BY THE U.S. GENERAL ACCOUNTING OFFICE

Report To The Secretary Of Defense

Navy Should Join The Air Force And Army Program To Develop An Advanced Integrated Avionics System

Modern technology should soon enable separate avionics systems in an aircraft to be consolidated into a single package to conserve space, save weight, and reduce costs.

This report points out the potential benefits of avionics consolidation and recommends the Navy join in a demonstration program now being conducted by the Air Force and Army to exploit such benefits.

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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

NATIONAL SECURITY AND
INTERNATIONAL AFFAIRS DIVISION

B-215379

The Honorable Caspar W. Weinberger
The Secretary of Defense

Dear Mr. Secretary:

Most military aircraft have numerous individual communications, navigation, and identification (CNI) equipments that, when aggregated, are becoming size, weight, and cost prohibitive. To solve these problems, the Air Force and Army are jointly developing a technology--called Integrated Communication, Navigation, Identification Avionics (ICNIA)--to integrate these functions into one system. The Navy recognizes the need for such technology to meet future aircraft avionic needs, but it has not joined the ICNIA program.

Our review of the ICNIA program shows that this is an opportune time for Navy participation. Although the Navy's next-generation Advanced Tactical Aircraft conceptual studies are not complete, the aircraft will use integrated CNI. However, if the Navy does not join the ICNIA program soon, the opportunity for a triservice program offering significant potential cost savings through avionics standardization will slip away. We believe near-term Navy participation would involve minimum funding compared to the cost of altering the program after the design is fixed, or the cost of a separate Navy development program.

Navy officials acknowledge the benefits of ICNIA, and recognize that it will cost more for the Navy to develop its own integrated system later. Therefore, the Navy has been considering joining the program, but funds are not available because no Navy aircraft program has specified a requirement for integrated CNI. In addition, one of Navy's primary concerns has been that it could become committed to specific hardware configurations before it identifies specific needs.

The Defense Science Board and our Office reports show that the earlier all participants become involved, the more likely a joint program will succeed. Navy participation in the ICNIA program now could help develop a standard integrated CNI system and enhance the possibility of a successful triservice program.

The ICNIA program is presently in advanced development and is scheduled to begin full-scale engineering development in the early 1990s. Advanced development is expected to cost about $131 million. Full-scale engineering and production costs have not yet been estimated.

INTEGRATED CNI AVIONICS

Current CNI equipments are single-function units that generally satisfy only one particular requirement. For example, the F-16A/B requires nine separate avionics items to fulfill its CNI requirements. These items include two intercom units, two radios, four navigation units, and an identification transponder. These items (1) represent significant research, procurement, and life-cycle costs, (2) are becoming size and weight prohibitive, and (3) are not easily updated to meet changing threats. Also, failure of any one of several critical single-function avionic systems can cause a mission abort. In addition, each single-function item requires a separate logistics network which increases total support costs.

One way to solve these problems is to integrate the various functions, once the individual functions are fully developed, into one unit. According to ICNIA program office studies, an integrated CNI system offers significant cost savings and increased operational efficiency over existing avionic systems. For example, the ICNIA System Definition Study states that an integrated CNI system offers (1) about 30- to 50-percent reduction in the size, weight, and cost over existing single-function CNI systems, (2) design flexibility to meet changing threats through modularity and programmability, and (3) standardization, which will decrease support costs.

Furthermore, with ICNIA, it is expected that priority mission functions can be carried out even with various component failures. This is to be achieved through built-in redundancy and automatic reprogramming which will allow use of components performing lower priority functions to replace defective components performing mission critical functions. An integrated system also offers growth capability through software reprogrammability for new requirements driven by new threats and mission changes.

Air Force/Army CNI initiatives

The Air Force has been interested in CNI integration for many years. After favorable results from exploratory development programs in the 1970s, the Air Force, in 1980, funded an advanced development program called ICNIA. The Army proposed a similar program, but decided to join the Air Force development program in April 1983.

The goals of this ICNIA technology demonstration program are to reduce total weight, volume, and life-cycle cost by half compared with discrete function systems, and to establish a design that will enable a system to be tailored to meet different aircraft functional and physical requirements. Thus, each type of aircraft will be equipped with only the specific capabilities required for its mission. For example, the A-10 aircraft does not fly long-range missions and does not have a long-range high frequency radio requirement. Therefore, a high frequency radio capability would not be included in the ICNIA system for that aircraft.

Under the joint Air Force/Army ICNIA program, two advanced development models are being built by the contractors to demonstrate capabilities of 16 current and planned functions operating in one system. (See app. I for a detailed listing.) This initial technology demonstration is not restricted by size, weight, and power constraints. A critical design review is scheduled in June 1985 for the two advanced development models, with deliveries scheduled in the first half of fiscal year 1988.

Currently, the Air Force plans to start a 2-year effort in July 1985 to determine the ICNIA functional requirements for each aircraft and make installation and cost effectiveness studies. Plans are to begin full-scale engineering development by 1990 or earlier.

Navy CNI initiatives

The Navy's need for an integrated CNI system was apparent in the early 1970s. As a result, about $10 million was spent in advanced development during the period 1976 to 1981 on a program called the Tactical Information Exchange System (TIES). The objectives of TIES and the joint Air Force/Army ICNIA program are the same.

The TIES program was planned for use on a Vertical/Short Take-off and Landing aircraft that was subsequently canceled in 1981. Since this was the only aircraft project sponsoring TIES, the program funding stopped, and the program was discontinued.

Navy officials recognize that ICNIA technology is needed to meet their future avionics requirements. They also recognize that participation in a joint ICNIA development effort is more economical than pursuing a separate development effort.

Furthermore, the incremental cost to the Department of Defense (DOD) for the Navy to join ICNIA would be modest in comparison to the cost of a separate Navy program later. For instance, an active monitoring effort could produce front-end engineering benefits to the Navy while having minimal impact on Air Force and Army costs or requirements. Such an effort could be undertaken, according to a Navy administrative official, at minimum additional cost. Adding the two unique Navy functions to the ICNIA design would cost about $12 to $15 million in 1984 dollars, but this could be spread over several years. (See p. 7 for a discussion of these two functions.) By comparison, the Navy Air Systems Command estimated that the cost of a separate program would be about $60 million. Furthermore, the $60 million was a preliminary estimate for a program that did not include some of the more expensive functions included in ICNIA.

There could be other increased costs if the Navy does not become an early, active participant. We believe it is reasonable to conclude that the combined costs for the later stages of two separate development programs, including full-scale development, would be considerably more expensive than if the Navy participated in the ICNIA program. Also, greater costs would occur in the ICNIA program if the Navy joined it in its late stages. This is because the engineering and design changes which would likely be needed would be more costly and disruptive later in the program.

The Navy could fund the ICNIA program in two ways: (1) by research and development funds or (2) by an aircraft program with a requirement for integrated CNI. So far, neither alternative has provided the needed funds.

Navy officials do not see a need for ICNIA for current-generation aircraft. These aircraft already have proven CNI components. Navy officials said that there is a reluctance to join the ICNIA program because the avionics suite of its next-generation aircraft, the Advanced Tactical Aircraft, is not yet defined. They believe that joining ICNIA now could be premature, reducing the flexibility of selecting the optimal method of meeting requirements. For example, the Navy wants to consider expanding integration beyond CNI to include such additional avionics as electronic warfare systems.

We believe the Navy should reconsider its position on ICNIA and join the current advanced development stage of the program for several reasons:

--The Navy has a need to use integrated CNI technology for its Advanced Tactical Aircraft and for perhaps retrofitting some existing models as well.

--Navy participation appears to be the most cost-effective way to achieve integrated CNI.

--Early participation can help insure the success of a joint integrated CNI program.

These issues are discussed further below.

The Navy has a need for integrated CNI

Navy officials agree that the future Advanced Tactical Aircraft will have integrated CNI equipment but they do not want to be committed to a specific hardware configuration at this time. Currently, the ICNIA program is not developing a discrete integrated CNI system, but is a laboratory and flight demonstration program. Therefore, the flexibility the Navy seeks would be available since the Navy would not be committed to a specific system.

If Navy requirements are considered in the design, the Advanced Tactical Aircraft, and other aircraft as well, can benefit from the demonstrated technology and the cost savings associated with a triservice program. We believe that integrated CNI technology could potentially have application for certain existing Navy aircraft that will be used beyond the year 2000 such as F-14s and F-18s. However, Navy aircraft program managers see integrated CNI as undemonstrated and are planning to use several other separate CNI components instead. The Air Force, on the other hand, plans to study the feasibility of putting integrated CNI into the F-15, F-16, and F-111. Such a system, if successful, could be of great benefit to the Navy if the Navy had input into its design.

Navy participation appears to be the most cost-effective route to CNI integration

A July 1982 Naval Air Systems Command advisory memorandum to the Chief of Naval Operations, Command and Control Section (OP-094), recommended Navy participation in the ICNIA program as the most cost-effective method of developing an integrated CNI system. The memorandum compared a $14 million expenditure to join the program through advanced development, with the approximate $60 million cost for developing a Navy-only system through advanced development.

There are also major life-cycle economies to be realized through standardized avionics. Such cost savings cannot be quantified easily or precisely because they depend on several factors, including the type and quantity of ICNIA terminals eventually procured, the associated ground support equipment, the procurement method used, and the duplicative research and development efforts that would be avoided. However, there are studies that project major savings through standardization. For example, DOD sponsored a study in the mid-1970s that indicates 13- to 26-percent reduction of avionic life-cycle costs through standardization. Also, our 1978[1] and 1984[2] reports on avionics cite cases where substantial savings were or could be achieved by standardizing.

Delay in Navy participation jeopardizes success of a triservice program

To succeed, joint programs should have all participants involved as early as possible. For the present, it is still practical for the Navy to join the ICNIA program; however, continued delays in designing Navy requirements into ICNIA may reduce the chances of a successful triservice program. Recently, the Defense Science Board and our Office reported on joint service acquisition programs. Both reports found that often the failure of joint programs is caused by interservice disagreement on requirements and mergers arranged too late to succeed.

Navy requirements can still be added to ICNIA design

The ICNIA program does not address two Navy-unique requirements that use digital data links to support tactical communication, command, and control systems. However, ICNIA program office officials said that the addition of Navy requirements to ICNIA now should not cause a major program disruption. Since the program is still only in advanced development, the ICNIA concept can accept Navy requirements with minimum redesign.

The ICNIA program office told us that Navy participation at this time would have no adverse impact on the Air Force or Army ICNIA program schedules, and that the incremental cost of adding the Navy requirements, together with delivering Navy advanced

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[1]Letter report to the Secretary of Defense (PSAD-78-105, May 12, 1978).

[2]Increased Joint Avionics Standardization Could Result in Major Economies and Operational Benefits (NSIAD-84-127, July 10, 1984).

development models, would be about $12 to $15 million in fiscal year 1984 dollars. This cost assumes that two competing contractors will continue to design and build the ICNIA advanced development models, and would increase the current advanced development program estimated cost of $131 million by only about 10 percent.

The two Navy-unique requirements that the ICNIA contractors included in their 1983 proposals are called Link 4 and Link 11. Link 4 is used as a precision all-weather aircraft carrier landing system and as the control link between E-2C command and control aircraft and the F-14A fighter aircraft. Link 11 is used to convey target and position information among ships and aircraft in the task force. Because the Air Force and Army use only voice radio to control their tactical aircraft, the Navy digital data requirement is not a part of the current ICNIA design.

Early participation required for joint program success

We reported previously that the further into development a system is--full-scale development or beyond--the more elusive agreement on requirements becomes; that is, as program momentum grows, so does the sponsoring service's opposition to compromise.[3] As full-scale development is approached, fundamental decisions are becoming firm and investments committed. Our 1983 report cites several examples where joint program failures have been attributed to one service being well into a program when another service joined.

Similarly, the report of the Defense Science Board 1983 Summer Study on Joint Service Acquisition Programs published in February 1984 states

> ". . . analyses revealed that virtually all instances of failures in joint programs stemmed from the fact that little or no attention was paid to the front-end work so necessary to establish a firm foundation for a joint program. Either the prospective parties were not consulted on common requirements, or the relative priorities of the partners were sufficiently divergent that future funding problems were virtually inescapable."

As it now stands, two essential Navy requirements are not included in the ICNIA design. If attempts are made to add them at a later time when the ICNIA design is firm, there is the risk

[3]Joint Major System Acquisition by the Military Services: An Elusive Strategy (NSIAD-84-22, Dec. 23, 1983).

of repeating joint program failures of the past. In addition, the later the Navy joins the program the more likely it will be more costly because of disruption to the progress of the other two services.

CONCLUSIONS

Our review indicates there are significant potential benefits to be realized by the Navy in joining the ICNIA effort. It appears to be the most cost-effective way for the Navy to develop an integrated CNI system for use on the Advanced Tactical Aircraft. Also, depending on its cost effectiveness, the ICNIA system could be a viable candidate for retrofitting older aircraft. Finally, the ICNIA program is a laboratory and flight demonstration, rather than the development of a discrete avionics system. Therefore, if the Navy joins the program, they are not tying themselves to a particular system, but would be advancing the state-of-the-art technology ultimately required for future military aircraft, and would be providing the basis for long sought after triservice avionics standardization.

Regarding concerns over the availability of funds, the Navy does have the option of participating initially as an active monitor at minimal cost and then spreading the cost of adding the unique Navy requirements to the design over several budget years.

RECOMMENDATION TO THE SECRETARY OF DEFENSE

We recommend that you direct the Secretary of the Navy to join the ICNIA technology demonstration. This action would give each of the services a voice in advancing state-of-the-art avionics technology and in developing a standard CNI system at minimum combined cost for the three services.

AGENCY COMMENTS AND OUR EVALUATIONS

DOD provided official oral comments on a draft of this report on May 14, 1985. DOD concurred with our findings and recommendation, but believed a clarification was needed to avoid giving the impression that development of individual CNI functions under separate programs was not needed. This clarification was added on page 2 of this report.

OBJECTIVES, SCOPE, AND METHODOLOGY

We reviewed the Army, Navy, and Air Force ICNIA development programs to (1) identify existing or near-term examples of consolidated or integrated avionic systems and their expected cost and operational benefits and (2) assess whether existing consolidation/integration programs are adequately emphasizing long-term efforts that will benefit next-generation aircraft and whether existing programs in the different services should be merged. During our evaluation, we reviewed integrated CNI requirements, cost and schedule estimates, and acquisition plans. We did not do a technical review of the programs, nor did we independently verify reported cost estimates.

We interviewed and/or collected documentation from officials of the Air Force and Army ICNIA program, the Air Force Aeronautical Systems Division, the Air Force Wright Aeronautical Laboratories, the Office of the Under Secretary of Defense for Research and Engineering, the Joint Services Review Committee, Office of the Chief of Naval Operations, Naval Air Development Center, Naval Air Systems Command, and the Defense Science Board.

We performed our review in accordance with generally accepted government auditing standards.

. . . . .

As you know, 31 U.S.C. 720 requires the head of a federal agency to submit a written statement on actions taken on our recommendations to the House Committee on Government Operations and the Senate Committee on Governmental Affairs not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

We are sending copies of this report to the Director, Office of Management and Budget. Copies are also being sent to the Chairmen, House Committee on Government Operations, Senate Committee on Governmental Affairs, and House and Senate Committees on Appropriations and on Armed Services.

Sincerely yours,

Frank C Conahan

Frank C. Conahan
Director

ICNIA CAPABILITIES BEING DEVELOPED

BY THE AIR FORCE AND ARMY

The following is a list of ICNIA capabilities being developed.

Air Force:

--Joint Tactical Information Distribution System (JTIDS) (time-division multiple access (TDMA) and distributed time-division multiple access (DTDMA) versions)

--Enhanced JTIDS System (EJS)

--Enhanced Position Locating and Reporting System (PLRS) User Unit (EPUU)

--HAVE QUICK

--Single Channel Ground and Airborne Radio System (SINCGARS)

--Global Positioning System (GPS)

--Tactical Air Navigation (TACAN)

--Identification friend or foe (IFF) MARK XII (interrogator (I) and transponder (T))

--Microwave Landing System (MLS)

--Very high frequency (VHF)

--Instrument Landing System (ILS)/VHF Omnidirectional Range (VOR)

--Traffic Collision Avoidance System (TCAS)

--IFF MARK XV

--High frequency (HF)

--Ultrahigh frequency (UHF)

--Air Combat Maneuvering Instrumentation (ACMI) system

Army:

--PLRS/EPUU

--SINCGARS

--VHF

--HAVE QUICK

--HF

--GPS (two channel)

--IFF MARK XII (I&T)

DESCRIPTIONS OF CAPABILITIES

JTIDS

JTIDS is an L-band line-of-sight communication system that is also used for relative navigation. Communications consist of voice, data, or timing messages. Frequency hopping and spectral spreading are used to provide antijam and low probability of interception capability. The Air Force will use a TDMA technique, whereas, the Navy will use distributed DTDMA system.

EJS

EJS is a voice system that uses the JTIDS waveform. At present, the training mode is identical to the voice mode of TDMA JTIDS. The operational mode is being defined.

EPUU

PLRS is an Army/Marine Corps line-of-sight system designed to provide relative position information and limited data exchange between users. Message routing, net control, and user unit position calculations are performed by a master unit. All messages are relayed through the master unit.

EPUU incorporates all of the attributes of PLRS. In addition, it allows user units to communicate directly with one another without going through the master unit.

HAVE QUICK

HAVE QUICK is a special applique which physically replaces the frequency synthesizer on the AN/ARC-164 UHF radio. This applique provides the means to add slow frequency hopping to increase the antijam capability of the radio. It also provides some spectral spreading, thereby reducing the probability of intercept.

SINCGARS

SINCGARS is the jam-resistant VHF-FM radio communications system that will provide the primary means of command and control for infantry, artillery, and armored units. It will be the primary means of communicating in the Division for conduct of the land war. SINCGARS replaces the current VHF-FM combat net radios. Airborne versions of the radio will be used on aircraft that communicate with Army ground units.

GPS (five channel)

GPS is an all-weather, 24-hour continuous navigation system that uses satellites in circular inclined orbits to obtain worldwide position, velocity, and time estimates. The five-channel set continuously tracks and monitors four satellites simultaneously. The fifth channel monitors other satellites to ensure optimum performance.

TACAN

The TACAN system is an L-band line-of-sight navigation system that provides distance and bearing information from an aircraft to a beacon. Ground beacons are located close to airports along enroute airways and aboard Navy ships. Airborne beacons are used by tanker aircraft.

IFF MARK XII (I&T)

The IFF MARK XII is an L-band line-of-sight system used to identify friendly aircraft. It consists of an I and T when installed on an aircraft. (Ground installations may only have an interrogator.)

MLS

MLS is designed to provide guidance to the azimuth and elevation flight path angles as received from a ground station. Unlike a conventional ILS, the MLS receiver allows the desired azimuth and elevation angle to be selected in the cockpit. The MLS is being designed to replace ILS.

ILS

ILS is an all-weather navigation system used at airports for landings. The ground-based beacon transmits heading (bearing) information in the VHF band. The descent information is transmitted in the UHF band. In addition, marker beacons are used to tell the aircraft how close it is to the runway.

VOR

VOR is a directional indication system operating in the frequency band of 108 to 118 megahertz. The passive airborne receiver obtains bearing information from a ground-based beacon. The beacon broadcasts a continuous wave carrier amplitude modulated by a rotating antenna which produces the desired bearing information. Station identification is also broadcast in Morse Code and advisories (weather, status of other stations, and so forth) may be broadcast over a voice channel.

TCAS

TCAS is used to prevent midair collisions. It uses a transponder to obtain information from other aircraft. The system keeps track of other aircraft, and provides warnings of impending collisions and recommendations on how to avoid them.

IFF MARK XV

The IFF MARK XV is a cryptographically secure spread spectrum L-band line-of-sight system used to identify friendly aircraft. It is to be the replacement system for the IFF MARK XII.

HF

HF radio operates in the 2 to 30 megahertz frequency range. It is not restricted to line-of-sight operation, and is therefore used for long-distance communication.

UHF

UHF radio operates between 225 and 400 megahertz. It is line-of-sight restricted, and is used for air-to-air and air-to-ground communication.

VHF

VHF radio operates between 30 and 300 megahertz. It is line-of-sight restricted. It is used for ground control and communication with ground combat troops.

ACMI

ACMI system is used to aid in training pilots. Aircraft are equipped with an instrumentation system that provides aircraft data and position to a ground terminal in real time. The instrumentation system is normally contained in a external pod. This data can be displayed and/or stored for playback during critiques at the end of the training mission. ICNIA will interface with the airborne instrumentation system to provide the ACMI access to aircraft data not normally available.

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