informatics inc. 4720 MONTGOMERY LANE / BETHESDA / MARYLAND 20014 / PHONE 654-9190

16 November 1965

As requested the ANTACCS Phase II Interim Report No. 558-21-1 is enclosed for your information.

Sincerely,

John A. Lytle
Project Manager

Prepared for:

Office of Naval Research

Interim Report

20 October 1965

ANTACCS Phase II Report

Report No 558-21-1

Contract Nonr 4388(00)

Prepared by:

Informatics Inc.
4720 Montgomery Lane
Bethesda, Maryland

John A. Lytle

TABLE OF CONTENTS

1.0 INTRODUCTION

This is the Informatics Inc interim report on the Advanced Naval Tactical Command and Control Study (ANTACCS) Phase II work under Contract Nonr 4388(00). The work is being conducted under the direction of the ONR Advanced Warfare Systems Division. Informatics Inc. delivered four volumns of the ANTACCS Phase I report and the material presented herein is a follow-on of the Phase I work and concentrates on three specific study tasks.

The Development of the Scope and Operating Concept for a Naval Tactical Command and Control System for the 1970-80 period.

The Development of a Description of the Command and Control Subsystem for a CVA for the 1970-80 period.

The Development of a concept for a data system hardware and software family which might be utilized to fulfill the 1970-80 system requirements.

All of the study tasks have been approached from the fundamental point of view that a major objective of the total ANTACCS effort is to provide assistance to Naval system planners who are responsible for future command and control system development and implementation management. The study results, therefore, are not merely stated and described as products, but rather, are described in a manner which shows the methodology or logical approach used in developing the product along with the product description . This approach description allows system planners to test our work products by several means. First, the methodology used in arriving at problem solutions can be evaluated with respect to solving Navy problems, second, the input information and assumptions used may be analyzed for completeness or omissions and last, the product can be verified or altered by planners using more complete or more current input information and assumptions and reworking the problem using the analysis methodology.

This problem approach is not foolproof, however, because techniques and methodology for informations systems analysis are still in infancy and may well not approach wide acceptance for many years.

Our objective in the methodology demonstration is to use the best problem solution approaches known to us today and update these with our recent experiences and judgement.

The study tasks reported herein are presented at the current stage of completion. As an aid in following our work Figure 1 shows the study tasks in ANTACCS Phase II. Those marked ii are the responsibility of Informatics Inc., those marked EMC^2 are the responsibility of Electronic Management Computerology Corporation. Those marked as mixed are the responsibility of both companies. The study tasks which are the responsibility of Hobbs Associates are not shown on the figure.

Current plans and study emphasis indicate that the scope and operating concept study will be completed in January 1966. The results of this task are pivotal for studying future Naval tactical command and control systems, whether platform based (CVA), operations based (Anti Submarine Warfare), or command level based (CTF). Informatics, Inc. and EMC^2 are both working on this task. Section 2 describes the Informatics Inc work to date on the scope and operating concept task.

Section 3 describes the Informatics Inc. progress to date on the CVA System Description Task. This progress is primarily based on our study visit to the U.S.S. America.

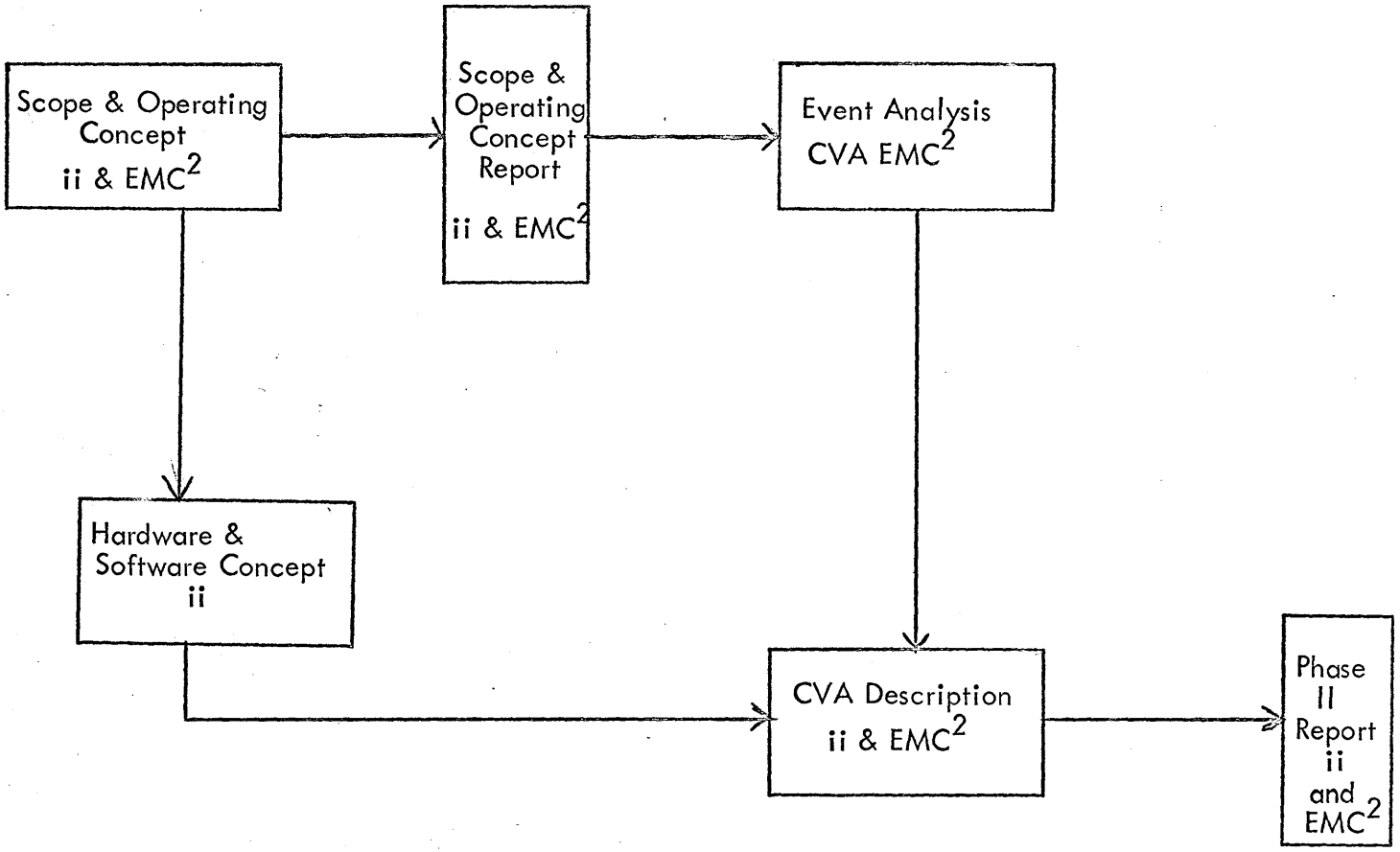
Section 4 describes a preliminary concept for a data system hardware and software family and suggests a new form of system development and implementation which may be possible using this approach.

Section 5 presents the objectives and plan for the remainder of Phase II.

Figure 2 shows the ii tasks and the man months expended against these tasks through September 1965.

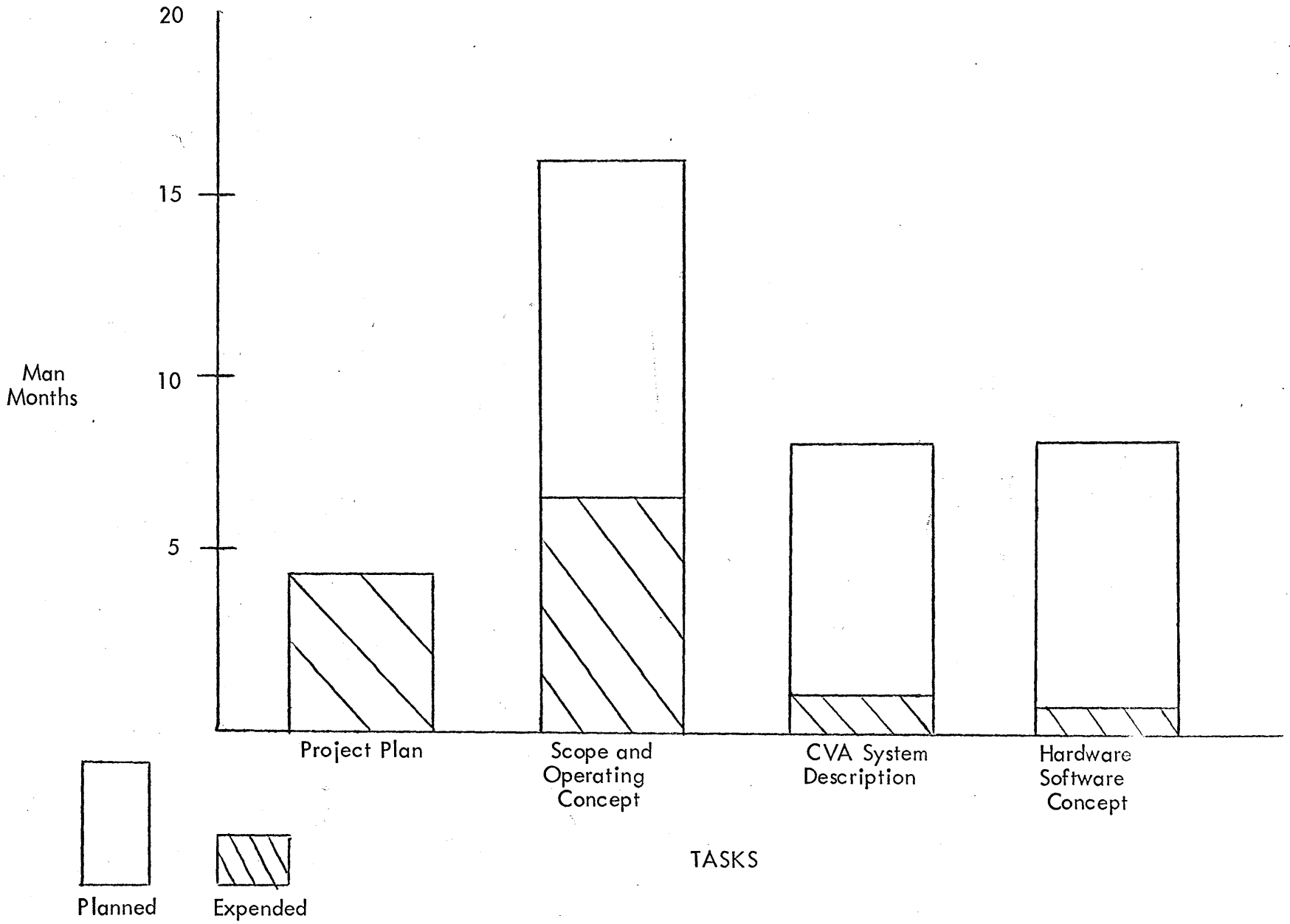
Relationship of Tasks for ANTACCS Phase II

Figure 1



Informatics Inc. Project Expenditures through September 1965

Figure 2



2.0 SCOPE AND OPERATING CONCEPT TASK

2.1 SCOPE METHODOLOGY

This task has the objective of laying the groundwork for all of the ANTACCS Phase II tasks and for other studies in Naval tactical command and control. The scope and the bounds of the problems under consideration should be established in detail and understood at the completion of this task. The inputs to the task are the ANTACCS Phase I report, current tactical operations, predicted tactical operations, and Navy Guidance. The use of each of these inputs in the analysis is described next.

Current tactical operations inputs are required to provide team orientation into the operations of Naval tactical forces. This orientation is for two purposes: to become familiar with the operational divisions and sections on the various Naval tactical units and to ascertain the areas which must be analyzed in detail during the study.

Other types of information which may aid in understanding current tactical operations are operations orders, plans, and scenarios which may be available in OPNAV from past operations.

The next information input is expected tactical operations. The primary sources of information are OPNAV, OEG and other Naval organizations which develop future doctrine, types of forces, and other tactical engagement necessities. The study team cannot hope to develop future tactical operations doctrine but merely to use expert opinion from the previously mentioned Naval offices as an information base in analyzing automation/mechanization potentials to predicated tasks and functions required in these tactical operations. The Phase I report also provides inputs to the detailing of scope and operating concept because it contains a collection of requirements information for various nodes of Naval tactical organizations.

In using Naval guidance inputs, emphasis is focused on bringing together information from ONR, OPNAV, BUSHIPS, OEG, NAVCOSSACT, Fleet Programming Centers, and Operational Fleet Personnel to insure that the study team is working against realistic expected command support requirements and environment.

The general procedure for defining scope using these various inputs is shown in Figure 3. The first step, defining subject areas, requires an understanding of the general type of system under study. As in all definition problems criteria are required for selecting among alternates. Development of these criteria is shown as the next step. Collection of information which relates to the subject areas is shown to be dependent on the subject areas selected. Next the collected information is filtered using the various criteria and a preliminary scope definition is formed. Iterations through this general procedure are shown to allow refinement of the definition against overall scope definition criteria.

2.2 SCOPE SUBJECT AREAS

The subject areas for defining the scope are:

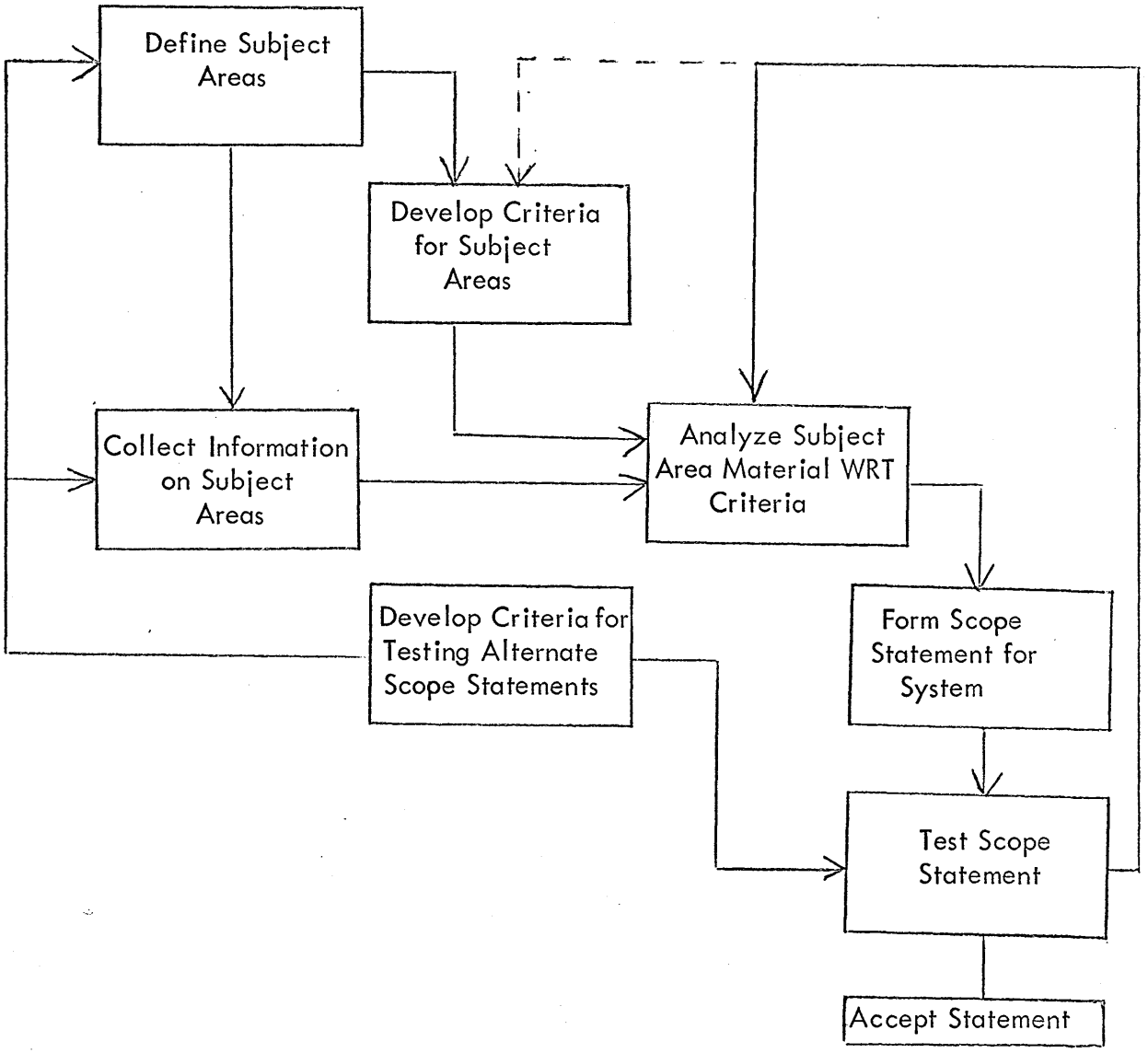
1. Levels of command and staff to be supported, including a method for defining a level of command. (EMC^2)
2. A delineation, for each level of command, of the range of operational tasks to be supported. This may take the form of several matrices as follows: (EMC^2)

LEVEL OF COMMAND

ELEMENTS OF COMMAND

FUNCTIONS	Planning	Organizing	Directing	Controlling
OPERATIONS				
INTELLIGENCE				
LOGISTICS				
ADMINISTRATION				

Figure 3

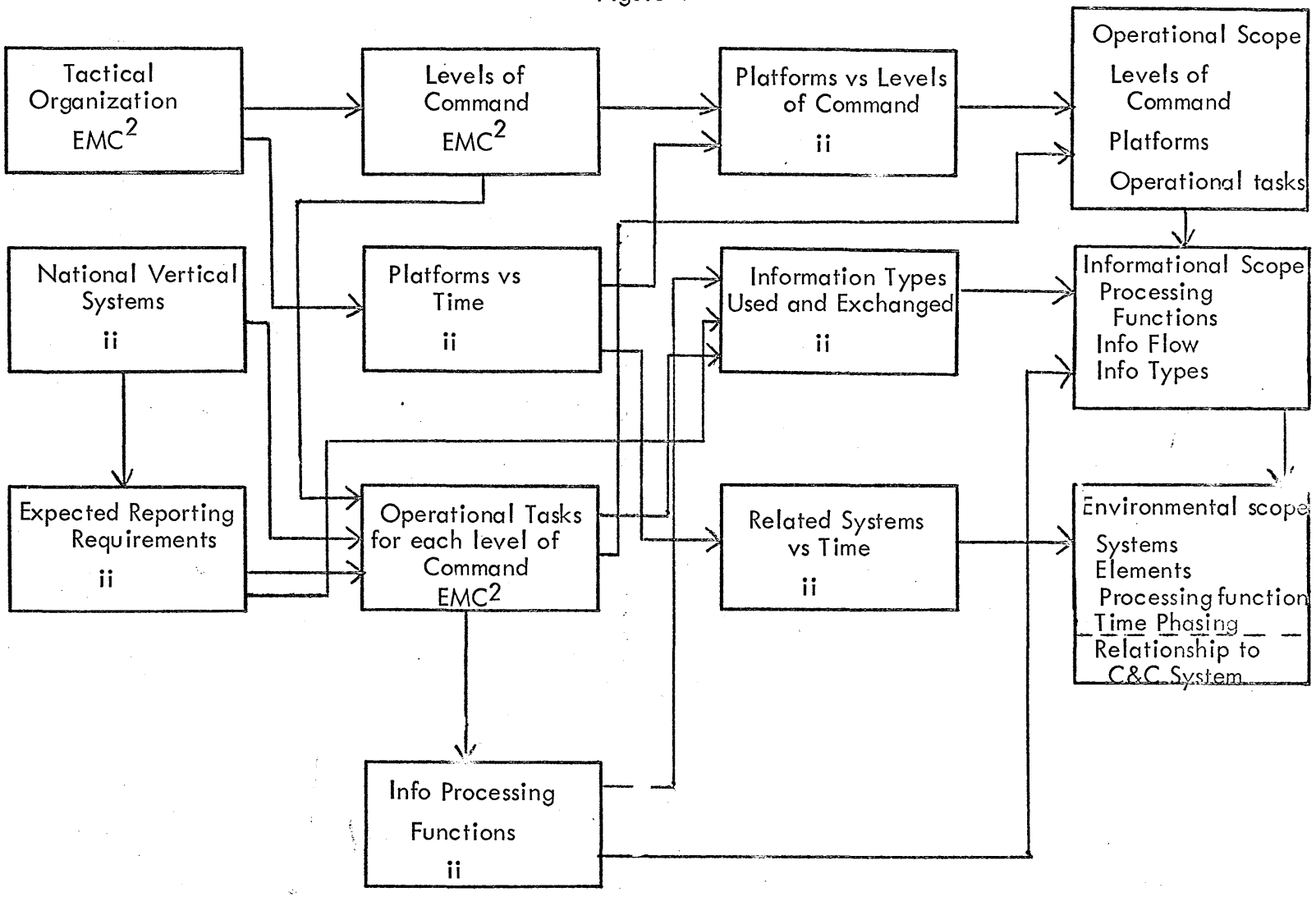

Define Subject Areas
Develop Criteria for Subject Areas
Collect Information on Subject Areas
Analyze Subject Area Material WRT Criteria
Develop Criteria for Testing Alternate Scope Statements
Form Scope Statement for System
Test Scope Statement
Accept Statement

3. A description of expected tactical organizations, including a discussion of how various tactical organizations might be formed to perform operations or missions. (EMC^2)
4. A description of the platforms which will be used including life expections for each unit type. (ii)
5. A matrix which relates platforms and levels of command. (ii)
6. A general description of the type of information which will be used and exchanged regardless of degree of mechanization of particular portions of command or communications. (ii)
7. A discussion of the constraints on tactical systems caused by the National Organization of Vertical Systems, i.e., logistics, intelligence, communications, weather, etc. (ii)
8. A description of the expected reporting requirements of tactical commanders to Naval and National Command levels. (ii)
9. A description of information handling and communications systems which may be present in the environment with any tactical C&C system with particular emphasis on time phasing of operational usefulness, information exchange among systems, and information processing functions of the various systems. (ii)
10. A description of the information precessing functions which support the operational tasks. (ii)

NOTE: The EMC^2 or ii at the end of the subparagraph indicate the contractor who has responsibility for the subparagraph or paragraph.

Figure 4 shows the interrelationships of these ten subject areas. It also shows how these subjects contribute to the scope definition which consists of operational scope, informational scope and environmental scope.

Figure 4


Tactical Organization EMC2
Levels of Command EMC2
Platforms vs Levels of Command ii
Operational Scope
Levels of Command
Platforms
Operational tasks
National Vertical Systems ii
Platforms vs Time ii
Information Types Used and Exchanged ii
Informational Scope
Processing Functions
Info Flow
Info Types
Expected Reporting Requirements ii
Operational Tasks for each level of Command EMC2
Related Systems vs Time ii
Environmental scope
Systems
Elements
Processing function
Time Phasing
Relationship to C&C System
Info Processing Functions ii
STUDY AREAS
PRODUCTS

The Operational Scope is a statement of the operational tasks of each command level in the expected tactical organizations. Each command level is also keyed to the type of ship where the commander may be embarked. This scope statement is dependent upon definitions of tactical organizations, levels of command, platforms, and operational tasks (delineation of responsibilities) of commanders. This scope statement is time dependent, since platforms and tactical organizations will change with time. The operational tasks in specific detail are also time dependent. However, the general task requirements to prepare operations plans, to organize resources, and to direct and/or control operations will remain constaint over time.

The Informational Scope is dependent upon the operational scope. It consists of a description of the information types, flow, and processing functions. It is particularly important to state this information for each level of command (node), and for the total command organization.

The Environment Scope is a two level statement. Each information handling system in the environment bounded by the Operational Scope should be described by the information processing functions supported, time of system operational capability, and the system elements (and location).

The second part of the enviornment scope definition is developed by matching these descriptions with the informational scope definitions.

In summary, Informatics Inc. is responsible for the following scope study areas:

Describing Platform types over the Time Period of operational Usefulness

Describing the relationships between Platform and Levels of Command

Describing the Information Used and Exchanged

Describing National Vertical Systems which may effect Tactical C&C Systems

Describing Expected Reporting Requirements to High Echelons

Describing the information handling systems which may be present in the operational environment

Describing the information processing functions which support the operational tasks.

The remainder of the section describes our progress on these study areas.

2.3 SCOPE CRITERIA

A number of criteria have been developed in order to analyze the subject area members. These criteria are presented below by scope subject area.

Platforms

1. Does the platform participate in a tactical operation?
   and
2. Is the platform organic to a task organization?
   and
3. Is the platform a combatant unit or command unit?
   and
4. Will the platform be operational in 1970-80?

Platforms Vs Level of Command

1. Is the platform designed to support a task element or unit commander?
   or
2. Is the platform designed to support a task group or force commander?

Information Types Used and Exchanged

1. Is the information command information (orders and reports)?
   or
2. Does the information support tactical operations planning, directing, or controlling? (own forces information, enemy forces informations, environmental information)?

National Vertical Systems

1. Does the National Vertical System provide material support to tactical units?
   or
2. Does the National Vertical System provide information in support of tactical operations (intelligence, environmental)?
   or
3. Does the National Vertical System provide facilities to tactical units (communications terminals)?
   or
4. Does the National Vertical System prescribe procedures to tactical commanders? (Emission control, encryption, frequency allocations)

Reporting Requirements

1. Is the report based on tactical operations?
   or
2. Does the report contain intelligence or weather information?
   or
3. Does the report contain own force status or position information?

Other Systems

1. Is the system organic to a tactical unit or tactical organization?
   and
2. Does the system acquire, process, or disseminate tactical command or command support information?
   and
3. Will the system be operational in the 1970-80 period?

Information Processing Functions

1. Does the function support command decisions? (plan approval, engagement, weapons usage, etc.)
   or
2. Does the function support information decisions? (Message routing, track correlation, track identification, etc.)
   or
3. Does the function provide own resource information?
   or
4. Does the function provide environmental information?
   or
5. Does the function provide intelligence information?

2.4 INFORMATION ON SUBJECT AREAS

Informatics Inc. has made a number of visits to Naval offices in order to obtain input information to the subject areas. A number of further visits and document reviews are required to complete the data gathering. Our progress in each of the subject areas is described next.

Platform Types Over Time Period Operational Usefulness

Informatics Inc. is currently using the information provided in the ANTACCS Phase I report, Volumn II. Details will be expanded and verified during the next period.

Relationship Between Platforms and Levels of Command

This task is dependent on the information currently being supplied by ECM^2. The study task will be accomplished in the next period.

Information Handling System in the Envrionment

The systems which have been partially described to date in Phase I are:

NTDS, ATDS, MTDS, CAPE, SINEWS, SHIELD, ASWEPS, TFDS, TRANSIT, SINS, SOSUS, ASCAC AND FFDS.

These descriptions all require more detail concerning operational concepts, type and formats of data, and time of operation usefulness.

IOIS and A-NEW have been described in Phase II to date. ADSAF, ATACS, and TIPI will be described during the next period.

The interface or integration of these systems and an Advanced Naval Tactical command and control system will be established during the next period using the following definitions:

1. Integration - This means that the system is assimilated by the C&C system. All of the hardware, software, and procedures required are merged and the other system looses its identity.

2. Electrical Interface - This means that the system and the C&C system are electrically connected for the transfer of control signals, information, etc.

3. Information Interface - This means that the system and the C&C system are related through the transfer of information from one system to another using format rules, encoding standards, etc.

4. Procedural Integration - This means that systems are integrated through human facilities, i.e., procedures are established so that people can perform tasks using both systems to support them. This usually requires the person to change the format, encoding, or the form of the information which is passed from one system to another.

5. No relationship between the systems because there are no common functions or information.

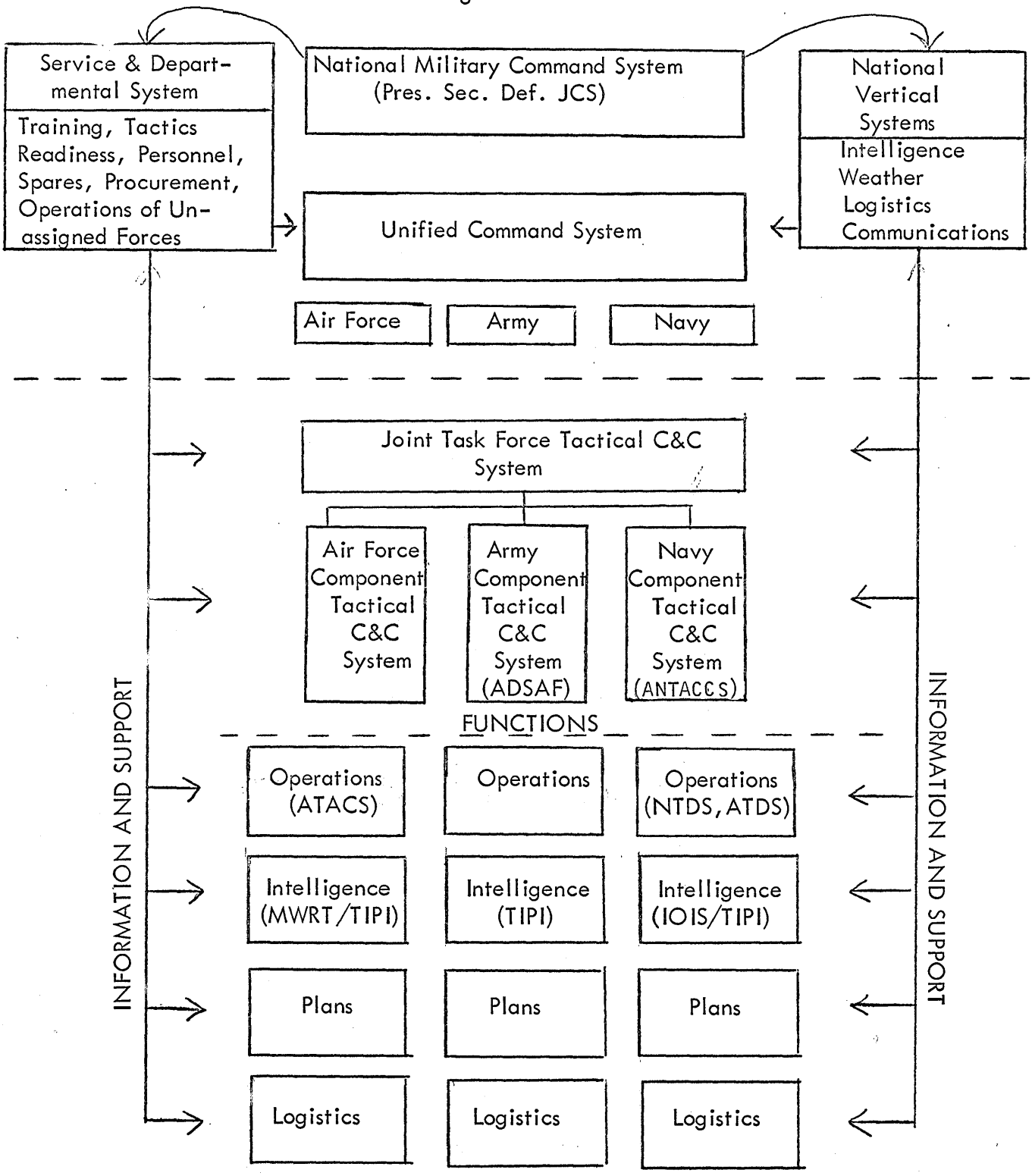
The five states of relationship are dependent upon the degree of similarity of the functions and information which the various systems support or work against, and the time phasing of the operational usefulness.

National Vertical Systems

Figure 5 shows our impression of the general relationships among systems which serve The National Military Command, The Service Departments, National Vertical Systems, and Tactical Forces. The four National Vertical Systems identified are:

Intelligence
Weather
Logistics
Communications

Tactical Command & Control Systems, Relationships, Support
Figure 5



The principal characteristic of these national systems is that they can be divided into two general groups.

Support Systems

Information Systems

The support systems, communications and logistics, provide services or resources to command activities. The information systems, intelligence and weather, provide information for use of command activities.

At the present time the information systems can be classified as manual or semi-automatic systems. There is tremendous effort being expended to automate them.

Informatics Inc. has obtained preliminary information on the Joint Meteorological Satellite Program and on the U. S. Naval Weather Service. It indicates that tactical forces of the 1970-80 will receive two principal types of weather information from non-organic systems. Analog or video imagery data and processed digital data will be available from burst type readout and teletype readout, along with general purpose broadcast. Rates, formats, specific contents, etc., will be published in reports by the Meteorological Offices in early 1966. Informatics Inc. will obtain this information and integrate it into the scope definition as appropriate.

An important aspect of the logistic support systems is that it must be supported by an information system. A number of large systems currently exist to handle some of these information support requirements. Some information is available on the logistics system as well as on the communication and intelligence systems. Informatics Inc. will obtain this information and consider the impact which the National Vertical Systems may have on tactical C&C systems. The following questions will be used in this consideration.

What constraints are imposed upon the tactical force information system by all vertical systems?

How are the tactical C&C systems to be interfaced (see interfaced definitions above) with the vertical systems?

What are the message formats for each system? How do they compare with each other? What security level will be required? At what frequency will the message be sent or received?

What are the operational conflicts between the various vertical systems and command and control?

What informational conflicts will arise as a result of the interface of tactical command and control with National Vertical Systems?

Who will have the authority to resolve any and all conflicts arising from the interfacing or integration of tactical command and control and National Vertical Systems?

Who will establish the requirements for the vertical systems?

What will the conditions under which the vertical systems will operate independently and/or interface with tactical command and control?

Does the National Vertical System have a similar function (higher level) to the department or staff function of the tactical unit or command?

If functional duplications exist and conflict, how will these conflicts be resolved - by whom?

Does the National Vertical System work against inputs from tactical forces?

Does the National Vertical System provide information to tactical units or command? If so, what type, etc.?

Expected Reporting Requirements to Higher Echelons

The areas of investigation for the description of the expected report requirements to Naval and National command levels are:

What type of operations and status reports are required in a normal environment?

What type of reports will be required in an emergency environment?

What will be the format requirements of each type of report?

What will be the communication and security requirements of each type of report?

Which command levels are responsible for the various reports in the normal condition?

How will the command level reporting requirements change under actual engagements or emergency condition?

What will the frequence of reporting requirements under normal and emergency conditions?

Does the reporting requirement necessitate that new reporting by units or commands in addition to the present reporting?

Figure 5 also indicates the general nature of the tactical force relationship to National Military Command, Naval Departmental and Type Command and National Vertical Systems Areas. It is readily apparent from this diagram that a tactical force will have information interfaces with all of the above named higher echelons.

A very preliminary list of reports which may be required by the force command to one or more of these higher echelons is:

Casualty

Deployment and Movement

Strike Related

Situation

Reconnaissance

CHOP

Weapons Status

Replenishment

Acknowledgement of Orders

Local Weather

Engagement

Readiness

Emission and ECM

Interdiction Operations

Individual Tactical Units may also be required to report to higher echelons beyond the task command using a number of the above named reports.

Informatics Inc. will be gathering more information on this subject and reporting it during the next period.

Information Used and Exchanged

This study area is currently underway.

The primary sources for the development of this item are expected reporting requirements, operational tasks for each level of command, and information processing functions. As these items become final a general description of the type of information will be used and exchanged will be developed. The following set of questions have been established as guidelines in developing the description.

What types of information will be exchanged?

What are the level of command which exchange the various types of information?

What is the context of the information to be exchanged by each level?

What is the order of priority of the information to be exchanged?

What will be the frequency of the information to be exchanged?

What is the distribution of the information?

Are the requirements for redundancy of information exchanged or used?

How will the receiver use the information?

What are the requirements for using the information exchanged by the various levels?

Under what conditions will the information be exchanged and used?

What will be the mode of exchange?

What levels of security will the information have?

Is the information related to an identifiable source as a tactical unit or tactical command function?

Can the information be classified as command data?

Can the information be classified as tactical data information support to the tactical unit department, tactical command staff, or commander?

Information Processing Functions

This task activity will be developed in concert with the EMC^2 and the other Informatics Inc. scope items.

3.0 CVA SYSTEM DESCRIPTION

3.1 PURPOSE

The purpose of this work is to describe the data system which will support the CVA commander and the embarked Commander Task Group or Force. This system description will cover the operational tasks to be supported, the technical functions and the data processing operations required. The description will be developed from the point of view that present hardware and software systems aboard the CVA will be the starting point for evolving to the advanced hardware/software concept described in section 4.

3.2 PROGRESS

The principal effort to date on this task has been the study visit to the operating CVA. The majority of the work will be completed after scope and operating concept definition has been established since the CVA system is a subset of the total Naval Tactical C&C system.

The CVA visit was planned to fulfill the following objectives:

To clarify our understanding of command procedures and activities on a CVA.

To observe and summarize the type of information processing accomplished by staff and operating sections in supporting commanders during operations.

To gain a first hand overview of the layout and relationships among the CIC, TAC PLOT, FLAG PLOT, AIR OPS., Bridges and other operating areas on the CVA.

To isolate tasks, functions, etc. which may require future data system assistance.

To obtain an appreciation of the commonality or diversity of information processing and historical information banks which are utilized by operating personnel.

The team was able to meet each of these objectives for the following type of exercise operations:

1. General Air Operations of Launch and Recovery both day and night

2. Air Defense Exercise when under attack by aircraft

3. Air Defense Exercise when under attack by aircraft using passive and active ECM.

Briefings on the functions performed and observations of operations were made in the following spaces:

Flag Bridge
Flag Display and Decision
Flag War Room
Bridge
Navigation
Meteorology
Communications Operations
Combat Information Center
- Weapons Control
- Intercept Control
- ECM
- Surface Control
- Carrier Air Traffic Control Center

Sonar Room
Primary Flight Control
Flight Deck Control
Hanger Deck Control
Engineering Control
Damage Control Center
Integrated Operational Intelligence Center
Ready Room
Supply Data Processing Center
Computer Room for CIC

In addition to these observations, Admiral Cobb, Command Carrier Division Two and CTG for this exercise held a staff and study team meeting on 4 September. A number of general observations and questions were discussed at this meeting. The new FLAG Display and Decision (D&D) space on this ship which replaces FLAG PLOT was discussed in detail. The space is located below deck and is well located with respect to related ship spaces. Admiral Cobb and his staff indicated that this new area is being tested to ascertain whether it is superior to previous FLAG PLOT locations. Early indications are that the area appears better equipped to support the FLAG than previous areas. A further observation by the Admiral was that future FLAG officers may not expect a portable D&D but may move to the ships which have these facilities. In addition, members of the FLAG staff briefed the team on individual responsibilities during the week. The team also received briefings on various exercises being conducted and purposes of the exercises.

Figure 6 is an illustration of the command, staff and operations activities which were observed during the CVA visit. This diagram supports the generalization that a tactical C&C system must support two types of commanders. The tactical unit commander who works through and is supported by departmental heads as shown on the bottom of the figure, and the task commander who works through and is supported by a classical type military staff. The task command support functions are shown in the circle.

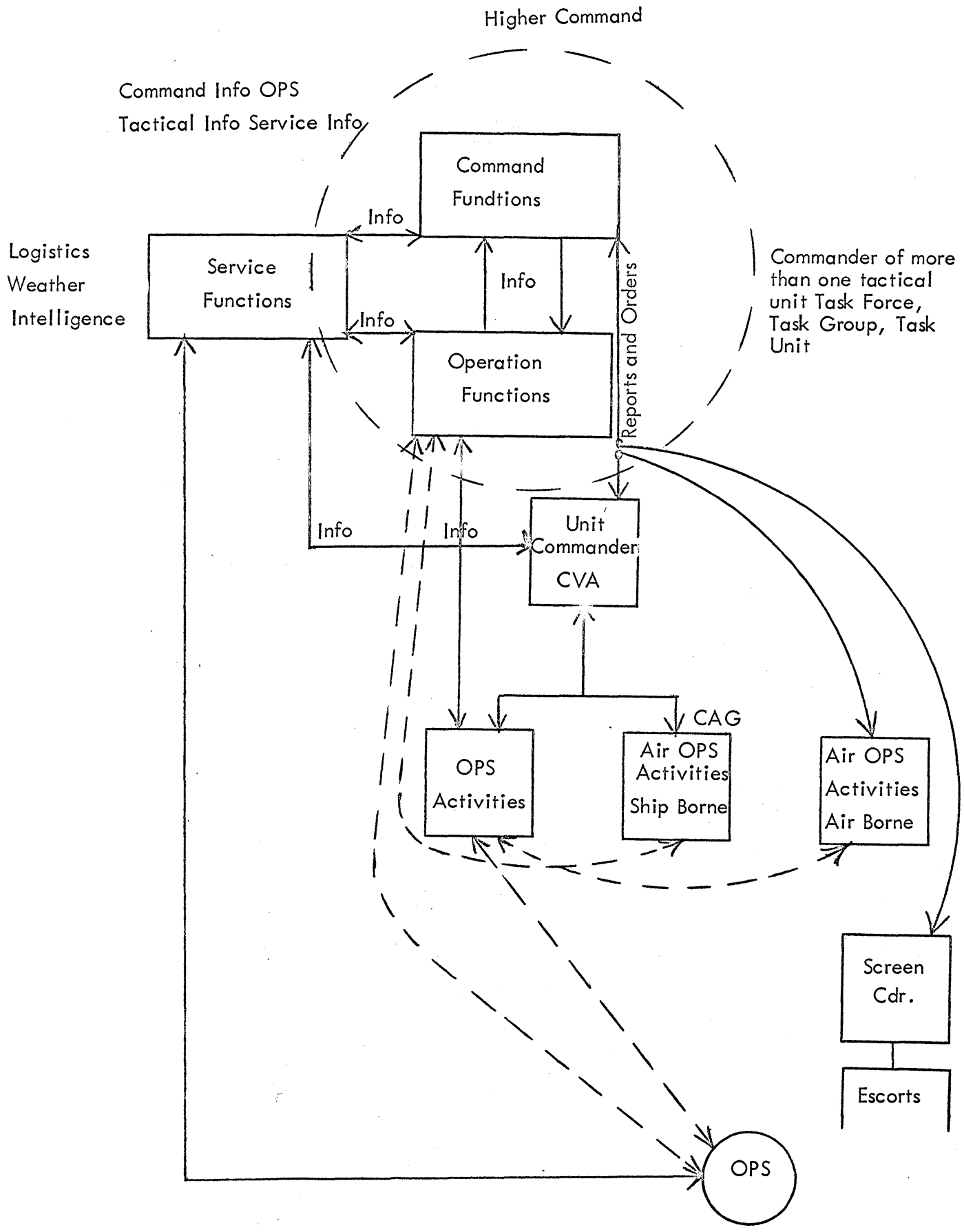
In the command environment of a CVA there are two types of command information structure:

1. The task directed command information structure of the CTF or CTG for tactical operations.

2. The ship directed command information structure for the unit commander for the ship operations.

In the task directed command information structure, the plans officer, the staff operations officer and the specified operations officer (Air Operations, ECM, Strike Weapons, ASW, Intelligence, Surface Operations, and ASW) work closely with the operations officers of the ship to develop the plans for the tactical operation under command of the task commander.

Figure 6


Higher Command
Command Info OPS
Tactical Info Service Info
Command Fundtions
Info
Logistics
Weather
Intelligence
Service Functions
Info
Info
Operation Functions
Reports and Orders
Commander of more than one tactical unit Task Force, Task Group, Task Unit
Info
Info
Unit Commander CVA
CAG
OPS Activities
Air OPS Activities Ship Borne
Air OPS Activities Air Borne
Screen Cdr.
Escorts
OPS

The ship directed command information structure is focused on carrying out the operations order on a daily basis. The instrument used is the operation plan of the day.

The operations plan of the day is issued by the executive officer, it is his interpretation of the operations orders for the CVA including the Air Wing. It states the guide lines that the department heads are to use in developing (planning) the activities for the department on a daily basis. The department head must interpret the guide lines within the frame of the job to be done, the resources and personnel required, the time to accomplish the job, and his authority and responsibility. Any deviation from or difficulties involved in the execution of the goals stated in the operations plan of the day must be reported to the executive officer for resolution or redirection.

With the department plan firmly established, the department head must organize, direct and control his personnel and resources so to accomplish each task in the time required. It is his responsibility to insure that the tasks are properly ordered so that his personnel and resources are neither strained nor slack as to be ineffective or non-responsive to change in direction. Through his subordinate officers the execution of his plan is directed and controlled.

The department head will personally direct the major task and he will receive reports on the progress, possible and actual probelms encountered and recommendations on the other tasks from his officers. With this information, the department head will resolve any problems that may arise which fall within his area of responsibility and authority. In turn, he will report on progress, the possible or actual problems encountered, the condition of his men and resources, and the recommendation in carrying out the operations plan of the day to the executive officer.

3.3 ANALYSIS GUIDELINES

Some analysis guidelines to be used in developing the system for mechanizing or automating functions or function linkages on the CVA are listed below:

Does the data input, processing, etc., exceed human capacity to handle without extensive queueing, etc.?

Can the function processing be logically expressed?

Is the function characterized by large data base entry and lookup (IS&R) processes?

Is summary data or information required rather than all available information?

Does non-timeliness of function output or linkage data cause a delay in operations or other functions which may delay availability of information to persons requiring information?

Is there a large amount of constant demand or emergency demand clerical work required in the function data streams?

This means that clerical work must be differentiated from analytical work. Many clerical type jobs contain analytical tasks. These must be analyzed to ascertain if mechanization/automation techniques can be applied.

Is there a data or information requirement for many users in approximately the same time frame (users on same tactical unit or in different units)?

Can the cost of mechanization/automation be estimated?

Can the cost of manual operations to be supported be estimated?

Can the cost for supporting commanders be compared to costs for systems other than data handling (weapons, radar, etc., other service)?

Can function correspondence be established between competing systems?

Can costs eventually be assigned to types of combatant ships and tactical organizations and missions?

Can costs to interface with higher level or National Vertical Systems be stated (man power, money, time, etc.)?

4.0 DEVELOPMENT OF AN HARDWARE/SOFTWARE CONCEPT

4.1 INTRODUCTION

The ever increasing demand for data processing assistance to Naval functions in a tactical environment is evident. An important concern to Naval system planners is the proper evolution of such data systems in light of:

Continual improvements in hardware capability

Current investments and future commitments to hardware/ software

Additional and/or continuing changing functional requirements

Presented here is an approach to resolving these three apparently opposing forces. The rational for this approach starts with the general purpose nature of digital computers and associated peripherals, which together with a suitably general purpose software framework will make it possible to develop ever increasing data processing services to multiple users in the form of a public utility. This system will be called the Integrated Naval Data Systems (INDS).

This exposition is concerned with the problems of providing data processing services to Naval tactical units. These units are typically physical entities such as ships and airplanes. In particular, we are concerned here with the individual ship and will, for the most part, treat it as an entity, although it may be part of a Task Force or Group and hence have external dependencies.

4.2 CURRENT APPROACH TO DATA PROCESSING SUPPORT

The classical approach to analyzing the applicability or suitability of data processing to a particular problem is to define the requirements, determine the processing load and recommend appropriate hardware and software solutions. This indeed was the basic manner in which the Navy solved the specific problem of automatizing the CIC (e.g., NTDS). In fact, this has also been the approach in the design of the IOIC.

Hence, it is not surprising that today's CVAs include in their suit a variety of computerized subsystems including, for example:

NTDS:	USQ20
IOIC:	AN/UYK1, USQ20
SPN10:	New digital system to replace analog computers
Supply:	UNIVAC 1500 (to be installed)

It is evident at this time that such proliferation will probably continue on a subsystem basis. It must, however, be pointed out that the very fact that computers are general purpose is good enough reason why they should be looked upon as a centralized utility which can be made common to many purposes and, in fact, possibly on a more economical basis than decentralized and fragmented capabilities.

Thus, just as the generation of electric power is an accepted centralized utility (at home, office or on ship), so data processing can be looked upon as a public utility. This concept is rapidly becoming a reality in today's commercial world as a result of significant technological advances with respect to developments in hardware and software in areas of data communication, time-sharing systems and remote user consoles. Hence, data processing as a public utility should be examined for relevancy to Naval tactical unit requirements. For conveniency we select the CVA as an example for this examination.

4.3 OBSERVATIONS CONCERNING DATA PROCESSING ON A CVA

Based on the considerations of the ANTACCS study to this date, and especially upon the one week trip on board the U.S.S. American (CVA), the following observations are made:

a. The CVA is a large operational unit much like a large business. It has a variety of data processing problems, all of which are interrelated, hence requiring excellent communications.

b. There are essentially three modes of ship operation: routine, flight operations and general quarters.

c. Often the same data is collected and passed on at more than one point on the ship.

d. Often the same data is required by more than one point on the ship.

e. Large volumes of redundancy in information are accumulated over short periods of time (e.g., CATCC).

f. Much information is accumulated to identify exceptions or for demand review.

g. The movement of data is highly clumsy as it requires tote boards transcription.

h. The realiability of hand written tote board information is questionable.

i. The flow of information (reporting and dissemination) is the most critical and "man consuming" task on board the CVA during General Quarters.

j. There is a simple but severe problem of capturing status information and relaying this information.

k. The ship is "talker" bound.

l. Each ship subsystem has several alternatives for degraded service.

m. There are a number of highly critical and time dependent operations where pressures on personnel are high and decision making significant (e.g., recovery of aircraft).

Translating the above to data processing terms, it is evident that the following technological capabilities can improve performance:

a. Remote data acquisition devices

b. On-line data input devices

c. Data readouts displays

d. Inquiry consoles

Clearly these capabilities function best with on-line, remote user stations tied to a data processing system in the sense of what is popularly called a time sharing system. In addition to these peripheral devices which directly assist the personnel, it is also necessary to have the required data processing support. It is our strong conviction that the Navy investiage and consider a centralized and public utility for the following reasons:

a. Provides common data base, limiting current redundancies

b. Provides better system redundancies

c. Simplifies overall EDP maintenance

d. Reduces spare parts inventory

e. Makes more efficient use of the equipment

f. Possibly reduces total required equipment.

These, of course, are the usual reasons for arguing for an integrated multi-computer system to serve as a public utility. In the case of the CVA there is the additional supporting requirement for centralization since most of the ship's operation is interrelated. Hence, if independent computerized subsystems were to profilerate (as they are now doing), there would come a time when a centralized computer system would probably need to be established anyway to perform the communication switching function.

This combination then of public utility, time-sharing and centralized data processing forms the basis for the philosophy of the Integrated Naval Data System (INDS) presented here.

4.4 RATIONALE FOR THE INTEGRATED NAVAL DATA SYSTEM

The concept of the data processing public utility was first advanced by W. F. Bauer in a 1958 paper. It is known that several large corporations are now developing such systems for nationwide and public use. Dozens of other companies are developing such systems for their own use. In fact, the commerical market is possibly leading the military in this technological area.

Perhaps at this point it is important to point out the difference between "centralized", "public utility", and "time-sharing" data processing systems.

A public utility could be centralized or decentralized in the form of a single system or a network of systems. A centralized system could be a physically intact system of multiple modules or a distributed system. Time-sharing characterizes the method of using a data processing system. For example, multiple, on-line users of a public utility data processing system would not necessarily participate in time-sharing.

We assume a computer utility for INDS having the following form and capability:

a. Modular and expandable arithmetic and high-speed memory modules

b. Communication multiplexers

c. Auxiliary storages

d. Conventional peripherals

e. Special purpose, remoted and customer oriented peripherals.

Such a system was described and motivated in the ANTACCS I Phase and in fact is discussed in Volume III, page 5-32 of the Final Report. Also Informatics has advocated the development of a family of Naval computers to meet tactical requirements. This family has been discussed in Volume V of the ANTACCS Final Report and also in the special report submitted on the MTACC project, "MTAC Computer Technology Exploration", 20 September 1965 and can serve as the basis for INDS.

In addition to the hardware, there is a requirement for an advanced Executive System which is capable of managing ever increasing demands on the system. This executive would perform all the traditional housekeeping tasks of a conventional monitor and the time-sharing function, and in addition would have the capability for dynamic scheduling, resource allocation and data management.

The closest near state-of-the-art hardware and executive having the above attributes are those executives now being planned for systems such as the IBM 360-67 and GE 645. Also the Air Force has such objectives as part of the GENESYS and INTIPS effort sponsored by ESD and RADC respectively.

The Navy has the additional important problem of developing a system rationale with does not:

a. Invalidate current or programmed systems.

b. Limit the load capacity on the system.

c. Prohibit future improvements and/or displacement of specific hardware capability.

d. Prevent fair competition to hardware manufacturers.

An INDS like system can meet these objectives.

Fortunately the Navy prescribed the now well known 30 bit NTDS communication interface.

INDS would carry forward this standard and thereby maintain an evolutionary interface with current systems. When such systems are retired, they would be displaced by members of the family of Navy data processors.

The load capacity would be open ended by virtue of the modularity of the computer family.

Future dependencies upon specific devices would be eliminated by providing users universal programming languages and symbolic data referencing or file management operators.

Finally, the utilization of varied manufacturers devices would not be limited as long as electronic interfaces are adhered to and the executive system is able to parametrize in a generic data processing sense the varied capability of the system components.

Admittedly, much is assumed for the executive and penalties of overhead in efficiencies can be claimed for a system like INDS if it must meet the requirements of this section.

Unfortunately cost effectiness studies for systems like INDS have not been adequately made at this time. Furthermore, most, if not all, of the current experience has been with fragmented time-sharing systems such as Project MAC or commercial systems such as IBM's Quiktran. (By this is meant that the MAC like systems service independent users.) Hence, it is not possible at this time to state conclusive arguments realted to cost.

However, it is equally important to consider INDS from a functional viewpoint and note the advantages that can be gained. This is done in the next section.

4.5 OPERATIONAL ASPECTS OF THE INTEGRATED NAVAL DATA SYSTEM

As described in Section 4 INDS potentially meets desirable objectives from the point of view of hardware management and computer utilization. From the user's point of view INDS should ideally provide a data processing service such that once programs are designed and implemented modifications to the hardware system do not effect the user's operational programs. The analogy to an electrical power utility is the lack of concern by the consumer of how the electric power is generated, as long as a standard plug and 110 volts permits use of an electrical device.

Overall system functions would be relegated to the executive package. This leads to prescribing tight rules of how job programs would tie into the system. Users would then prepare their jobs within well defined bounds, making easier the task of specific task implementation.

This conclusion can not be supported at this time, since adequate experience is unavailable and appropriate studies have not been made. However, investigations by Informatics in the use of a higher order language (PL-1) for real-time operations concluded that dramatic savings in implementation efficiency are possible. The adequacy of sophisticated data management packages such as being developed now for the IBM 360 family should be observed to determine the degree of savings such systems accrue to users end.

Perhaps the best way to describe the impact of the recommendation being made here is to consider the effect of such a system on a potential subscriber.

Subscribers fall into two classes: specific and general users. The first class expects to make careful, efficient and/or optimal use of the available utility resources.

This group would require full understanding of the hardware and software and the detailed specification for specific devices. This group expects to gain advantages from specific system components, which under the philosophy of INDS raises a user risk since there would be no guarantee of future system integrity, both in terms of the continued presence of a specific device or the ability of supply specific services under degraded conditions.

The second group of general users operate within the "universal" character of the INDS utility, both in terms of user oriented lanaguages that would be made available and with respect to the problem of data and file management. These users would, for example, characterize information files in terms of logical records and associated symbolic references but never assign physical storage units or be concerned with physical addressing.

In addition to this type of usage, which is still very much data processing system and programming oriented, both the specific and general user would have availabel an additional INDS capability. This is the ability to make true user oriented requests of the system in terms of pre-programmed, task oriented operations. For example, there may be available query languages for file operation and file maintenance. Thus a user would not be expected to code his own programs to modify, delete or add a record to one of his personal files. Another user oriented INDS supplied capability would be a report generation capacity. Also there would be available arithmetic operations and other functions which would be of common interest.

Working within this higher order, task oriented capability, INDS would also permit combining available operations into newly ordered sequences of operations and thereby create new, and more sophisticated operations - without necessarily knowing how to to program a computer.

Admittedly a general system such as is implied here must, for example, be parametrized so that users can express the nature of their problem and their expected usage so that the INDS executive is capable of making best use in some optimizing sense of the specific hardware modules currently available to the system. In fact, "currently" in this regard refers to the moment of use.

It is clear that a utility having a finite capacity and multiple consumers can not be designed to satisfy the absolute peak load. Since all users can be expected to request the fastest response possible it is incumbent upon the INDS management to assign priority values to the contending users. Such a priority system is of course a dynamic one and would be expected to recognize, for example, that during the Recovery Cycle of Flight Operations the talking down of aircraft with the SPN-10 system becomes more important for a 30 second period that perhaps the update of a log which can be delayed.

4.6 RECOMMENDATIONS FOR IMPLEMENTING INDS

INDS is a concept for exploitation of computers. It is a capacity which is surely the direction of the near future. It is our belief that such a utility system will be common to military and commercial users.

Figure 7 compares the present approach to fulfilling system requirements to that of the hardware/software utility of INDS. The INDS development concept will permit specific requirements to be met by software addition rather than by hardware and software development. This approach requires one complete hardware and basic software system development cycle at the outset. This cycle may be five to seven years. Once the operational system is qualified and implemented, specific requirements for processing are implemented by developing software only. This software cycle is one to two years and allows orderly system growth. System interface and integration decisions can now be made at the software levels rather than at the hardware and software level.

The concept of INDS has special significance to Naval tactical units and expecially for the CVA. Because of the long range commitments for outfitting ship units and incremental improvements made to existing ships it makes sense to remove the question of data processing compatibility, growth and operation from the end users to a specialized group of INDS managers. This group would have status equal to other service type departments responsible to the ship commander, e.g., Supply Engineering. This department would be called the Data System Support Department.

A decision to adopt a system like INDS would require the development of both a hardware and software capability. It is believed that the hardware concept could be developed in a year's time and a production of such hardware available some 3 to 5 years later after the software implications are fully understood.

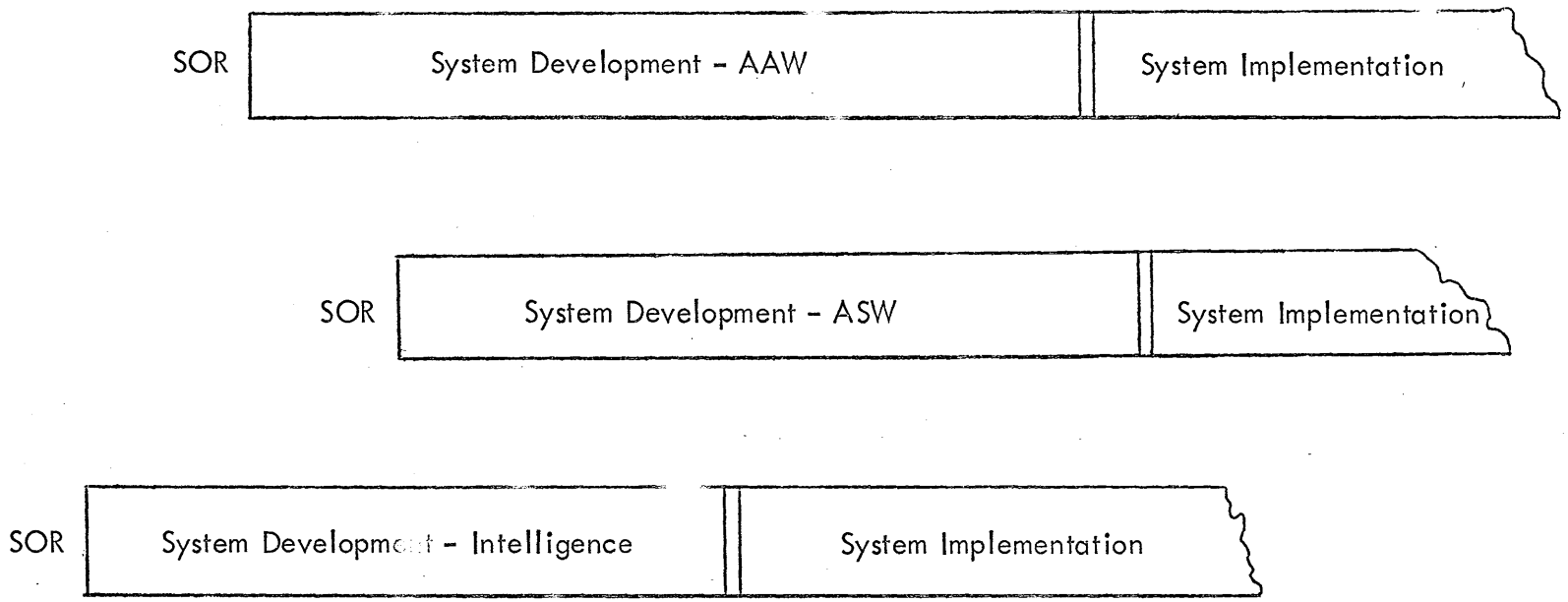
The software question is more complicated. Here a true research project of some three years duration would be required. Such research would have to be performed by actual use of equipment.

Hence the following is recommended:

1. Set up an INDS project office at some land based facility.

2. Provide a reasonably good state-of-the-art time-sharing system having modular growth capability (e.g., PDP6, IBM 360-67, GE 645).

Present System Development
Figure 7



Disadvantages

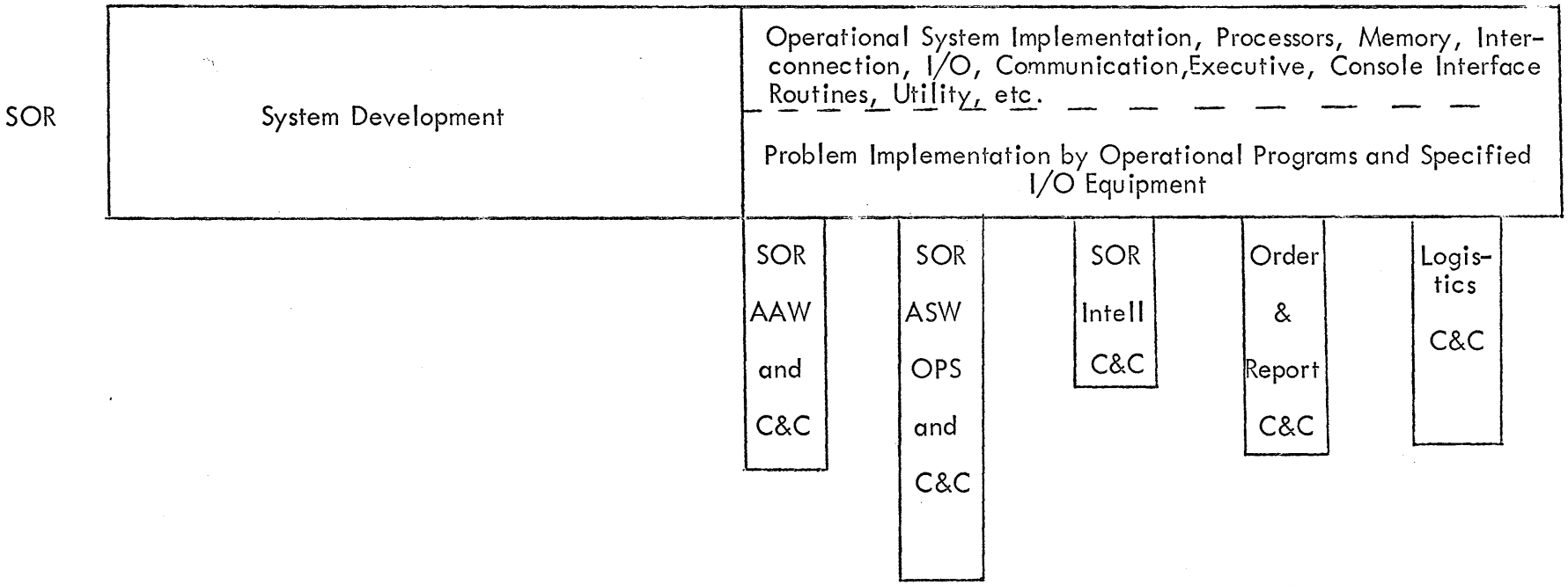
Integration by Edict
No overlapping backup
Total cost difficult to establish
Duplicates of similar efforts

Advantages

Administration
Less Complexity per System
Channels work

Future System Development
Using New Technology

Figure 7 (con't)



Disadvantages

Original System Cost is Large

Advantages

No recycle on Hardware Development
Data Accessability to all
Standard Programs
Mutual Back-Up, Integration by Design

3. Include a 3 computer USQ 20 system consisting of a typical CVA set of programs to tie directly into the time sharing system.

4. Prepare an Executive System reflecting the INDS capability.

5. Demonstrate the utility by now implementing within the INDS Executive framework new capability.

6. Produce specifications for hardware systems.

Adequate performance of this test cell would then qualify the software concept for implementation within the framework of the recommended hardware. This combined hardware/software complex would then qualify as shown in Figure 8. It is expected that an INDS like system could therefore be developed and fit for Naval operational use around 1975.

Figure 8

1) Experiment with current equipment

2) Develop hardware concept

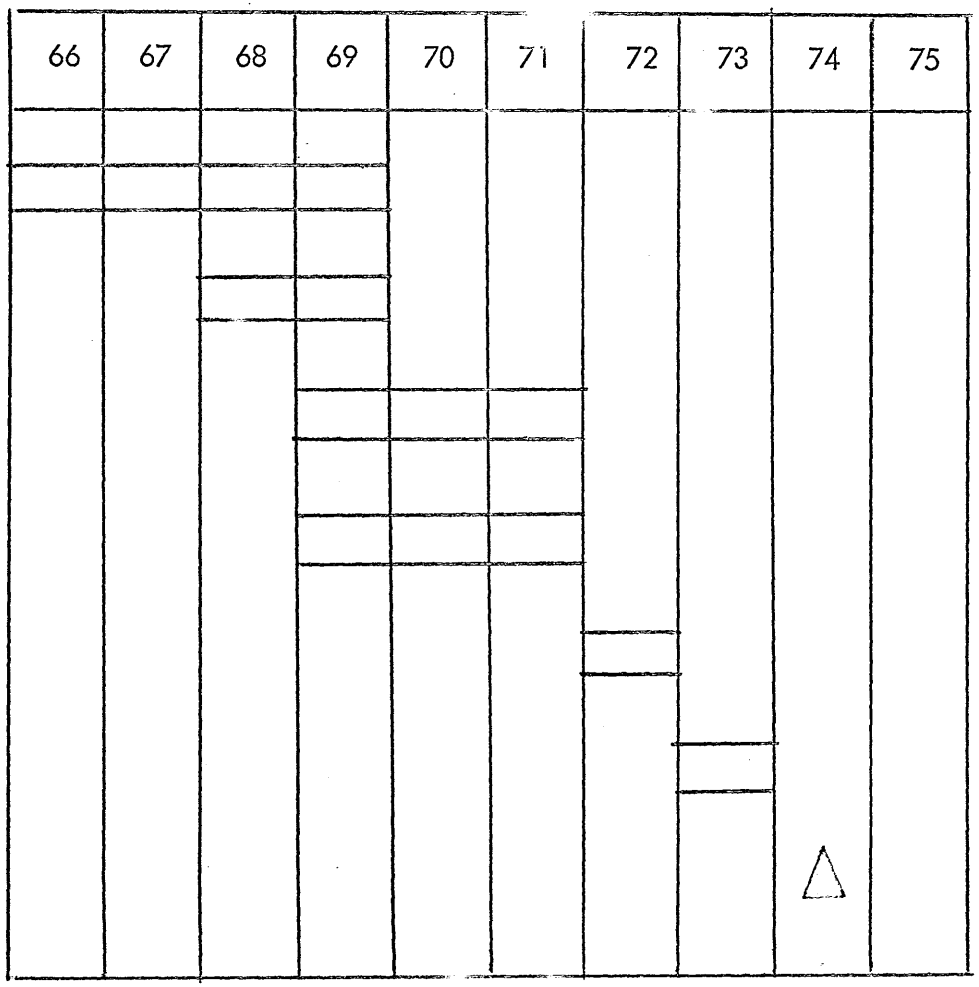
3) Produce hardware for qualification

4) Produce software for qualification

5) Qualify

6) Produce production models

7) Outfit new CVA



5.0 PLANS FOR THE COMPLETION OF ASSIGNED TASKS

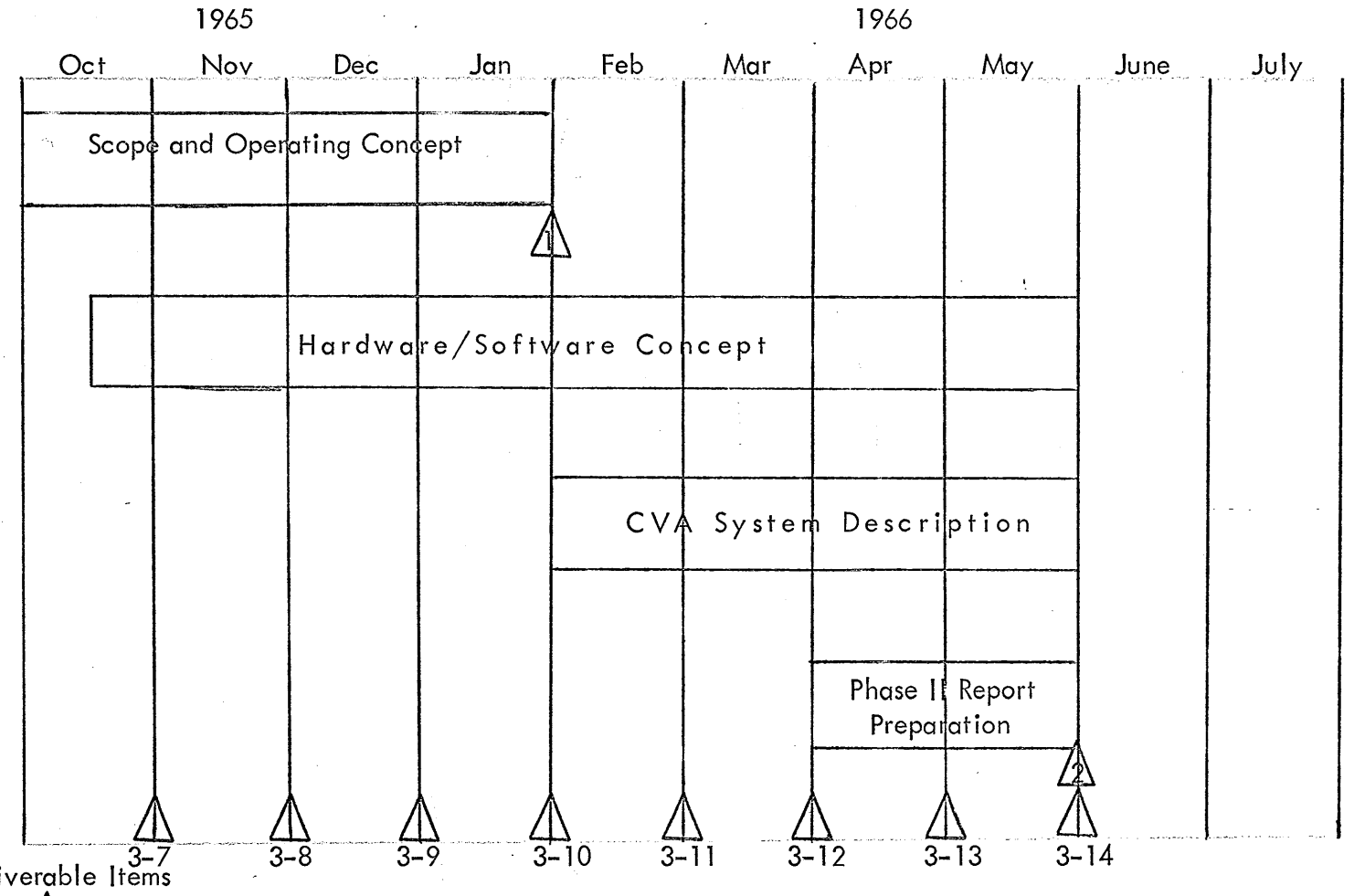
Figure 9 indicates the schedule for completing the present Phase II tasks. The scope definition and operating concept description will be completed in January 1966. A tactical C&C system scope definition and a procedure for arriving at this definition is the first part of this product. An operation concept for the use of data systems in the second part of the product. The operating concept should be a description of how the task commanders and tactical unit commanders might utilize data systems to support their command activities, operations, and functions.

The hardware and software system concept task will be a detailed statement of the characteristics of the system. The subjects to be covered are the hardware and basic software characteristics and a blueprint for operational requirements, statements and software specifications. This work will be completed in May 1966.

The CVA system description will contain a list of the operational tasks and technical functions to be supported and the application of the hardware/software family to meeting these support requirements. A plan for system evolution from present data systems will also be included. The work will be completed in May 1966.

Figure 9

Informatics Inc. Plan Using Present Funding*



Deliverable Items

1 Scope and Operating Concept Report

2 Phase II Report

3 Monthly Progress Reports

*Note The current funding end date is 31 January 1966. This ending date should be changed to 31 May 1966 in order to complete the planned work.