considered include replacing the installed ADP system with a compatible system and competitive replacement through use of functional specifications. DOD has not completed its requirements but has already decided on a system architecture and plans a competitive procurement. However, a close look at the long and very costly parallel processing period that will occur under the selected architecture indicates that an upward compatible procurement offers obvious savings in terms of hardware operation and maintenance and software conversion costs. These savings, if properly considered, give the incumbent vendor a significant advantage in a competitive procurement.

Third, the approach suggested by DOD is not an incremental effort. As indicated in the modernization schedule contained in the January 1981 report, installation of the new processors is not scheduled to begin until fiscal year 1988 and will not be completed until the end of fiscal year 1990. To wait until fiscal year 1988 to significantly improve WIS performance through the introduction of new processors is not incremental progress. As we have noted in our WIS reports, many of the shortfalls in the capability of WIS can be attributed to the use of computers that were not designed to function in the highly interactive command and control environment. Further, the use of such inefficient hardware encourages the development of application software that has little or no utility on more modern hardware.

We recommended that DOD stop continual studies of WIS problems and replace the current computers based on mission essential needs with modern upward compatible computers before continuing the modernization process. In this way, DOD can identify detailed information requirements and design and program application

software responsive to these requirements. Strict use of standard high-level programming languages such as Ada without machine-dependent or vendor-unique features will prepare the WIS community for a subsequent competitive procurement if a different architecture is needed. Currently, the extensive use of nonstandard languages and vendor-unique extensions makes the introduction of noncompatible hardware extremely difficult, time consuming, and expensive. This difficulty is reflected in DOD's unprecedented 6-1/2 year parallel processing period.

DOD's asserted belief that the current mix of requirements analysis and architectural alternatives review is proper cannot be substantiated. As we noted in our report, DOD has already selected a system architecture for WIS before the requirements have been determined. This is counter to official DOD guidance on system development. Detailed information requirements must be compiled first, and then alternative architectures which can satisfy these requirements must be identified. Selection from these alternatives should be based on lowest total life-cycle costs with proper consideration given to growth potential and other factors. DOD's premature selection of an architecture will almost surely distort the identification of detailed information requirements. Therefore, the follow-on WIS will be unlikely to efficiently and effectively meet the needs of its users if the current DOD course of action is continued.

DOD's assertion that we ignored the JCS' WWMCCS ADP Concept of Operations for Post-1985 is unfounded. While this document does indeed establish four major groups or families of functional ADP applications, it does not establish a requirement that separate hardware and system software be developed for each. Rather, JCS has recognized the convenience of developing requirements and software through this approach. However, two of these families, the Nuclear Planning and Execution and Tactical Warning and Space Defense, are needed at only a few sites and can best be handled by separate efforts already completed, underway, or planned. The remaining two families, Resources and Unit Monitoring and Conventional Planning and Execution, are planned for all current WIS sites. These two families are closely related, require similar kinds of processing, and are the focus for the follow-on WIS. The JCS document requires only that the hardware and system software be standard within a family of applications; it does not preclude the use of a single computer system serving two families at any given site as is the current practice. We believe the JCS requirement that standard hardware and system software be used within a family of applications is an unnecessary constraint on system development and performance. The JCS requirement for standard hardware and system software is not a valid "user requirement" because it does not relate to users but to system engineers and designers.

The specific recommendation referenced by DOD has been incorporated in the recommendations in chapter 4.



DOD comment

We agree with your concerns about the need for strong management of WIS and we are proceeding to establish efficient and effective management along the lines stated in our January 1981 report. We strongly disagree that we are unable to establish effective central management and submit that your conjecture that we return control of the WWMCCS system back to the individual sites will lead to exactly the same situation which existed in the 1960s about which your earlier reports have been so critical.

Evaluation: DOD has been unable to provide strong management for WIS, although this problem has been recognized since the inception of the program. Command and control systems must cut across service lines if they are to provide reliable and responsive support to NCA. Therefore, a concerted effort is required to establish and maintain needed interoperability. However, because each service funds its own WIS command and control system development efforts, little, if any, incentive exists for the services to work together cooperatively.

The basic problems of equipment compatibility and interoperability can now be resolved through strict adherence and enforcement of machine independent standards rather than through standard hardware, system software, and application software. This approach embodied in the current WIS failed because the standard hardware, system software, and application software were acquired and developed without properly considering the needs of local commanders. Consequently, these commanders developed a significant amount of their own system and application software to overcome these deficiencies. Since these efforts had an inadequate hardware and system software base, they were generally less efficient than before the introduction of standard hardware and system software. Further, the complexities of this "joint environment" make timely changes to the system very difficult, if not impossible. The seemingly endless reviews of each action result in user needs being given low priority.

Our recommendation would not result in a return to the 1960s WIS environment. DOD is incorrect in stating that our earlier reports have been critical of the 1960s WIS environment; rather, our earlier reports have been critical of the failure of the standard WIS systems to correct these problems as was intended. The current state of the art in computer technology allows for effective and efficient data exchanges between remote sites using different equipment and system software. For any alternative to be effective, standard terminology, data elements, and data base management techniques are necessary. By having WSE designate these items as the system architecture and consolidating responsibility for the development, operation, maintenance, and funding for the intercomputer network within the Defense Communications Agency, each site could then develop its own configuration within this framework, reporting valid data requirements up and across

the chain of command. WIS would then operate as a true system rather than a collection of separate systems as it is now. The need for strong central management of WIS would then be obviated.

DOD comment

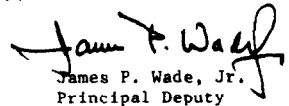
Documents designating WIS as a major systems acquisition are being prepared for the approval of the Secretary of Defense. This process will ensure that the issues of consolidated management, requirements and acquisition strategy will be resolved. Additional comments on your draft report are enclosed.

Evaluation: Designating WIS as a major systems acquisition would certainly draw additional attention to the problems of WIS. However, the contention that such an action will ensure that the issues of consolidated management, requirements, and acquisition strategy will be resolved is not guaranteed by this process.

DOD comment

On May 15, 1981, we advised your staff that the subject report had been classified by the Department of the Army. We would be happy to meet with your staff to assist in sanitizing the text should you desire to issue an unclassified report.

Sincerely,

  
James P. Wade, Jr.  
Principal Deputy

Enclosure

Evaluation: We met with DOD officials and have made appropriate changes so that the report is now unclassified.

Additional Comments on Draft GAO Report dated April 14, 1981  
"The Worldwide Military Command and Control Information  
System--Problems in Information Resource Management"  
(GAO Code 941211) (OSD Case 5689)

1. General Comments

Many of the comments and statements of fact in the GAO report reflect the January 1980 WIS report to the Congress and documentation which was either in a draft status, unofficial working papers, or plans which are now obsolete. In order to get the most current planning information, the GAO should read the document entitled "Modernization of the WWMCCS Information System (WIS)", dated 19 January 1981, prepared for the Committee on Armed Services, United States House of Representatives, in response to House Report No. 96-916.

**Evaluation:** As noted earlier, the January 1981 report was used extensively in the preparation of this report. The contention by DOD that our report findings, conclusions, and recommendations are based on inaccurate or obsolete data is not supported in DOD's comments.

**DOD comment**

Through their continual investigation of WWMCCS ADP and the WIS, there have been many interchanges between GAO auditors and the DoD personnel working on the WIS program. As a result of these meetings, it is felt that there is general agreement between GAO and DoD/WSE with respect to the major drivers of the WIS program. The major issues which were mutually considered to be paramount for a successful WIS development are: adequate statements of requirements, establishment of standards and standard data base structure/data base management system, and system acquisition through the specification of functional requirements. In addition to the new WIS development, the need to incrementally upgrade both the current WWMCCS ADP and the WWMCCS Intercomputer Network (WIN) is also recognized and addressed in the 19 January 1981 WIS report to Congress.

**Evaluation:** DOD is correct that we consider adequate statements of requirements, establishment of standards and standard data base structure/data base management system, and system acquisition through the specification of functional requirements to be major issues. However, there are other major issues where there are disagreements. These include the need for timely improvements, analysis of comparative costs of alternatives, and selection of the least total overall cost design that meets valid requirements according to current Federal regulations. These issues have not been properly addressed by DOD, and we believe they are critical

in developing a follow-on WIS from a technical standpoint (not related to the management issue).

DOD comment

The criticisms of the WIN in the draft GAO report do not reflect the performance of WIN during the most recent JCS-sponsored exercises. In November 1980, and again in March 1981, the JCS conducted two major crisis management exercises: PROUD SPIRIT 80 and POLL STATION 81. In both of these exercises, WIN was a primary means of transferring operational data between command centers. In addition, the WIN teleconferencing capability was extensively utilized to coordinate a wide variety of planning activities. While the performance of WIN in previous exercises was less than desirable, recent statistics show that significant performance/reliability improvements have occurred.

Evaluation: This comment fails to recognize the most recent final exercise report prepared by JCS which recognized WIN deficiencies. According to the JCS report evaluating PROUD SPIRIT 80, there were several exercise artificialities that improved WIN performance. However, JCS found WIN performance unsatisfactory. First, the Command and Control Technical Center and Honeywell Information Systems Incorporated provided additional programming analysis and maintenance engineering support to 15 WIN sites. Second, Honeywell provided on an assignment basis an additional 256K of memory to prevent system saturation during the exercise at the Joint Deployment Agency. Also, before the exercise, the Joint Deployment Agency was provided its own system with two central processing units. Formerly, it shared a system with two central processing units with the U.S. Readiness Command. In addition, file transfers were considered successful if completed, regardless of the length of time it took to complete them.

The following synopsis from the JCS evaluation of WIN performance during PROUD SPIRIT 80 provides the official viewpoint which differs from that contained in DOD's comments.

"Overall WIN was unsatisfactory during Exercise PROUD SPIRIT 80. However, WIN seemed to be significantly more effective in support of mobilization and deployment during Exercise PROUD SPIRIT 80 than during previous exercises. Users and operators credited the increased effectiveness to operational procedures and technical enhancements prior to the exercise. Many of the operational procedures and technical enhancements were the result of lessons learned during Exercise POSITIVE LEAP 80. Observers also cited the increased memory capacity given the JDA [Joint Deployment Agency] by HIS [Honeywell Information System] for use during the exercise as contributing to increased effectiveness. The capability of WIN showing the most improvement, and thereby contributing to the seemingly increased overall effectiveness was that of file transfer. Because of its

importance to the joint deployment process, file transfer performance overshadowed areas wherein performance was less effective. With the exception of file transfers, WIN performance generally fell below the performance levels achieved during Exercise POSITIVE LEAP 80. Nevertheless, WIN continued its transition, first observed during Exercise POSITIVE LEAP 80, from a teleconferencing medium only, to a more complete intercomputer network."

We believe the JCS evaluation of WIN performance supports, rather than conflicts with our assessment of WIN. That is, after 8 years of operating the WIN system design, DOD is still making minor incremental improvements and WIN is still unsatisfactory.

#### DOD comment

Management of rapidly growing information requirements and collateral growth in WWMCCS support resources has been a perplexing problem which has permeated WWMCCS since its inception. Although steady progress has been made in the management of this vast and complex system, management initiatives have not always kept up with the system's rapid expansion. Several initiatives to strengthen and improve the WWMCCS management structure have been taken:

--The Command, Control and Communications Systems Directorate within the OJCS has helped focus more management attention on the WWMCCS arena.

--The establishment of the WIS Executive Committee to provide overall guidance for the WIS modernization effort.

--The establishment of the WIS Coordinating Committee to coordinate WIS activities and review hardware and software development concepts

--The establishment of the WWMCCS ADP Coordinating Office to assure that key decisions affecting WIS are implemented.

--The establishment of a WWMCCS ADP Technical Support Manager responsible for technical changes and upgrades.

In addition, a Joint Program Management Office (JPMO) has been proposed which would have overall WWMCCS/WIS management responsibilities.

**Evaluation:** These management changes are reflected in our report. However, these changes generally have had little effect, if any, because the necessary resources have not been allocated for new functions. As we noted in this report, the proposed WIS Acquisition Management Office/Joint Program Management Office can only perpetuate prior and current management problems because the authority and control of resources--fiscal, equipment, and personnel--will

remain with the services and commands. Without the authority and control of resources, strong, effective, and centralized management cannot exist.

These management problems manifest themselves in a variety of ways. The decision process becomes unduly prolonged and is unlikely to result in decisive action. Generally, the result has been maintenance of the status quo with a recommendation for further study. For example, because the WWMCCS Council was not convinced that a new ADP system suggested in a comprehensive 1976 study would actually result in significant operational benefits, DOD requested funds to establish a WWMCCS ADP Operational Utility Research and Development Program to assess the operational usefulness of ADP in a command and control environment. This goal was never accomplished because the funds were used to establish research efforts in computer hardware. Such efforts were inappropriate for DOD to fund because hardware manufacturers have their own much larger research efforts.

#### DOD comment

##### 2. Specific Comments

###### (a) GAO Statement:

Current conditions dictate a need to accelerate the modernization schedule. It is undesirable to wait another 10 years before the system is modernized. (Pages iii, v and 11).

###### Response:

The modernization schedule (page 45) in the 19 January 1981 WIS report to Congress shows new hardware installation starting in FY 85. Modernization includes the software as well as the hardware. Therefore, the modernization schedule shows the period of time needed to achieve the total operational capability; this reflects the total software development effort for the Resource and Unit Monitoring, and Conventional Planning and Execution WIS functional families. Six and one-half years are estimated to be the optimum time period for cost effective design and implementation of the large WIS software families (as determined through cost studies and cost/schedule models such as PRICE S).

(See GAO note on p. 67.)

Evaluation: The modernization schedule in the January 1981 WIS report to the Congress shows installation of the new WIS computers to begin in fiscal year 1988, not 1985 as implied by DOD. All of the computers will not be installed until the end of fiscal year 1990. Therefore, it will take nearly 10 years before the system is modernized. We disagree with DOD's assertion that 6-1/2 years is the optimum time period for cost-effective design and implementing the new application software. Generally, the life expectancy of application software, without redesign or reprogramming, is in the range of 5 to 10 years, according to the General Services

Administration. Therefore, 6-1/2 years for development is too long a cycle to be cost effective, particularly if it is preceded by 3 more years of requirements analysis. This long development cycle may or may not be cost efficient, but it cannot be called cost effective because it is not effective. Given the shortfalls of the current system, this is certainly the case.

DOD comment

(b) GAO Statement:

GAO's evaluation of the plan (January 1980) showed that too much emphasis is being placed on the selection of a system architecture before defining information requirements. (Pages iii and 19).

Specifically, after more than two years since the start of the WIS modernization effort, the Department:

--does not plan to properly define the detailed information requirements necessary as a cornerstone for successful system acquisition. (Pages v and 38).

--has prematurely selected a computer architecture before defining requirements which relies on advances in computer technology beyond the existing state-of-the-art. (Pages v and 45).

Response:

The current WIS requirement efforts and planned requirements definition work are outlined in Section 5.2 of the 19 January 1981 WIS report to Congress.

Information requirements have been defined and specified at the data element level and are documented and validated in JCS Pub 6 (The Joint Reporting Structure-1974).

There is a current WIS effort underway to collect information requirements at the next level of detail; these requirements are being collected by site for each site's needs as well as to support the needs of the Joint Operational Families defined in the Concept of Operations. The Services and OJCS are in the process of collecting information requirements prior to the development of any WIS Request for Proposal.

The current WIS architectural development is one which was done in parallel with, and in response to, the "WMMCCS ADP Concept of Operations and General Requirements for Post-1985" which is a validated statement of requirements that will be published as Annex B of Volume II of JCS Pub 19. The selected architectural approach was developed in response to the requirements described in the Concept of Operations and General Requirements while it was in draft format. We feel that the selected WIS architecture, including the definition of the WIS functional families, is a direct reflection of the Concept of Operations and General Requirements.

All WIS procurement specifications will be prepared with functional and information requirements and the final WIS configuration will reflect the results of industry's best implementation design to meet the requirements.

Evaluation: According to the January 1981 WIS report, "requirements" is a rather loose term. DOD uses this term very loosely in its comments. The joint reporting procedures govern currently collected information, and therefore, in the strict sense, constitute requirements. However, there are gross deficiencies in currently collected information and how it is provided and processed. These deficiencies have been recognized as early as 1974 by DOD. DOD's requirements collection effort, because it is based on the current Joint Reporting Structure, will perpetuate these deficiencies.

DOD is incorrect in asserting that the selected architecture was developed in response to requirements described in the WWMCCS ADP Concept of Operations for Post-1985. This document only established the functional families for the purpose of defining requirements and developing application software. It does not contain the detailed information requirements necessary to select an architecture. Therefore, no basis exists for separate systems. Further, separate systems, as opposed to other configurations of the same or similar processing resources, will probably be inefficient in terms of staffing, computer, and fiscal resources.

If WIS procurement specifications are prepared with functional and information requirements, then the system acquired will reflect any deficiencies in the statements of requirements. On the basis of the current status of the requirements collection efforts, we believe DOD will not produce a statement of requirements that will accurately reflect user needs. Any system acquired based on functional specifications not reflective of users' needs cannot possibly efficiently and effectively satisfy users' needs. Further, the selected WIS architecture precludes several different design approaches which may be more cost effective. Such designs include a single system with multiple central processing units and dual systems sharing a single set of peripherals, including disk and tape drives.

DOD comment

(c) GAO Statement:

Specifically, the Secretary of Defense should:

--plan for and incorporate only state-of-the-art computer technology in the WIS design. (Page vi).

(See GAO note on p. 67.)



Response:

The guiding philosophy behind all WIS development is that only existing state-of-the-art technology will be used for the WIS procurement. A conservative definition of state-of-the-art computer technology consistent with low risk is that it is available as a product line item from industry. At this time all of the computer technology identified for use in developing the WIS is available from industry as a product line item (including local networking).

With regard to the issue of reliance on technology which is beyond the state-of-the-art in the local network area, it is not clear that the DoD and the GAO have the same technology in mind. A very high speed bus (50 Megabits/second) has been offered commercially by the Network Systems Corporation for over five years under the trade name HYPERCHANNEL. Xerox Corporation offers a local network (3 Megabits per second) as a commercial product under the "Ethernet" name. The Ethernet has also been adopted by the Digital Equipment Corporation as a standard product integrated with their current line of computers. It is felt that the local networking technology has matured to the point where it is low risk today.

The diagram following page 45 of the draft GAO report is from a draft working paper which was never officially published. If there is a need for any diagrams depicting that concept, the one on page 38 of the 19 January 1981 WIS report should be used.

Evaluation: We believe that DOD is incorrect in stating that local network technology for WIS command centers is state of the art. First, the comments fail to recognize the unique problems of developing a local network within military command centers.

Second, the comments ignore the research program established by the Defense Communications Agency to conduct research in local networks for military command centers. Our information came from an annual report on this effort costing \$275,000.

Third, DOD portrays Network Systems Corporation's input/output bus HYPERCHANNEL as an example of local network technology. HYPERCHANNEL is a bus and not a network. It can interconnect equipment only within an extremely limited physical distance, and therefore, cannot be used in a local network for a military command center.

Fourth, Ethernet is a local network developed jointly by Xerox Corporation, Digital Equipment Corporation, and Intel Corporation. Xerox did not have adequate financial and technical resources for this effort, and therefore, sought the assistance of the other firms. DOD incorrectly lists the data rate of this system which is 10 megabits per second instead of 3 megabits per second. Ethernet is based on a particular machine architecture

set which does not include the current WIS computers and communications gear. While Ethernet and several other functionally similar local networks are offered commercially, primarily for office automation, they are not readily adaptable to WWMCCS command centers.

Hence, our recommendation is valid. We do not believe the technology as required for local networking of military command centers is low risk. Further, the House Committee on Appropriations (H.R. No. 96-450, Sept. 20, 1979) has made it clear that the follow-on WIS should make optimal use of off-the-shelf equipment for its computers, networking, and related hardware. This contrasts with DOD's approach to the modernization of WIS where new developments at substantial risk will be funded.

We have retained the diagram used in our draft report which, in our opinion, provides additional details on the selected architecture.

DOD comment

(d) GAO Statement:

Specifically, the Secretary of Defense should:

--replace the current computers with modern upward compatible computers designed to function in the highly interactive command and control environment before continuing the modernization process. (Pages v and 53).

Response:

We are considering the replacement of the current WIS computers with modern, upward compatible computers consistent with the WIS baseline upgrade phase as outlined in the 19 January 1981 WIS report to Congress.

However, replacement of the current WWMCCS computers poses several problems. The WWMCCS procurement authority delegated by GSA to the USAF provides for 35 computer systems of fixed and specified capabilities. Serious contractual issues concerning the scope of the delegated procurement authority (DPA), the need for recompetition of the WWMCCS contract if the new architecture exceeds the scope and intent of the DPA, the ability to acquire a new DPA, and the ability of the Department of Defense and the vendor to agree to costs, maintenance, supply, and service consideration in a reasonable time need to be addressed.

Evaluation: We recognize that DOD must properly justify replacing the current WIS computers with modern, upward compatible computers. However, current Federal regulations provide a means to replace the current WIS computers with modern, upward compatible computers based on mission essential needs. In essence, DOD is admitting that its management of WIS is so lax and ineffective that it questions its ability to accomplish this needed upgrade. We could point out numerous similar upgrades accomplished by DOD, such as the WWMCCS' Command and Control Processing and Display System.

DOD comment

(e) GAO Statement:

Specifically, the Secretary of Defense should:

--employ life cycle management on the current WIS and any future systems. (Pages vi and 53).

(See GAO note on p. 67.)

Response:

Two actions have been initiated by the Department of Defense to improve the implementation of life cycle management of WWMCCS ADP and WIS. The first of these is an effort within DCA/CCTC to collect WIS/WWMCCS ADP fiscal data throughout the Department for the FY 82-87 time frame. These data will reflect contractor resource costs and will be collected at the project level, e.g., system software, standard application software, command and/or service-unique software, hardware lease, telecommunications costs, etc. Subsequent data collection and processing will be directed toward maintaining currency about the appropriation and distribution of funds as well as refining the cost data to reflect expenditures for significant subelements of the project level data; e.g., WIN, JDS, Level 6, etc. The result of this effort will provide DoD managers with improved information concerning current and projected life cycle costs of WWMCCS/WIS activities.

The second action will be reflected in the FY 83-87 PPBS documentation. Previous PPBS submissions addressed functional costs (i.e., development, testing, maintenance) across releases and made it difficult to track life cycle costs of products. Planning and programming of resources in the FY 83-87 time frame, for selected DoD Program Elements, have been reoriented to show life cycle costs of hardware acquisitions and software releases.

The Department recognizes the benefits that accrue through life cycle management and has, through DoD Directive 7920.1, directed its application throughout the Department.

**Evaluation:** This comment represents a welcome departure from past DOD statements concerning the applicability of DOD Directive 7920.1. In its November 19, 1979, letter, commenting on our 1979 report, DOD asserted WIS was exempt from this directive. The two recently initiated actions described by DOD to provide life-cycle management will be evaluated in subsequent reviews.

DOD comment

(f) GAO Statement:

Centralize the management and control of resources for the intercomputer network within the Defense Communications Agency. (Page 54).

(See GAO note on p. 67.)

Response:

During the development, evaluation, and initial deployment of the WIN, responsibility for the communications component of the WIN was shared by directorates within DCA. That phase of the WIN is now completed and actions were initiated in FY 81 to consolidate the management and control of the WIN communications facility within the Operations and Readiness Directorate, DCA. The transfer of responsibilities and the consolidation of the management and control functions will be completed in FY 82.

The Organization of the Joint Chiefs of Staff (OJCS) has operational responsibility for the WIN and exercises that responsibility through the WIN Director, OJCS/C<sup>2</sup>ADP. Technical management and control of resources, as well as development and maintenance of the WIN system, will continue to be performed by the Defense Communications Agency.

**Evaluation:** DOD efforts to centralize current Defense Communications Agency management activities within a single directorate are recognized. However, our intention in making this recommendation was that the Defense Communications Agency be responsible for funding and operating WIN equipment at WIS sites (i.e., to remove control of network equipment from the local WIS commands). In this way, local priorities will not affect the operation and maintenance of WIN.

DOD comment(g) GAO Statement:

GAO's evaluation of the plan (January 1980) showed that:

--the existing state-of-the-art in computer technology makes it entirely feasible for each command to develop its own computer configuration to support its assigned missions and the President and Secretary of Defense. (Page iv).

We believe the only viable alternative is to:

--develop a system architecture based on standard network protocols, standard terminology, standard data elements, standard data formats and a functionally standard data base management system(s). Individual WWMCCS sites would be free to develop their own computer configurations within this framework, reporting valid data requirements up and across the chain of command. (Page 54). (See GAO note on p. 67.)

Response:

The architecture discussed by the WWMCCS System Engineer (WSE) in the 19 January 1981 WIS report to Congress provides an architecture which will allow individual WWMCCS sites to acquire and configure components of the WIS to satisfy mission requirements. There is no substantive disagreement with the thrust of the GAO recommendation. However, it is of considerable concern to the Department that the adoption of standard protocols, data formats, etc. does not manifest itself in a proliferation of dissimilar, i.e., nonstandard hardware, telecommunications, and software components.

Quite aside from the efficiency that can be achieved through standardization, one must assess the costs and benefits that accrue when standard interfaces, data representation, etc. are implemented within a standard system. As the draft GAO report properly notes on pages 3-4, WWMCCS ADP capabilities in the 1960s did not provide or support a standardized system. The current WIS does support a standardized hardware base, standard system software--including standard data base management systems as well as a standard data management system, standard applications software, and standard telecommunications software for the WIN. It also provides, through the WWMCCS ADP Contracting Office, the Single Service Training Manager, the Single Service Logistics Managers, and the Command and Control Technical Center of DCA, standard contracting support, training, logistics support, and maintenance. Failure to recognize the positive benefits of this standardization, as well as the cost savings to the

taxpayers that result from it by developing a standard architecture providing only the elements identified in the subject report, could return the WIS to the environment of the 1960s and seriously degrade the current operational utility of the WIS.

The WIS will continue to support the ability of individual WMMCCS sites to develop their own configurations tailored to their specific missions and support of the overall WMMCCS command structure through: (1) standard computer systems; (2) the continued progress the Department has shown in identifying and adopting standard interfaces and protocols; (3) the demonstratable efforts now in process to identify and develop standard modular, functional, mission oriented capabilities and configurations; (4) the implementation of modern technology in operating systems and computer system architecture which provides an increased degree of flexibility; and (5) the introduction of local networking technology which further enhances the configurability of a system.

Evaluation: In our report we clearly demonstrate DOD's inability to effect strong, centralized management for WIS. To avoid duplication of the current management problems and their manifestations in the future WIS, a new approach is needed. The following items as indicated in our report--standard network protocols, standard terminology, standard data elements, standard data formats, and standard data retrieval techniques--are the necessary essential elements to make WIS a responsive, reliable system.

DOD fails to see the difference between our recommendations and the current WIS. The difference is clear. The current WIS has standard system software, data base management system, and application software. Unfortunately, WIS also has an abundance of nonstandard system software, data base management systems, and application software. Therefore, standard as used by DOD is standard in name only. DOD misuses standard to mean centrally supported while we use it to mean the only allowable practice.

Once appropriate standards are established and enforced, the services and commands can procure systems within this framework to meet their requirements. In this way, the operational usefulness of WIS would be enhanced because exchanging information would be much easier. At the user level, the ability to access information at other sites through an improved intercomputer network would also be greatly simplified.

DOD maintains that the use of standard hardware contributes to substantial cost savings. Generally, hardware costs represent only about 20 percent of total system costs, so the potential for hardware savings is minimized compared to years past. In the current WIS, the "savings" from standard hardware has been more than offset by more than \$200 million in incremental hardware and system software enhancements as WWMCCS sites attempted to develop a reliable and responsive system.

Maintenance support, training, and logistics support under our proposal might be provided more cheaply because almost all of the WWMCCS sites use support services from different vendors for other local computer systems serving different functions. Also, equipment compatible with the tactical level could be purchased, making the exchange of data between WIS and other U.S. and Allied systems much simpler and quicker.

DOD comment

(h) GAO Statement:

However, as noted in the plan, no studies or cost estimates for software conversion/redesign have been made. Thus, DoD is uncertain of the magnitude of the problem or the costs involved in converting/redesigning existing WIS software or the availability of less costly alternatives. (Page 13). (See GAO note below.)

Response:

On pages 44-47 of the 19 January 1981 WIS report, the highlights of the results of the WIS software conversion/redesign cost studies are presented in addition to total acquisition costs for the new WIS development. These cost estimates are backed up by substantial cost estimate studies including computer cost modeling for software.

Evaluation: We have changed the report to reflect this estimate and to explain why it does not provide a firm estimate of conversion/redesign costs.

GAO note: Page references in this appendix referring to this draft report do not necessarily agree with the page numbers in final report.

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