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Final Report

June 1977

ALTERNATIVE AUTOMATED DATA PROCESSING SYSTEM CONCEPTS FOR SUPPORT OF THE FMF (1980-1990)
Volume I: Study Overview and Results

By: L. S. PETERS, K. R. AUSICH, G. F. WALLACE, C. G. KERNS, E. B. SHAPIRO, and J. H. WILLETT

Prepared for:

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HEADQUARTERS MARINE CORPS
WASHINGTON, D.C. 20380
AND
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Subj: Alternative Automated Data Processing System (ADPS) Concepts for Support of the FMF (1980-1990)

1. The study objective was, "To develop and evaluate alternative concepts for FMF automated data systems in the 1980's. The concepts should define alternative Marine Corps approaches to improvement of the Force Information System concept while integrating the approaches with the Marine Tactical Command and Control System (MTACCS) concept and the Naval Aviation Command Management Information System (NALCOMIS) in such a manner as to enhance the combat effectiveness of the FMF." Within the stated objective, the concepts had to accommodate the following major factors:

a. Emphasize support of Marine Air/Ground Task Forces (MAGTF's);

b. Provide continuous ADPS support in garrison, afloat and ashore;

c. Provide more responsive support to lower Fleet Marine Force (FMF) echelons;

d. Minimize requirements for technical personnel; and

e. Maximize simplicity of operation, support and management.

2. All objectives were accomplished satisfactorily.

3. The study has been accepted for planning purposes.

a. Neither of the alternatives will be implemented as an entity. Rather, portions of the alternatives will be selectively implemented in coordination with related efforts.

b. The decision on the study recommendation for a support activity dedicated to FMF systems has been deferred.

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4. A copy of this letter will be affixed to each copy of the final study report.

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This document is one volume of a five volume final report that describes the results of a study effort to identify alternative ADP concepts for the Fleet Marine Force (FMF) during the 1980s. The focus of the study was the administrative type information processing associated with the management of manpower, operations, and logistics activities of the FMF rather than the tactical control activities. The goal of the study was to define alternative ADP concepts that could serve the FMF's needs in garrison, afloat, and within a combat area. A systematic analysis

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approach was employed that analyzed requirements, ADP technology, ADP system architectures, operational effectiveness, and system cost. The individual volumes of the final report are titled: Volume I: Study Overview and Results; Volume II: FMF Information Processing Requirements; Volume III: ADPS Technology Estimate for the 1980s; Volume IV: Description and Analysis of Alternative ADPS Concepts; Volume V: Cost Analysis for Alternative ADPS Concepts.

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PREFACE

This volume is part of the final report of SRI Research Project No. 4950, entitled "Alternative Automated Data Processing System Concepts for Support of the FMF (1980-1990)."* SRI initiated this 20-month study in November 1975 for Headquarters, U.S. Marine Corps under Contract No. N00014-76-C-0582 from the Office of Naval Research. HQMC project management was initially provided by the Information Systems Support and Management Division, now a part of the Command, Control, Communications, and Computer Systems Division.

The study followed the approach described in the SRI Study Plan, "Alternative Automated Data System Concepts for Support of the FMF (1980-1990)," dated 1 January 1976--as approved and modified by CMC ltr RDS/ISMS-11-pmb 5230/1 dtd 26 Mar 76.

This is Volume I of the final report which consists of five volumes whose titles are:

Volume I : Study Overview and Results

Volume II : FMF Information Processing Requirements

Volume III: ADPS Technology Estimate for the 1980s

Volume IV : Description and Analysis of Alternative ADPS Concepts

Volume V : Cost Analysis for Alternative ADPS Concepts.

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*As defined by governing Marine Corps documents, an automated data processing system (ADPS) is an interacting assembly of procedures, processes, methods, personnel, communications, and automatic data processing equipment (ADPE) to perform a series of data processing operations--a combination of automatic data processing resources and automated data systems. An automated data system (ADS) is an assembly of procedures, processes, methods, routines, or techniques (including but not limited to computer programs) united by some form of regulated interaction to form an organized whole, specifically designed to make use of ADPE.

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Volume I describes the research objectives and provides an overview of the entire project, along with a comprehensive study bibliography. It also includes an Executive Summary.

Much of the material contained in these volumes was published previously in draft form during the course of the project as SRI Technical Notes. However, the material has been revised and reissued in the final report, which then supersedes all the previously published interim and draft material.

I EXECUTIVE SUMMARY

A. General Conclusions

In this study, SRI developed and evaluated two ADPS concepts as alternatives to the concept currently providing automated command and management information processing support to the FMF. Common to both alternatives is the advanced ADP technology that will be available and suitable to FMF operations beginning early in the 1980s. SRI's evaluation of the benefits and costs of the alternatives relative to those of the current FMF ADPS capability shows that a strong rationale exists for the selection of one or the other as the 1980-1990 replacement of the current system concept.

The primary justification for such a course of action lies in the nature of the FMF requirement for future information processing. Study of that requirement strongly supports the view that the FMF requires an expanded automated information capability for the 1980s. Expansion and reorientation of the current capability is necessary to provide a comprehensive automated resource for improving management of FMF units locally down to the battalion/squadron echelon, as well as to facilitate the satisfaction of Marine Corps Class I ADS reporting requirements. Use of either alternative ADPS concept in the FMF will contribute to a more complete evaluation, and realistic maintenance of readiness, and it will provide a wide range of new operational capabilities.

A survey of currently available ADP hardware and software clearly indicates that the prerequisites for automated support of such information processing requirements in the FMF can be met in the early 1980s. The trends in both hardware and software development show every indication

of movement toward meeting the reliability, mobility, ruggedness, ease of use, and size requirements characteristic of the FMF environments in which a new FMF system will operate. Advances will be required, however, in several hardware technologies for full satisfaction of the requirements of FMF operational situations.

To achieve the necessary capabilities of an FMF ADPS in the 1980s will require, in addition to a new suite of ADP hardware, a significant change in the current approach to software techniques and architecture. Software techniques appropriate to this redirection are currently in use in many sectors of the information-processing community, and they are rapidly proving to be the most effective approach in environments similar to those of the FMF. These new techniques will unquestionably include the concept of "firmware" and its many implications, the concept of data base management systems, and the concept of interactive inquiry/retrieval.

Given the framework of the alternative system architectures presented in this study, the objective of satisfying the FMF ADP requirements with anticipated constraints on manpower (both in number and skill level) appears achievable. Current trends in hardware and software have resulted in systems that are easier to maintain, operate, and program. Another extremely significant trend that promises a decreased ADP-oriented personnel requirement is the much more efficient involvement of the user himself in the satisfaction of his day-to-day information needs and applications.

The cost of the expanded automated capability in the FMF is not prohibitive. ADP hardware costs for a given amount of computing power are declining continually. Personnel costs dominate the ADPS life cycle cost, but since the newer systems make more efficient use of systems users and system operators alike, dedicated ADP personnel costs are also declining. The requisite skill levels for operators and maintenance personnel involved in the daily operations of computing resources is being lowered by the new technology.

With the current expressions and understanding of security and privacy directives, there do not appear to be any major obstacles to the satisfaction of requirements for physical security, security of information, integrity of the system or the information contained therein, guarantees of privacy of personnel data, or in meeting electromagnetic emanation (TEMPEST) requirements. Also, the requirement for interoperability with existing or proposed systems presents no major obstacles.

B. Specific Results

SRI's development and evaluation of the two alternative ADPS concepts followed comprehensive analyses of the FMF information processing requirements and the ADP technology projected for the 1980s. These analyses indicated clearly that FMF units down to the battalion/squadron level had not only a requirement, but also a desire, for expanded automated support of their information processing activities. The technical analysis supported the feasibility of using minicomputer and microcomputer technology to provide such computing capability at the lower echelon units. It was determined that ADP configurations could be assembled that were well tailored to the activity levels and support resources of the lower and upper FMF echelons.

It was also evident that the FMF required a flexible, modular ADPS to provide support for garrison, afloat, and combat ashore activities, as well as for operations of different magnitudes, complexities, and intensities. Current and projected ADP technologies appeared well able to provide that capability.

A basis for restricting the set of alternative ADPS concepts that would both meet the requirements and be achievable in the early 1980s was provided by SRI's evaluation of FMF ADPS requirements and review of the applicable ADP technology. That basis was expressed in the form of

five conditions that summarized the relationship of the FMF operational objectives, environmental constraints, and information processing activities to the projected technology base. These five conditions are:

(1) A tightly coupled network of ADP systems for on-line, real-time sharing of computing power or data bases via a communication system cannot be supported in all FMF combat environments. However, batch teleprocessing (in a store and forward mode) can be supported in such environments.

(2) A hierarchy of ADP systems supporting ADP services of different capacity and function must be present to serve the multilevel needs of the FMF organization.

(3) A minimum of three levels must be contained in the ADP system hierarchy.

(4) The lower level of the ADP system hierarchy should not possess an ADP capability less than that contained in stand-alone intelligent terminals.

(5) Each level of the hierarchy must be able to operate autonomously to serve the primary needs of the user of that level.

SRI judged that unless the ADPS developed for the FMF meets these conditions, it cannot simultaneously meet the following two objectives, given the operational, technical, and economic realities of the early 1980s:

- Support all the input requirements of Class I ADS and satisfy the reporting needs of the various HQMC functional managers.
- Satisfy the operational requirements of the FMF commanders in the three FMF environments (garrison, afloat, ashore), as well as support the several MAGTF configuration options.

The significance of this analysis to the ultimate outcome of the study cannot be overemphasized. On the basis of the five conditions, SRI was able to narrow its study of alternative concepts to distributed configurations of minicomputers and intelligent terminals, while excluding large centralized systems highly dependent on telecommunications.

While the five conditions are tightly interrelated, the subject of telecommunications is particularly important. With regard to the use of telecommunications in conjunction with ADPS, the threat to disruption of combat communications and the need for capability to operate in the absence of communications caused SRI to minimize the telecommunications requirements in the design of alternative ADPS concepts. SRI, therefore, took a pragmatic position. SRI judged, on the basis of its analysis, that it was impractical at this time to design an FMF ADPS concept having a high dependence on the availability of real-time interactive, system-wide communications for combat environments. This judgement coincides also with the current LFICS capability and future schedule of implementation of TRI-TAC developed digital communications equipment--important elements of which are not scheduled for IOC earlier than the latter half of the 1980 decade.

At the same time, SRI did not rule out the use of telecommunications if they were available. A compromise was reached in which the alternatives that SRI developed will be provided with the capability of using telecommunications resources of the Marine Corps LFICS at every level when those resources are available. As a backup in case of the absence of telecommunications, SRI provided its alternatives with the capability of physically transporting magnetic media (cassettes, diskettes, and so on).

Within the constraints of the five conditions, SRI determined that two concepts appeared feasible for FMF implementation and provided a reasonable range of alternative characteristics. These were named the Distributed Hierarchical (DISHIER) system concept and the Distributed Activity (DISACT) system concept, and they were described in detail technically and operationally. Also described and evaluated as a benchmark was the current, or BASELINE, system. SRI evaluated these three systems on the basis of their relative technical, operational, and fiscal characteristics.

SRI concluded that both of the alternative concepts offered considerable improvement over the BASELINE system capability for meeting the FMF

requirements. BASELINE, in fact, was judged to be unable to meet basic FMF requirements, while the alternatives both provided an effective fulfillment of basic requirements. Operationally, the alternatives provided a capability for rapid deployment of ADPE that units had used and gained experience with in garrison. Since the alternatives assign ADPE to individual units at battalion/squadron echelon and above, they are inherently able to support effectively the different MAGTF configurations and the different intensities of operations that face the FMF.

The significant benefits that the DISHIER and DISACT concepts bring in addition to the better coverage of FMF environments and individual units are:

- Improvement of the Marine Corps Class I ADS reporting process through source data entry capability and telecommunications capability that will:
  - Provide one-time entry of data on machine-readable media
  - Provide data editing and validation checks close to the source of data entry
  - Speed the process of information reporting from the battalion/squadron level and up
- Augmentation of the resource management capability at each echelon from the battalion/squadron up by means of the following automated functional tools:
  - Interactive inquiry/retrieval of information from local data bases
  - File management capabilities
  - Report generation capabilities
  - Text handling
  - Logical and mathematical algorithms.

The cost of providing the expanded capability of the alternative concepts to the FMF does not appear to be excessive. As part of its analysis, SRI conducted a life cycle cost analysis of both alternatives and BASELINE, taking into account the development, investment, and operating costs necessary to carry the system from its concept definition through a 10-year lifetime.*

* BASELINE is an operational system, so its life cycle cost was estimated only on the basis of a 10 year operating lifetime.

BASELINE is projected to cost approximately $300.4 million. This estimate includes the cost of the FASC operations and maintenance, and the personnel and material support of the Navy aviation logistics systems being exercised on the Marine Air Group's U-1500 computers.

DISHIER is projected to cost approximately $244.9 million, but that figure does not account for the cost of a future system (like NALCOMIS) to support the Navy aviation logistics systems. Since the BASELINE system cost for a Navy aviation logistics ADS capability is approximately $70 million, one can estimate that an additional cost to DISHIER (primarily additional personnel costs) for a system like NALCOMIS would bring the total FMF ADP cost under the DISHIER concept to a level that slightly exceeds that of BASELINE (see discussion beginning on p. 90).

DISACT is projected to cost approximately $334.3 million. That figure also does not account for the cost of a Navy aviation logistics ADS capability. An FMF configuration combining both DISACT and NALCOMIS will cost more than $334.3 million. A discussion of this point begins on p. 90.

The estimated number of personnel required to operate and maintain the three system concepts is as follows:

Alternative ADPS	Manpower Requirement
BASELINE	862/650*
DISHIER	540
DISACT	757

It should be noted that the addition of a Navy aviation logistics ADS to DISHIER and DISACT will add to the number of men required for these systems, although the total FMF manpower resource supporting ADP under either of the

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*The first estimate is the Table of Organization strength on which the $300.5 million BASELINE LCC is based. The second estimate reflects current on board strengths (see p. 90).

two alternatives is not expected to exceed the manpower resource requirement of BASELINE. The capability of the alternatives to provide significantly greater automated capability with approximately the same number of operations and maintenance personnel is a result of the advanced technology and the fact that the users of the alternative concepts DISHIER and DISACT are effectively used to support their own applications.

C. Recommendations

In the course of this study, the SRI team gained a broad perspective on the Marine Corps' commitment to, and support of ADP operations in the FMF in the 1980s. That perspective forms the basis for some general recommendations that the SRI team judges would benefit the future development of ADPS concepts in the FMF. While the recommendations are naturally interrelated, they can also be acted upon to significant degrees independently, and they do not necessarily need to follow a specific chronology.

Specifically, it is recommended that:

- The Marine Corps should develop and implement a comprehensive plan addressing all ADP objectives of the FMF, their priority, and their schedule for satisfaction.
- The Marine Corps should organize and support an FMF ADS development and maintenance activity (composed of a body of Marine Corps ADP specialists) oriented specifically toward the needs of the FMF.
- The Marine Corps should act to determine in more detail the resources (ADPE and personnel) that will be required by future ADPS.
- The Marine Corps should consider a prototype test of one of the SRI alternatives ADPS concepts as a cost-effective approach to future ADP development.

Discussion of each recommendation follows.

SRI believes the Marine Corps should establish as early as possible a comprehensive plan that places the information processing objectives of

the FMF in perspective with the total Marine Corps ADP objectives. This action will require that the timing and scope of implementation of FMF ADPS be related to the several ongoing programs designed to serve the Supporting Establishment, as well as placed in consonance with developing MTACC systems and expanding LFICS telecommunication capabilities. This is especially important because the chronology and staging of the replacement, upgrading, and expansion of FMF computer resources can have a significant positive or negative impact on the operational readiness of the FMF in both the near- and far-term.

SRI believes the Marine Corps should organize a specific ADS development and maintenance activity that is directly concerned with the type, mode, logic, personnel, users and environments of the FMF information processing activity. This body is required because of the significant differences in the nature of information processing in the FMF versus that of the Supporting Establishment. This organizational activity would function to represent the FMF point of view in the ongoing Supporting Establishment planning activities in ADPS, as well as to promulgate the implementation of future ADPS in the FMF. Considerable knowledge and personal experience with FMF requirements has accrued through the SDA tests and as a result of SRI's study. This knowledge would constitute an important basis for such an activity were it organized.

SRI believes the Marine Corps should begin a more detailed identification of the various resources that will be required by future FMF ADPS and begin to make more definitive estimates of the sizes of these resources. There is currently insufficient detailed information on the use of automated system resources in the FMF context, including manpower for software development and maintenance, to make more than initial estimates of the cost or potential activity levels of new systems. It is vital to begin acquiring, accumulating, and evaluating this resource utilization information to estimate accurately the size of the new systems and to determine definitive knowledge of the skill and manning levels required for FMF systems.

Finally, SRI believes the Marine Corps should consider establishing a trial or prototype system of one of the alternatives, or variant thereof, proposed by this study. Considering the current state of efforts with respect to ADPS in the FMF and the Supporting Establishment, this is seen as a very cost-effective approach with a low economic risk. This prototype activity should test the feasibility of the alternative ADPS concept and would result in the acquisition of ADPE size information and transaction volume data that more specifically defines the devices and capabilities needed by the system. This prototype activity would be of immediate service to the FMF users involved and would ensure a smoother transition and more effective use of the systems when they are finally placed throughout the FMF. One prototyping strategy might be to equip a single FMF combat element (for example, the FSSG) within a MAF. Another might be to equip selected components of several elements of a MAF.

II HISTORICAL PERSPECTIVE

By late 1975, the U.S. Marine Corps had already accrued more than a decade of experience with management-oriented ADP. This involvement included use of both second and third generation ADPE, the development and use of several major data processing applications, the creation of organizational arrangements to accommodate ADPS, and the training of ADP-oriented technical personnel. The nature of the Marine Corps experience, as well as ongoing ADP development programs at that time, had a significant influence on the starting point and the subsequent development of SRI's study.

A. FMF ADPS Background

At the time the study was begun by SRI, ADPS was being provided to the FMF under the Force Information System (FIS) concept. Under this concept, each Marine Amphibious Force (MAF) was provided with one large-sized and one medium-sized Force Automated Services Center (FASC). Each large FASC used an IBM 360 Model 65 large-scale, general-purpose, third generation computer. Each medium FASC used an IBM 360 Model 50 medium-scale computer. FMFPAC Headquarters also had its own IBM 360 Model 50; while FMFLANT Headquarters had an IBM 360 Model 30.

Centralized data processing services and centralized data bases were provided to Division, Wing, and Force Troops from these centers. Each FASC was situated in an area having a major concentration of FMF activities, and it served users in its particular geographic area. Further, each Marine Air Group (MAG) within each Wing had an organic data processing capability provided by an AN/UYK-5 (Univac 1500) computer. This was dedicated to support of Navy aviation logistics systems.

Aboard LCC- and LHA-class ships, the USMC Commander Landing Force (CLF) staff had access to a computer system on which they could exercise the ASIS shipboard command system. Aboard the LCCs, the computer system was the second generation Univac CP-642B; aboard the LHAs, the computer system is the third generation Univac AN/UYK-7. These computers, however, were under Navy control on the ships.

Each FASC was considered to be deployable. It was housed in a movable shelter and provided with movable sources of air conditioning and electric power. Deployment occurred only with a MAF, however, and required a period of from 30 to 60 days. The MAG computers were housed in large vans that were somewhat more readily deployable.

Major computer programming and ADS design activities for the FMF were performed under the Central Design and Programming Activity (CDPA) concept. CDPAs were located at Supporting Establishment installations. Individual CDPAs were assigned responsibilities for development efforts and for computer programming activity for specific functional areas such as manpower, logistics, and aviation.

Computer programming for FMF applications was done largely in COBOL, a higher-level programming language. Some programs also used assembly language programming, especially large Supporting Establishment ADS to which the FMF supplied data as part of its reporting requirement. The MARK IV file management and information retrieval system, accessible through its own command and inquiry language, was in widespread use at the FASCs. A variety of general utility programs and packages was also available.

Marine Corps ADS were categorized into three classes as follows:

- Class I Systems--Centrally managed Marine Corps standard ADS controlled by a functional manager at HQMC. These systems are designed, programmed, and maintained by a CDPA.

- Class II Systems--Centrally managed Marine Corps ADS initiated and sponsored by the FMF or Supporting Establishment to meet recurring local management requirements. These systems are designed, programmed, and maintained by a CDPA.
- Class III Applications--Locally programmed (at the FASCs) data base inquiries or special reports which draw, by means of a data management system or application program, on existing magnetically readable data maintained by or for a Class I or Class II system.

B. Motivations for the Study

Motivations for this study were provided by several different factors and time critical influences. HQMC responded to these by initiating this major concept formulation study to keep pace with perceived needs and various impending developments.

1. Perceived Problems and Needs

One major and growing problem connected with information processing in the FMF was the heavy burden of upward data reporting falling upon FMF units and personnel. This data reporting, much of it for Class I systems required for overall Marine Corps and Supporting Establishment management activities, absorbed significant resources of FMF operating personnel, including combat personnel.

Another problem was the high level of data error rejection and correction activity that was being experienced by the FMF. The need for reducing this, and the benefits of doing so, were apparent.

The need to provide Commanders and staffs of units below the division/wing/FSSG level with more flexible and responsive ADP services was recognized as acute.

The problems of lengthy processing cycles and long turnaround times for Class I outputs intended to serve the needs of FMF units forced many FMF activities to rely on internal manual and ad hoc methods of providing necessary operating information.

The comparative unsuitability of the FASC installations to be deployed with MAGTFs into an amphibious objective area was perceived as a major problem. Deployment could be supported only in the case of MAF-sized forces, and only then for operations exceeding 30 to 60 days. FASC support of deployed MABs and MAUs was impossible.

Finally, the overall philosophy and architecture of the FIS concept was not well suited to supporting teleprocessing and remote access to services, especially during deployments.

2. Time Critical Influences

In addition to immediate ADP-related needs and problems recognized within the FMF, several developments demanded that a major integrating study be conducted if major duplications of effort were to be avoided, and if unambiguous requirements were to be agreed upon and met.

The first of these developments was the impending obsolescence of the IBM 360 computers and the programmed replacement of these in the early 1980s time frame. Delay in such replacement would penalize the FMF in terms of decreased machine reliability, unavailability of vendor hardware and software support, and shortage of experienced data processing personnel.

A similar development was the programmed replacement of the MAG computers by a new ADP concept/system in 1978-1980. This concept and the related computer hardware and software were being developed by the Navy under the Naval Aviation Logistic Command and Management Information System (NALCOMIS) program.

The planned implementation of the Marine Tactical Command and Control System (MTACCS) concept in the 1980-1985 time frame was forcing re-evaluation of ADP doctrines and systems throughout the Marine Corps. Systems under the MTACCS concept were expected to replace and supplement portions of the ADS contained within the FIS concept. Implementation of the MTACCS concept would require a re-examination of all current FMF management systems--whether automated or not.

3. Precursor Studies

The study SRI undertook was not the first major study in which the Marine Corps took significant steps to address the concerns cited in the foregoing subsections. Several important studies, by both Marine Corps personnel and by civilian contractors, preceeded SRI's study and provided valuable data and insights.

The study by the Marine Corps Advanced Amphibious Study Group concerning ADPS for the Marine Corps was reported in a final report in August 1975 and exposed many of the problems, factors, and approaches considered by the current study.[1*]

The Data Management Device Requirements (DMDR) Study completed by Informatics, Inc. in June 1974, provided useful analysis of lower echelon requirements and opportunities for ADP.[2]

In the telecommunications area, the Marine Corps Teleprocessing Requirements Study conducted at Naval Electronics Laboratory Center,[3] provided valuable background on communications, as did the documentation of the Landing Force Integrated Communications System (LFICS) Architecture for the period 1975-1990.[4]

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*All references are listed at the end of this report.

4. Concurrent ADPS Programs

Several Marine Corps and other Service ADPS research and development programs in progress during the study period influenced the nature of the study. The ADP situation prevailing in the FMF at the start of the study was significantly altered by some of these concurrent programs during the past 20 months.

The concurrent programs of significant actual or potential influence were the following:

- The Source Data Automation (SDA) experiments in both the FMF and the Supporting Establishment[5-8]
- The Marine Tactical Command and Control System (MTACCS) Program[9]
- The Navy NALCOMIS Program[10]
- The Marine Corps program of computer replacement and regional consolidation of Support Establishment ADP facilities
- The DoD-sponsored military computer family studies.

The SDA test demonstrations especially provided a significant amount of concrete experience in the use of comparatively small, standard, commercial, multifunction, computer-based systems at the functional user level under realistic FMF operational conditions. They provided data as to types of functions desired, activity levels, serviceability of non-ruggedized equipment, acceptance by operating personnel, and so on.

In terms of its eventual total magnitude and ultimate impact on FMF operations, the MTACCS program was probably the most consequential new development in progress. Any new FMF ADPS must be clearly be consistent with the ADP systems of MTACCS. Throughout the study, SRI kept well informed with regard to MTACCS programs. However, because of certain facts, a reasonable degree of separation of focus was possible.

MTACCS is concerned with real-time tactical command and control systems; whereas this study was concerned with administratively oriented command and management information systems. In deployed operations and at the lower echelon levels, the distinction between the two areas can become blurred; however, it provided, in general, a considerable differentiation of focus between the two programs. A further separation was possible on the basis of the timeframes of the programs. Significant fielding of MTACC systems will not take place until 1985 and later. This study was concerned with systems that could be fielded shortly after 1980.

The NALCOMIS Program, being concerned with Naval aviation logistics, will affect the aviation element of the FMF. NALCOMIS, however, apparently will not address the total spectrum of command and management requirements of Marine Aviation; rather, it primarily addresses Navy aviation logistics concerns. Hence, at best, NALCOMIS will require a companion capability if Marine Aviation information processing is to be well supported.

The regional consolidation and ADPE replacement program provided the Marine Corps with significant additional experience in telecomputing and remote access to computing services. It promises, in the future, to be a central element for the interface between FMF and Supporting Establishment ADP.

Although nothing conclusive or binding came out of the DoD-sponsored military computer family studies during the term of the study, the implications of a computer family approach to equipping an FMF ADPS were considered throughout the alternative ADPS concept formulations undertaken by SRI.

III STUDY APPROACH

All of SRI's study efforts were directed toward the overall study objective of "developing and evaluating alternative concepts for FMF automated data processing systems in the 1980s that improve the FIS concept while integrating the concepts with MTACCS and NALCOMIS in such a manner as to enhance the combat effectiveness of the FMF." Guiding research objectives, the scope of research, basic research assumptions, and the integrated SRI approach to satisfying the overall study objective are described below.

A. Research Objectives

The satisfaction of the overall study objective required SRI to focus its work upon eight specific intermediate research objectives. These intermediate objectives were addressed through a program of research phases and tasks whose results are described subsequently.

The eight specific research objectives were to:

- Determine the information processing requirements of the FMF at the present time (1976), for the forseeable future (circa 1980), and for the second half of the next decade (1985-1990)
- Define the desired role for ADPS in meeting all or part of the FMF information processing requirements within the USMC organizational and operational context
- Identify the Supporting Establishment/CDPA relationship with the FMF processing requirements and with the nature of FMF ADPS alternative concepts
- Review the developing ADPS and telecommunications technologies to determine what technologies will be available and attractive in the period 1980-1990

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- Develop a range of alternative ADPS concepts suitable to meet the needs of the FMF in the period 1980-1990
- Determine the system development implications and the system support implications of each alternative ADPS concept
- Perform a life cycle cost analysis for each alternative ADPS concept
- Develop study conclusions and recommendations concerning ADPS alternative concepts for the FMF in the 1980s, and provide the analysis support to justify USMC acceptance of these findings.

B. Study Scope

A set of three or four concept alternatives differing in size, capability, cost, development characteristics, and support requirements was desired in order to provide a reasonable basis for exercising potential development options. Technical management of such an effort required a well-defined study scope. The following two subsections characterize material that was included in the study and material that was considered beyond the purview of the effort.

1. Included Subject Material

The study effort addressed the following considerations concerning ADPS resources available to support the FMF:

- All Marine Corps automated data processing systems used or supported by the FMF were considered.
- All development efforts under the MTACCS and NALCOMIS concepts were considered.
- Existing Marine Corps equipment and systems--both hardware and software--were considered.

- The ADPS of other services, and particularly the Navy, were considered for their availability and suitability to support FMF needs in various development postures. Also considered were all government pressures toward contract services and standardization of hardware, software, and languages.
- Marine Corps, Navy, and DoD developments concerned with all application of common family computing equipments were monitored.
- Consideration was given to recent technological advances, such as minicomputer-based systems, distributed data bases, data base management systems, and interactive information retrieval systems.
- Both fully militarized and commercially available ADPE and software packages were considered for appropriate utilization.

The study effort addressed the following considerations concerning ADPS operational constraints and requirements:

- Support to all echelons in the FMF was considered.
- Continuity of ADPS support to FMF units in garrison, aboard ship, or deployed in a combat area was emphasized.
- Teleprocessing requirements, including data transmission security requirements, were clearly identified, and dependence upon electronic telecommunications facilities for communication between deployed forces and the supporting establishment was minimized.
- Interfacing and interoperability requirements for Marine Corps ADPS in respect to non-Marine Corps systems were observed. The potential benefits of establishing additional optional interfaces and interoperability were investigated.

2. Excluded Subject Material

The study effort excluded the following types and aspects of computerized systems within the Marine Corps:

- ADPS that have no direct or indirect function in support of the FMF were not considered, except insofar as they could be included naturally and without significant effort within the alternative concepts developed for support of the FMF.
- Computerized systems whose sole function was to control a weapon, a surveillance device, a vehicle, or the like, were not included in the study scope.
- Computerized systems whose sole function was the real-time control of communication systems were not included.

The type and depth of the descriptions of the alternative concepts developed by this study were modified by the following exclusions:

- The descriptions were written in terms of generic classes and types of ADPS equipment, programming languages, and personnel. Hence, the names of specific product brands/models, versions, and billets, were avoided.
- Equipment descriptions included inherent capability, capacity, and speed, but they excluded internal design features and characteristics.
- File characteristics were addressed with regard to the data base management scheme, but specific file structures or contents were outside the scope of the analysis.
- Data bases were aggregately (for example, centralized or distributed) and used in the model representations, but individual data elements were not addressed.

C. Assumptions Governing Study

SRI made several major assumptions during the course of this study. These guided the study direction and impacted the effort to a significant degree. This section identifies the major assumptions made in the areas of: (1) USMC force levels, deployment, and employment; (2) ADPS development and operations; and (3) ADPS support.

1. USMC Force Levels, Deployment, and Employment

Assumptions in this area had as their purpose coordination of the development of ADP alternative concepts with the evolutionary development of the USMC concept of operations. Issues of concern to the development of ADPS alternatives that hinge on the concept of operations include: size, deployability, range of employment options, and environmental capability. On this basis, SRI employed the following assumptions:

- All ADPS will be developed to support the FMF; hence, their requirements and support are subordinate to the more general requirements and support of the FMF operating units.
- The USMC mission and concept of operations for the FMF are definitively stated in the Marine Corps Mid-Range Objective Plan, and they will only change in an evolutionary manner over the time of concern to this study.
- Force levels and budgetary support will not appreciably increase during the timeframe addressed by the study; rather, the anticipated trend will be one of status quo or slight decrease.
- The Marine Corps will retain three active divisions and air wings, and one reserve division and one reserve wing all configured primarily for amphibious operations.
- ADPS support of MAGTFs must be considered in afloat and combat environments that are unconstrained by current force locations and deployment policies. The alternatives must consider rapid expansion in time of crisis, to include a call-up of the reserves.

2. ADPS Development and Operations

Assumptions in this area had as their purpose coordination of ADPS alternative concept generation with the existing ADPS configuration and ongoing development program. This input was important to establish the environment that will exist and the base from which to proceed should an ADPS concept be selected for implementation in the 1980s. The following assumptions were made:

- The extended length of major system acquisition requires the anticipation of future ADP trends and capabilities, but high risk areas are to be avoided in the development of ADPS alternative concepts, so that the cost and initial operational capability (IOC) objectives of the concept may be met.
- For non-MTACCS command and management ADPS, emphasis should be placed on common off-the-shelf ADPE.
- MTACCS development will be completed during the 1980s, and it will define the tactical ADPS framework of the FMF throughout the decade.
- USMC management structures now in effect will continue to operate with only minor modification of scope or form.

3. ADPS Support

Assumptions in this area had as their purpose coordination of the development of ADPS alternative concepts with the continuing ability of the USMC to exercise and maintain future ADPS configurations. Since operations and maintenance of the ADPS will be the largest single cost factor, it was important to consider general questions that affect the support burden. The following assumptions were made to define major considerations:

- The maintenance of ADPS support for the FMF will require a continuous program for training personnel and exercising equipment
- The proliferation of ADPS support to wider USMC usage and access portends a concurrent increase in control and monitoring activity
- Increased activity will be required in the areas of planning and training to expand the level of ADPS support available to the FMF in afloat and combat ashore environments
- A major concern in extending ADPS support to all deployed activities of the FMF at all times is the availability, capacity and security of telecommunication links

- In the area of aviation, the Marine Corps will continue to operate using systems and equipment dictated to support Navy developed ADPS
- In time of crisis, Marine Corps ADPS must be capable of rapid expansion
- Proliferation of ADPS within the Marine Corps will be tightly controlled.

D. Study Plan

As is evident from its objectives and scope the study was a comprehensive attempt to address the problem of providing ADPS support in the FMF in the next decade. It addressed many distinct, but interrelated investigations, analyses, and synthesis activities.

The study approach, itself, was built upon four self contained sequential phases of work. One benefit of this action was that it naturally provided the Marine Corps and the SRI project team with a decision point, at the end of each phase, at which time the results and implications of the phase could be appraised and project redirections implemented. Another benefit was that key members of the project team could participate in each phase and thereby contribute continuity and coherence to the overall effort. At the same time the individual members of the project team could be varied and augmented from phase to phase to best address the differing technical emphases of a particular phase.

1. Phase Structure of the Study

The four project phases, each identified by its primary research focus, were the following:

- Phase I : FMF Requirements Determination
- Phase II : ADPS Technology Review
- Phase III: ADPS Alternative Concepts Development

- Phase IV : Life Cycle Costing and Project Results Summarization

The approximate durations of each of these phases were as follows: Phase I, 6 months; Phase II, 5 months; Phase III, 6 months; and Phase IV, 3 months.

Each of the phases consisted of several research tasks. The tasks generally advanced the project toward one or more of its stated objectives and typically produced a significant element of deliverable documentation. The results of these tasks were typically documented in interim reports to the study sponsor.

A major interim technical report was issued at the end of Phases I, II, and III. All interim technical material has been revised and reissued as part of the final report, which also reports all work done in Phase IV. Hence, the final report encompasses and supersedes all of the interim documentation and is the complete document of record for the overall study.

Overviews of the approaches and results of the four phases are given in Sections IV through VII of this volume, and detailed coverage is given in the other final report volumes.

2. The SRI Project Team

For this study an interdisciplinary team, made up of three main contingents drawn from different centers and laboratories of SRI, was assembled. One group consisted of experienced military systems analysts with a background of work on Naval and Marine Corps studies. These analysts provided familiarity with Marine Corps doctrine, organization, system developments, and previous research studies. A second group consisted of senior computer and information systems scientists. These brought familiarity with ADPS architectures and components, telecomputing, ADP technology trends, and with ADPS operational problems. The third major contingent

were cost analysts experienced in the life cycle cost analysis of military weapons systems, communications systems, and information systems.

The Marine Corps oriented analysts provided continuity and project direction throughout the study. The other researchers were generally employed in the areas of their speciality in the appropriate tasks of the study effort.

E. Information Gathering by SRI

In order to get a true understanding of the FMF ADPS problem and in order to make maximum use of existing information in the attainment of project objectives, SRI conducted extensive information gathering efforts from several sources.

A major literature search was made early in the study. This embraced the reports of other studies performed by or for the Marine Corps, relevent Marine Corps manuals, and official Marine Corps directives. The literature search also extended to publications of the offices and projects of the Navy, Air Force, and Army. Certain pertinent publications from the general technical literature of ADP systems, life cycle costing, and related areas were also included. The bibliography of publications used for study reference is included in this volume as an appendix.

Other major sources of information were the USMC Supporting Establishment organizations, particularly several of the field Automated Services Centers (ASCs), representatives of the Functional Managers at HQMC, and the Marine Corps CDPAs. These were visited by members of the SRI project team throughout the duration of the project.

Much of the most directly pertinent information was learned first hand by SRI researchers from personnel of the various elements of the FMF. SRI visited several of the FASCs, interviewed extensively both commanders and staff officers at several FMF echelons, observed both SDA development activities and field exercises, and briefed designated FMF groups during the

study. These contacts kept SRI in close touch with the FMF ADPS problem and the Marine Corps' perception of their needs through the 20 months the study was in progress.

IV FMF INFORMATION PROCESSING REQUIREMENTS

This section presents an overview of the requirements analysis conducted by SRI during the course of the study. It summarizes and interprets a detailed statement of FMF echelon-level information processing tasks amenable to automation under a future FMF ADPS. That statement is reported in its entirety in Volume II of this report.

A. Objective and Scope

The objective of SRI's study of requirements was to identify the information processing requirements that should be considered in developing an ADPS for the command and management needs (vice tactical control needs) of the FMF during the 1980s.

Information processing requirements refer to those activities that are necessary for the systematic collection, manipulation, and dissemination of data useful in the management of FMF resources by units within the FMF, and by elements of the Supporting Establishment. These activities may be undertaken through either manual processes or automated processes.

SRI's compilation of requirements was meant to serve the specific purpose of providing a supporting base for proposing and evaluating ADPS alternatives for future FMF use. SRI addressed only those FMF tasks that appear amenable to data processing support and that would benefit from such support were it available. Because the focus of the study was on the 1980s, the requirements sought were not simply those that could be observed in Marine Corps data processing today, but also new requirements that can be expected to exist in the FMF in the 1980s.

In its research, SRI made no attempt to cost-justify the automation of FMF tasks involving information processing. Rather the philosophy was one of identifying opportunities for increased performance, decreased resource usage, extended capability, and better responsiveness of information processing in the FMF. Cost justification arguments, however, could be applied to a variety of aggregated task requirements, especially through qualitative logic and analogy with other ADPS experiences and studies.

B. Approach

Several facets of SRI's approach to identifying and stating requirements for use in formulating alternative ADPS concepts are discussed in the following subsections. These facets form the core structure that SRI used in the tabulation of FMF echelon-level information processing tasks. That tabulation includes 18 different tables covering more than 50 pages of text in Volume II of this report. The discussion in the following paragraphs outlines the structure and fidelity of that effort.

1. Environmental Factors

From the inception of the study SRI reasoned that any future FMF ADPS must be suited to supporting units of the FMF in any of the operating situations in which the FMF's stated mission could place them. This meant that information processing requirements had to be stated for peacetime administrative activities, as well as deployed combat activities. To do this SRI focused upon three characteristic FMF operating environments:

- The garrison environment
- The deployed afloat environment
- The combat ashore environment.

Independent analyses of the characteristics and information processing implications of these three environments were conducted, and information processing requirements were developed and tabulated separately for each.

2. Organizational Framework

In reviewing requirements SRI separately considered the three major classes of FMF elements, namely the ground element, the air element, and the combat service support element. In conjunction with these classes SRI associated three echelon levels, namely the division/wing/FSSG level, the regiment/air group/LSG level, and the battalion/squadron/LSU level. Echelons lower than latter were determined not to be well suited to the support of organic ADP equipment. Treatment of the three echelon levels were extrapolated to determine requirements of command elements of MAFs, MABs, and MAUs.

3. Management Requirements Structure

To integrate and coordinate the different functional areas that might be affected by automation, SRI expressed the requirements through six generalized management functions that are performed in varying degrees within all MAGTF elements, at all echelon levels, and by all functional areas. These functions are:

- Planning--devising a detailed method, formulated beforehand, to accomplish a specific goal.
- Programming--allocating resources to specific uses and assigning personnel to particular tasks in support of a plan.
- Evaluating--assessing other activities in relation to preconceived criteria of a plan.
- Monitoring/Inventorying--keeping track of and updating information describing personnel, materiel assets, and events.

- Forecasting--identifying in advance alternative options and predicting their likely consequences.
- Supervising/Controlling--making all decisions and actions--in addition to those embraced in the foregoing--necessary to implement a plan or to meet any organizational or operational or operational objective.

4. ADP Functional Requirements

Finally, in order to express the requirements in terms that made visible the generic capabilities of ADPS alternatives that would satisfy the requirements, SRI associated with each echelon-level activity the primary ADP functions it required. The ADP functions used were:

- Source Data Entry--the initial recording of data to be processed by a data processing system (for example, manual entry of data onto a coding form, or automatic recording of data by a sensor device); and/or the actual entry of data into a data processing system for processing (for example, the reading of magnetic media into a computer, or the on-line interactive entry of data into a computer).
- Processing--the processing of data within a data processing system (either manual or automated); such processing falls into the following broad categories:
  - Data Correction/Validation--the performance of checks on the correctiveness of entered data
  - Text Handling--the performance of editing and manipulating operations on textual material
  - Mathematical Calculations--the performance of arithmetric/numerical operations on data
  - Information Storage/Retrieval--organizing, storing, selecting, and extracting information; rearranging the order of data and information (that is, sort, merge, and update)
  - File Management--the building and maintenance of data bases.
- File Storage--the holding of data or information in files; for example, the storage of information in record books, in internal computer memory, or in auxiliary computer memory.

- Data Transmission--the outbound transmission of data to a different data processing facility or to a remotely located user location; for example, transmission of data over a telephone line, or the transportation of data by a courier.
- Information Output/Display--the output of information from a data processing system for end use by humans; for example, the printing of hardcopy reports, or the generation of electronic visual displays.

With each of these data processing functions SRI associated a qualitative or semi-quantitative measure that was used to indicate the amounts, rates, or complexity of the various functions required for the various management functions in specific elements of the FMF organization. On this basis a representative profile of the information processing activities and requirements emerged for each echelon level.

C. Results and Conclusions

A major impetus for this study was a general recognition that the current FMF ADPS capability would not adequately support FMF information system requirements in the 1980's. Obvious deficiencies, such as the absence of ADPS capability for deployed MABs and MAUs, and the excessive time needed to deploy the MAF's FASC, supported this conclusion.

Looking toward the future, it was also evident that the incorporation of advanced ADP technology and procedures offered opportunities for efficient and effective enhancement of FMF command and management information system capability. However, an FMF-wide study of command and management requirements from an ADP perspective had not been conducted previously Through the FMF information processing requirements analysis conducted as part of this study, SRI was able to generate such a perspective.

Based on SRI's analysis, it may be stated that the numbers, distributions, and interrelationships of FMF activities suited to ADP within each of the three combat elements present a strong argument for a coordinated

FMF-wide ADPS down to, and including, the battalion/squadron/LSU echelon level. It is also evident that such an ADPS must support two major classes of activity at each echelon level, namely (1) the information reporting activity of FMF units to higher commands (and/or Supporting Establishment), and (2) the management of local unit information and management applications.

Automated support of these two classes of activities down to the battalion/squadron/LSG echelon promises to provide the following benefits:

- Reduction in the FMF man-hours currently expended to input Class I information for reporting purposes.
- Near abolishment of redundant manual handling and transcribing of Class I information, with an attendant increase in the accuracy and acceptability of entered data.
- Improved capability and responsiveness for selective retrieval of pertinent information from a large reservoir of stored information.
- Availability of powerful logical and mathematical tools for more effective evaluation of the status of FMF resources.

These benefits will inherently improve readiness, and extend the breadth and quality of command and management capabilities for planning, monitoring, and decisionmaking at all echelon levels.

1. FMF Reporting Activity

A fundamental requirement exists to streamline and automate the present FMF Class I reporting systems. The current combination of manual and automated processes is markedly deficient and unwieldy relative even to some of today's ADP systems operating in other organizations. These shortcomings manifest themselves in the following manner:

- Updates of master data bases, because of the unacceptability of lower echelon data records and the length of time required to institute error correction procedures, can require weeks or even months.

- Component data bases within a single Class I ADS are difficult to synchronize.
- Significant numbers of man-hours are involved in redundant transcription of data from paper to computer cards to magnetic media.
- Data entry is marked by a lack of verification and validation of format and content at the entry source.
- File management and data base integration capabilities fall well short of capabilities offered in today's ADP market.
- Information retrieval is cumbersome and lacks responsiveness.
- The Class I reporting processes are decoupled from the local unit management needs.

In summary, the current methods by which Class I reporting is accomplished exhibit characteristics of technical obsolesence, and the accomodations that the FMF organization routinely makes to circumvent the lack of technical capability severely distorts the fundamental makeup of the information system.

The requirement to streamline and automate the reporting process translates in ADP terms to a requirement for source data entry, wherein data is captured close to its source and manually recorded only one time on machine-readable data media. To match the operational realities of the FMF information system, it is necessary that the source data entry capability include user data entry assistance in the form of prompts, editing, and validation checks.

2. FMF Local Unit Management

A fundamental requirement exists to upgrade the present manual system supporting local unit management to an automated capability. Based on SRI's investigation of echelon-level information processing activities, there are a sufficient number of local unit activities (at each echelon from battalion/squadron/LSU level and up) that lend themselves to automa-

tion to warrant such an investment. These activities include management procedures involving:

- Planning--generating, recording, and modifying Operations Plans and annexes; investigating and adjusting resource allocations.
- Programming--writing and distributing orders; scheduling operations, work shifts, training, and equipment maintenance.
- Evaluating--analyzing performance; assessing readiness; identifying costs.
- Monitoring/Inventorying--accounting of resources; locating supplies; maintaining an overview of men, equipment, supplies, fiscal resources, and requisitions.
- Forecasting--predicting resource shortcomings; extrapolating logistic and operating trends.
- Supervising/Controlling--maintaining current status of in-process operations and support; adjusting resources based on identification of priority needs.

All of these activities are currently performed by the FMF using primarily manual methods, paper data bases contained in file cabinets, and acetate status boards. The slowness and cumbersomeness of this situation relative to current automated capability results in no use of much information available to FMF units, as well as less optimized use of information that is tapped.

The requirement to automate the manual systems and processes supporting local unit management translates in ADP terms to a requirement for responsive user access to the following functional capabilities:

- Automated data capture and input
- Data storage, manipulation, and retrieval
- Report generation
- Query and response mode operation
- Analysis capability.

3. Characteristics of FMF Information Processing

The basis of SRI's perspective was generated, in part, by several major characteristics of FMF information processing that have significant influence on the generation of alternative ADPS concepts. These characteristics include:

- Current resources for, and the distribution of, information processing activity among the echelons of the FMF.
- The differences in information processing activity among the separate combat elements of the FMF.
- The timeliness associated with different management activities.
- The need for complete availability of ADP across the FMF operating environments, as well as the differences in the activities among the different environments.
- The composition of local data bases.

a. Distribution of Information Processing Activity

SRI's analysis of FMF information processing activity clearly indicates that a sufficient amount of activity occurs at each command echelon from battalion/squadron/LSG level on up to warrant automated support. Currently, the burden is being largely born by manual means that include the following:

- Computer listing from Class I ADS.
- Manual card filing systems (maintained to alleviate the lack of responsiveness of Class I ADS, and to assemble data not collected by Class I ADS).
- Class III applications computer listing (built primarily to extend Class I ADS to meet user needs).
- Card deck data bases.
- Typewritten forms.
- Typewritten textual material of an enduring nature.
- Acetate and typewritten status boards.
- Chalkboards.

In aggregate, these elements are difficult to update, modify, or manipulate in an orderly and efficient fashion given the current FMF capability. Because of the organizational hierarchy of the FMF, this problem is severe at the lower echelons, but it is even more aggravated at higher echelons due to their increased purview of FMF resources.

Under the present system, extra work (that is, the maintenance of parallel manual data bases) is being done to accomodate the slowness of information flowing back from the Class I systems, and this extra work has a low marginal return since only limited data manipulation can be performed manually.

SRI has found that the problems are similar, but not the same at each echelon level because the nature of information processing differs at each level. Higher levels must view resources and opportunities in aggregate and pay particular attention to planning and forecasting. Lower levels are more often faced with problems of daily scheduling and supervising.

b. MAGTF Element Factors

SRI determined that each of the three elements of a MAGTF has unique characteristics with regard to information processing requirements that potentially could affect both the functional description and scale of an ADPS that would support them individually.

The ground combat element (except for certain equipment oriented units such as the tank battalion) is primarily manpower and operations oriented. Because it is supported logistically by the combat service support element, there is a relatively smaller ADP capacity requirement for the ground element than for the other elements.

The combat service support element, therefore, is heavily burdened with high volume logistics information processing. Much of the activity of the support function is centered in supply warehouses and maintenance shops. This contrasts again with the ground element where most activity is centered in the command element offices.

The aviation element combines operations and support so that its purview encompasses the range of activities that the ground element and combat service support element do in combination. A complicating factor for the aviation element is the fact that both Navy and Marine Corps systems and supplies are used, so that separate accounting and logistics support practices are required.

c. Information Timeliness Requirements

SRI's analysis of the activities of the FMF in the three operating environments indicates that most activities are cyclic with usually well defined periods. An aggregate overview, however, distinguishes differences between the operating environments according to the following general pattern:

Operating Environment	Activity Cycle
Garrison	Weekly/Monthly
Afloat	Non-cyclic fixed objective
Combat Ashore	Daily/Weekly

This overview serves to emphasize the compression of time (or conversely the increase of activity) that occurs in the combat environment, and the affect it has on information processing in the FMF.

In addition to that aggregate view, the individual management functions performed at each echelon level are also time dependent, usually with their characteristic frequency a function of the echelon level

where they are performed. For example, planning at the division level may project months in advance while planning at the battalion level projects only days in advance.

The final major time influence is the one that occurs in the Class I reporting requirement. In this case, information must flow in some cases from the lowest echelons to the large central data bases of the Supporting Establishment. A typical timeliness objective for this activity occurs in the JUMPS/MMS reporting process where it is considered essential that the update of the central data base never be more than 4 to 6 days behind the occurrence of the reportable event.

d. Availability of ADP Capability

One aspect of the environmental impact on FMF information processing discussed previously was the differences in the timeliness of activities in garrison, afloat, or ashore. There are, however, other fundamental questions regarding the impact of the operating environments on ADP operations. One of these concerns the continuity of ADP service during the transition of a MAGTF from one environment to another.

It is apparent from SRI's study of operational and information processing requirements that:

- There is a requirement both afloat and ashore for a complete data processing functional capability for all MAGTFs.
- The external reporting requirements are less affected by interruptions in data processing support because the time criticality of information is not so stringent as it is in the local support applications.
- The effectiveness of local information processing especially is determined by its capability to provide uninterrupted service, in a timely manner, in both the afloat and ashore environments, as well as during the transition between the two.

- The most critical functional data processing capability in assuring transitional capability between the environments lies in the information storage/retrieval and output/display capabilities.

e. Composition of Local Data Bases

The requirement to automate management functions within individual units at the lower echelons required SRI to investigate the composition of the data bases that would reside there. Several important conclusions can be drawn from that investigation:

- A substantial portion of a local unit data base can be assembled from the information already captured and reported to Class I ADS.
- There exists a significant body of information at each unit that is pertinent to that unit alone.
- Within each functional area, the content of the Class I ADS information most valuable to a particular unit depends to a significant degree on the echelon where that unit resides. For example, different subsets of a Class I ADS central data base will be found at division, regiment, or battalion.

V ADPS TECHNOLOGY IN THE 1980s

To complement and provide a technical perspective for its investigation of FMF information processing requirements, SRI conducted a comprehensive review of current ADPS technology and its future expectations. This section presents an overview and interpretation of that review. A detailed report on the SRI technology review is contained in Volume III of this report.

A. Objective and Scope

The explicit objective of this phase of the study was to review the current state, and project the directions, of ADP technology that will be available to support any modern command and management ADPS developed for the FMF in the 1980s.

The review was a direct step in the development of the SRI study team's ideas that ultimately culminated in the generation of alternative concepts. Since the earlier requirements investigation had identified the FMF ADPS problem, the technology review then explored the technology-related aspects of these same concerns and issues. It also uncovered additional issues relevant to the development of alternatives.

The technology review served to bring a pragmatic influence to the thinking that went into alternatives development. Emphasis was placed on anticipating future ADP trends and capabilities while avoiding those high risk areas that could jeopardize an initial operating capability early in the 1980s. Only those technological developments that could be soundly counted on to be available in the early 1980s were considered for the ADPS concepts. This consisted largely of developments that already exist

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in a functionally capable form today (although perhaps not in the small size and operationally rugged form that could be achieved by the 1980s).

B. Approach

This task was approached as a technology review rather than a technology assessment. This meant that the knowledge collected was gained from inspection of the current ADP literature and from consultation with experts in the various technology fields. Although no original research was conducted, the analysis effort drew extensively on the awareness and experience of the SRI staff well acquainted with ADP technology. Much of the most important literature surveyed is included in the study bibliography as an appendix to this volume.

Separate reviews were conducted in each of the following traditional areas of ADP concern:

- Computer hardware technology
- Data base technology
- Software technology
- Non-automated procedures
- Telecommunications technology
- System architectures.

C. Results and Conclusions

Since the last major Marine Corps ADPS procurement, and continuing over the 20 month duration of this study, a significant change has taken place in computer technology. Many important trends impacting on the FMF's requirements and potential system needs were established in computer hardware development. These trends indicate that the FMF's objectives for reliable, flexible, transportable and uncomplex (from a user standpoint) information systems can realistically and economically be accomplished in the coming decade.

Historically the state of ADP technology and the nature of ADP systems has significantly limited the FMF's use of ADPS in deployed environments. Current trends indicate that practical and realistic support can now be obtained through the application of available and developing technology in the FMF afloat and combat ashore environments at several different levels in the FMF organiation.

The following sections review the specific technical ADPS factors and their implications that lead to such a conclusion. Although much of what is stated also pertains to the large centralized systems supporting HQMC functional managers, this discussion concentrates on the changes in technology that are particularly significant to local information systems support of FMF units and MAGTFs.

1. ADPS Hardware

The most dramatic changes in ADPS technology have appeared in computer hardware. These changes will continue, and their impact will be felt primarily through lower costs for current activities and the availability of cheap computing power at all management levels within an organization. Hence, these changes will provide increased flexibility through the application of computing power to a much wider range of users and applications.

a. Central Processing Units

Since 1960, changes of an order of magnitude have occurred to the processing speeds of computers. Computing speeds sufficient to support the processing requirements of FMF will be available in reliable small (almost miniature) packages. This computing capability will be able to operate in a broad environment of more severe ambient temperature and humidity ranges and with more diverse power sources, including self-contained

ones. It will allow an entirely different maintenance regime--nearing that of the "throw-away" component including a replaceable plug-in CPU.

One of the significant consequences of changes in CPU technology will be the availability of an extremely broad and complete range of power and/or size of device, thus making it more nearly possible to match the computing resource with user requirements. This capability will be modular and compatible in the sense that as user needs change, it will be a simple task to replace the existing CPU module with one matching the changed speed requirement or the change in logic power. It is not anticipated that FMF will require a broad spectrum of different logic or diverse speeds, but this technological advance will provide a better fit of power with needs, making it possible to choose from a wider variety of CPU characteristics. It should be noted that one of the additional benefits of microprocessor technology is that because of the low cost of this logic, there need no longer be *"CPU utilization rate" concerns.* Of no less significance will be the fact that a change in CPU will not have the same traumatic effect on users as it has today.

In summary, the beneficial changes to the FMF in CPUs will be decreased size, lower costs for equivalent power, appropriate speed, more directly applicable logic, higher reliability with decreased maintenance, and high mobility.

b. Memory

For purposes of discussion, this hardware is categorized as that which is traditionally viewed as "core memory." Undoubtedly many of the emerging technologies will be perfected and available in the next decade. The metal-oxide semiconductor (MOS) manufacturing technologies, charge-coupled devices (CCD), bubble memories, laser technologies, and other processors still under investigation form a very competitive and volatile basis

for memory technology advancement. The most significant contribution of these research and manufacturing efforts to ADPS development for the FMF will be a continued lessening of computer memory costs.

For all practical purposes, the state of the art in computer memory technology is very nearly sufficient to satisfy FMF requirements. That is, the speed of access to memory and the availability of memory working area to users, presently available, seem adequate to meet FMF requirements--especially on minicomputers and microprocessors at lower unit levels. The major contributions that further developments will provide will be reduced power requirements, further reductions in volume (cube) and weight, greater reliability, and a greatly reduced maintenance requirement.

Of all the changes in technology, the changes in computer memory technology will be the least important to the FMF. This is not to say that these changes will not be of great significance and impact to ADPS in other areas of Marine Corps systems.

In summary, the most significant consequence to the FMF of changes in memory technology will be reduced costs.

c. Rotating Storage

Included in this technological area are disks, tapes, and drums in all their manifestations. This is one of the fastest moving area of technological advance. One of the initial objectives for this class of resource was to provide storage capacity at reduced costs compared with other memory devices. This objective continues to be one of the driving factors. In addition, the objective of portability or reduction in size has come into play and will continue to serve as a primary objective in the 1980s.

Of the changes in rotating storage devices, the coming changes in mass storage (drums, large disks, and the current disk pack concepts) are probably of least significance to FMF. There will be significant changes in the role that magnetic tapes play in ADS operations. For example, magnetic tapes will become uneconomical as intermediate on-line storage devices. However, just as it was wrongly thought by some in the past that magnetic tape would wipe out the punched card, it is now wrongly believed by some that the disk pack will completely replace the magnetic tape. Each medium will continue to play a part in the large system operations, but not necessarily the same function as in current systems.

The most important changes in rotating storage will be in diskettes, floppy disks, tape cassettes, and other forms of mini-tapes or tape cartridges. The trend in these media has been toward increased storage density along with decreased physical size. There will continue to be a movement to use these mini-devices as replacements in the storage hierarchy for the other forms of auxiliary storage.

The integration of this storage medium into mini and micro processor system architecture is what will allow systems to be developed and fielded that will meet the requirements of the FMF ADPS. It is precisely this form of system architecture that will allow a range of systems to be used that will have the power, flexibility, portability, reliability, and cost advantages that the FMF can effectively use in the garrison, afloat, and ashore environments.

A significant problem that the FMF must be concerned with is that of acquiring equipment too early in a period of technological advancement. During the next 5 years, there will still be changes of large magnitude in size of equipment, power requirements, recording densities, media reliability, and physical packaging in this equipment. Care must be

taken to design the ADPS and to time the acquisition of ADPE so as to get the benefits of major technological advancements that are very close to becoming readily available on the market.

In summary, the advance in rotating memory technology will be the factor that allows FMF ADPS requirements to be met in a way that satisfies the stringent operational and environment conditions--even at very low organizational levels. The changes in rotating storage technology that allow new architectural concepts and system designs as well as provide new physical devices are probably the most important hardware changes with respect to the FMF ADPS requirements.

d. Peripheral Input/Output Devices

This class of equipment includes readers, scanners, printers, and terminals of all varieties. Also, such devices as paper tape readers and punches; plotters, audio input/output (I/O) units and other specialized terminals are included in this category but are of lesser importance to FMF ADPS development.

The most significant consideration in the changing technology of I/O devices will be the proliferation of the number and types of devices available. The emphasis will be on specific or specialized devices for each application tailored to the user or application environment; for example, credit card or badge readers vs. a generalized magnetic strip reader, or teller terminals and fast food service terminals as opposed to a multipurpose keyboard. The trend to portability of devices in this area has begun and this trend will continue, ultimately leading to higher reliability and ease of maintenance as well as decreased costs with volume and competition.

Of great interest and importance to FMF ADPS development will be the advances in printer or hard-copy output devices, since there will definitely be a requirement for stand-alone printer or hard-copy devices

in the hierarchy of ADPE used by the FMF. Equipment emerging today along these lines is evidence that some of the appropriate attributes will be available to satisfy Marine Corps requirements for printer copy at most levels. There is every indication that continued reduction in size and weight will take place and that portability requirements will be met.

The major problem in stand-alone printer devices here for the FMF will be their maintainability in the field. Continued advancement in non-impact type equipment may provide the answer. This is one area where FMF requirements may be somewhat different from those of other ADP users. The FMF is less interested in ultra-high speed output or in precise reproducible clear character representation than in ruggedness and dependability. One solution would be reliance on other technologies that would make it possible to minimize hard-copy output in an FMF ADPS.

Terminals will be an integral part of FMF ADPS development. Both the typewriter-style terminal as well as the CRT-oriented terminal are candidates of interest to FMF. Both technologies have been developing rapidly in the past few years. This development will probably hit its peak during the next decade, at least for devices as we know them now.

A most significant change in terminal development is one of building more intelligence into the terminal. The modern terminal is not, and need not be, a simple straightforward input device. The requirements of FMF will call for selective use of staged levels of sophistication available in terminal equipment. Particularly important to the FMF is the stand-alone capability to support remote or non-netted system activities.

With respect to typewriter-style terminals, the technology will continue to emphasize reduction in size and weight as one of the more important product attributes. Terminals with lightweight self-contained power supply, removable, portable recording media, built-in coupler, and a wide environmental operating range will be available to satisfy Marine Corps requirements in the 1980s.

CRT-type terminals are developing at a rapid rate and are becoming a standard component of many of the smaller self-contained computing systems. The entire field of visual display terminals (VDT) will be undergoing rapid change during the next decade. The result will be a much wider variety of applications in their use as peripheral I/O devices. It remains to be determined what level of resource requirement will be generated during FMF ADPS development for I/O facilities without associated hard copy. There is no question that in the near term, as a terminal, these devices can be used as a very effective replacement for the keypunch. As visual display equipment technology changes, it will impact the FMF through its availability as an integrable component of all but the lowest level computing hierarchy. But the more significant contributions of VDT advanced technology will be in the area of C^3 and in tactical operations.

In summary, peripheral I/O equipment technology change will provide FMF ADPS development with a range of printers to satisfy their intermediate range hard-copy requirements with devices that are dependable, readily transportable, and easily maintained. The technology will also supply terminals with a range of sophistication, transportability, reliability and price to meet the requirements of a hierarchy of distributed computing power and capability.

2. ADPS Software

The 1980s will be an era in which very dramatic, and traumatic, changes will be realized in ADPS software. This will be of vital concern to the FMF, because without changes of considerable consequence, FMF ADPS will have the same frustrating, expensive, software development experience that has characterized the past few years. We are concerned here with the operating systems, the programming languages, and application program development techniques. The observations made here are meant

to apply specifically to the aggregation of hardware and software necessary to fulfill local FMF ADS requirements, whose objectives may be quite different from other Marine Corps requirements.

During the 1980-1990 time period, the operating system and application language facility will be integrated into what appears to the user as a single entity. That is, for the emerging class of user-oriented computers (microprocessor based) there will be only an application or "computing" capability in evidence and there will be no need to distinguish between different languages or software entities. This is not to say that there will be some new super language. What it does mean is that there will be a set of tools, each one matched to the user's needs and couched in the terminology of the user's discipline.

Much of what is now implemented as operating systems, language compilers, assemblers, and libraries will be embodied in hardware or pseudo-hardware of the new computer systems. An early example of this technology trend is provided by the IBM 5100 which has implemented in firmware what many systems designers had been doing entirely with software. One of the more significant implications of this change is the impact on system software maintenance with considerable improvement in system stability and compatibility. Modular design, or building block system implementation techniques, will also allow more effective and economical use of computational resources. The nature of these changes will permit greater concentration of effort in the user or application area. Consequently, more effective methods and tools for managing and maintaining application programs will be available.

The emerging software (or, more appropriately, user interface technology) of the 1980s will dictate <u>exclusive</u> use of a language capability similar in concept to what is now known as "high-level" language. This will consist of syntax that is a natural part of the application or user area. Again, this is expected to be specifically formulated at the level

of the FMF user and more explicitly should be one of the basic requirements of any FMF ADPS. For most levels of ADPS in the FMF there will be no requirement for programmers or operators, only users. This trend is already apparent in many industrial and commercial applications and is a direct result of matching minicomputer power to specific user needs with cost saving objectives.

Software development activities in the next decade will reflect many of the changes taking place now and will also reflect the changes in hardware and computer system architecture. There is, however, one aspect of software development that will not change with the changing hardware or language technology. The necessity for software design will always remain. There will be no magic hardware, system, or language that will replace clear unambiguous system requirements and objectives, or that will automatically create complete and precise specifications. Given a well-formed design, the time from conception to implementation and test of a program can, with the advancing technology, be considerably less than that experienced today.

The most significant software development efforts that can be undertaken by FMF in support of ADPS requirements will be application oriented. These tasks will still require design efforts and will go through the typical development phases, but with several differences. Especially within the FMF environment, this effort will exploit on-line interaction with the system, much of it in the form of dialog. In essence, the machine itself will be the programming notebook, program documentor, debugger, test-generator and user manual producer. Because of the ease and ready access to the system, much of what today is generated in hard copy, listings, manuals and procedures will be kept in machine form on the system. This will alleviate document storage problems, updating of old versions, and problems of paper consumption.

In summary, changing technology in software during the next decade will result in much of what is now code or software becoming hardware or "firmware." There will be no discernable differentiation between system software and application languages as far as the user is concerned. Future software development will be a dynamic integrated user-system dialog.

3. Data Base Management

In the coming decade, improved data base technology will have resulted in much of the information that is now stored and handled as independent ad hoc files being converted to data bases subject to data base management systems. The larger computer systems will generally offer a broad range of data base management capabilities, with ample storage capacity, and reasonable performance. This fact will certainly impact the FMF's interaction with Supporting Establishment ADPS. The FMF will be called upon to submit and receive information via large-scaled integrated data bases maintained by Supporting Establishment systems. However, from the FMF point of view, these transactions will be generally simple and straightforward, that is less diverse and complicated than they are today.

With respect to data base management in the FMF ADS per se, just as the changing technology is providing hardware, software, and system architectures suited to the Marine FMF's needs and operating environments, it is also producing data base tools suitable for the FMF ADS. The technology is beginning to provide data base management facilities that are operational on all the various types and sizes of computers, storage devices, and input-output units that will be found in an FMF ADPS. For example, significant data base management facilities are now becoming available on minicomputers. Furthermore, the languages and procedures required for data base transactions that will be part of an FMF ADS in the next decade can be made very user-oriented. Thus, the technology available for use

in the FMF will not be merely a scaled down version of that used for large computers in centralized systems but will be tailored to the small system user, in his operational environment, and in his language.

4. Physical Packaging

Impressive advances in the physical packaging of ADP systems are currently being made, and more can be expected in the next 5 years. By physical packaging is meant the combination of components, functions, and features into physical devices or units. Packaging can have great influence on the ultimate utility of ADPS to the user.

Advances in physical packaging are being made possible by a combination of technological factors resulting from progress in other technological areas. Among these factors are:

- Electronic miniaturization, which permits small devices
- Low electric power requirements, which permits use of standard power sources
- Low heat generation, which lessens or eliminates the need for cooling
- Elimination of mechanical mechanisms in favor of electronics
- Inherent ruggedness of solid state components
- Modular replacement methods for electronic components
- Large memory capacities in smaller modules for data and programs
- Availability of firmware in place of software
- Availability of standard components from which to construct customized systems.

Progress in packaging is making possible the design and production of "fully integrated" units. A fully integrated computer system is such that:

- All system functions are incorporated into one, or a very small number of cabinets
- All components are well designed to work together
- Components are modular and easily replaceable
- The components exhibit good human engineering of the user interface
- The components possess excellent environmental tolerance and mobility characteristics.

A few examples of such systems can be found today--often developed explicitly for military applications. Increasingly such systems will become available as off-the-shelf commercial devices.

In summary, whereas nearly all of the more desirable physical, functional, and performance features in an ADP system are available today in one manifestation or another, the next 2 to 5 years will see a jump forward in the availability of off-the-shelf systems that combine all of these features into fully integrated units. Such fully integrated packages are likely to offer attractive solutions to the FMF ADPS operational requirements as early as 1981 or 1982.

5. Telecommunications

With the future development of LFICS, the 1980's will see a transition to digital transmission of electronic signals, even for voice. A major aspect of digital transmission is the relative ease (compared with analog) with which encryption can be applied, especially for voice. A major thrust of LFICS is secure voice.

In particular, LFICS is moving toward a standard 16 kbps (kilobit per second) transmission channel building block. This channel capacity should be quite suitable for most data communications applications of the FMF ADPS.

During the mid and late 1980s a transition to an all digital communications environment will occur. The primary means of communications

will be through a switched, multichannel digital system. All switches will accommodate the transmission of 16 kdps data streams among the architectural nodes of the LFICS.

A major advancement of the LFICS in the 1980s will be the strong emphasis on communication security for both voice and data. The use of digital transmission (as opposed to analog) makes possible the extensive, economic, and practical use of encryption and decryption devices.

Current LFICS plans call for a major transition to occur in Marine Corps communications during the period FY 1983-88. The transition affects terminals (both voice and data), transmission links, multiplexers, and switches. This period will see (1) the phasing in of digital elements and the phasing out of analog elements, (2) the phasing in of wide band circuit switches and automatic store and forward switches and the phasing out of manual store and forward switches, and (3) the phasing in of encryption devices.

While the long term provides for essentially all digital networks, the 1980s will continue to see the use of analog radio equipment modified to also accomodate digital signals.

The problem of fast switching for responsive interactive terminal traffic requires technical advancement. Packet switching, when ultimately deployed, may provide the solution for a smooth blending of computer and other traffic. Packet radio, in particular, should be monitored. Due to the long lead times involved (potential deployment could be in the very late 1980s), however, the FMF ADPS may need to adopt both an interim and long-term design.

5. Philosophy and Environment

The ADPS design and operating environment will undergo significant changes in the next decade. Computer-assisted tools will be widely available in a number of packages to assist the FMF in solving operational problems and providing administrative and management techniques to more effectively accomplish mission requirements at all organizational levels at which requirements exist.

In estimating future ADP needs, the SRI team recognizes that the future environment of the data systems must coincide with the environment of the user, and the philosophy of system development must be compatible with the FMF user's perspective. The SRI team judges that the changes in computer hardware, software and implementations that will result from the technological advancements during the 1980s can result in the availability of ADPS which will be regarded by FMF users as tools in the same sense as jeeps, field kitchens, and tank retrievers are regarded now.

VI ALTERNATIVE ADPS CONCEPT DESCRIPTIONS

The objective of SRI's requirements analysis and technology review was the generation of alternative ADPS concepts that could support the FMF effectively in the 1980s. This section presents an overview of SRI's efforts in producing two viable alternatives, both of which are then briefly described below (along with a basically unchanged extension of the present ADPS configuration). A more complete description of the alternative ADPS concepts is contained in Volume IV of this report.

A. Objective and Scope

The research SRI addressed was the identification, selection, and description of alternative ADPS concepts capable of meeting the requirements of the FMF in the 1980s. The number of alternatives was intended to be kept small--no more than three or four best alternatives--in order that the competing concepts could be described fully and ultimately evaluated. SRI attempted to explore alternatives that exhibited sufficient variations of features, capabilities, and costs to provide a meaningful range of choices to Marine Corps decision makers. By direction, one of the alternatives considered was the current ADPS in the FMF.

The aim of the alternative concept descriptions was to define and communicate the essential characteristics of the concepts being considered, in order to make possible an analysis, comparison, and choice between them. However, they were not to be considered as full, detailed system designs. It was known that if a concept were to be adopted, a more complex system design effort would be necessary.

B. Approach

A substantial number of ADPS concepts initially presented themselves as potential candidates for use in the FMF. These emerged primarily from the application of existing commercial concepts to the FMF context. As the first step in its approach, therefore, SRI conducted an analysis to reduce the number of candidates to a manageable number of the most promising alternatives. By eliminating the less promising candidates early a more thorough analysis of the best candidates could be performed.

The selection process was conducted through a formal process of exclusion based on several conditions that SRI viewed as necessary to the viability of any ADPS concept to support the FMF. These conditions were developed and their validity argued on the basis of four considerations: (1) SRI's analysis of the FMF information processing requirements; (2) FMF operational concepts that affect the ADPS concept characteristics; (3) Marine Corps resource constraints in the ADPS area; and (4) SRI's review of ADPS technology.

The conditions that SRI stated and defended were:

- A tightly coupled network of ADP systems for on-line, real-time sharing of computing power or data bases via a communication system cannot be supported in all FMF combat environments. However, batch teleprocessing (in a store and forward mode) can be supported in such environments.
- A hierarchy of ADP systems supporting ADP services of different capacity and function must be present to serve the multilevel needs of the FMF organization.
- A minimum of three levels must be contained in the ADP system hierarchy.
- The lower level of the ADP system hierarchy should not possess an ADP capability less than that contained in stand-alone intelligent terminals.
- Each level of the hierarchy must be able to operate autonomously to serve the primary needs of the user of that level.

SRI believes that unless the ADPS developed for the FMF meets these conditions, the ADS cannot simultaneously meet the following two objectives, given the operational and economic realities of the technology:

- Support all the input requirements of Class I systems and satisfy the reporting needs of the various HQMC functional managers
- Satisfy the operational requirements of the FMF commanders in the three FMF environments (garrison, afloat, ashore), as well as support the several MAGTF configuration options.

A full discussion of why SRI holds this belief is contained in Volume IV.

When the exclusion conditions were applied to the various alternatives, two concepts labeled DISHIER and DISACT were selected for analysis. To these two was added a third, the BASELINE concept.

C. Results and Conclusions

The three alternative concept descriptions developed in this phase are summarized in this section.

Each alternative provides a different distribution of computing resources and computing functions to the FMF. Each offers a somewhat different balance between the dual roles of providing ADP support for Class I systems and providing ADP support to local units and their commanders.

1. Summary Description of BASELINE

The name BASELINE stands for the current FMF ADPS concept. An overview of the physical architecture of BASELINE is given in Figure 1. The BASELINE architecture is distinguished by the following features:

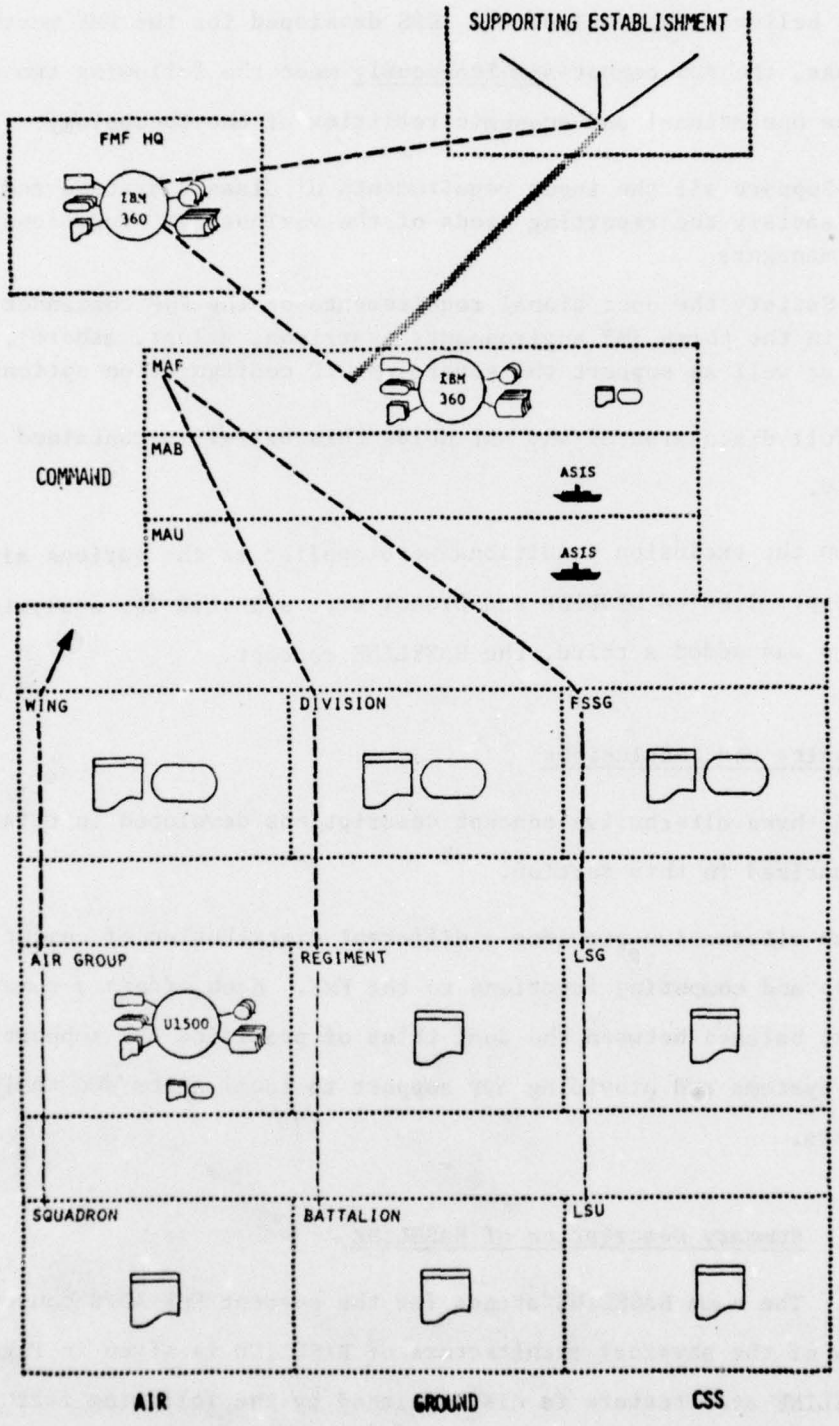


FIGURE 1 BASELINE OVERVIEW

- Large general purpose computer systems at MAF level and smaller general purpose computers (dedicated to Navy aviation logistics) with the MAGs
- An absence of automated information processing at all other echelon levels, except for some data entry (punched cards) at division/wing/FSSG level and the capability to request computer listing from the MAF computer at all levels
- Only minor use of telecommunications, with the abundance of information transfer being physical transportation of a hardcopy media.

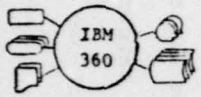
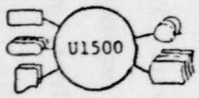
The underlying concept for the architecture of this ADPS is based on that of geographically centralized service bureaus providing general ADP services upon request by supported units.

Some immediate implications of the BASELINE configuration are that the size, mobility, and logistic support requirements component ADPE do not support the operational concepts of the units they support. For example, deployed MAGTFs cannot be effectively supported afloat/ashore by BASELINE except after long delay times and only for very stable environments. Coupled with that deficiency is the fact that a large portion of information processing remains manual in BASELINE. Especially at the lower echelons, information is provided to satisfy Class I ADS, but there is little responsive automated support for management of FMF units locally.

BASELINE has two processor system types. In generic terms, the IBM 360 system is a relatively large and capable general purpose computing system. As presently configured it supports a primarily batch operation. The U-1500 is a smaller general purpose computer that is dedicated to the support of several large Navy aviation logistics programs. The features of these two component systems--their hardware characteristics, their system software features, and the system functions they support--are described in Table 1.

Table 1

BASELINE ADPS IMPLEMENTATION

Component Systems	Hardware Characteristics	System Software Features	Supported System Functions
 IBM System 360	Large scale 3rd generation general purpose computer system Extensive disk auxiliary memory Extensive tape auxiliary memory One or more high speed hard copy printers Punch-card I/O devices Interactive keyboard terminals Telecommunications interface	Multiprogramming operating system Utility program library Low level language processor (assembler) Higher level language compiler and programming aids File management and retrieval package Text handling package	Data entry Data handling Report generation Data retrieval File creation for data forwarding
 UNIVAC 1500	Medium scale, 2nd-3rd generation, partially militarized general purpose computer system One magnetic tape unit One high-speed hardcopy printer One teletypewriter One punch-card reader/punch	Executive program Assembler program Language compiler Loader Utility package	Data entry Data handling Report generation File creation for data forwarding

The reporting philosophy underlying BASELINE is exception reporting to the central Class I ADS data bases. This principally involves reporting of records of events that would alter a particular system's data base (e.g., the JUMPS/MMS data base). Reporting is characterized by a scheduled batch submission (usually daily) from reporting units up from the battalion/squadron echelon. Management information flow in BASELINE is portrayed in Figure 2. The flow is characterized by a combination of manual and automated processes, with multiple transcription actions and significant amounts of traffic for correcting errors submitted in the reporting process. Data is typically reported on typewritten paper for central card punching or optical character recognition.

Although Figure 1 summarizes the general scheme by which ADPE are associated with FMF units; it does not fully indicate a specific MAGTF configuration. In Figure 3 an example of the ADPE distribution for a deployed MAF is shown. This particular configuration utilizes:

- 1 IBM 360 system (1 IBM 360 remains in garrison)
- 5 U-1500 systems.

The total manpower requirement to operate and maintain BASELINE is estimated to be approximately 862 man-years per year. Of this total, the estimated profile of skills required is summarized in the following tabulation:

Job Category	Man-Years	Percent of Total
Analyst/programmer	201	23%
Senior analvst/programmer	94	11%
Systems programmer	23	3%
Senior systems programmer	22	3%
ADPE operator	487	56%
ADPE maintenance	35	4%

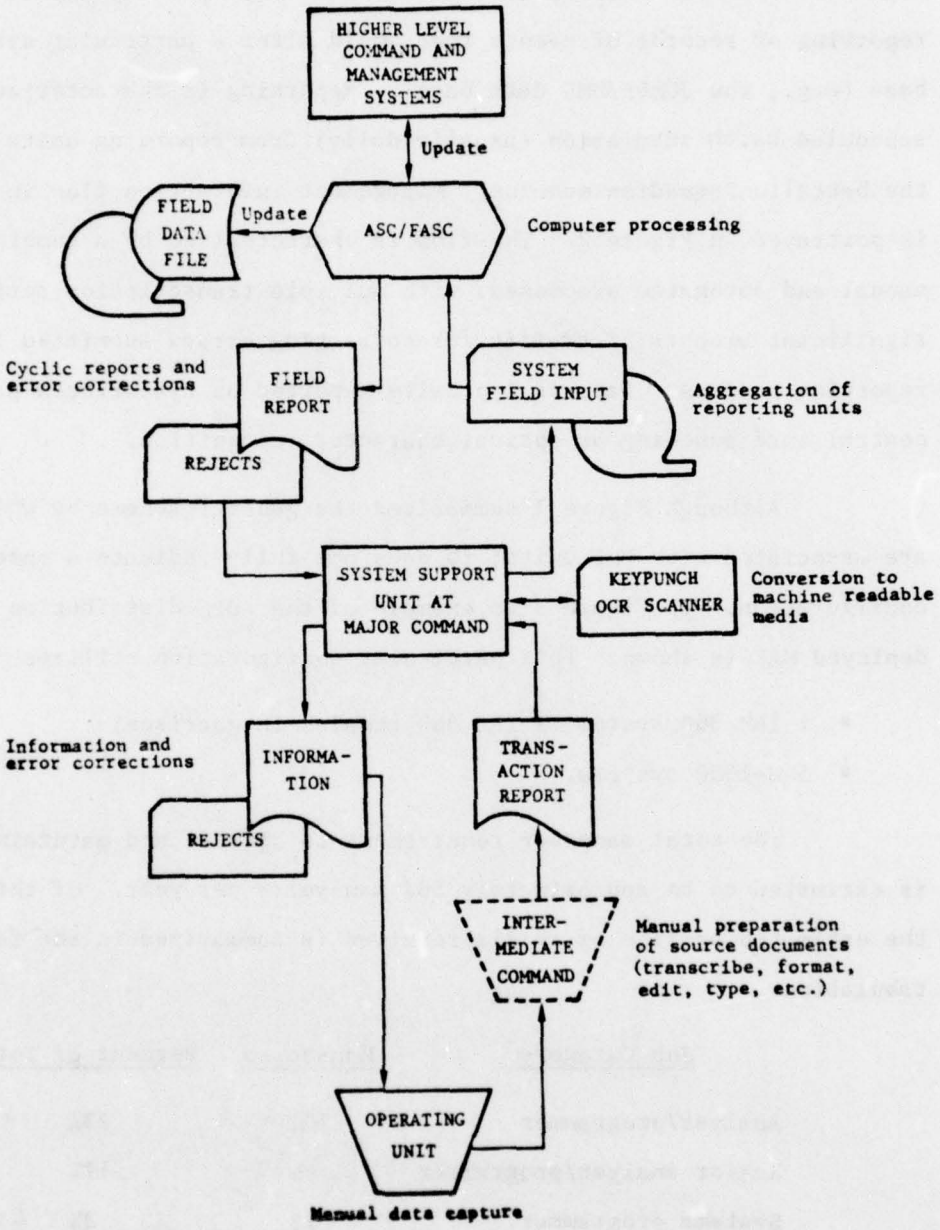


FIGURE 2 MANAGEMENT INFORMATION FLOW IN BASELINE

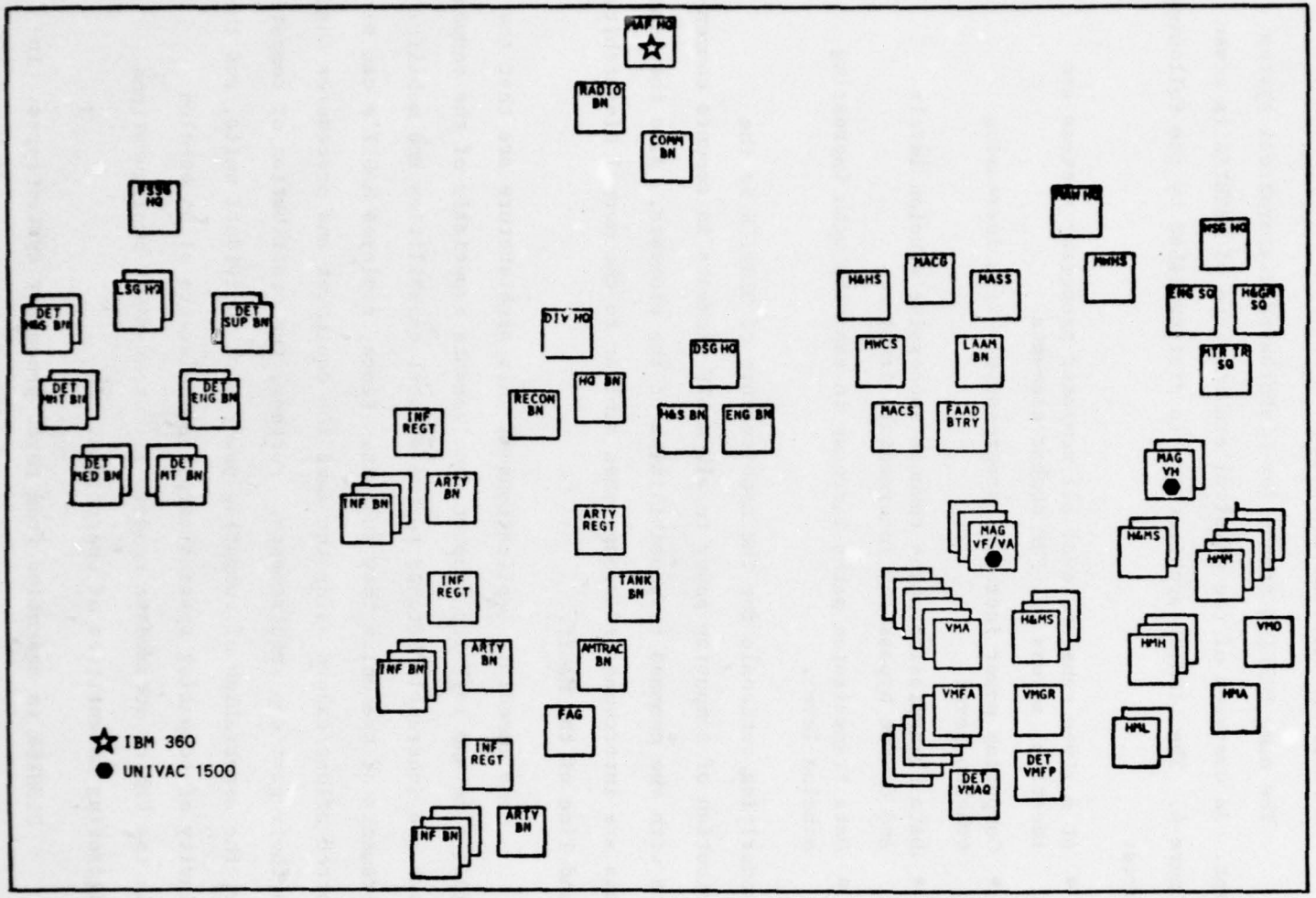


FIGURE 3 MAF DISTRIBUTION OF ADPE IN BASELINE

2. Summary Description of DISHIER

The name DISHIER stands for Distributed Hierarchical system concept. An overview of the physical architecture of DISHIER is given in Figure 4. The DISHIER architecture is distinguished by the following features:

- At a given echelon level all computer processor systems are identical across all FMF combat elements
- Computing power increases progressively with increasing echelon level
- Data transmission paths connect successive echelon levels and do not bypass any intermediate level
- Data transmission paths increase in capacity with increasing echelon level.

The underlying rationale for the architecture of DISHIER is the distribution of computing power to all MAGTF elements in amounts commensurate with the command responsibilities of the elements. Also the computer systems are interconnected along lines similar to the normal hierarchical command line of the MAGTF.

Some immediate implications of this archietcture are that the physical size and logistic support requirements especially of the component systems are inherently matched to the support capabilities and mobility requirements of the units they support. Hence, deployed MAGTF's can be supported afloat/ashore using the same ADP equipment and procedures that serve their garrison requirements. Further, the distribution of computing power, the association of computing power with individual units, and the similarity of computing systems across all elements of an echelon enable the FMF to accomodate readily different MAGTF configurations and differing intensities of operations.

DISHIER is assembled from three processor system types. In generic terms System A is an intelligent terminal with a relatively exten-

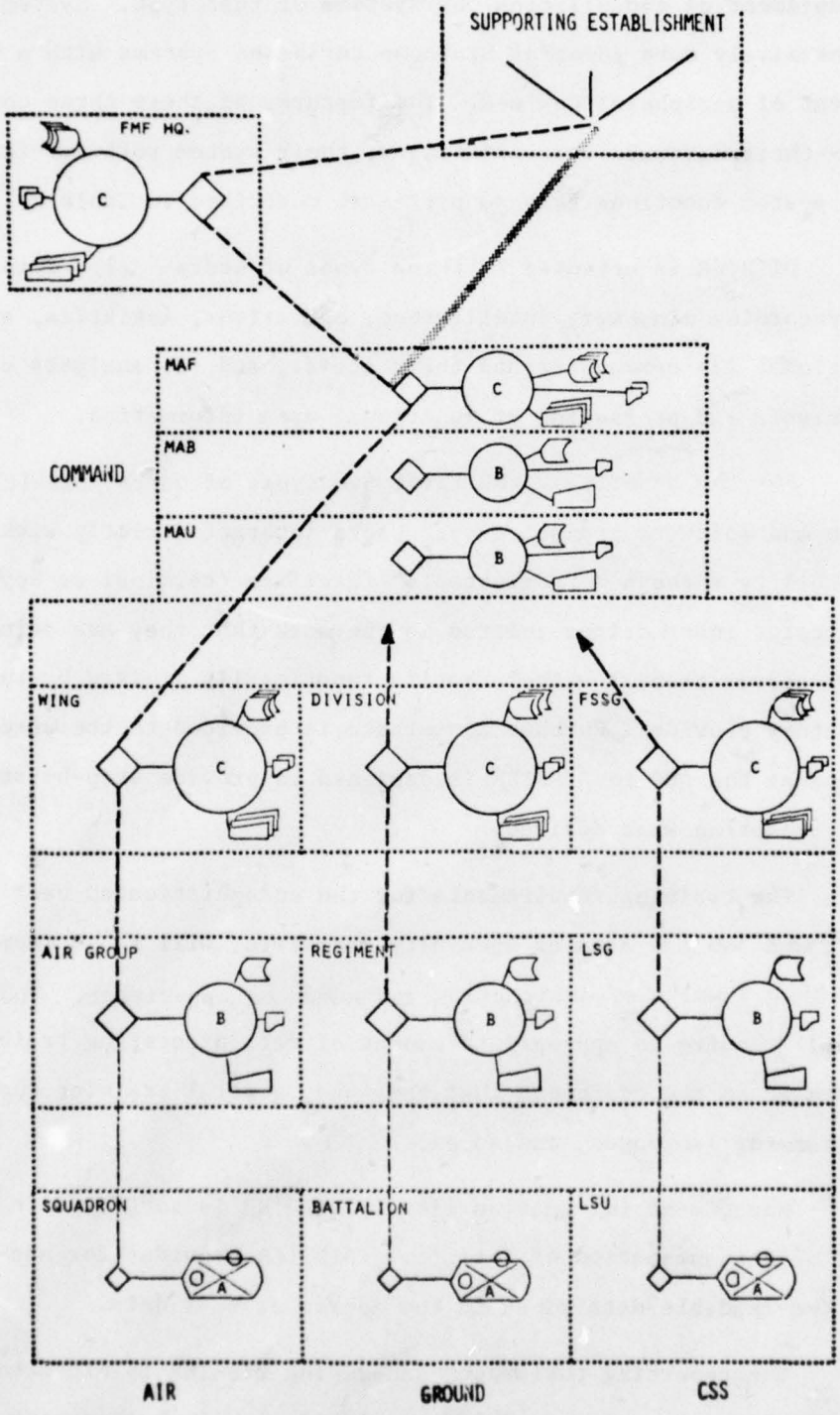


FIGURE 4 DISHIER OVERVIEW

sive complement of capabilities for systems of that type. Systems B and C are successively more powerful minicomputer based systems with a significant complement of peripheral devices. The features of these three component systems--their hardware characteristics, their system software features, and the system functions they support--are described in Table 2.

DISHIER is oriented to three types of users: (1) administrative clerks recording manpower, intelligence, operations, logistics, and financial transactions, (2) commanders and their staffs, and (3) analysts concerned with analysis and processing of functional area information.

For the benefit of the first two types of users, DISHIER emphasizes hardware and software transparency. Users interact directly with the computing capability through a "comfortable" interface (terminal or keyboard) and uncomplicated instructions related to the work that they are doing. The computer serves them as a tool that is functionally limited by the number of keys they provide. Further assistance is provided to the unsophisticated user because the ADS in DISHIER is designed to provide step-by-step instruction or user prompting when desired.

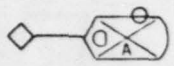
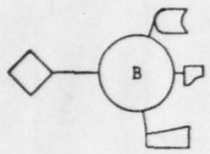
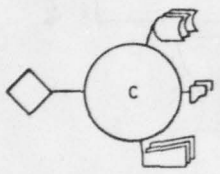
The training requirements for the unsophisticated user familiar with his own job and area of specialty therefore, will range from 1 to no more than 2 weeks of instruction and hands on experience. The analyst users will require an appropriate amount of data processing training--including training on the equipment that they use, general training such a knowledge of programming languages, and so on.

Management information flow in DISHIER is portrayed in Figure 5. As part of its automation of this flow, DISHIER provides for one-time entry of machine-readable data close to the source of that data.

The reporting philosophy underlying DISHIER is exception reporting to the Class I systems. This principally involves reporting of records of events that would alter a particular system's data base (e.g., the

Table 2

DISHIER ADPS IMPLEMENTATION

Component Systems	Hardware Characteristics	System Software Features*	Supported System Functions
 System A	Micro-processor based system Programmable or PROM processor RAM main storage Auxiliary storage Keyboard/display input device Hardcopy output device Telecommunications interface Removable magnetic I/O medium	Control program System utilities Application language processors System diagnostic routines Preprogrammed applications Text handler	Data capture, verification, and editing Simple word and text processing Simple file management of small files Simple information storage and retrieval Numerical calculation Report formatting System self-diagnosis Data communication
 System B	Mini-processor based system Programmable processor Multiprogramming processor hardware Sizeable main and auxiliary storage Multiple keyboard/display input devices Multiple hardcopy printers Telecommunications interface Removable magnetic I/O medium	Operating system for batch and interactive processing Report generator program Preprogrammed applications Query language Rudimentary programming aids	Foreground/background processing Sophisticated storage and retrieval File management Report generation Data communication
 System C	Mini-processor system--variable configuration Multiprogramming processor hardware Ample main storage Extensive auxiliary storage Multiple keyborad/display input devices Multiple hardcopy printers Telecommunications interface Removable magnetic I/O medium	Multiprogramming operating system Compilers for high-level languages Utility program library Diagnostic program package	Multiprogramming and interactive processing String processing General data base management Interoperability interfaces High speed, high volume data communication

*It is anticipated that many of these features may be implemented in firmware.

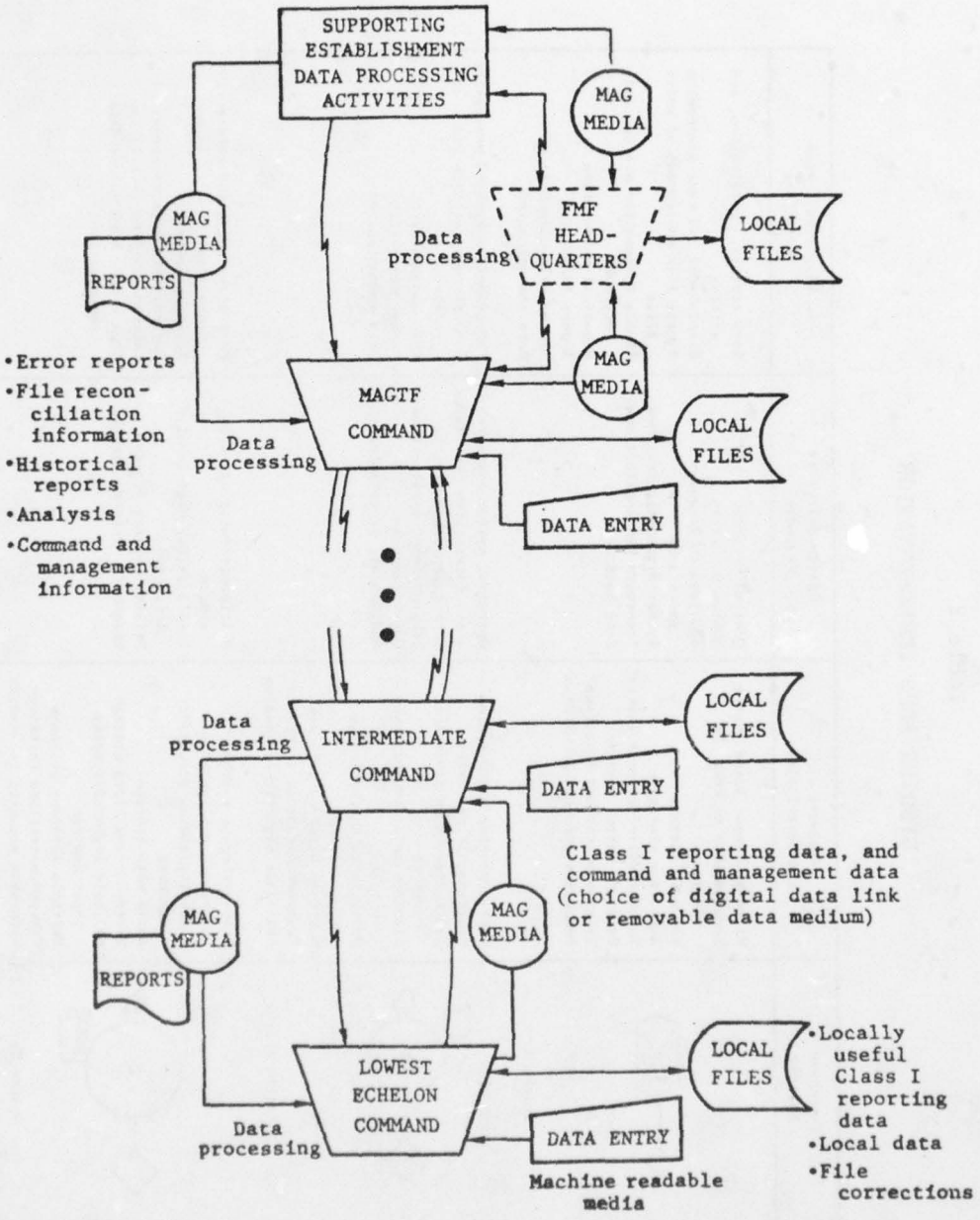


FIGURE 5 MANAGEMENT INFORMATION FLOW IN DISHIER

JUMPS/MMS data base). Reporting is characterized by a scheduled batch submission (usually daily) from reporting units up from the battalion/squadron echelon. The following points are significant:

- DISHIER will not require telecommunication links between nodes other than those already envisioned by the LFICS architecture to support future systems.
- Transmissions will be batch-oriented--with no interactive transfer of data or query of data bases between LFICS nodes (intranodal interactivity between terminals and processor is allowed).
- The majority of data to be transferred will have a precedence commensurate with its administrative (rather than tactical) orientation and its nonperishable nature.

In DISHIER digital traffic flows (1) predominately upward within the hierarchical structure (versus downward or laterally), and (2) on a point-to-point basis, that is, given traffic source directs the bulk of its traffic to the same destination point. Two points related to this flow bear emphasis:

- Any information forwarded from one echelon to another passes through (and hence may be used by) all intermediate echelons.
- Successive echelons are connected by two types of data transmission paths: an electronic data communications path (through LFICS links), and a physical transportation path along which data can be sent if the electronic path is unavailable or unattractive. Along the second path data will generally be sent as recorded data on removable magnetic media such as cassettes or diskettes.

Although Figure 4 summarizes the general scheme by which ADPE are associated with FMF units, it does not fully indicate all the possibilities for associating ADPE to units in specific MAGTF configurations. Some units may not require their own systems. Others may merit multiple systems. In Figure 6 an example of the ADPE distribution for a deployed MAF is shown. This particular configuration utilizes:

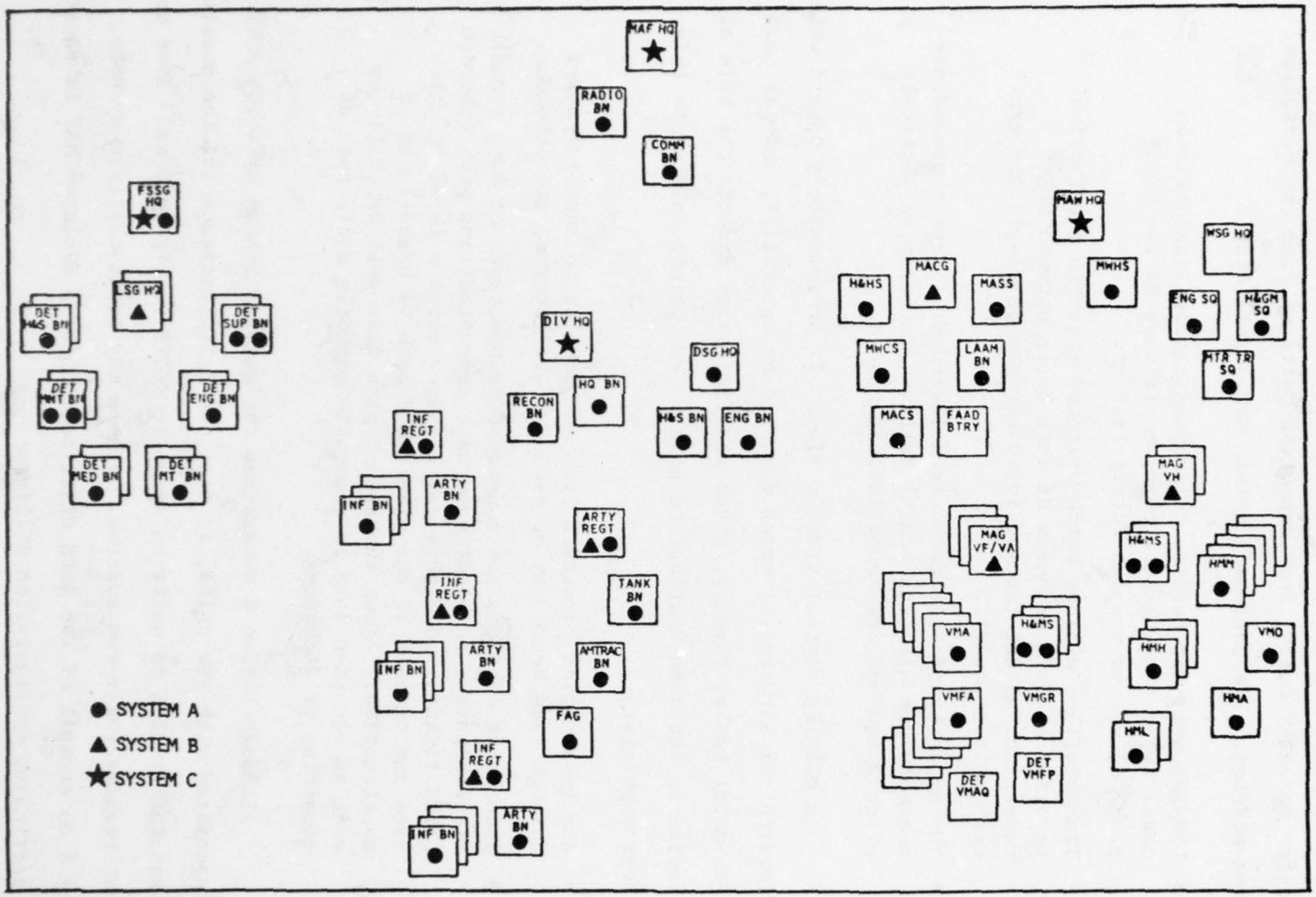


FIGURE 6 MAF DISTRIBUTION OF ADPE IN DISHIER

- 4 units of System C
- 12 units of System B
- 87 units of System A.

The total manpower requirement to operate and maintain DISHIER is estimated to be at least 540 man-years per year. Of this total, the estimated profile of skills required is summarized in the following tabulation:

Job Category	Man-Years	Percent of Total
Analyst/programmer	81	13%
Senior analyst/programmer	39	7%
Systems programmer	12	2%
Senior systems programmer	13	2%
ADPE operator	308	58%
ADPE maintenance	87	16%

3. Summary Description of DISACT

The name DISACT stands for Distributed Activity system concept. An overview of the physical architecture of DISACT is given in Figure 7. The DISACT architecture is distinguished by the following features:

- A dissimilarity exists in the distribution of computing power between that of the ground combat element and that of the air element and combat service support element
- Computing power is tailored specifically to support FMF unit information processing workloads as close as that unit as operational considerations will allow
- Data transmission paths connect successive echelon levels, as well as high activity nodes (such as logistics activity nodes) as required
- A majority of the computing resources (men and ADPE) are found at echelons below division/wing/FSSG.

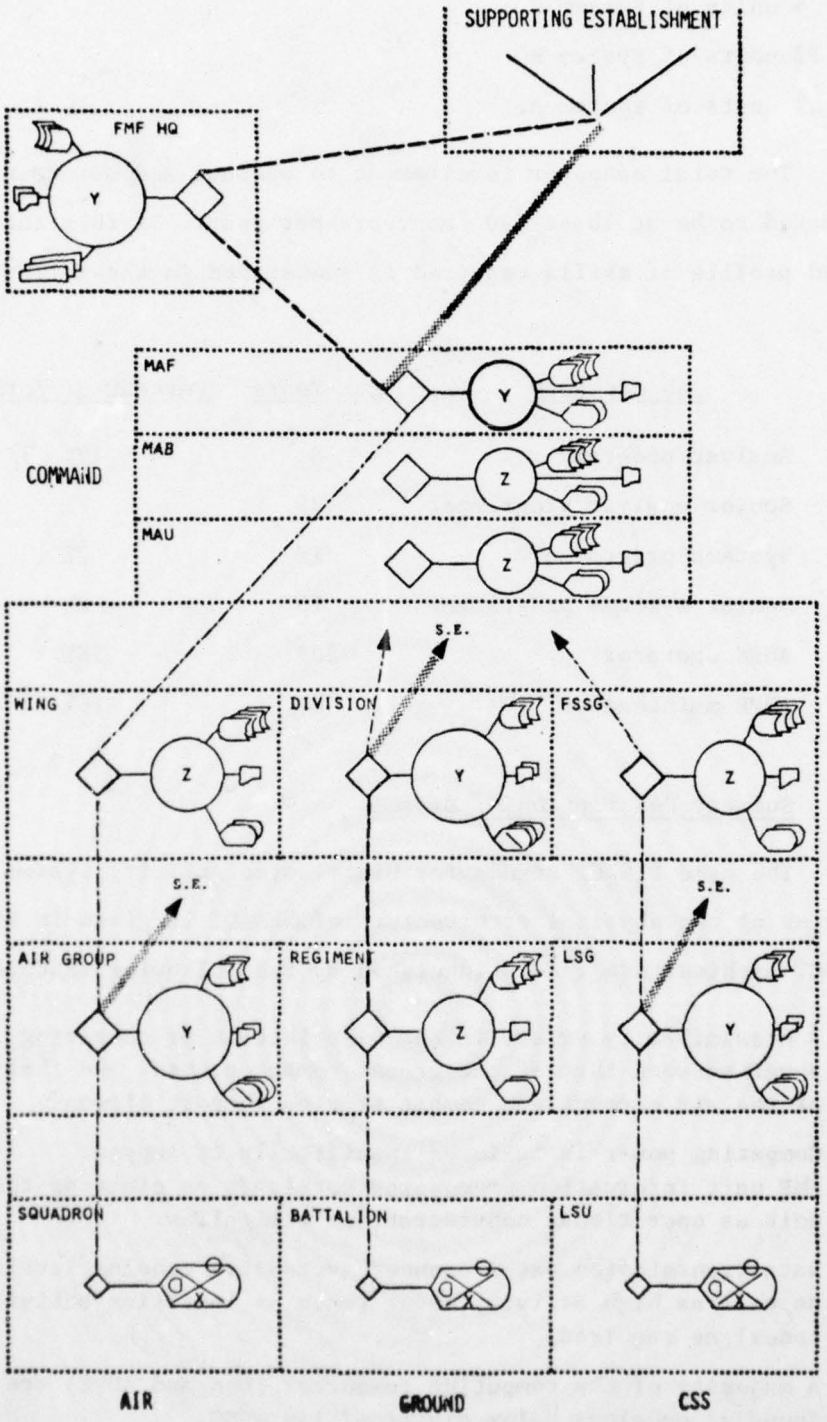


FIGURE 7 DISACT OVERVIEW

The underlying rationale for the architecture of DISACT is the distribution of computing power to all MAGTF elements in amounts tailored to meet the information processing workload where it occurs, rather than passing data processing burdens to higher levels.

Some immediate implications of this architecture are that the physical size and logistic support requirements especially of the component systems do not unduly constrain the support capabilities and mobility requirements of the units they support. Hence, deployed MAGTFs can be supported afloat/ashore using the same ADP equipment and procedures that serve their garrison requirements. Further, the distribution of computing power, the association of computing power to individual units, and the similarity of computing systems across several elements of a given echelon enable the FMF to accomodate readily different MAGTF configurations and differing intensities of operations.

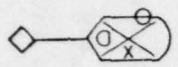
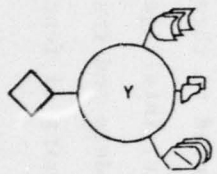
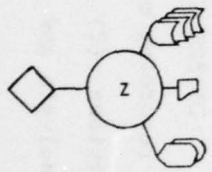
DISACT is assembled from three processor system types. In generic terms System X is an intelligent terminal with a relatively extensive complement of capabilities for systems of that type. Systems Z and Y are successively more powerful minicomputer based systems with a significant complement of peripheral devices. The features of these three component systems--their hardware characteristics, their system software features, and the system functions they support--are described in Table 3.

DISACT is oriented to three types of users: (1) administrative clerks recording manpower, intelligence, operations, logistics, and financial transactions, (2) commanders and their staffs, and (3) analysts concerned with analysis and processing of functional area information.

For the benefit of the first two types of user, DISACT emphasizes hardware and software transparency. Users interact directly with the computing capability through a "comfortable" interface (terminal or keyboard) and uncomplicated instructions related to the work that they are doing.

Table 3

DISACT ADPS IMPLEMENTATION

Component Systems	Hardware Characteristics	System Software Features*	Supported System Functions
 System X	Micro-processor based system Programmable or PROM processor RAM main storage Auxiliary storage Keyboard/display input device Hardcopy output device Telecommunications interface Removable magnetic I/O medium	Control program System utilities Application language processors System diagnostic routines Preprogrammed applications Text handler	Data capture, verification, and editing Simple word and text processing Simple file management of small files Simple information storage and retrieval Numerical calculation Report formatting System self-diagnosis Data communication
 System Y	Mini-processor system--variable configuration Multiprogramming processor hardware Ample main storage Extensive auxiliary storage Multiple keyboard/display input devices Multiple hardcopy printers Telecommunications interface Removable magnetic I/O medium	Operating system for batch & interactive processing Report generator program Preprogrammed applications Query language Rudimentary programming aids Data management package	Foreground/background processing Sophisticated storage and retrieval Data management Report generation Data communication Activity oriented applications
 System Z	Mini-processor based system Programmable processor Multiprogramming processor hardware Sizeable main and auxiliary storage Multiple keyboard/display input devices Multiple hardcopy printers Telecommunications interface Removable magnetic I/O medium	Multiprogramming operating system Compilers for high-level languages Utility program library Diagnostic program package Data management package	Multiprogramming and interactive processing String processing General data base management Interoperability interfaces High speed, high volume data communication

*It is anticipated that many of these features may be implemented in firmware.

The computer serves them as a tool that is functionally limited by the number of keys they provide. Further assistance is provided to the unsophisticated user because the ADS in DISACT is designed to provide step-by-step instruction or user prompting when desired.

The training requirements for the unsophisticated user familiar with his own job and area of speciality therefore, will range from one to no more than two weeks of instruction and hands on experience. The analyst users will require an appropriate amount of data processing training--including training on the equipment that they use, general training such a knowledge of programming languages, and so on.

Management information flow in DISACT is portrayed in Figure 8. As part of its automation of this flow, DISACT provides for onetime entry of machine-readable data close to the source of that data.

The reporting philosophy underlying DISACT is exception reporting to the Class I ADS. This particularly involves reporting of records of events that would alter a particular system's data base (for example, the JUMPS/MMS data base). Reporting is characterized by a scheduled batch submission (usually daily) from reporting units up from the battalion/squadron echelon. Hence:

- DISACT will not require telecommunication links between nodes other than those already envisioned by the LFICS architecture to support future MTACCS systems
- Transmissions will be batch-oriented--with no interactive transfer of data or query of data bases between LFICS nodes (intranodal interactivity between terminals and processor is allowed)
- The majority of data to be transferred will have a precedence commensurate with its administrative (rather than tactical) orientation and its nonperishable nature.

In DISACT digital traffic flows (1) predominately upward within the hierarchical structure (through intermediary activity nodes perhaps),

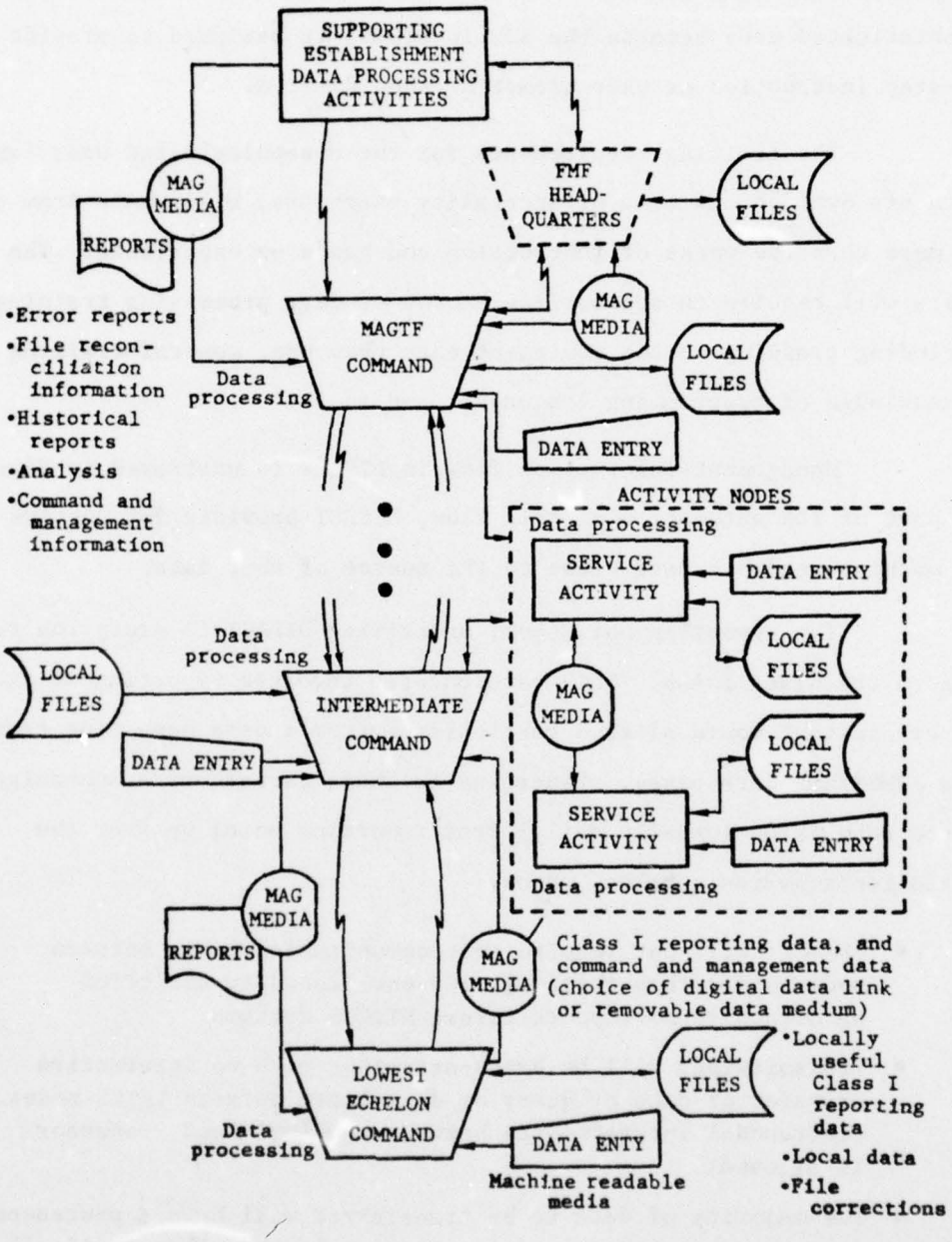


FIGURE 8 MANAGEMENT INFORMATION FLOW IN DISACT

and (2) on a point-to-point basis; that is, a given traffic source directs the bulk of its traffic to the same destination point. Two points related to this flow bear emphasis:

- Any information forwarded from one echelon to another passes through (and hence may be used by) all intermediate echelons.
- Successive echelons are connected by two types of data transmission paths: an electronic data communications path (through LFICS links), and a physical transportation path along which data can be sent if the electronic path is unavailable or unattractive. Along the second path data will generally be sent as recorded data on removable magnetic media such as cassettes or diskettes.

Although Figure 7 summarizes the general scheme by which ADPE are associated with FMF units, it does not fully indicate all the possibilities for associating ADPE to units in specific MAGTF configurations. Some units may not require their own systems. Others may merit multiple systems. In Figure 9 an example of the ADPE distribution for a MAF is shown. This particular configuration utilizes:

- 9 units of System Z
- 11 units of System Y
- 77 units of System X.

The total manpower requirement to operate and maintain DISACT is estimated to be at least 757 man-years per year. Of this total, the estimated profile of skills required is summarized in the following tabulation:

Job Category	Man-Years	Percent of Total
Analyst/programmer	168	24%
Senior analyst/programmer	65	9%
Systems programmer	55	8%
Senior systems programmer	17	2%
ADPE operator	352	51%
ADPE maintenance	100	15%

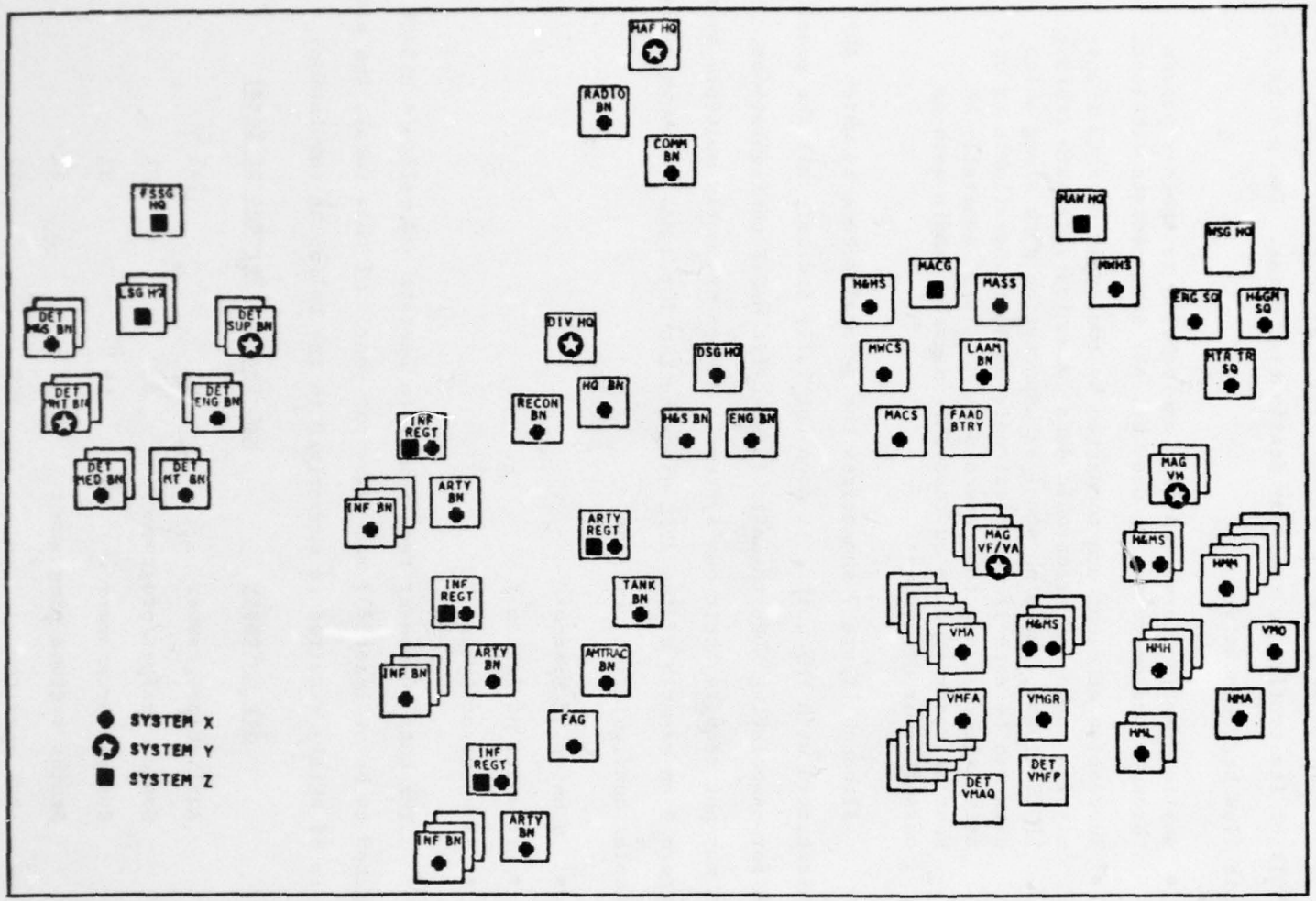


FIGURE 9 MAF DISTRIBUTION OF ADPE IN DISACT

VII ANALYSIS OF ALTERNATIVE ADPS CONCEPTS

This section presents an overview of the SRI analysis of the relative benefits and costs of the three alternative ADPS concepts. That analysis was based on technical, operational, and fiscal factors. A more detailed accounting of the technical and operational factors affecting the implementation of the ADPS alternatives is contained in Volume IV. A more detailed accounting of the fiscal factors, including life cylce cost (LCC) descriptions, is contained in Volume V.

A. Objective and Scope

The objective of SRI's comparative analysis of the three alternative ADPS concepts was to: (1) assess each alternative's capability of supporting the FMF in the 1980s based on the requirements that SRI identified and the operational conditions that the FMF will encounter, and (2) evaluate the three alternatives as to their relative advantages and disadvantages technically, operationally, and fiscally.

The nature and scope of the analysis was strongly shaped by the fidelity of the concept descriptions. The SRI study team determined early in the study that it was particularly difficult to attempt significant quantification of the analysis, since general concept descriptions rather than rigorous system designs were being examined. Quantitative analysis, therefore, was restricted primarily to the LCC analysis and to certain aspects of the alternative concepts such as the number of personnel required to support the systems and the amount of equipment that would be required to meet the operational considerations.

The qualitative analysis that SRI performed focused upon the investigation of outstanding ADP issues that have plagued FMF ADPS previously, or new issues that could be predicted from the inherent characteristics of the proposed ADP philosophies and technologies. A "weighted" analysis, evaluating the relative importance of one issue to another, was not attempted.

B. Approach

The approach the study team employed was first to compare the two alternatives DISHIER and DISACT in aggregate with BASELINE. The purpose of this comparison was to bring to the forefront the advantages of the two alternatives relative to BASELINE. This was relatively straightforward since the generation of the two concepts had the BASELINE deficiencies well in mind.

Second, a more subtle analysis was performed to make clear the distinguishing characteristics of DISHIER and DISACT relative to one another. This analysis was undertaken because of the superficial similarity of their descriptions, and because this was an opportunity to explore the real options in scope, cost, and ADP philosophy that the Marine Corps can realistically exercise within the constraints of the FMF information processing and operational requirements.

C. Results and Conclusions

The results and conclusions SRI derived from its analysis of the alternative ADPS concepts are presented in two parts. The first part compares the DISHIER and DISACT characteristics in general with those of BASELINE. The second part then discusses the differences between DISHIER and DISACT.

1. Comparison of BASELINE with the Alternatives

An overall conclusion that can be drawn regarding the capability of BASELINE relative to DISHIER and DISACT is that BASELINE would not effectively support a broad base of FMF ADP requirements in the 1980s, but that DISHIER and DISACT would (although in somewhat different degrees, as discussed in Part 2 of this section). This conclusion is based on the SRI team's analysis of the hardware, software, and operational capabilities of BASELINE, DISHIER, and DISACT relative to the FMF information processing requirements.

a. ADP Hardware Perspectives

BASELINE hardware is rapidly approaching its cost-effective lifetime. Extension of its lifetime will cause increasing support burdens. In particular, vendor support will soon be discontinued in favor of later generation ADPS. The obsolescence of BASELINE hardware, therefore, is one major disadvantage of BASE' INE relative to DISHIER and DISACT, which will be composed of a new generation of hardware. Consequently, the current BASELINE hardware will be less reliable, harder to maintain, and more demanding environmentally (in terms of power sources and air conditioning) than the equipment in either DISHIER or DISACT.

Furthermore, BASELINE ADPE is much less deployable than the ADPE in DISHIER and DISACT. It takes longer to set up and check out, and it cannot operate aboard ship or early during an amphibious landing. If the BASELINE FASC does not deploy, there are insufficient telecommunications capabilities in BASELINE to provide effective remote support of the deployed forces. In contrast, DISHIER and DISACT employ ADPE that is rugged and able to be operated both aboard ship and in the amphbious landing area.

BASELINE embraces a large centralized aggregation of computing power in the FASCs. The functional scope of the FASCs makes them

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unsuited to serve the lesser needs of MABs and MAUs, even if the resources could be made available. The result is that the BASELINE concept is relatively inflexible to different deployment configurations, and cannot easily be expended or contracted (in terms of modular amounts of computer power) to meet different intensity operations. DISHIER and DISACT, however, are highly adaptable configurations with individual pieces of ADPE assigned to each unit at the battalion/squadron/LSU echelon and above. In the simplest terms, if an FMF unit of any size is deployed, the ADPE in DISHIER and DISACT goes with it, and if the intensity of operations increases more modules of the same equipment can be added from non-deployed units.

Another result of the centralization philosophy of BASELINE ADPE configuration is that there is little accomodation of real-time inquiry and retrieval through user-oriented interactive terminals. The lack of terminal interfaces means that access to BASELINE computing power almost always requires physical access to the FASC location. Such access is particularly difficult for outlying units. DISHIER and DISACT avert this shortcoming by providing interactive terminals at each unit from battalion/squadron/LSU level on up.

The one major advantage that BASELINE provides in the hardware area is that the majority of Marine Corps ADPE (with the exception of the MAG U-1500) is from a single vendor. This fact promotes system compatibility and eases the hardware maintenance burden. It has a positive effect on lessening the number and skill of Marines required to operate and maintain BASELINE. There is no reason, however, why DISHIER and DISACT cannot be acquired from a single vendor/contractor source who will act as system engineer and be responsible for furnishing a system having uniform and coordinated installation, maintenance, and operation requirements.

In summary, the hardware disadvantages in BASELINE relative to the hardware contained in DISHIER and DISACT are significant. It is true that several of the points made here concerning BASELINE disadvantages

could be lessened by modification of the current hardware configuration, but the fact remains that the BASELINE concept of a few large centralized ADPE configurations to support the FMF is less attractive and less capable than the more distributed configurations of ADPE contained in DISHIER and DISACT.

b. Software Perspectives

BASELINE software is batch processing oriented; therefore, the ability to have inquiry and retrieval of selected information from BASELINE data bases in a real-time or interactive way is small. Batch programs typically have a turnaround time of about 1 day, and physical proximity of ADP users to the FASC is required. DISHIER and DISACT, in addition to batch processing, provide for real-time user interactions through terminals. This added capability will be provided through functional software resources and language facilities that are very much easier for users to employ than traditional BASELINE computer programming.

Due to the batch operations in BASELINE and the extensive use of punched cards in the FASC, FMF data may undergo several manual transcriptions before it finally updates a computer data base. Furthermore, such data is typically sent to a central location for visual editing and validation. DISHIER and DISACT provide, by comparison, one-time data capture on machine-readable media through entry at terminals close to the source of the data. In both these alternatives, data entry will be assisted by logic and format checks, as well as user prompts and explanatory assistance.

Relative to the DISHIER and DISACT software configurations, BASELINE is judged to have very limited capability for the following software functions important for a variety of resource management activities:

- Inquiry/retrieval
- Source data entry (data capture, edit, and validation)
- Report generation
- File management (including the ability to integrate data bases effectively and efficiently)
- Text handling.

The future BASELINE applications software can be expected to be more difficult to develop, maintain, and modify than the software contained in DISHIER and DISACT since it is not oriented toward a interactive user functional capability. DISHIER and DISACT are very user oriented, however, and their software heavily emphasizes user functional capability.

BASELINE software development personnel will be required to have extensive ADP training and skill to fulfill FMF user's applications. In contrast, a substantial portion of the FMF applications in DISHIER and DISACT will be directly implemented by FMF staffs and functional area users who will be working on their own applications with easy-to-understand interactive functions and high level languages.

c. ADPS Operations

Characteristics and consequences of the operational concept of BASELINE are well known and documented. Major deficiencies involve the difficulties in making the reporting process less error prone, and in the synchronization of the various data bases that support or use the central data bases. Another major deficiency is BASELINE's inability to address and satisfy the management support requirements within the various units of the FMF, beginning at the offices of the division/wing/FSSG echelon and extending downward to the battalion/squadron/LSU echelon.

From an ADP operations viewpoint, BASELINE's combination of hardware, software, and procedures does not provide the same capability or ease of use that DISHIER and DISACT do. In particular, BASELINE is unable to support a large body of management-oriented data processing activities performed by low echelon FMF units and by specialized staff offices at higher echelons of the FMF. This body of activities includes planning, programming, evaluating, forecasting, monitoring, inventorying, and supervising functions of command staff, warehouse managers, and maintenance shop managers in the three FMF combat elements.

Because BASELINE does not support such activities effectively, parallel manual data bases must be maintained and information dissemination is slow. Selective, responsive data inquiry, retrieval, modification, or analysis is difficult in BASELINE. DISHIER and DISACT, however, provide significant ADP capabilities at all echelons down to battalion/squadron/LSU. These ADP capabilities will effectively support local unit management activities in an efficient, coordinated, and responsive manner.

The Class I reporting operations in BASELINE are marked by slow system updates and by a large number of errors that generate rejection of data entered at the central data bases. In comparison, DISHIER and DISACT promise to improve the reporting process through one-time entry of data on machine-readable media, lower level editing and validation checks, user-oriented data entry assistance, and electronic transmission of digital data.

By its philosophy, organization, and control BASELINE does not adequately involve or effectively serve the non-ADP-oriented users of information processing in the FMF. Furthermore, the Supporting Establishment management requirements appear to dominate software development resources. For example, the CDPAs are significantly more oriented to satisfying Supporting Establishment requirements than they are to satisfying FMF applications. This situation results in a noticeable lack of FMF user involvement and participation in ADP operations, as well

as in ADS development and maintenance in BASELINE. The resources, procedures, and organization of the DISHIER and DISACT have been designed to overcome these shortcomings.

DISHIER and DISACT, by the nature of their newer technologies and more broadly based ADPS concepts, would also provide greater capability than BASELINE in the areas of security and interoperability. Security benefits of DISHIER and DISACT will include APDE redundancy among the FMF units and logical file access control on every computer. Interoperability is fostered by the high level, general function orientation of DISHIER ADPE and software configurations.

d. Costs

Functionally, DISHIER and DISACT offer significantly greater ADP capabilities than BASELINE does. The question that arises, therefore, concerns the cost to the Marine Corps for this increased capability. One measure of that cost is the life cycle cost (LCC) of each of the three concepts. Based on the SRI cost analysis effort, the following LCC results were obtained:

ADPS Concept	LCC Estimate
BASELINE	$300.4 million*
DISHIER	$244.8 million
DISACT	$334.3 million

Two points need clarification with regard to these estimates. First, the LCC estimates were based on a projected 10-year system lifetime.

*The $300.4 million LCC estimate for BASELINE was derived based on the ADP manning levels contained in Marine Corps Table of Organization documents. On that basis, the number of ADP-oriented billets (as of 22 October 1976) was 862. Research has shown that the on-board strength of Marine in ADP-oriented billets of the FMF, however, was only 650 (as of July 1977). Were the on-board strength manning levels taken as the basis of the LCC estimate, the BASELINE LCC would be approximately $222.3 million.

The BASELINE estimate was based entirely on system operating costs (that is, replacement of the current IBM 360 computers in BASELINE was not considered, and no major changes in systems software were considered). DISHIER and DISACT estimates are, however, based on the combination of development, investment, and operating costs.

Second, there is the point of the interface between each alternative ADPS concept and a Navy Aviation supported logistics ADPS within the air element of the FMF. This point is complicated because the Navy is contemplating replacement of its current U-1500 ADPS with an advanced CPU. That CPU will, in turn, form the basis for a future MAG-level system called NALCOMIS. NALCOMIS is currently only conceptually defined, but it will include extensive terminal support in addition to computing capability.

The interface between the FMF ADPS and the Navy Aviation logistics ADPS is one of resource commitment. The Navy will procure ADPE and provide software development support for Marine Corps Aviation units; however, such an ADPS will be dedicated to Navy Aviation logistics reporting and management. (Hence there is still a need for strictly Marine Corps ADP support of aviation units in addition to NALCOMIS.) The Marine Corps commitment with regard to NALCOMIS consists of operating and maintaining the ADPE and its applications during daily operations.

Under the current FMF configuration of FASCs and MAG U-1500 systems (together called the BASELINE alternative in this study), the FMF manpower resources that are dedicated to support of the automated Navy Aviation logistics program have a 10-year LCC of approximately $68.2 million. The BASELINE LCC estimate of $300.4 million includes this cost.

The LCC estimates of $244.8 million for DISHIER and $334.3 million for DISACT do not, in contrast, explicitly account for the LCC to the Marine Corps of a future NALCOMIS ADPS. The reason for this was

that since the exact functions and services that NALCOMIS will provide have not been decided upon, no definitive LCC or manning level estimates were available for incorporation at this time.

On the basis of the following assumptions, however, "ballpark" estimates can be made for the LCC of an FMF ADP configuration composed of NALCOMIS with either DISHIER and DISACT:

- The NALCOMIS ADPS in the FMF will provide for automated upward reporting of aviation logistics information of the type currently reported for 3M, SUADPS-EU, and so on.
- NALCOMIS will also provide some (undetermined amount) automated capability for the daily management of aviation logistics resources within the FMF.
- NALCOMIS will provide greater capability in both areas than does the current U-1500 system.
- DISHIER and DISACT provide similar services (albeit to different degress) for strictly Marine Corps systems exercised in the FMF aviation units.
- The maximum cost to the Marine Corps for personnel to operate and maintain NALCOMIS (independent of any other FMF ADPS) will be in the same neighborhood as the current $68.2 million required to support the U-1500 concept.

The estimates are: (1) the combination of DISHIER and NALCOMIS will cost approximately $313 million, and (2) the combination of DISACT and NALCOMIS will cost $360-370 million. Rationale for these results are discussed below.

The $313 million estimate for the combination of DISHIER and NALCOMIS is based on the fact that the total FMF ADP billets would have to be increased over the DISHIER manning levels by the number of personnel required to operate and maintain the NALCOMIS ADPS in the FMF. This is necessitated because there is little overlap between the functions of the DISHIER concept which provides automated support primarily for the reporting and status monitoring of Marine Corps Class I ADS, and the NALCOMIS concept which provides the Navy aviation-related logistics

functions. To arrive at the figure of $313 million, therefore, SRI combined the DISHIER LCC of $244.8 million with the maximum assumed cost (as stated above) of NALCOMIS to the Marine Corps of $68.2 million.

The $360-370 million estimate for the combination of DISACT and NALCOMIS is based on the fact that considerable duplication of service could occur between DISACT, as presently described, and NALCOMIS. The DISACT description provides for a large amount of computing capability at the MAG level to accommodate in an automated fashion the considerable local unit management responsibilities at the intermediate maintenance activity (IMA) of the air element. Many of these activities may, in fact, be served by NALCOMIS, in which case the DISACT resource requirement could be cut back.

The extensive DISACT capability was included because of the uncertainty in the services (above the reporting function) that NALCOMIS would provide. If the NALCOMIS local unit management capability is substantial (as current discussion suggests), the DISACT capability at that level may gravitate toward the level of capability that is contained in DISHIER at each echelon of the air element. That being the case, the reduced cost of DISACT would offset the additional cost of manning NALCOMIS, leaving the total FMF ADP LCC with a net increase over the stated DISACT LCC of approximately $26-36 million for a total FMF LCC of approximately $360-370 million.

2. Comparison of DISHIER and DISACT

DISHIER and DISACT share many characteristics, but estimates of their LCCs and manning levels have shown a substantial range. The purpose of this discussion, therefore, is to explain the different functional and operational capabilities that they provide the FMF.

As suggested by its greater resource requirement, DISACT has greater capability and scope than DISHIER. This is allocated primarily to the combat service support and air elements. The capability provided the ground combat element is substantially the same in both concepts.

a. Combat Service Support Element

The system concepts for DISHIER and DISACT in the CSS element both provide three levels of ADP system capability. Major differences between the two concepts involve the upper two levels. In both systems, the lowest level (LSU or battalion level) capability is a small stand-along system that provides source data entry and functional management tools appropriate for the low echelon level.

The DISHIER concept for the middle level (LSG level) system provides a nominal minicomputer system configuration designed primarily to aggregate data, to edit and validate data at a higher level, and to summarize the information flowing from the lower level to the central data bases of the FSSG and the Supporting Establishment. There is some provision for the building and maintenance of middle level data bases both from the information flowing upward and from spinoffs from the larger system at the FSSG level. The number of interactive terminals is sufficient to allow the executive staffs of the command to monitor in a responsive manner the functional area activities of recent happening.

At the upper level (FSSG level), DISHIER provides a powerful minicomputer system configuration designed to build and maintain central data bases covering the purview of the entire CSS element. Final editing, verification, and validation of Class I ADS data occurs at this level in DISHIER, and the executive staffs are provided sufficient terminal capability to monitor and generally supervise the large logistics-related ADS. Automated tools supporting general planning functions for the CSS element are provided for use with these large data bases.

The DISACT concept for the middle level (supply and maintenance activity nodes) provides, in contrast, a powerful minicomputer system configuration designed to support the following activities:

- Final aggregation and summarization of large logistics-related ADS data entered at all levels.
- Final editing, verification, and validation of logistics-related ADS data entered at all levels.
- Data base maintenance and management for the large logistics-related ADS data entered at all levels.

It provides sufficient terminals for the executive staffs to monitor and generally supervise the large logistics-related ADS, as well as terminals for the managers of warehouses, maintenance shops, and motor transport pools to interactively control the manpower and material resources under their supervision.

Sufficient capability and capacity is contained in this powerful minicomputer system to allow the retention of historical data concerning the maintenance histories of equipment, average time for repairs, and the rates of use and inventory levels of the supply system. Functional tools are available to provide management assistance for job scheduling and time accounting on a near real-time basis.

At the upper level (FSSG level), DISACT provides a nominal minicomputer capability. Because this level is not burdened with the reporting process editing and maintenance of the large logistics-related ADS data bases, however, it is free to address more sophisticated analysis and decision aids efforts associated with the complex planning, forecasting, and evaluating activities that take place at this level.

In summary, DISACT concentrates the majority of its computing power at the middle level, while DISHIER concentrates the majority of its computing power at the highest level. The middle level power in DISACT allows it to address a wider range of automated functions, as well as maintain longer time histories. As a result, the functions of the two upper levels in DISACT are more clearly distinguished, whereas in DISHIER they do much the same activity--only to different degrees.

Because the greatest amount of "event" and "transaction" activity takes place in the middle level logistics warehouses and maintenance shops, the DISACT concept can clearly provide the more timely and responsive support of these activities. The opportunity also exists for interactive management of scheduling, personnel assignment, and in-job process monitoring with the middle level capability of the DISACT system, but that capability is much more limited in DISHIER.

b. Air Element

The same general considerations described above hold also for the air element. DISACT concentrates the majority of its computing power at the middle level (MAG and H&MS level), while DISHIER concentrates its computing power at the upper level (Wing level). Because the air element is also highly involved with logistics system activities, the same results apply as they did for the CSS element.

There is, however, an additional consideration because of the support that the air element receives from Naval Aviation. Of particular concern is the interface between the FMF ADPS and the future NALCOMIS ADPS. The current plans for NALCOMIS are to provide MAG-level computing capability, but the scope of that capability is somewhat unclear. If, in fact, it provides a majority of the middle level interactive management functional capability, the DISACT capability for the air element may be allowed to be lessened. If it does not, the DISACT concept may well augment the NALCOMIS capability even for aviation logistics-related matters. In either case, the NALCOMIS concept should not alter the DISHIER concept.

Appendix

STUDY BIBLIOGRAPHY

Appendix

STUDY BIBLIOGRAPHY

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