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LONG RANGE PLAN FOR EMBEDDED COMPUTER SYSTEMS SUPPORT

VOLUME II

1981 October

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CDRL 05A
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Prepared for

Air Force Logistics Command AFLC/LC
Wright Patterson AFB, Ohio 45433

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The life cycle support of the ever increasing number of computer systems embedded in weapon systems is a major challenge to the Air Force. With continued operational and support emphasis on performance and responsiveness to a dynamic mission environment, significant enhancement of support capabilities for all categories of embedded computer systems is required. This report contains recommendations for acquiring such capabilities. VOLUME 2 of 2.

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FOREWORD

The life cycle support of the ever increasing number of computer systems embedded in weapon systems is a major challenge to the Air Force Logistics Command. With continued operational and support emphasis on weapon performance and responsiveness to a dynamic mission environment, significant enhancement of support capabilities for all categories of embedded computer systems is required. This report, Long Range Plan for Embedded Computer Systems Support (Volume II), and Executive Overview (Volume I) contain recommendations for acquiring such capabilities.

This volume is one of two individually bound volumes that constitute the Phase III Final Report, Study of Embedded Computer Systems Support, for Contract F33600-79-C-0540,CDRL 05A. The efforts and analyses reported in these volumes were sponsored by AFLC/LO and cover a reporting period from December 1980 through August 1981.

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ABBREVIATIONS AND ACRONYMS

AFALD	Air Force Acquisition Logistics Division
AFIS	Air Force Intelligence Service
AFLC	Air Force Logistics Command
AISF	Avionics Integration Support Facility
APSE	Ada Programming Support Environment
ATD	Aircrew Training Devices
ATE	Automatic Test Equipment
BIT	Built-in Test
CDR	Critical Design Review
C-E	Communications-Electronics
CMAC	Computer Monitor and Control
CRISP	Computer Resources Integrated Support Plan
CRWG	Computer Resources Working Group
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
DAR	Defense Acquisition Regulations
DBM	Data Base Machine
DBMS	Data Base Management System
DE	Diagnostic Emulation
DEPS	Development Engineering Prototype Site
DIA	Defense Intelligence Agency
DMA	Direct Memory Access
DSARC	Defense Systems Acquisition Review Council
EDMS	Engineering Data Management System
EISF	Extendable Integration Support Facility
ESC	Electronic Security Command
EW	Electronic Warfare
EWIR	Electronic Warfare Integrated Reprogramming
FCA	Functional Configuration Audit
FCR	Fire Control Radar
FLTS	Flight Line Test Set
FQR	Formal Qualification Review
FTD	Foreign Technology Division
HSK	Hardware Simulation Kernels

ABBREVIATIONS AND ACRONYMS (Concluded)

ICS	Interpretive Computer Simulation
INS	Inertial Navigation System
ISF	Integration Support Facility
ISS	Integrated Support Station
IV&V	Independent Verification and Validation
KAPSE	Kernel Ada Programming Support Environment
MAPSE	Minimum Ada Programming Support Environment
MENA	Mission Element Need Analysis
MIS	Management Information System
NSA	National Security Agency
OFP	Operational Flight Program
OL	Operating Location
O/S CMP	Operational/Support Configuration Management Procedures
PCA	Physical Configuration Audit
PDR	Preliminary Design Review
PIU	Programmable Interface Unit
PMRT	Program Management Responsibility Transfer
PO	Program Office
RTDO	Real Time Data Operations
SDR	System Design Review
SIMSPO	Simulator Program Office
SON	Statement of Need
SRR	System Requirements Review
SSC	Software Support Center
TAF	Tactical Air Forces
TRR	Test Readiness Review
VHSIC	Very High Speed Integrated Circuits
WST	Weapon System Trainer

1. LONG RANGE ECS SUPPORT PLAN

Over the past ten years, technological advances have occurred in virtually all aspects of weapon system functions. This is particularly evident in sophisticated weapon systems that encompass embedded computer systems as an essential and integral part of system structure. This trend is expected to continue and is forecast to accelerate in the future with Very High Speed Integrated Circuits (VHSIC), fiber optics, microprocessors—just to name a few of the rapidly changing technologies being embodied in weapon systems and requiring support by the Logistics Command. This plan addresses the management and technical support of computer systems embedded in weapon systems and highlights the significant differences from the traditional Air Force Logistics Command's classical role in providing wholesale logistics support to operational commands by ensuring that weapon systems are operational through buying, supplying, transporting, and maintaining the system and their components.

1.1 PURPOSE AND SCOPE

The purpose of this Long Range ECS Support Plan is to project the 1990 ECS support environment and based on that forecast to describe an approach and outline the administrative and programmatic initiatives necessary to achieve, over the next ten years, a mission responsive ECS support posture. The plan encompasses the five categories of ECS identified in AFLCR 800-21 and uses the support concepts described therein as a starting point. The plan also draws upon the current posture assessments and associated deficiencies identified in the nine-volume final report resulting from the precursor Phase II Study of Embedded Computer Systems Support (October 1980). This plan outlines the HQAFLC management and technical activities required to establish a command-wide ECS support posture and provides methodology including resource estimates and schedules for implementing the plan. An overview of the long range plan components and their relationship is shown in Figure 1-1.

1.2 POSTULATED 1990 ECS SUPPORT ENVIRONMENT

An accurate prognostication of the future is of course impossible, but a consensus of recent government and industry studies and analysis indicates that a realistic projection of the future ECS support environment will certainly include continuation of a rapidly evolving and expanding use of technology, an ever-increasing enemy threat and corresponding demand for mission responsiveness, and continuing competition for scarce ECS support resources. A typical example of such a forecast is a recent "DOD Digital Data Processing Study—a Ten Year Forecast"

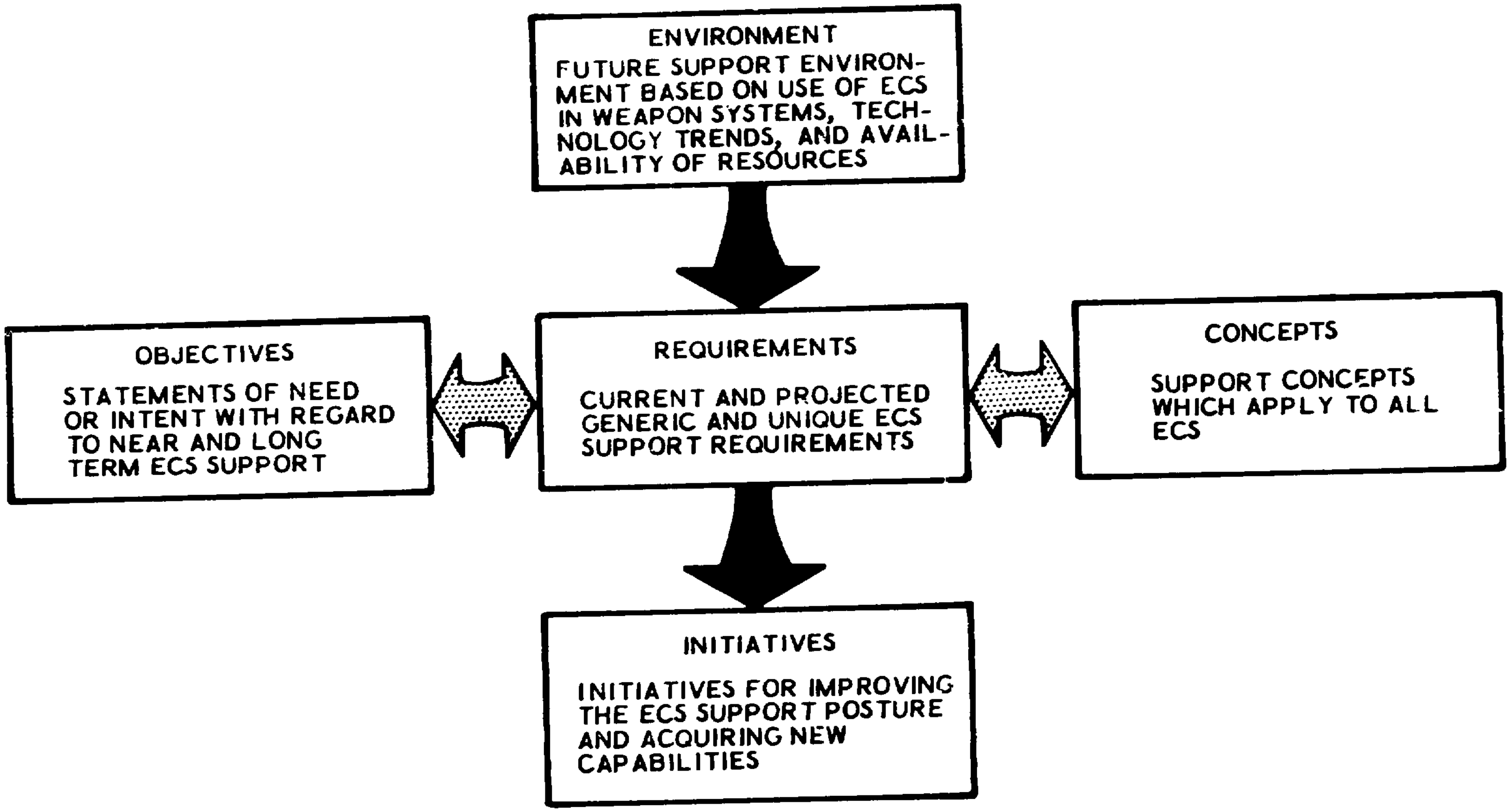

Figure 1-1. Overview of Long Range ECS Support Plan Components

which was performed by an industry team under the auspices of the Requirements Committee, Government Division, Electronics Industries Association (EIA). The industry team consisted of representatives from Control Data Corporation, IBM, Intel, ROLM Corporation, and TRW.

The study team used multiple sources to obtain and verify information including DOD budget data; congressional testimonies; over 40 personal interviews with experts in industry, DOD, congressional staff, OMB, and GSA: periodicals; industry market research publications including Frost and Sullivan, DMS, Quantum, et al.; and published data from several government sources including OMB, GSA and GAO. A few of the highlights contained in the executive summary of the study report are shown in Table 1-1.†

Within the DOD and Air Force the pressure for "Better-faster-more with less" will continue. Consequently, the foreseeable and postulated future ECS support environment is expected to be characterized as follows:

- Continued world tension with alignment/realignment of national interests,
- Multiservice and multination use of ECS and ECS support systems,
- Increasing complex weapon and support systems,
- Increased pressure for interoperability and standardization of ECS and ECS support systems,
- Increased vulnerability of ECS to enemy countermeasures,
- Extension of ECS support systems to theater and flightline for combat mission needs,
- Increased competition for engineering and scientific disciplines as well as support funds,
- Rapidly increasing ECS workload, and
- Increased need for ECS management and technical training.

1.3 ECS SUPPORT OBJECTIVES AND CONCEPTS FOR 1990

1.3.1 ECS Support Objectives

The requirement to provide for embedded computer resources stems from the traditional logistics weapon system support role of buying, supplying, transporting, and maintaining

†Unless otherwise stated, all dollars are current in billions.

Table 1-1. DOD Digital Data Processing Study: A Ten-Year Forecast

- "Embedded computers are defined in the study as specially designed, for example, designed to satisfy MIL-Specs, and are acquired as part of a total weapons package, thus "embedded" in a weapons system. It is not generally recognized by most personnel in the computer field that embedded computers presently represent over 60 percent of the DOD computer budget, and the percentage is projected to increase to approximately 75 percent by 1985 and 83 percent by 1990. Microprocessors will have an ever-increasing influence in the embedded area; much more so than in the ADP area."

- "It is forecast that in the coming decade, nearly every weapon system will have an embedded computer (or computers) somewhere in its control subsystem and/or C^3I subsystem."

- "Single chip microprocessors capable of performing a million instructions a second (1MIP) are forecast to be developed during the early 1980's."

- "Defense Electronics will increase from $20.1 in FY80 to $75.7 in FY90. Defense computers will increase from $6.7 in FY80 to $45.8 in FY90—from 33 percent of Defense Electronics in FY80 to 60 percent by FY90."

- "Software and Services will increase from $4.6 in FY80 to $37.2 in FY90—from 69 percent of the total Defense computer expenditures in FY80 to 81 percent in FY90."

- "Software hourly rates have nearly tripled since 1965 and are projected to be over five times the 1965 base by 1990. However, the cost of computer hardware is decreasing dramatically. By 1990, the cost of large mainframe computers and the cost of mini/macro computers are projected to be one-fifth and one-tenth respectively of the 1965 base."

- "In 1955, there were approximately 1000 computers and 10,000 programmers, a 1:10 ratio in the U.S. Today, there are approximately 900,000 computers and 240,000 programmers, a 37:10 ratio. Even with productivity improvements, the shortage of qualified software personnel will not end; software costs will continue to rapidly escalate."

- "During the 1980's:

    - The total DOD budget will increase 2.8 times,
    - The DOD Electronics budget will increase 3.8 times,
    - The DOD Computer budget will increase 6.8 times.
    - The DOD Software budget will increase 8.1 times."

systems. However, the management and technical support of ECS, and particularly the reprogramming of embedded computer software, is an engineering intensive activity. The actual programming/coding is a relatively small part of the ECS change process. The system and digital engineering required for problem analysis/isolation/definition along with the engineering design of proposed problem or enhancement solutions and verification/validation testing is usually by far the most critical resource in terms of skill, equipment, and schedule. A generic description of the ECS software change process is shown in Figure 1-2. Extensive use of both engineering and scientific disciplines is also required for the acquisition of ECS support tools and equipment as well as the operation of ECS support facilities.

The current Statement of Need (SON)/Mission Element Need Analysis (MENA) addresses the practice of acquiring system specific or point design ECS support facilities (tools, equipment, and skills) and the need for increased standardization and automation of ECS support processes and procedures, along with increased integration and sharing of critical ECS support resources. This long range ECS support plan, which supports the SON/MENA, is based upon a set of twelve postulated ECS support objectives. These objectives, which are closely related, were compiled from a longer list of more specific problem/deficiency objectives and are, therefore, not necessarily aimed at any one ECS support requirement or current/projected deficiency. They are applicable to the entire life cycle ECS acquisition and support process and extend across the five ECS categories.†

- Acquire and maintain a flexible technical support base and establish data flow to rapidly respond to ECS combat needs.

- Provide efficient and effective ECS life cycle management and system engineering support.

- Promote efficient, effective, and timely use of interservice as well as inter- and intracommand ECS support resources.

- Acquire and maintain quality ECS and ECS support systems.

- Ensure currency and survivability of ECS support systems.

- Acquire and maintain ECS technology and intelligence bases and provide for intercommand and interservice exchange and use of data.

- Ensure an attractive and competitive ECS management and engineering career field.

- Minimize critical organic ECS engineering, scientific and technical skill needs.

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†Appendix A contains an elaboration of each of the objectives.

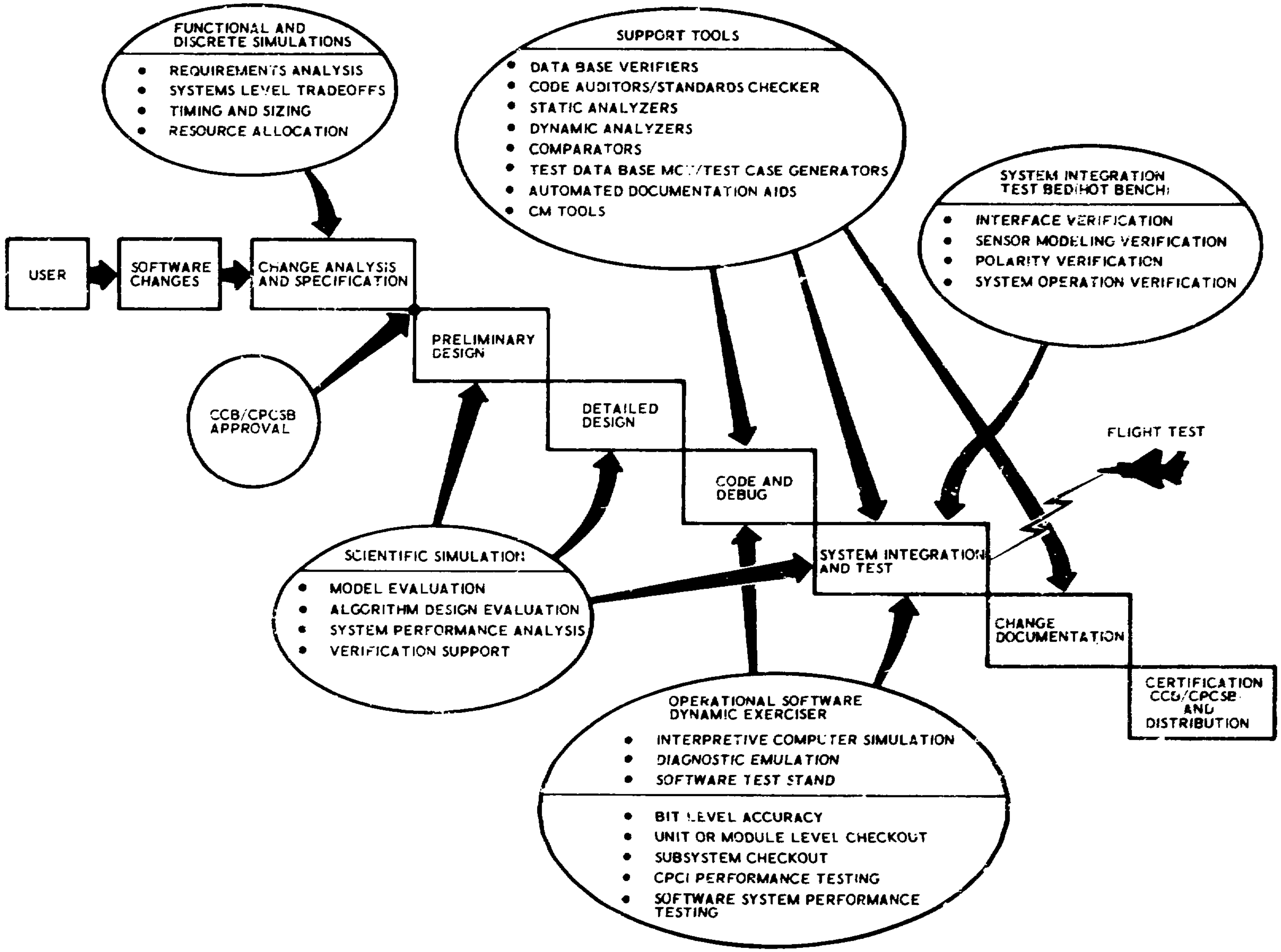


Figure 1-2. ECS Software Support Analogous to Original R&D Development

- Provide for efficient and effective training and cross-training in ECS engineering, scientific, and technical skills.
- Optimize the complementary strengths of organic and contractor skills.
- Accomplish efficient and effective ECS support cost estimating, tracking and accounting.
- Influence the proliferation of ECS and ECS support systems.

1.3.2 ECS Support Concepts

Support concepts for each of the five ECS categories as currently documented in AFLCR 800-21 have evolved over a period of time. While these individual category concepts are still in various stages of implementation, the technology implemented in future weapon system designs is expected to blur the currently perceived distinction between the five categories, particularly between C-E, EW, and OFP. Closely coupled with the individual category support concepts, whatever their distinction or numbers, are ECS support concepts which are intended to apply within each category as well as across the categories. They address ECS support in the aggregate and provide the framework for achieving the previously stated objectives and acquiring the overall ECS support capabilities required over the next decade. Table 1-2 shows the five ECS categories and the current support concept described in AFLCR 800-21. It also shows postulated improvements/alternatives to these concepts along with the closely related overall ECS support concepts postulated as a basis for the long range ECS support plan.

1.4 RELATIONSHIP TO OTHER ECS SUPPORT PLAN

The long range ECS support plan is consistent with existing and projected Department of Defense and Air Force directives, regulations, policy, and guidance for acquisition and support of computer resources. For example, it is consistent with Department of Defense Directives 5000.1, "Major Systems Acquisition," 5000.2 "Major Systems Acquisition Process," and 5000.29 "Management of Computer Resources in Major Defense Systems;" it is complementary to Air Force Regulation 800-14, Volume I, "Management of Computer Resources in Systems" and Volume II, "Acquisition and Support Procedures for Computer Resource in Systems;" Air Force Regulation 800-28 "Air Force Policy on Avionics Acquisition and Support," Air Force Logistics Command Regulation 800-21 "Management and Support Procedures for Computer Resources used in Defense Systems," and the recent Air Force policy memorandum on "Standardization of Embedded Computer Resources." It is both consistent with and complementary to various other AFLC and AFSC studies and ongoing activities such as the "Computer Technology Forecast and Weapon System Impact Study" (COMTEC-2000),

Table 1-2. Postulated 1990 ECS Support Concepts

ECS Category	Current Support Concept (AFLCR 800-21)	Postulated Future Support Concepts by Category	Postulated Future ECS Support Concepts for All Categories
Aircrew Training Devices (ATD)	Development Engineering Prototype Site (DEPS)	• For current ATD with existed DEPS consolidate software development and configuration management at a central ATD support center. Use DEPS for problem reporting and system integration and test. • For future ATD emphasize supportability and concurrency. Use operational flight programs in the ATD and standard simulation models for common AISF and Weapon System Trainer functions. Develop weapon system and trainer modification in the AISF • For cockpit or other procedures trainers which are dissimilar or not dependent/related to operation flight software should be supported in the ATD Support Center	• Maximize sharing of distributed ECS support resources by use of Modular integrated ECS support facilities and standardized automated ECS support tools • Manage and support highly integrated ECS dispersed at geographically separated support locations by establishing a system for ECS management and technical data flow. • Increase ECS supportability and minimize ECS life cycle support costs by use of improved system engineering tools and techniques for ECS design-performance-support trade-offs and ECS support planning. • Minimize dedicated ECS technology and intelligence resources by centralizing expertise and sharing inter-command and other service resources. • Minimize critical ECS engineering and scientific skill needs by optimization of organic contractor skill mix and increase the use of organic lower skilled ECS personnel by automation and standardization of ECS support processes and procedures. • Maximize ECS management and technical data flow by use of ECS support networks.

Table 1-2. Postulated 1990 ECS Support Concepts (Concluded)

ECS Category	Current Support Concept (AFLCR 800-21)	Postulated Future Support Concepts by Category	Postulated Future ECS Support Concepts for All Categories
Automatic Test Equipment (ATE)	Software Support Center (SSC)	• Use ISF/MME weapon system engineering and facilities to define requirements for acquired and modifying ECS ATE and implement changes in the Software Support Center	• Maximize sharing of distributed ECS support resources by use of Modular integrated ECS support facilities and standardized automated ECS support tools
Communication Electronics (C-E)	Integration Support Facility (ISF)	• Extend selective ISF capability to flight line by developing portable integration support facility subsets • Use dedicated ISF for major air-craft and missile system ECS and for multiple C-E and EW systems	• Manage and support highly integrated ECS dispersed at geographically sepa-rated support locations by establishing a system for ECS management and technical data flow. • Increase ECS supportability and mini-mize ECS life cycle support costs by use of improved system engineering tools and techniques for ECS design-performance-support trade-offs and ECS support planning.
Electronic Warfare (EW)	Electronic Warfare Avionics Integration Support Facility (EWAISF)	• Emphasize modular ISF archi-tecture for multiple systems sup-port and for systems with multi missions • Extension of ISF capability for ECS growth or major ECS modification • Extension of ISF capability to theater and to flight line	• Minimize dedicated ECS technology and intelligence resources by central-izing expertise and sharing inter-command and other service resources. • Minimize critical ECS engineering and scientific skill needs by optimization of organic contractor skill mix and increase the use of organic lower skilled ECS personnel by automation and standardization of ECS support processes and procedures.
Operational Flight Programs (OFP)	Avionics Integration Support Facility (AISF)	• Use ISF capability for technology evaluation and impact assessment and initial crew and technition training	• Maximize ECS management and technical data flow by use of ECS support networks.

the "Embedded Computer Resources Support Planning for the 1980's (ESP-80), and the United States Air Force Avionics Master Plan.

The long range ECS support plan is designed for use by planners and implementers responsible for current and future AFLC life cycle ECS support activities as well as overall guidance and direction for the aggregate of ECS support over the long term. As such, it serves as guidance for development and implementation of plans for the separate categories and for standardization of support elements across categories.

1.5 PROJECTED 1990 ECS SUPPORT SCENARIO

The following scenario assumes that the administrative and programmatic initiatives, presented in Volume I and detailed in subsequent sections of this volume, have been implemented. It also assumes that normal logistics planning appropriate to weapon system acquisition and support has or is being conducted. Figure 1-3 summarizes the various components discussed in this section. A detailed discussion of ECS support requirements is presented in Section 2 of this volume and by ECS category in the Phase II report (Volumes III through VII).

AFLC ECS support activities for a new embedded computer system begin in earnest with formation of the Computer Resources Working Group (CRWG). Writing the Computer Resources Integrated Support Plan (CRISP) and detailed definition of support system requirements proceeds quickly since AFLC will have developed model CRISP's, established support system data bases, and defined the AFLC position on support system requirements for each general type of system containing ECS. CRWG meetings and CRISP reviews will be held by video teleconferencing to access necessary expertise, ensure coordination with other weapon system support elements, and minimize travel costs. Prior to PMRT, AFLC will perform an Independent Verification and Validation (IV&V) of the ECS and its supporting documentation, which will significantly aid AFLC in improving product quality at transition, training, and in the acquisition and use of the new support system.

Definition of the Operational/Support Configuration Management Procedures (O/S CMP) will be facilitated by use of AFLC developed model O/S CMP's and standardized configuration management systems as a basis for initial drafts. Reviews involving the various user and support agencies will also be via video teleconferencing. New weapon systems, while more complex than most current systems, will be easier to support due to AFLC initiatives to improve system design for supportability and testability along with increased interface control and standardization of languages and instruction set architectures. Support systems will be modular and reconfigurable, and will utilize standard models (e.g., for such functions as aircraft, environmental, and terrain simulations). Increased weapon system and support system standardization

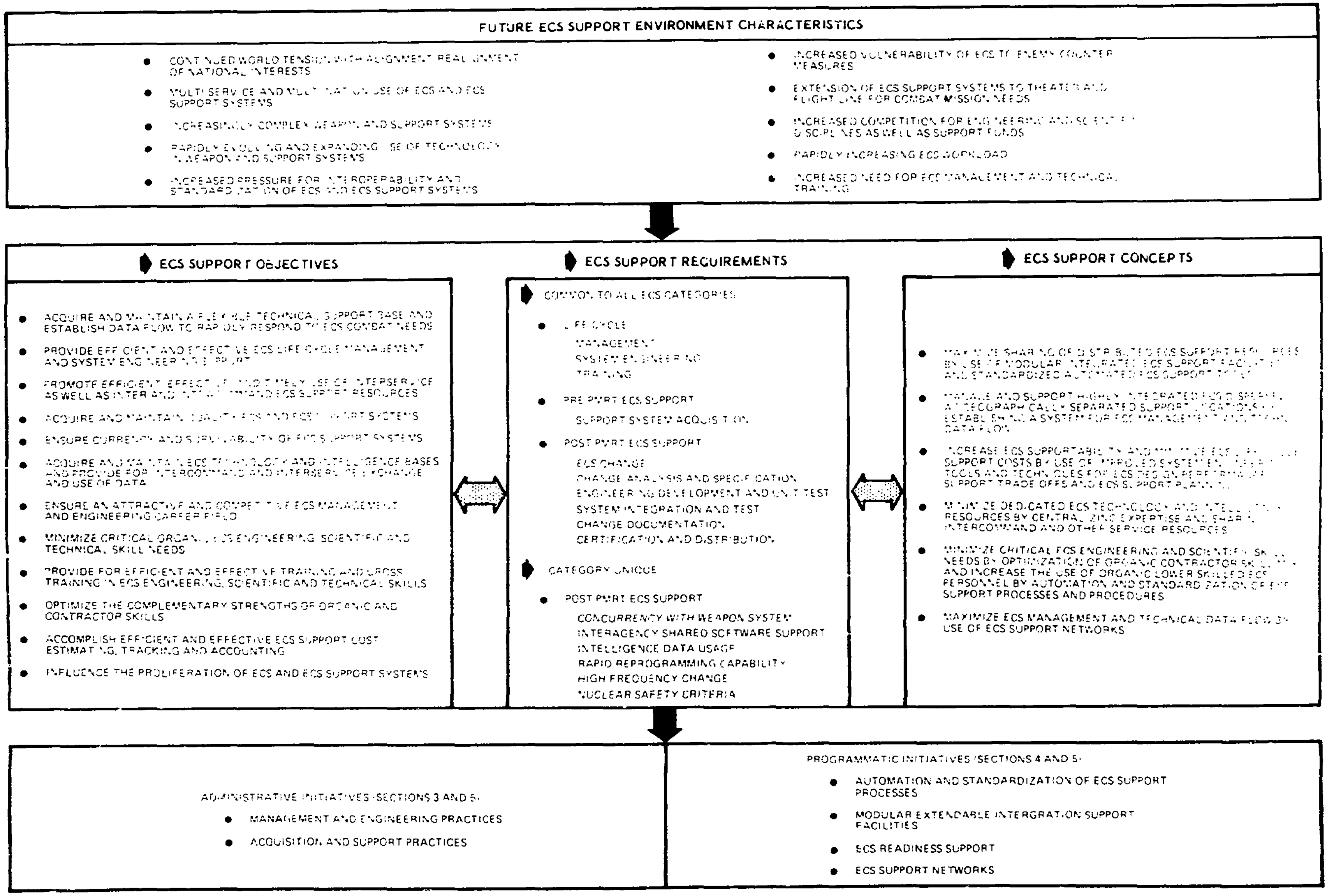


Figure 1-3. Components of the Long Range ECS Support Plan

will allow support dollars to be invested in improving the quality of the support systems and to increase productivity.

After Program Management Responsibility Transfer (PMRT), automated standardized tools will aid in configuration management and documentation as well as in the actual ECS and software change and test process. A copy of updated software and its supporting documentation will be transmitted after change certification via the AFLC ECS support network to operational units and other users and to the designated AFLC software repository. Support in solving particularly difficult ECS technical problems will be sought from the appropriate AFLC skill concentrations. These skill centers will also assist the ALC's in dealing with the new technology embodied in weapon systems, major weapon system modification programs affecting ECS, and in developing standard support systems. The ability to video-conference with AFLC and USAF specialists, and increased usage of automated tools will aid in increasing productivity of engineering and technical personnel. New and improved professional education and training programs, again employing video teleconferencing in lieu of costly and inconvenient TDY, along with ECS career progression incentives will assist AFLC in obtaining adequate numbers of trained engineers, programmers, and technicians.

AFLC definition of intelligence support roles and responsibilities and enhancement of support facilities will allow AFLC to perform preemptive engineering and increase responsiveness to a dynamic mission environment. Automation and standardization of ECS support tools, modular system integration facilities and ECS support networks will alleviate many of the difficulties of integrating subsystems managed at geographically separate locations.

2. EMBEDDED COMPUTER SYSTEM SUPPORT REQUIREMENTS

Embedded computer system support requirements and current deficiencies were examined in detail during the first two phases of the study effort and an overview is provided here primarily for emphasis and completeness. Software support requirements were emphasized and the requirements common to all ECS categories, and those requirements unique to a particular category were identified. These requirements, documented in Volume III through VII in the Phase II Report and summarized in Table 2-1, are expected to continue for the foreseeable future. For easy reference, additional detail on these current ECS support requirements is provided in Appendix B.

The current ECS support posture, also documented in the Phase II Report, is an assessment of the degree to which the support requirements are being met. Many of the support deficiencies identified by category in the Phase II Report are similar or common to several or all categories of ECS systems. The various current support deficiencies are grouped according to their general type, and are presented in summary form in Tables 2-2 through 2-5. Also shown are the affected categories along with recommended corrective actions for each deficiency. The corrective actions are embodied in the various recommended administrative and programmatic initiatives presented in Sections 3, 4, and 5.

2.1 FUTURE ECS SUPPORT REQUIREMENTS/PROBLEMS

The trend toward more weapon systems encompassing embedded computer systems as an essential part of system structure is expected to increase the AFLC role in direct mission support. With weapon system performance and combat readiness directly coupled to ECS support, new support requirements/problems which were not addressed in the Phase II Report are expected to surface. One such example, not yet definitized as an established support requirement, is the multiuse system or subsystem containing an ECS. The PAVE TACK system which is used on both the F-111 and F-4 is a case in point. Other systems under development or being considered for development such as JTIDS, LANTIRN, and GPS introduce situations where a weapon system contains ECS systems/subsystems which are not under the direct control of the weapon system manager.

In addition, planned product improvements as well as the use of aircraft for missions other than originally designed have changed and will continue to change support requirements for ECS because different configurations of the ECS are being supported with different demands on resources as functions of time or criticality. For example, the F-16's original design role is being expanded to include both air-to-air and air-to-ground capabilities. The F-15 Strike Eagle would

Table 2-1. ECS Support Requirements

Common to All ECS Categories
Life Cycle
Management
System Engineering
Training
Pre-PMRT ECS Support
Support System Requirements
Supportability Design Criteria
Post-PMRT ECS Support
ECS Change
Change Analysis and Specification
Engineering Development and Unit Test
System Integration and Test
Change Documentation
Certification and Distribution
Category Unique
Post-PMRT ECS Support
Concurrency with Weapon System
Interagency Shared Software Support
Intelligence Data Usage
Rapid Reprogramming Capability
High Frequency Change
Nuclear Safety Criteria

Table 2-2. Summary of ECS Support Deficiency Corrections, Life Cycle Support

Deficiency	Corrective Action	ECS Category
• CRISP's and O/S CMP's are not timely or detailed	• Prepare formal short course on CRISP and O/S CMP preparation and requirements definition for training of new CRWG personnel	ALL
	• Develop model CRISP's and O/S CMP's for each type of system and assign highly capable engineers to CRWG's for new systems	ALL
• Software control and change procedures and terminology are established locally and implemented manually	• Standardized and automated procedure and processes to reduce workload and permit aggregate tracking and status accounting	ALL
	• Adopt standard structure, terminology and procedure	ALL
• The requirement for training engineers and technicians exceeds the supply, while available engineers/technicians are tasked with nontechnical duties	• Establish command-wide continuing and cross-training education programs	ALL
	• Maintain salaries at comparable industrial levels, develop ECS support career ladders	ALL
	• Expand use of technical support personnel such as technical librarians, data entry operators	ALL

Table 2-3. Summary of ECS Support Deficiency Corrections, Support System Acquisition

Deficiency	Corrective Action	ECS Category
• ISF development lags needs for ECS support	• Perform early identification of support system requirements, assure that weapon system funding adequately includes the support system	C-E EW OFP
• Proliferation of system unique and custom designed ECS support facilities, test equipment, and test programs	• Establish improved Management Information System, automate documentation and configuration management	ALL
	• Enforce standardization of support systems and tools	ALL
	• Develop modular ISF capable of supporting a family of systems	C-E EW OFP

Table 2-4. Summary of ECS Support Deficiency Corrections, Generic Change Process

Deficiency	Corrective Action	ECS Category
• Test requirements poorly defined due to lack of requirements baseline	• Procure and maintain requirements baseline	ATD ATE
	• Provide traceability of test to requirements in test plan	ATD ATE
• Organic ability to perform/support the ECS change process is limited due to shortages of engineering personnel	• Improved software change tools	ALL
	• Improved software analysis tools	ALL
	• Automated documentation, CM tools	ALL
	• Professional and continuing education	ALL
	• Standardization of languages, instruction set architecture, and computer interfaces	ALL
• Engineering analysis is complex and manpower intensive	• Apply design for testability, bit, etc. to acquisition	ALL
	• Exchange expertise and capabilities where practical	ALL
	• Develop scientific simulation of supported *system for* change	C-E EW OFP
	• Develop improved S/W analysis tools	ALL

Table 2-4. Summary of ECS Support Deficiency Corrections, Generic Change Process (Continued)

Deficiency	Corrective Action	ECS Category
• Change analysis responsibility is vague and overlapping	• Consider centralization of analysis and testing responsibilities to one focal point per system	ATD ATE
• The TCTO distribution process is slow and cumbersome for distribution of combat system ECS software	• Study automated distribution systems and methods to find more responsive methods of distributing CPCI and documentation	ALL
• Inadequate communication for rapid changes to deployed systems	• Develop area reprogramming capability and improve interfaces to intelligence data, define rapid change procedures	C-E EW OFP
• The documentation process is manpower intensive. It consumes an inordinate amount of the change cycle. Procedures vary. Documentation production and distribution is slow even after the mats are completed	• Standardize automated configuration management and documentation tools	ALL
	• Develop automated distribution system and central CM data base, supported by an information management system	ALL
• No repository exists for software baseline data	• Establish repository; develop automated configuration management and documentation tools, with network communication to repository	ALL

Table 2-4. Summary of ECS Support Deficiency Corrections, Generic Change Process (Continued)

Deficiency	Corrective Action	ECS Category
• Some systems have no reliability documentation baseline	• Determine minimum set of necessary documentation	ALL
	• Procure and maintain necessary software documentation	ALL
	• Perform IV&V to assure documentation quality	ALL
	• Develop automated documentation systems	ALL
• Lack of documentation and nonstandard configuration management procedures constrain rapid problem analysis and change specification	• Develop automated documentation systems	ALL
	• Develop standard configuration management procedures and automated support system	ALL
• An improved capability to test integrated systems is needed	• Exchange capabilities and expertise where practical	ALL
	• Standardize integration and test capabilities and support tools	ALL
	• Build reprogrammable computer monitoring and control devices capable of supporting multiple ECS	C-E EW OFP
	• Develop diagnostic tools for software testing; e.g., static stands, diagnostic emulators, interpretive computer simulations	C-E EW OFP

Table 2-5. Summary of ECS Support Deficiency Corrections, Category Unique Support Requirements

Deficiency	Corrective Action	ECS Category
• ATD frequently lags weapon system changes by several years	• Analyze/Fund/Contract for ATD changes concurrent with the weapon system	ATD
	• Determine feasibility of ATD simulator software maintenance on AISF	ATD
• Sharing of software support responsibility between agencies compounds configuration control and data communication problems	• Develop automated configuration management and a network for CM data communication	ATD C-E OFP
	• Develop further definitions of support agency roles and responsibilities	ATD
• Properly cleared support facilities and personnel are not in place to support classified ECS software. Intelligence support requirements need further definition	• Conduct comprehensive review of intelligence and security requirements	C-E EW OFP
	• Perform initial activities necessary to obtain properly cleared facilities and personnel equipped with the required automated support systems	C-E EW OFP
• No provisions for intelligence access and therefore limited capability for preemptive engineering for OFP systems	• Establish requirements for intelligence data to meet ECS readiness capability	C-E EW OFP
	• Initiate activities for obtaining facilities and billets for intelligence data application to meeting MAJCOM readiness requirements	C-E EW OFP

Table 2-5. Summary of ECS Support Deficiency Corrections, Category Unique Support Requirements (Continued)

Deficiency	Corrective Action	ECS Category
• Rapid change development and testing are constrained by the limited availability of software support tools	• Develop comprehensive set of software development tools	ALL
	• Design and develop modular ISF's which are extendable	C-E EW OFP
	• Develop scientific simulations for each system supported	C-E EW OFP
	• Develop reprogrammable CMAC or diagnostic emulator for each system supported	C-E EW OFP
	• Develop improved S/W development and test tools	ALL
• Rapid reprogramming requirement for C-E systems has not been clearly defined	• Request operational user to define need for rapid reprogramming and preemptive engineering	C-E
• Change requests frequency higher than response capability for some systems	• Use block change approach except for emergencies	ATD C-E EW OFP
• No nuclear safety provisions for other than ICBM's	• Adopt ICBM approach for cruise missiles and aircraft when and if required	OFP

increase the F-15's air-to-ground capability, and the F-4 which is equipped with an ECS that has separate software for the reconnaissance mission on the RF-4C and the air-to-ground mission on the F-4E. Although an ECS which is assigned multiple roles is generally supported by one ALC organization, interface requirements, testing constraints, and configuration management support requirements are increased significantly by the use of an ECS for multiple roles.

One of the major impacts of multiuse ECS is on the System and Item Managers. The assignment of an ECS to an SM and/or IM has serious ramifications from several aspects.

- If a multiple-use ECS is assigned to an Item Manager: How does the System Manager maintain system integrity? What is the impact on support tools and test stands? How do modifications get scheduled? Who maintains the configuration? How is distribution of the modified system affected?

- If the multiple-use ECS is assigned to a System Manager: How does the System Manager accept requirements from a second System Manager and integrate those into the modification schedule? How are priorities established? Who funds, schedules, tests, and manages the configuration of the modifications?

The problems that the ALC's will face because of multiple-use ECS are numerous and will become even more complex as the trend increases toward developing systems/subsystems as well as munitions, each with its own ECS, for use on several different weapon systems. In addition, the severity of the problem should be significantly decreased with implementation of the overall recommendations presented in the plan.

3. ADMINISTRATIVE INITIATIVES

Volume II of the Phase II report for this study identified several key ECS support issues faced by the ECS support community. These issues were separated into administrative and programmatic activities and recommendations were provided for each issue. This section addresses those issues identified in the Phase II report and other recommended initiatives which are primarily administrative in nature, particularly in the early stages of implementation. Although the initial efforts pertaining to the resolution of these issues may be administrative in nature, this does not preclude the establishment of later programs to improve discovered deficiencies. Specific recommendations resulting from the discussions in Volume II of the Phase II report and this section are combined and presented in Section 5 of this report. The following additional initiatives are addressed in this section.

- Management and Engineering Practices
  - Matrix Organization
  - ECS Career Progression
  - Training and Professional Education
- Acquisition and Support Components
  - Common ECS Support Components
  - Automatic Test Equipment
  - Multi-ECS Weapon System Support

The current AFLC management and engineering structure has evolved over the past several years. It was shaped to provide support to systems and items with primary emphasis on the hardware involved and was further designed to achieve spare and repair support without extensive regard to engineering development. The current and projected ECS support role, however, is engineering intensive and may require organizational realignment to achieve an efficient, effective ECS support posture. The organizational structure should follow the system approach and include each function of management and engineering for ECS. This structure would require a systems management approach with responsibilities for functional areas assigned to the various team members. This structure would address all aspects of ECS support within the command. It would provide the embedded computer resources and accomplish the management and technical support for ECS.

Logistics support of ECS requires a systems approach due to the many interactions within the system's environment. When managers plan, they must take into account the external variable such as user requirements, technology impacts, social forces, public laws, and regulations. The organizational design has to provide an environment for performance of the logistics functions by effective use of internal resources. Management must design planning systems, organizational systems, control systems, and resources systems. This network of interrelated systems requires daily interaction between the systems and their environments. The ECS support function must be included in the logistics support functions and have upper management support to ensure integration of ECS requirements into the overall logistics support systems. The task of management is to transform the inputs in an effective and efficient manner to produce outputs. A typical systems management model is shown in Figure 3-1.

New technologies such as laser systems, worldwide satellite communications, integrated systems, and multi-ECS have created new problems as well as new capabilities. As a result, plans and decisions must not be made in isolation. The impact of every new system on other systems has to be examined with meticulous care. This requires teams of technical specialists and broadly experienced generalists who can make effective use of the two powerful tools that enable systems engineers to meet the challenges provided by modern technology.

- A structured methodology, which forces even the most specialized individual on a team to think outside his speciality, to consider its interfaces with other disciplines, and to ask questions until at least the requirements are clear. The team can then work toward solutions that best meet systems requirements.

- The high speed digital computer, which enormously expands the human ability to organize, analyze, and evaluate information also enables engineers to model alternatives, simulate their operation, and trade off their hypothetical performance, cost, and other characteristics before time, money, and resources are invested in modifications to the system.

Even with these tools, the key ingredients are the systems engineers. Only they can apply the judgement that is needed to make effective use of the full spectrum of technology to produce an optimal design which meets the systems requirements.

AFLC must perform systems engineering and integration of large complex weapon systems. The techniques and practices must support current operating systems and adapt to new and improved systems based on high technology in support of national priorities. For this reason, careful planning and management are essential throughout the life of the system, from conceptual design to operational use. The systems engineering process will provide AFLC the means to improve design, scheduling, and performance of the weapon and support system and reduce life cycle costs. The system engineering process relies on the system engineer and it is likely that this will drive a gradual change from the predominant hardware orientation to a system orientation.

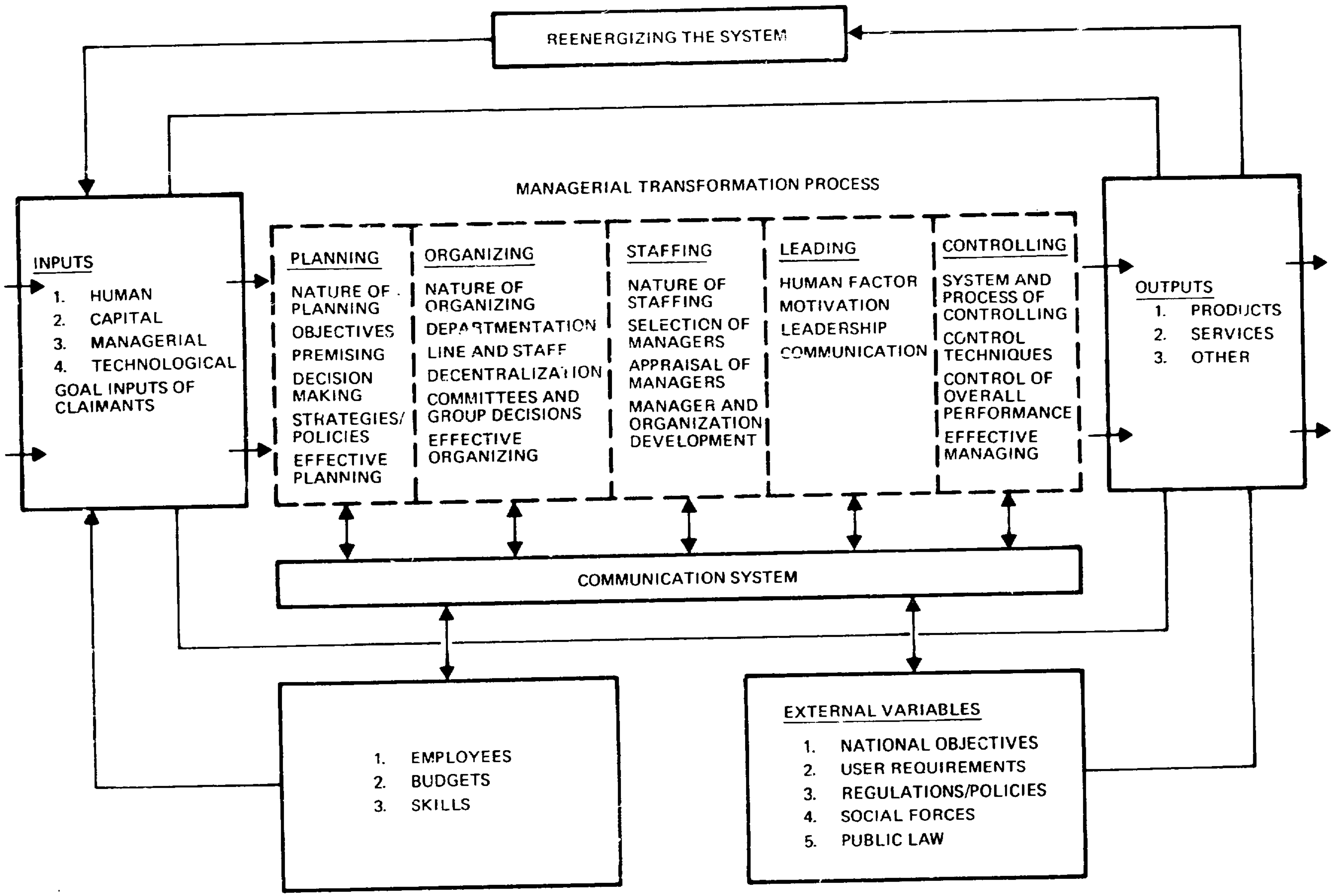


Figure 3-1. Systems Management Model

3.1 MANAGEMENT AND ENGINEERING PRACTICES

To meet the challenges suggested by the issues set forth in the Phase II, Volume II report and in this section, AFLC management and engineering practices should be adjusted to be more attuned with the highly complex, tightly integrated, engineering intensive weapon systems expected to accompany the Embedded Computer Systems (ECS's) Support in the 1980's. Major adjustments in this regard are

- Consolidate software and hardware engineering personnel in a single organization at each ALC to facilitate a more economical/responsive system engineering relationship within and across ALC's,
- Establish skill centers for concentrated specialities across the ALC's to better accommodate emerging technologies and to heighten the advantages afforded through a matrix structure,
- Develop more definitive AFLC career incentives and progression paths to attract and retain competent ECS personnel, and
- Institute a more structured training program which cycles available software and hardware engineers through a set of formal courses and a controlled job training program.

Corollary to these adjustments are three broad based initiatives which provide a framework for implementation.

- The HQ AFLC Logistics Management Office (LOE), in providing overall ECS leadership in AFLC, should develop, coordinate, and communicate to the ALC's ECS support strategies as well as the framework of policies necessary for their implementation.
- Hardware and software engineering resources should be drawn upon in a matrix concept where plausible by the managers of programs and projects within, as well as across, ALC's.
- Continuing efforts should be made at HQ AFLC, ALD, and ALC levels to execute the AFLC roles and missions, as assigned by current ECS guidance, with as much emphasis as possible placed upon mutual coordination and communication.

These changes and initiatives, together with the more specifically focused recommendations tendered in the Phase II report, will stimulate a more effective, efficient, and responsive means of conducting life cycle ECS Operation and Support (O&S). The text which follows amplifies these key areas.

3.1.1 Matrix Organization

The matrix concept, already an integral part of the AFLC structure, is the fulcrum upon which rests the ECS support posture of the 1990's. Engineering resources will simply be too scarce to programmatically isolate large nests of such expertise. The various aspects of cross-utilizing skills and capabilities across and within HQ AFLC, AFALD, and the Air Logistics Centers are discussed herein.

3.1.1.1 Organizational Structure/Functions

Headquarters Air Force Logistics Command (AFLC)

The primary agencies within AFLC which have an impact on embedded computer support are DCS Logistics Operations (LO), DCS Plans and Programs (XR), DCS Maintenance (MA), DCS Manpower and Personnel (DP), and Logistics Management (LM). Logistics Operations (LOE), the office of primary responsibility and thus responsible for policy, guidance, and resource validation affecting ECS, provides support to the operating command and assures adequate resources are available to perform this task. This requires inter- and intracommand coordination, policies, guidance, and engineering/technical support. At Headquarters AFLC, XR, MA, LM, and DP have major responsibilities as team members to ensure requirements for resources are identified, documented, and provided. Table 3-1 highlights the breakout of responsibilities between the HQ AFLC organizations. The 1990 ECS support strategy and the framework of policies to implement this strategy must be developed, coordinated, and communicated to the ALC's and ALD for their implementation. In addition to a cooperative effort by all ECS team members, strong leadership by LOE will be required to develop the strategy and policies, and to master technological impacts of ECS upon the command resources.

Air Force Acquistion Logistics Division (AFALD)

The ALD structure provides the interface and interaction with AFSC and the Defense Systems Acquisition Review Council (DSARC). Early pre-PMRT action is one of the most effective ways of reducing long-term costs of logistics support of ECS. They should work with AFSC to analyze alternative designs early in the development cycle of those systems that use embedded computers. Standardization of hardware and software where practical will help reduce life cycle costs. They should develop life cycle cost models of computer hardware and software to be used in design decisions for future systems. These models will incorporate all phases of logistic support for each ECS category including required data, equipment, and personnel. They should become skill concentrations as identified in paragraph 3.1.1.2 for standardization and identification of technology impacts through AFSC and industry interactions.

Table 3-1. HQ AFLC ECS Support Team

AFLC ECS Support Team	Principal ECS Areas										
	Personnel					Support Facilities		Equipment		Documentation, Data	
	Requirements	Acquisition	Assignment	Training	Career Management	Requirements	Acquisition	Requirements	Acquisition	Requirements	Acquisition
Logistics Operations (LO)	X	X	X	X	X	X	X	X	X	X	X
Manpower and Personnel (DP)	X	X	X	X	X						
Plans and Programs (XR)	X	X				X					
Maintenance (MA)	X	X	X	X	X			X	X		
Engineering and Services (DE)						X	X				
Logistics Management (LM)								X	X		
Contracting and Manufacturing (PM)							X		X		

They should work with the Material Management Acquisition Division (MMA) organization to ensure proper plans (i.e., CRISP, PMP, O/S CMP, etc.) are provided at PMRT. The Material Management Engineering Division (MME) through MMA should provide the acquisition engineering support to ALD. A coordinated effort between ALD, MMA and HQ AFLC is required to ensure proper embedded computer support resources are provided at PMRT. The identification and acquisition of these resources are vital to performance of management and technical support to ECS.

Air Logistics Centers (ALC's)

The ALC structure should collect the ECS hardware and software engineers into the service engineering organization with this organization matrixed to provide engineering support to each ALC user. This will consolidate engineering personnel and will allow a total digital engineering process to address technical problems, reduce training requirements, reduce duplication of critical engineering resources, and allow a career ladder within the area of professional expertise. This structure will provide for skill concentration to address new technology and to develop software controlled equipment that will allow reprogramming to be done at a lower level of technical knowledge. This will enable engineers to work complex engineering problems and will allow technicians to perform the more routine reprogramming and documentation functions. The net result will be a lower number of digital engineers to provide engineering and technical ECS support. Figure 3-2 illustrates this partitioning of functions.

The systems, item, and acquisition divisions require engineering management expertise (system, commodity, technology, and acquisition). This appears best satisfied by a resident supervisory level engineer permanently detached from the engineering division. Primary functions in this regard are to provide engineering guidance to the system and item managers and MMA, coordinate working groups, head special project teams, and serve as technical coordinator for the technical staff.

The engineering division is a logical focal point for all engineering within the ALC, and would be assigned all practicing engineers (except civil and industrial). A systems engineering capability would be established at each ALC to provide general class engineering expertise for all Federal Supply Class (FSC) assigned to a particular ALC. An ISF would be established for standalone systems. An acquisition engineering capability would be established at each ALC to assist MMA and the Acquisition Logistics Division in establishing engineering support requirements for systems in acquisition. Administrative guidance, office space, and supplies would be provided by the system or item manager (SM/IM) for co-located engineering personnel. Appraisals would be performed by the SM/IM and coordinated by the engineering division.

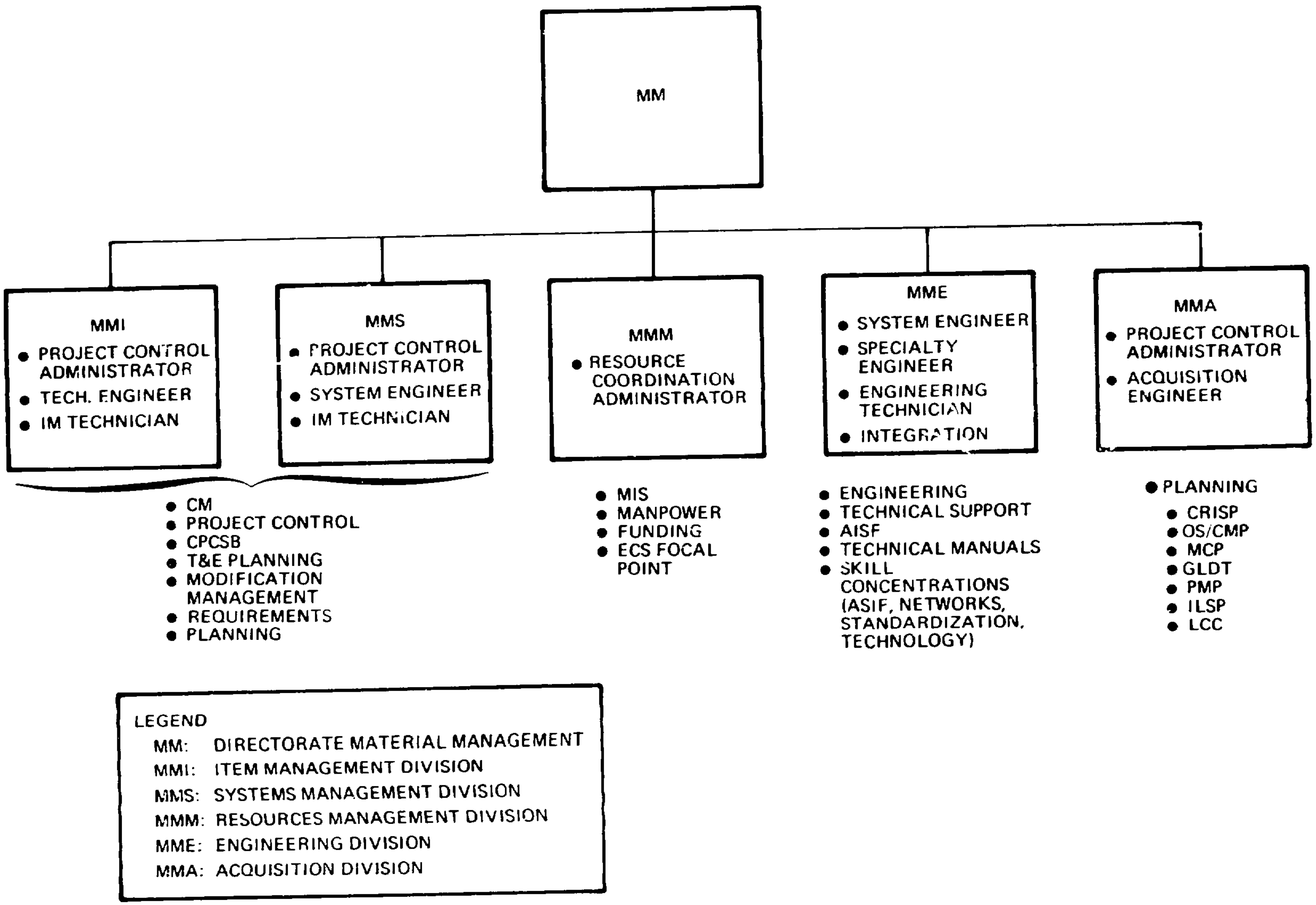


Figure 3-2. Typical ALC Support Functions

Manning for the co-located functions would be kept at the minimal levels and expertise on a project basis would be matrixed from MME as required. Any SM/IM could draw upon the resources of another ALC's MME when required, with the stipulation that TDY funding must accompany the request. Any SM/IM engineer would have the opportunity to use another ALC's ISF capability or participate in integration testing as required.

Existing specialized engineering divisions such as Material Management Communications Division (MMC), Material Management Aircrew Trainers Division (MMF), and Material Management Electronic Warfare Division (MMR) were established to focus management and engineering attention in a specific area. These and other areas should be periodically examined to determine the need for their strengthening or their continuance as separate entities.

3.1.1.2 Skill Concentrations

Geographical dispersement of the ALC's and the lack of a data transfer network decreases communications between engineers with similar weapon system support problems and fosters duplication of effort at each location. With the total number of ECS engineering, scientific, and technical personnel needed almost certain to increase in the next decade, the centralization of highly skilled engineers and scientists is approaching compulsory. Such a data bank for solving complex problems will serve as a catalyst for professional growth and development, as well as increased productivity. Identification of these skill concentrations and implementation of a network system will provide access to technology trends and standards for multiple AFLC organizations. New technology can be analyzed for incorporation into the ECS support posture with the requirements for new development tools/equipment to be defined for the AFSC program offices and laboratories. These skill concentrations would provide the conduit between AFLC managers/engineers and other commands/services for ECS support requirements and technology transfer. Computer program exchange and on-the-job training by experts, as well as cost savings reaped from the minimization of delays, elimination of duplicate developments, and reducti[illegible] of tra[illegible]re additional by-products of the skill concentration concept.

Skill centers, which are appropriately interfaced with other USAF activities, would be beneficial in the following areas:

- High order [illegible]age;
- Repository and CM Center for emulatators and other software tools;
- Repository and CM Center for mathematical models of aircraft, weapons, environment, sensors and actuators, mission models, data-reduction programs;

- Operator-computer interactive systems;
- Management of inter-center communication network; and
- AFLC initiated standardization.

Under this concept, each skill concentration would be responsible to research, develop, and disseminate knowledge throughout AFLC. The development and dissemination of standards should be accomplished by ALD as this organization normally has first knowledge of future system technologies. Once identified, HQ AFLC would assign the skill area to an ALC for the command's focal point of expertise. The assigned ALC would, in turn, provide technical counsel to other ALC's requiring assistance. These skill concentrations, assisted by the ECS support network, would interface with program offices, laboratories, and industry in developing the skill capabilities.

Skill concentrations should likewise be developed to address major ECS support impacts on AFLC, such as

- Networks,
- Standardization,
- Technology, and
- Others, as identified.

Formal plans for the develpment of these skill centers and supporting facilities for the support of known production aircraft and probable modifications expected during the next ten years should be prepared by HQ AFLC, with schedules and budgets prepared by the ALC. The commercial practice of investing two to five percent of projected system costs to analyze the economics and productivity of AFLC internal systems and facilities in advance of system selection is recommended for systems entering the inventory in the 1985 to 2000 time frame.

3.1.2 ECS Career Progression

The ECS engineering discipline requires an effective career management program to attract and retain qualified engineers to accomplish the necessary ECS support in a highly competitive environment. Such a program must provide for classification and qualification standard adjustments, professional and continuing education, training, challenging assignments, a means to track ECS skills, and the identification/communication of career paths that are made available to ECS support personnel.

Extending beyond the problems introduced by sheer skill shortages are problems in identifying the military and civilian digital engineers available for ECS support. In the military, there are no speciality codes which reflect the expertise needed in ECS. While expansions have been made in the 1550 technical arena (i.e., mathematics, statistics, computer science) the civil service qualification and classification standards do not recognize software engineering as a discipline.

Although the military has no speciality codes to reflect the expertise needed in ECS support, it does have a means of identifying officers with special experience or training not otherwise reflected in the classification system by AFSC's. These special experience identifiers (SEI') complement other classification tools and provide the means to retrieve specific experience or training for use in satisfying resource management requirements. SEI's identify experience in systems engineering and the functional areas of ATD, ATE, C-E, EW, and OFP. An additional complication is that digital engineers do not want to be identified as such because of the lack of upward mobility. Military personnel perceive limited promotion possibilities as an engineer and civilian personnel who acquire a computer software description currently tend to be dead-ended at the GS-12 or -13 level unless they move to a supervisory position.

It is thus essential that any AFLC career incentives and career progression paths adopted to attract and retain competent personnel include the identification of promising individuals, the education of those identified, as well as an array of assignments offering opportunity to progress in the subject career field. Such career control would improve the visibility of existing expertise within the services for assignments in the critical area of ECS support and other important, but less essential, jobs.

An example of a career progression ladder is presented in Figure 3-3. The ladder shows the career path that a beginning engineer may take after an initial assignment to MME. The training and experience will qualify the engineer to become a team member for acquisition engineering for a new system. At PMRT, the engineer would serve as a primary engineer on the transitioned system. At the seven- to eight-year mark, the engineer decides upon an engineering management or a technical skill path and obtains the appropriate formal education. Upon completion of the advanced degree, assignment is made to an engineering management position or to a skill concentration. Each of these paths lead to promotion opportunities at the GS-14 and GS-15 levels. At the 19- or 20-year point, assignment would be made to a professional military school, such as the National War College, Air War College, or the Industrial College of the Armed Forces.

The key point is establishment of engineering management and technical skill career paths that lead to advanced responsibilities and promotion. The engineer chooses a path and manage-

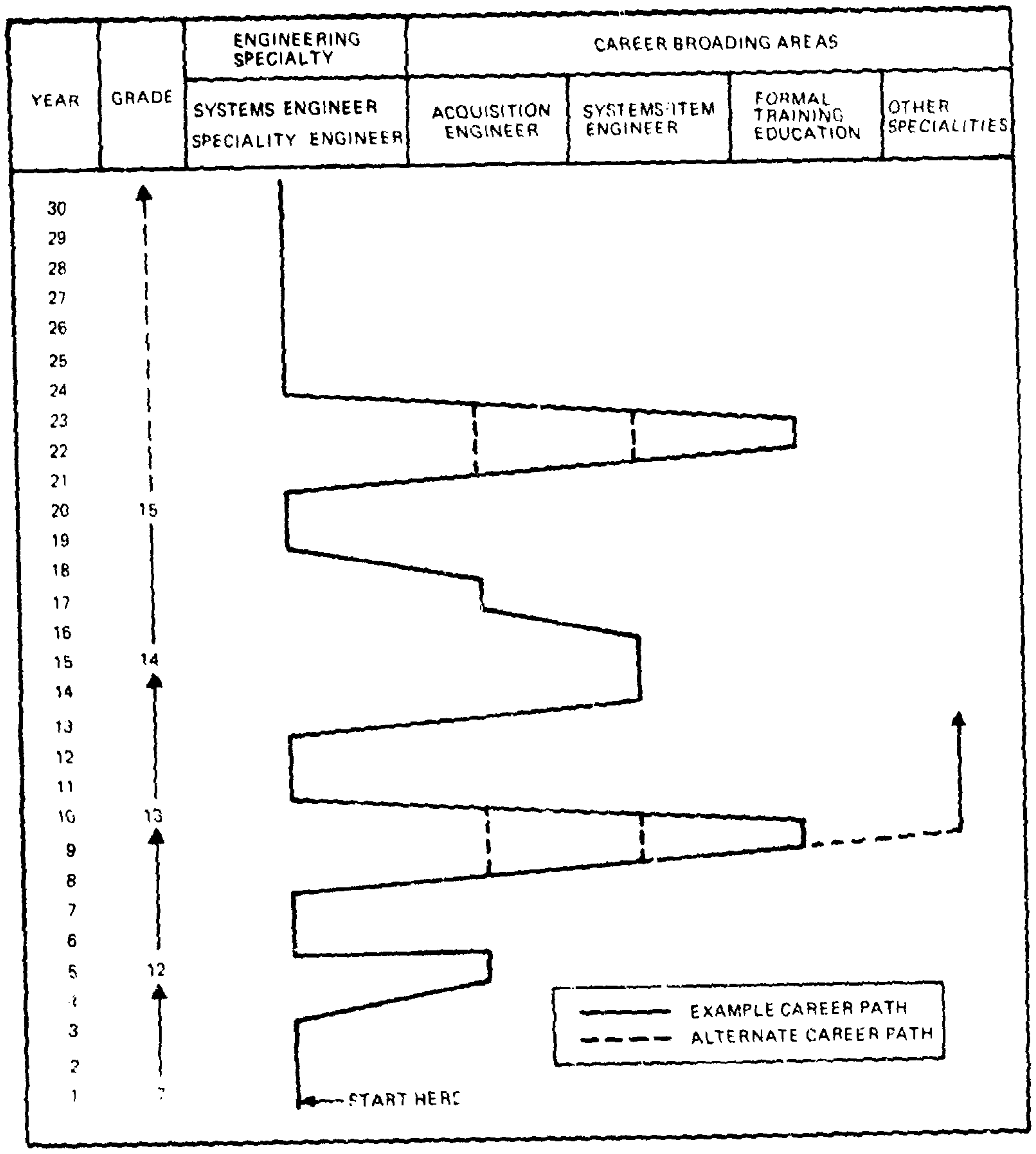


Figure 3-3. ECS Career Progression Ladder, Engineering Management and Technical Skills

ment provides opportunity for career advancement. Engineers who do not aspire to management positions or high technology skills should be assigned to challenging positions commensurate with their attained grade. They would be assigned to career broadening areas in addition to service engineering and be required to perform at an acceptable level of productivity. A career path for this option is shown in Figure 3-4.

AFLC has initiated and participated in engineer management programs such as civil service classification standards which is in the approval/publishing cycle and will include the addition of new terms/disciplines for performing ECS support. In addition, an accelerated promotion program to GS-12 in 2.5 years has been implemented and the AFLC Director of Civilian personnel (AFLC/DCP) has participated in conferences to develop an engineering career development program. The Air Force Logistics Command is urged to continue this involvement, while seeking to develop/modify civil service classification and qualification standards and military specialty codes and special experience identifiers.

Other initiatives recommended for AFLC adoption are

- Develop and implement a career management program,
- Develop and implement SEI's for civil servants,
- Develop and communicate a career progression ladder,
- Provide engineering management and technical skills career paths,
- Make assignments within the career path, and
- Ensure engineers are utilized in engineering positions.

3.1.3 Training and Professional Education

One method recommended for obtaining the system engineers needed to meet the ECS challenge of the 1980's is to cycle qualified software and hardware personnel through a set of formal courses and a structured on-the-job training program. The training required to qualify hardware engineers to perform ECS system engineering tasks includes basic computer sciences and software engineering courses, system-related courses, and on-the-job training. Commonalities among the digital systems supported at Air Logistics Centers will promote the economic development of the basic computer science skill prerequisite to system-related courses. Subjects should include

- Introduction to Digital Computation;
- FORTRAN, ATLAS, JOVIAL, or Ada;
- Assembly Language Programming;

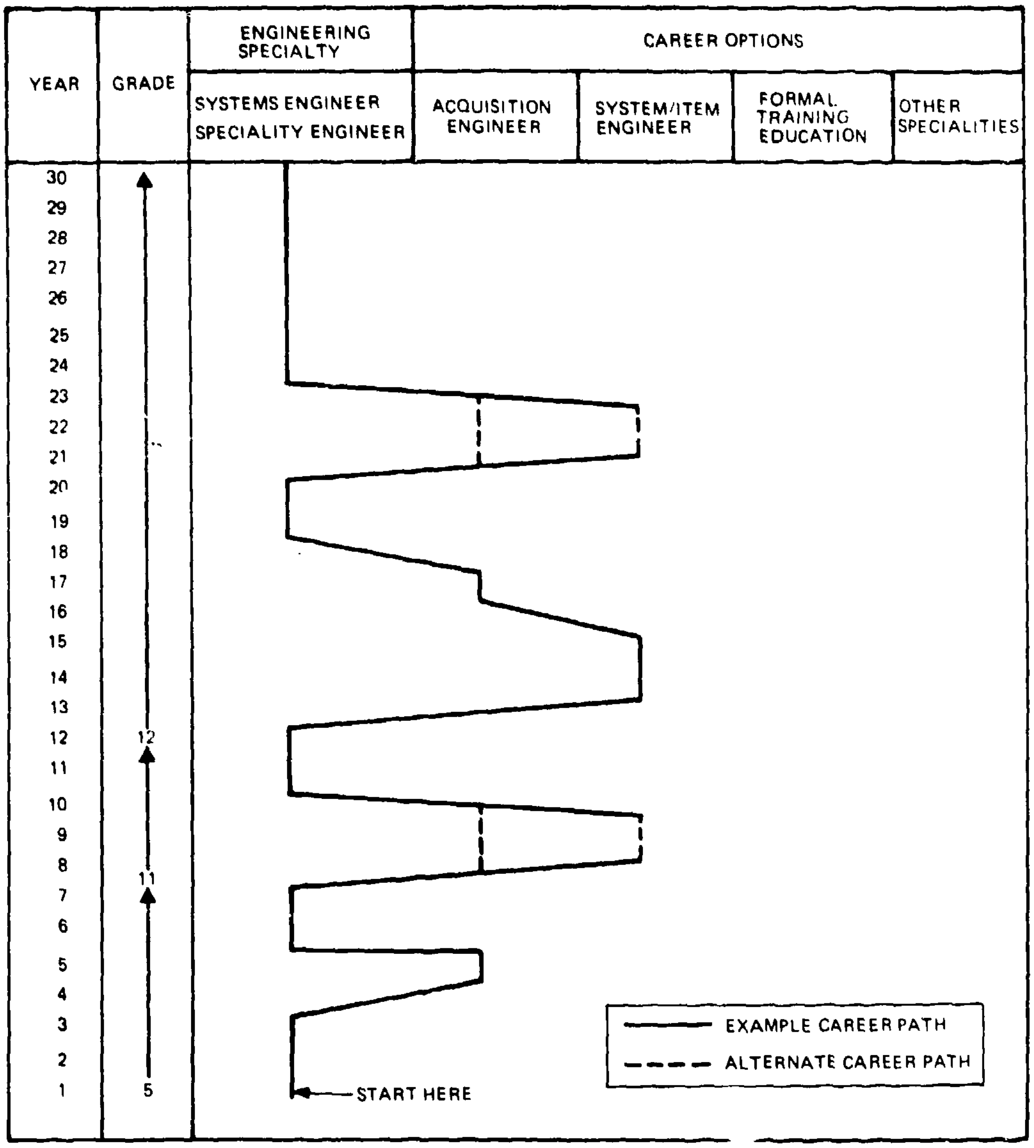


Figure 3-4. ECS Career Progression Ladder, Non-Engineering Management and Technical Skills

- General Purpose Computers;
- Avionics Computer/Software;
- Engineering Data Management Systems;
- Simulation and Mathematical Modeling; and
- Data Reduction Analysis Techniques.

A number of different methods are available to obtain the necessary system engineering academic training.

- AFIT School of Logistics Management
- AFIT School of Engineering
- Air Training Command
- Public universities and institutes
- Contractor-developed courses
- In-house-developed courses

Because no one method can satisfy all AFLC training requirements when time, cost, and course content are considered, a combination of methods are required. The system-related courses are required to indoctrinate personnel with the mission and functions performed by target systems. System-related courses should include: system overview and configuration, description of computer programs, instruction on specific assembly language test methods, and hardware capabilities and limitations.

Experience indicates that the most comprehensive training is achieved by over-the-shoulder observation and dedicated work with contractor personnel at the contractor facility during system development. This training should follow the formal course work and should be the stepping stone for assuming responsibilities for organic support. This training should be consistent with the typical career path discussed in the previous sections. Most of this over-the-shoulder training should come during the systems acquisitions cycle so the system engineer is fully capable of supporting the new systems at PMRT. To offset the time lost for training, communication resource centers should be established at each ALC. These centers, primarily established for teleconferencing, should have the following:

- Conference area with large display screen,
- Conference room with individual display and imaging consoles,

- Video transmission system with studio and control room for orginating training programs and conference briefings,
- Classrooms for live presentations and demonstrations,
- Outlets for local network interconnects,
- Room for multiple student training consoles, and
- Student console features (Video screen and control, private audio output audio input such as microphone, text keyboard, and switchable input, network, or video disk teaching machine).

System engineering and technician training requirements should be consolidated and a plan developed which describes the needs, applicable methods and resources required. To satisfy the long time planning goals of this document, the following actions are recommended.

- Expand the AFIT School of Logistics Management courses, to include a specific section on ECS systems management.
- Develop short course on ECS systems management for the teleteach systems and follow on communications media, to include video network and video disks.
- Develop a series of basic computer science courses for wide area use on video networks or local use of video teaching systems.
- Develop a basic systems engineering course for wide area use on video networks or local use on video disk teaching systems.
- Encourage AFIT Electrical Engineering (EE) and Computer Science (CS) students, projected for AFLC assignments, to specialize in subjects relating to ECS support.
- Establish a method to actively recruit AFIT electrical engineering and computer science students.
- Incorporate video instruction requirements into communications network studies and analysis.
- Use off-shelf video instruction and telecomunication services offered by commercial companies or public utilities where economically feasible.
- Develop a comprehensive instruction and training plan for ECS support personnel which complements the career ladder.
- Develop communication resource centers at each ALC.

3.2 ACQUISITION AND SUPPORT PRACTICES

AFLC engineering requirements for supporting systems are related to the quality of weapon systems at transition (transfer of support responsibility from a development phase to an operational/support phase). It is generally accepted that those systems which meet performance and reliability specifications require less engineering support than those systems with latent deficiencies or those which possess performance shortfalls. At the same time, it is a well-established premise that early detection of system deficiencies or necessary improvements involving ECS is more cost effective if corrective actions are initiated early in the system development phase as opposed to a later correction. Recognizing this fact, certain procedures and/or emphases can be implemented with a good potential for improving product quality at transition. These emphases are not applied without a development cost perturbation, yet the overall result is a reduced life cycle cost. The purpose of this section is to address improvements with the expectation that their implementation will improve system quality at transition and reduce overall life cycle costs. The improvements are divided into two groups: weapon systems and support systems.

Weapon System Improvements

Volume II and Volume IV of the Phase II report address cases where poor quality systems have transitioned. There are numerous factors which can cause poor quality, many of which are addressed within previously written volumes. The discussion here is presented to emphasize some improvement areas to help ensure improved quality. Although improvements such as IV&V and design for testability were previously addressed, they are important enough to warrant coverage here also. The specific improvement areas addressed are: conduct IV&V during development, limit system proliferation through additional commonality and planning emphases, emphasize design for testability, and stress better documentation for the systems.

Conduct Independent Verification and Validation

The attributes and components of IV&V were discussed in Section 9.2.2.3, Volume II of the Phase II report. Summarily, IV&V implements more testing, configuration, and product analysis whose overall purpose is to improve quality by ensuring that requirements and performance specifications are satisfied.

In ensuring that quality and supportable software is delivered to AFLC, the most important single activity is IV&V conducted by or under the cognizance of the eventual support agency. In referencing the definciencies related to product quality highlighted in the Phase II report, Volume II of this study, the alternative with the most apparent payoff is a full in-phase IV&V.

These deficiencies can be categorized into the following:

1. Latent software discrepancies,

2. Documentation deficiencies, and

3. Support tool deficienceis.

It can be easily seen that a well-structure IV&V by the support agency can remedy, or as a minimum, greatly improve all of these categories. The IV&V approach provides the support agency with the opportunity to

1. Discover latent deficiencies during the development process and propose them for correction,

2. Uncover documentation inconsistencies and insist on correction, and

3. Independently assess and develop additional support tools.

In doing this, the support agency can satisfy itself that

1. The software requirements adequately reflect the system requirements,

2. The software design satisfies these requirements,

3. The operational code (computer instructions and data) correctly implements the design,

4. No unauthorized code is present,

5. The operational code meets accuracy and performance requirements for the system in its intended operational environment,

6. The documentation adequately describes and accurately represents the baseline computer programs, and

7. That test and support tools are adequate for extended support.

Recognizing that accomplishment of the above activities requires a wide range of expertise and related experience, encompassing hardware, software and system disciplines, it probably will not be possible for all eventual support activities to possess the in-house ability for IV&V. Alternatives whereby the activity is done under the close cognizance of the support agency should be examined.

In most previous developments very little IV&V has been implemented during the system development phase except for space and missile systems. Rather, IV&V for most other systems was implemented after discovery of defectiveness to ascertain the overall significance of the defectiveness. IV&V has its maximum yield when implemented in parallel with the development because this exercises and tests the developing system in a manner to indicate deficiencies and at a time when a correction is less impacting. In spite of the early implementation of IV&V being more cost effective, it is seldom implemented except for high risk programs or those involving nuclear weapons because it adds an additional cost burden to the development. IV&V offsets intangible costs and a Program Manager interested in reducing development cost is not necessarily motivated to spending for deficiency prevention or for supportability issues.

While some level of V&V may be employed by the acquisition agency and should be encouraged by AFLC, the high leverage of IV&V to AFLC is application of the technique by AFLC prior to PMRT. The primary concern of AFLC during the system acquisition phase is system supportability and the acquisition of ECS support facilities, tools, equipment, personnel, and training. Therefore, AFLC commitment to perform some level of IV&V (depending upon ECS complexity) accomplishes two goals. First, it puts the development command on notice that ECS supportability is a firm requirement and second, by acquiring ECS support facilities (tools, equipment, and personnel) to perform the IV&V it places AFLC in a position to enforce supportability concerns prior to PMRT as well as assumption of the posture to support the system at PMRT.

Limit Support System Proliferation by Stressing Commonality

System developments through the past several years have tended toward independent, unique systems with little attention to other similar developments and with little attention toward modularity. As a result, not only is each developed system an entity of its own, but its support system is unique (or nearly so). Without any modularity and/or commonality considerations, each system "reinvents the wheel" by developing all of its components from scratch with little or no attempt to capitalize on previous component developments. If a development approach using modules was used, the building blocks or components would become technically stable thus combining into more reliable, quality systems.

The composite of multiple separate systems compounds the demands for engineering support. Reducing the number of dissimilar dedicated ECS support systems would lessen the AFLC support requirements for ECS. At the same time, using stabilized and proven modules or components as basic building blocks for systems and ECS support systems will tend toward higher quality systems thus lessening support impacts upon AFLC. Efforts such as the VHSIC project promise to help because of the emphasis of functional modules. Chips or components are designed for purposes which apply to more than one application, yet they are bound by controlled or standard interfaces. If more emphasis and approaches similar to VHSIC were applied to system development, then common portions of systems would improve overall system quality thus reducing overall support requirements.

Implement Design for Testability

Quite often weapon systems are designed with operational and reliability considerations in mind, but with insufficent attention focused on how to test the system. ECS systems, in particular, are sensitive to unexpected disruptions such as unprogrammed external stimuli for testing. Certain systems lack I/O pins for testing and are virtually impossible to test without disturbing their natural state, thus any administered tests are in an unrealistic environment. Adding a "test" capability to an established design often has derogatory effects upon the system, whereas, if the system had been designed with testability in mind, the probability of system degradation to facilitate a testing capability is lessened. It follows, without direct proof, that systems which are designed to be tested will be tested more thoroughly than those not designed for testing.

The probability of testing of chips, components, etc. getting more complex and sophisticated is proportional to the amount of design consideration for that purpose. An AFLC long-range support objective is to minimize complexity. This minimization can be assisted by additional emphasis to such functions as built-in-test and fault-isolation-testing (BIT/FIT). The VHSIC project is a good example of this. Not only is VHSIC focusing upon functional modules, but modules which are self-testable.

Stress Adequate Documentation

Inadequate documentation has been a common accompaniment for many previous ECS system developments. This issue has been addressed from a different perspective in several earlier study volumes but documentation is directly relevant to product quality because it describes the product and how to use and test it. Documentaion is expensive to generate and often the developing contractor or agency possesses enough internal engineering data to continue development but the data is not deliverable or is in an externally undecipherable format.

Poor documentation practices and improper planning appear to be the most common faults resulting in incomplete or inadequate documentation. The problem is one of management emphasis. The solution to this problem is not only better planning and implementation by management levels but clearly stated requirements for acquisition of baseline documentation combined with automated, standardized processes and procedures for maintaining the baselines.

Support Systems Improvements

As weapon systems have evolved to higher and higher sophistications and complexities, the associated support systems have also become more complex. Support systems have migrated from simple analyzers to AISF's. This migration has been attended by large changes in relative costs for support systems. What was an inconsequential cost for a support system only ten years ago has now turned into a cost large enough to impact the basic system development. The evolution of support system complexity is still in process and, because of this dynamic state, several support systems are of lesser quality than desired. The purpose of discussing this issue is to highlight some suggested areas for improving quality for subsequent support systems.

Assuming that overall quality of weapon systems could be vastly improved, there will still be a requirement for support systems such as AISF's because of the nature of ECS components and the need for a realistic environment for conduct of the ECS change process. Curing weapon system quality problems will not necessarily cure support system quality; however, it has high potential to reduce the overall loading for support systems. Fewer unique systems, adequate documentation, higher quality software, and better testability will tend to reduce the overall support required from AFLC.

Plan and Acquire Modular Support Systems

This emphasis is somewhat overlapping with the modular ISF addressed in Section 4.2. The use of a series of building blocks which are common between all support systems will quickly evolve to stabilize verified components whose quality, performance, and reliability will be known and thus can be factored into support system acquisition. The Computer Resources Working Group (CRWG) and the Computer Resources Integrated Support Plan (CRISP) provide the vehicle and the means for identifying support resources.

Ensure Weapon System Changes Compatible with Support Systems

This is a multi-faceted emphasis. First, there is a genuine need for validated simulators in support systems and trainers to ensure that their functions are accurate and realistic. Second, trainers need to be more architecturally aligned with the weapon system than they currently are. Third, weapon system changes must be compatible with test systems versions. Each of these facets is addressed in the following paragraphs.

- Simulator Validation. The simulators addressed here are ground EW simulators which simulate enemy capabilities. In the absence of having the real systems, simulation is necessary; however, if air missions are to train as a result of these simulators then the simulations must be accurate. Future simulations of this type must be validated through testing, analysis, and exercise to portray a realistic training scenario for mission aircraft. IV&V promises a good approach to this validation effort.

- Trainers Aligned with Weapon Systems. Many ATD's are independently developed from the weapon systems themselves, thus the ATD's and weapon system do not utilize any appreciable amount of equipment or software commonality. This results in subsquent weapon system changes not translating directly to changes in the ATD. As additional changes compound, the ATD deviates increasingly such that realistic training, in some cases, is not achievable. There needs to be additional emphasis on upfront planning for ATD to ensure that more long term utility of the trainers is possible.

- Weapon System Changes Compatible with Test System Version. Sometimes weapon systems undergo changes without any changes to test equipment being processed. This often happens prior to transition so there is a distinct probability that test systems will not adequately test the unit for which they were designed. There needs to be additional stress to ensure that test system versions equate to the unit to be tested.

3.2.1 Common ECS Support Components

AFLC should quantitatively investigate the economic advantages of standardized simulation software for use in weapon system integration support facilities and also in aircrew training simulators. The current approach of separate development of this simulation software for each individual application can cause a large duplication of effort. There is further duplication of effort in maintaining separate simulations of these same functions. However, because multi-use simulations are often more complex and costly than those customized to a particular usage, economic analysis and planning is required on a case-by-case basis.

3.2.1.1 ATD Maintenance on AISF

Maintenance of aircrew training simulator software in the AISF has been discussed (ECS Study Baseline Report, Volume III) as a partial solution to the problem of maintaining the ATD concurrent with the weapon system. A major problem with maintaining this software on the AISF is that, although the ATD and AISF may simulate exactly the same weapon system functions, they usually do so with different software models which have different levels of fidelity. Therefore, updating AISF software to a new configuration does not automatically produce a product usable in the ATD. However, the AISF software update could make corresponding ATD software updates much easier if both were performed by the same personnel. Whenever it is practical to use identical simulations in the ATD and AISF, by using software which meets or exceeds the requirements of both applications, the duplication of maintenance effort could be avoided and concurrency improved. An example of possible commonality between ATD and AISF's is given in the following paragraphs.

3.2.1.2 ATD/AISF Common Support Example

When an AISF is used to support the modification of digital avionics, it is frequently necessary to modify the AISF to incorporate pertinent weapon system changes prior to development of new avionics OFP's. When the AISF modifications are complete and the new OFP's developed, the updated hardware and software could be used to update any modules common in function and design with an Aircrew Training Device (ATD). In this section, the degree of commonality which is conceptually feasible between an AISF and a weapon system trainer (WST) is examined. The example is generic, but is based on the F-16 weapon system.

Figure 3-5 shows a conceptual view of an AISF. The heart of the AISF is the aircraft avionics systems, which are in this example interfaced via a MIL-STD 1553 serial multiplex data bus. Certain of the avionics functions, such as the inertial navigation system and the radar hardware, are simulated in this example. The AISF simulation host computers real time functions could be divided into simulation executive, aircraft and environment stimulation, simulation of certain avionics, AISF operator interface (pilot displays and controls plus visual system), and data collection (CMAC data, bus data and simulation data). Non-real time functions include test scenario generation and post-test data analysis.

Figure 3-6 shows an example of the comparable weapon system trainers. In this example, a partial compliment of onboard avionics is included in the WST. The inertial navigation system (INS) and fire control radar (FCR) hardware are simulated, so the overall avionics configuration is the same as in the AISF. The remaining simulator software contains functions very similar to those of the AISF. These include the aircraft and environmental simulation, real time executive, real time data collection, scenario generation, and post-test performance scoring. The weapon system trainer has no computer monitor and control requirement, but has both student and instructor consoles.

A comparison of common functional modules is presented in Table 3-2. The avionics compliment including OFP's and simulation of certain avionics hardware (radar, INS, CADC) could conceptually be identical in both the AISF and WST, although the simulations in both would have to meet the higher of the two requirements. The visual display used to provide a windshield view for the HUD might be considerably simpler in the AISF than would be needed in the ATD. However, the AISF displays and operator's console might be usable for the instructors's console. The AISF would not have a counterpart of the ATD pilot's console.

The aircraft and environmental simulations could probably be identical for AISF and simulator. Simulation data collection software, test control software, and post-test data reduction software would have lesser similarity. The ATD would not require CMAC's or MIL-STD 1553 bus monitors.

In summary, a major portion of the hardware and software used in real time operation of the example AISF could be identical to that used in the corresponding WST. This high degree of commonality would allow the AISF to be of significant benefit in WST operation and support.

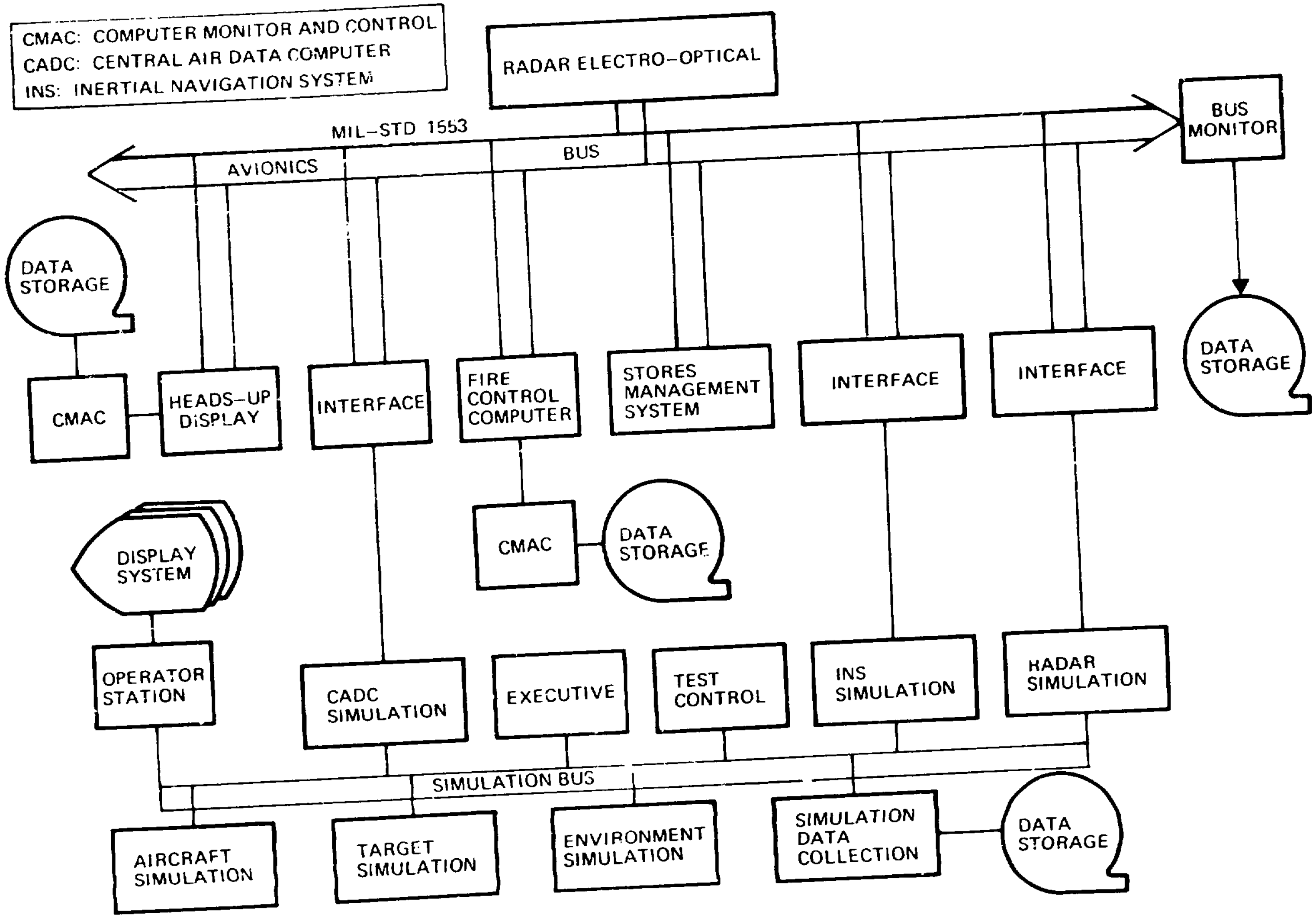


Figure 3-5. Example of AISF

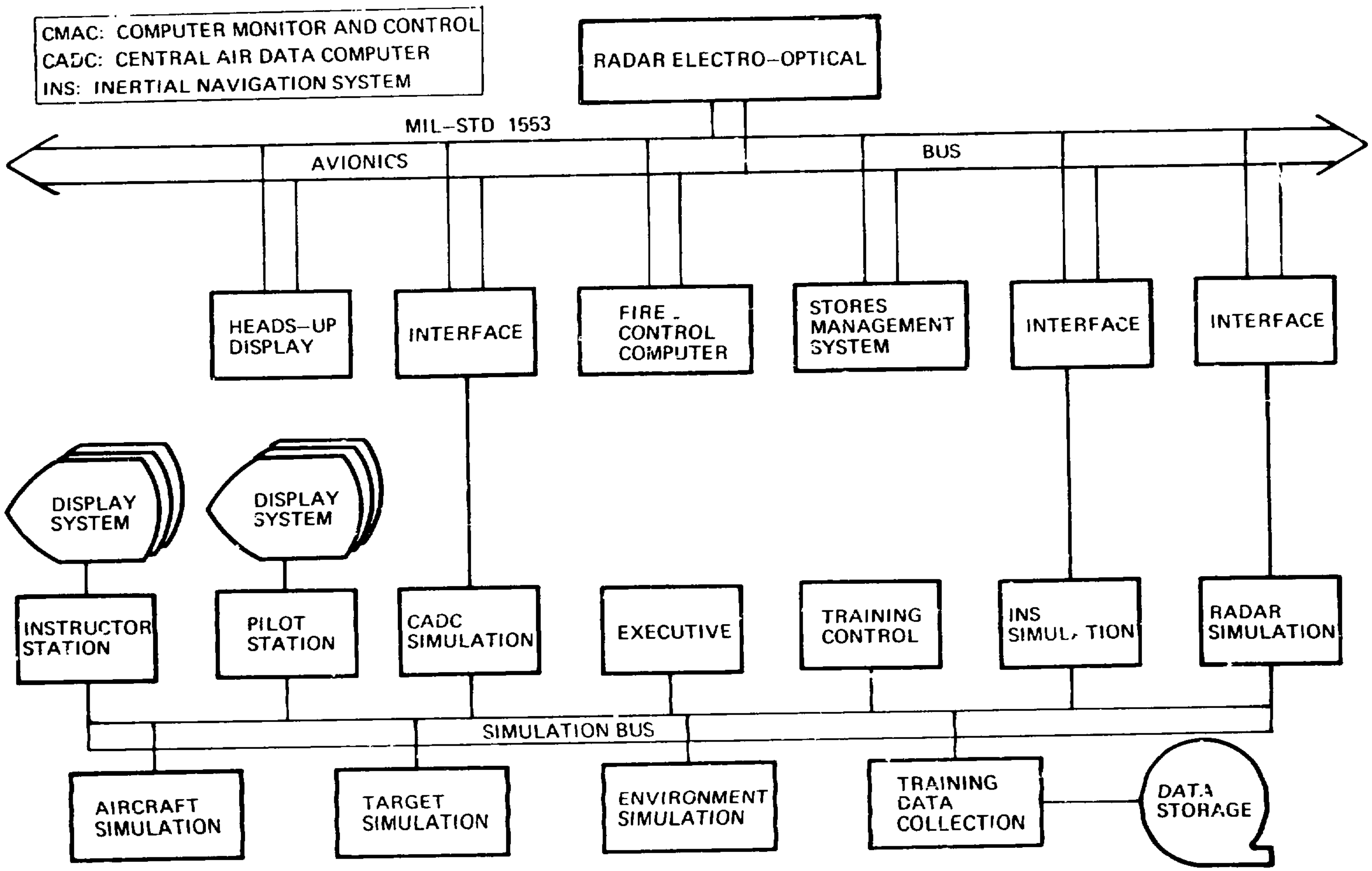


Figure 3-6. Example of Weapon System Trainer/Aircrew Training Device

Table 3-2. Components Common to AISF and ATD/WST Functions

AISF Component	ATD/WST Component	Degree of ATD/AISF Commonality
• Fire Control Computer (FCC)	• FCC	• Actual flight hardware and software in both
• Stores Management System (SMS)	• SMS	• Actual flight hardware and software in both
• HUD/Visual Display	• HUD/visual display	• AISF-HUD test interface capability, outside aircraft view and HUD symbology on visual display, HUD computers and software may be used • ATD/Instructors console: visual system showing HUD symbology and outside aircraft view; could be the same as AISF's • ATD/Pilot Console: actual HUD hardware and software; sophisticated visual system used for outside aircraft view
• Central Air Data Compute (CADC) or CADC simulatio	• CADC or CADC simulation	• Same modules could be used on both ADT and AISF
• Fire Control Radar (FCR) computer and radar hardware simulation. Radar hardware can be connected for static test	• FCR Computer and radar hardware simulation	• Identical radar hardware simulations and actual FCR computer and software in both; no provision to connect in actual radar hardware needed in ATD
• Inertial Navigation System (INS) simulation and INS hardware plug in capability for static test	• INS simulation	• Identical INS simulations could be used

Table 3-2. Components Common to AISF and ATD/WST Functions (Concluded)

AISF Component	ATD/WST Component	Degree of ATD/AISF Commonality
• Aircraft simulation	• Aircraft simulation	• Identical six-degree-of-freedom aircraft simulations could be used in both
• Environments simulation (earth, gravity, terrain, atmosphere, wind)	• Environments simulation	• Identical environmental simulations could be used in both; ATD's requirements are probably more demanding
• Operator station	• Instructor station	• Stations are very similar to identical in requirements
• None	• Pilot station/pilot visual system	• None
• CMAC hardware	• None	• None
• CMAC interface software, CMAC data collection software	• None	• None
• Bus monitor and bus data collection software	• None	• None
• Simulation data collection software	• Training data collection software	• Similar to identical software could be used
• Test Control software	• Training control software	• Software is similar, but probably not identical
• Post test data reduction software	• Student performance evaluation software	• Software would have only slight similarity

3.2.1.3 Standard Simulation Candidates

The following candidates are a partial list of simulated functions which potentially have multiple application.

- Aircraft dynamics simulation
- Earth model
- Earth gravity model
- Earth atmosphere model
- Terrain model
- Sensor models (radar, IR, laser designator, etc.)
- Inertial platform models

Standard simulations could be developed as software packages intended to be rehosted on the various ATD and AISF simulation computers, or developed and hosted on a low cost, readily available minicomputer or microcomputer. Standard simulation users would then have to procure and interface the standard host to their system rather than rehosting the software simulation.

3.2.1.4 Obstacles to Common Components

There are numerous managerial and technical reasons for the current approach of repeated development of simulations of the same functions. These reasons include the following:

- Funding and responsibility for development of weapon system simulations are assigned on a project-by-project basis;
- Standard simulations must be developed in response to the requirements of a variety of users, instead of those of a single project, and are probably more expensive to develop than a single simulation which meets the requirements of only a single project;
- Standard simulations probably will require more host computer memory and CPU time than a custom simulation;
- Lack of standardization of computer higher order languages and instruction set architectures has been an obstacle to software transportability; and
- The high cost of digital hardware and lack of standard high speed interface protocols have, in the past, been a barrier to the development of standard hardware/software simulation packages.

Funding and development responsibility is a management constraint, and could be resolved by management action. The cost effectivity of standardization needs to be resolved by quantitative analysis on a case-by-case basis. The last three obstacles are becoming less important due to standardization of programming languages, lower cost hardware, and increasing standardization of interface protocols.

3.2.1.5 Management Approach

In concept, responsibility for development of a standard subsystem simulation (sensor, inertial platform, etc.) could be assigned to the agency responsible for development or support of the subsystem. A skill center could be assigned as Office of Primary Responsibility for maintaining environmental models (gravity models, atmosphere models, earth and terrain models, etc.). The same skill center could be assigned responsibility for maintaining standard aircraft simulations. These should be assigned to a skill center rather than the aircraft program office (PO) since the same simulation equations could be used to represent different aircraft, with only data changes (aerodynamic and mass property data coefficients, etc.) to model different aircraft. The responsibility for generation of the specific data coefficients for a particular model aircraft could be obtained from the particular aircraft PO.

AFLC actions required to develop standard simulations are

- Perform cost analysis to select most cost effective function(s) for standard simulations,
- Resolve funding constraint by management action,
- Establish Office of Primary Responsibility for standard simulations,
- Perform user requirements analysis for each candidate standard simulation,
- Determine simulation hosting approach,
- Perform availability survey,
- Obtain and test prototype,
- Install prototype system and determine prototype deficiencies,
- Correct deficiencies and produce operational versions of standard simulation, and
- Maintain repository for standard simulations.

Certain of the above actions should of course be coordinated with other agencies, such as ASD and the Simulator Program Office (SIMSPO), to ensure that the standard simulations meet the requirements of all potential users.

3.2.2 Automatic Test Equipment

Testing has evolved from the age of reliability through the age of flexibility into the age of complexity. The evolution is continuing, but the question is: where is ATE heading? ATE users still demand reliability of testing, they still need flexibility, and they are confronted with runaway complexity. Against this familiar background, several developing trends are noted.

The cost of programming and supporting ATE is increasing faster than the cost of the equipment itself. But as the cost of computing power drops, it will be easier to equip systems with more built-in aids and to apply the massive computing power to device modeling.

There is a growing tendency for built-in test, ATE, and AISF to overlap each other. The distinction of one from the other is no longer as clear as in the past.

ATE technology is finding broader application in engineering and field service. In other words, consideration for ATE is impacting engineering design and the power of ATE is being used by service technicians.

Testing represents an increasing share of the total manufacturing dollar. IV&V can be thought of as a form of testing so, although hardware costs are down and are attended by lowered hardware testing costs, expanded use of IV&V will likely occur until software modularity is more prominent.

Test equipment will increasingly incorporate self-test and auto calibration as the associated costs of these functions go down. Simplified interfaces will also prevail.

Instruments will be broken up into several applications categories. A constant base of requirements will continue to call for flexible, manually operated instrumentation for an array of capabilities which do not use repetitive measurements. At the same time, microprocessor technology will provide improved performance over currently used general purpose equipment.

Finally, general purpose instruments oriented toward users who want to put ATE systems together will incorporate bus adaptability and these instruments will use higher operating speeds.

A recent review across the spectrum of ATE manufacturers and users cited the forecasted major challenges for the coming decade are

- Testing and performing fault isolation on microprocessor-populated products;
- Test speeds;

- Problems and challenges created by the growing popularity of fiber-optics;

- Need for some form of BIT for LSI and VLSI components;

- Problems involved in testing new, large memory devices;

- Urgent need to develop functional programs and fault isolation capability for complex UUT's at a reasonable cost;

- Requirements for analog ATE and fault isolation capabilities; and

- Need for digital in-circuit capability for handling LSI devices.

In view of these trends and challenges, ATE is destined for increased emphasis throughout the next decade. AFLC will be affected by the dynamics of ATE and, unless adequate upfront planning is implemented, the command will be controlled by the dynamics rather than controlling them. The upfront planning should take on a three-fold emphasis: first, each weapon system to be developed should incorporate adequate design for testability; second, AFLC should strive to get "smart" ATE with ample documentation to allow untutored people to use the ATE; and third, AFLC should apply emphasis to use as few ATE systems as practical to limit system proliferation.

- Incorporate adequate design for testability. This suggestion has been offered in the ATE volume of the Phase II report and as a means of weapon system quality improvement. In summary, design for test-ability requires planning within early design phases to enable the weapon system state to be verified as operative or not. Such emphases as additional and improved BIT and the MATE concept contribute toward this suggestion.

- Acquire smart ATE. Throughout the past decade, the motivation and intent of AFLC was to acquire ATE that did not require highly trained operators. The dependency upon the ATE itself to accomplish testing was prevalent; however, in reality the delivered ATE systems have migrated toward requiring more competent personnel. Breakthroughs in microprocessors, voice synthesis, improved graphics, interactive software, etc. promise to provide a better chance of acquiring smart ATE.

- Limit ATE proliferation. Establishing adequate standards and emphasizing modularity will significantly assist in this area. Success with this area is extensively dependent upon improved and expanded AFLC planning.

Table 3-3 is included to illustrate the problems that are identified with ATE. The data contained therein was extracted from the DOD Industry/Joint Services Automatic Test Project. Note that the maintenance planning and support concepts task group cited virtually every problem listed. There is little question that improvements in upfront planning and implementation is the most significant problem pertinent to ATE and facing AFLC through the next 10 years.

Table 3-3. Automatic Test Equipment Problem Areas

Task Group	Problem Area											
	Weapon Systems Program Planning	Program Management	Guides, Standards, Specifications	Test Effectiveness	ATS Cost	Personnel Effectiveness	ATE Calibration and Metrology	Test Technology	Build-In Test Effectiveness	ATE Complexity	Test Program Set Effectiveness	Non-Electronic Test
Software			X		X	X	X	X		X	X	
Automatic Test Generation				X	X	X		X		X	X	
Design FDR Testability	X	X	X	X				X	X	X		
Nonelectronic Testing	X	X	X	X				X	X			X
New Technology				X		X	X	X	X	X		X
Microprocessors				X			X	X	X	X		X
Advanced ATE Technology	X		X	X	X	X		X		X	X	
Interfaces			X	X	X	X	X	X		X	X	
Metrology and Calibration			X	X	X	X	X	X		X		
Systems Engineering	X	X	X	X		X				X		
Education and Training	X	X	X	X		X				X		
ATE Language Standardization			X	X	X	X		X		X	X	
Test Program Sets			X	X	X			X		X	X	
ATE Acquisition	X	X	X							X		X
Maintenance Planning and Support Concepts	X	X	X		X	X		X	X	X		X
Resource Management				X		X	X			X	X	

3.2.2.1 Extension of AISF Capability to the Flight Line

Most malfunctions are discovered during pre-operational checks, aircraft preflight, or during actual operations. During pre-operational checks there is considerable pressure to put the system online. As a result malfunction symptoms are hurriedly analyzed and one or more boxes pulled and replaced. There is little time for fault analysis and orderly fault isolation. It is in this dynamic environment that highly capable ATE has its greatest benefit.

The reliability of built-in-test (BIT) check will increase as more test circuits are embedded in the chip itself, it will become easier to identify and replace modules, boards, or components. On the other hand, ATE will use the same high-speed, high density technology to increase the capabilities of ATE systems. As a result of these two trends, the distinction between BIT and ATE will become less prominent.

The trend of ATE during the 1990's will also be toward more flight line test capability such as that demonstrated at SM-ALC for the F/FB-111. Another example is the flight line test set (FLTS), currently in early development stages, which is the largest scale excursion into this area. This piece of flight line AGE is intended for system testing of a subset of electronic warfare systems. The success of this program will undoubtedly determine the extent of future endeavors of this kind. Additional flight line AGE could conceivably be utilized for other avionics subsets or specialized testing where costs of such equipment can be justified. This could also be extended to different levels of tests where system access permits. This suggests the extention of intermediate, depot, and ISF capabilities to the flight line. Further, with increased communication capability, a problem solving link would exist between these facilities and flight line activities. To be most useful, the following characteristics are necessary in flight line ATE of the future.

- Modular. It must interface with and between the unit under test a wide variety of stimulus and measurement devices.
- Functional. It must surround the unit under test with an input-output environment closely simulating the one in which it will actually operate. Stimulus signals and responsive measurements must be real time duplicates of those used by the systems.
- Flexible. It must be easily reprogrammable so that it can respond quickly to unit under test design changes or operational conditions.
- Human Engineered. It must be easily operated by other than highly trained engineers. When possible the system should guide the operator through the test steps providing tutorial aid when required.

The ATE design concept presented in Section 3.2.2.2 will meet the objectives, take advantage of the available technology, meet operational requirements, and satisfy following ECS support concepts presented in Section 1.

- Maximize sharing of distributed ECS support resources by use of modular integrated ECS support facilities and standardized automated ECS support tools.
- Manage and support highly integrated ECS dispersed at geographically separated support locations by establishing a system for ECS management and technical data flow.
- Minimize critical ECS engineering and scientific skill needs by optimization of organic contractor skill mix and increase the use of organic lower-skilled ECS personnel by automation and standardization of ECS support processes and procedures.

3.2.2.2 AISF Extension Development Concept

To correct a system problem the technician or engineer must identify the problem to resolve it on site. Duplicating the problem involves reproducing the mode where the initial problem was observed. This can result in continually repeating sequential/procedural steps used in the operational environment. All this troubleshooting takes time and experience; therefore, accurate on site analysis at the time the problem occurred can pay high dividend in terms of efficient use of personnel and resources. Recognizing that it is not yet possible to troubleshoot an inflight malfunction until the aircraft returns to its base, efficiency is achieved when the malfunctioning system is correctly identified and replaced.

There is a correlation between flight line trouble shooting activities and problem solving in the AISF, especially when the technicians and engineers are dealing with transient failures, multiple time dependent failures, or application dependent failures. Most ATE is designed to detect and diagnose single hard failures rather than those associated with the dynamic execution of an applications program. To diagnose these dynamic problems, the technicians or engineers need to generate a dynamic environment which stimulates the malfunctioning software/hardware. This common need for dynamic stimulus and a highly capable ECS monitoring capability ties the needs of the flight line technician and the AISF engineer together. These common needs will bring about a closer relationship between the flight line and the AISF, especially to solve "bad actor" or "cannot reproduce" repeated failures.

The expanding use of communication satellites and communication networks will allow direct communications between the AISF engineers and the flight line technican. By using available communication tools and automated flight line aids, with software common to the support ISF, it will be possible to create, on a case-by-case basis, a powerful problem solving team. By solving problems at the operational site it will be possible to reduce the number of system components returned to the depot needlessly. By minimizing the number of components in the logistic pipeline, life cycle support costs can be reduced. To accomplish improved onsite testing, field level units must have

- Improved test sets capable of dynamic inputs and interactive measurements;
- Complementary ATE and BIT checks;
- Improved operator skills, including knowledge of system operation;
- Improved onsite display of test results, including graphic displays; and
- Fault environment snapshot recording/transaction capability.

ATE systems designed with the features displayed in Figure 3-7 will satisfy the above objectives.

Such an extendable test set could provide the following:

- Test set reprogrammable to satisfy a number of multilevel requirements,
- Function switches programmable to match the test program or test phases,
- Menu driven test function selection,
- Graphic representation of the test cycle,
- Data transmission capability for interaction with intermediate, and depot for the ISF support systems,
- Dynamic input/output comparison,
- Vectored probe to stimulate on chip test circuits, and
- Graphic and text display capability to provide self instruction and help functions.

3.2.3 Multi-ECS Weapon System Support

The increased emphasis on performance of the tactical forces, the drive to an all-environment force, and the impact of technology will combine to increase the complexity of aircraft and the use of ECS in multiple applications. These factors, in turn, will place increasing demands on the AFLC and their support of ECS. New systems being introduced to the fleet are being installed on different aircraft (See Table 3-4) and this is adding significant management and logistics burdens to the ALC's. The problems are compounded even further when joint efforts with U.S. allies, such as on the F-16, are undertaken or when support to foreign countries is provided, as in the case of the F-4 aircraft.

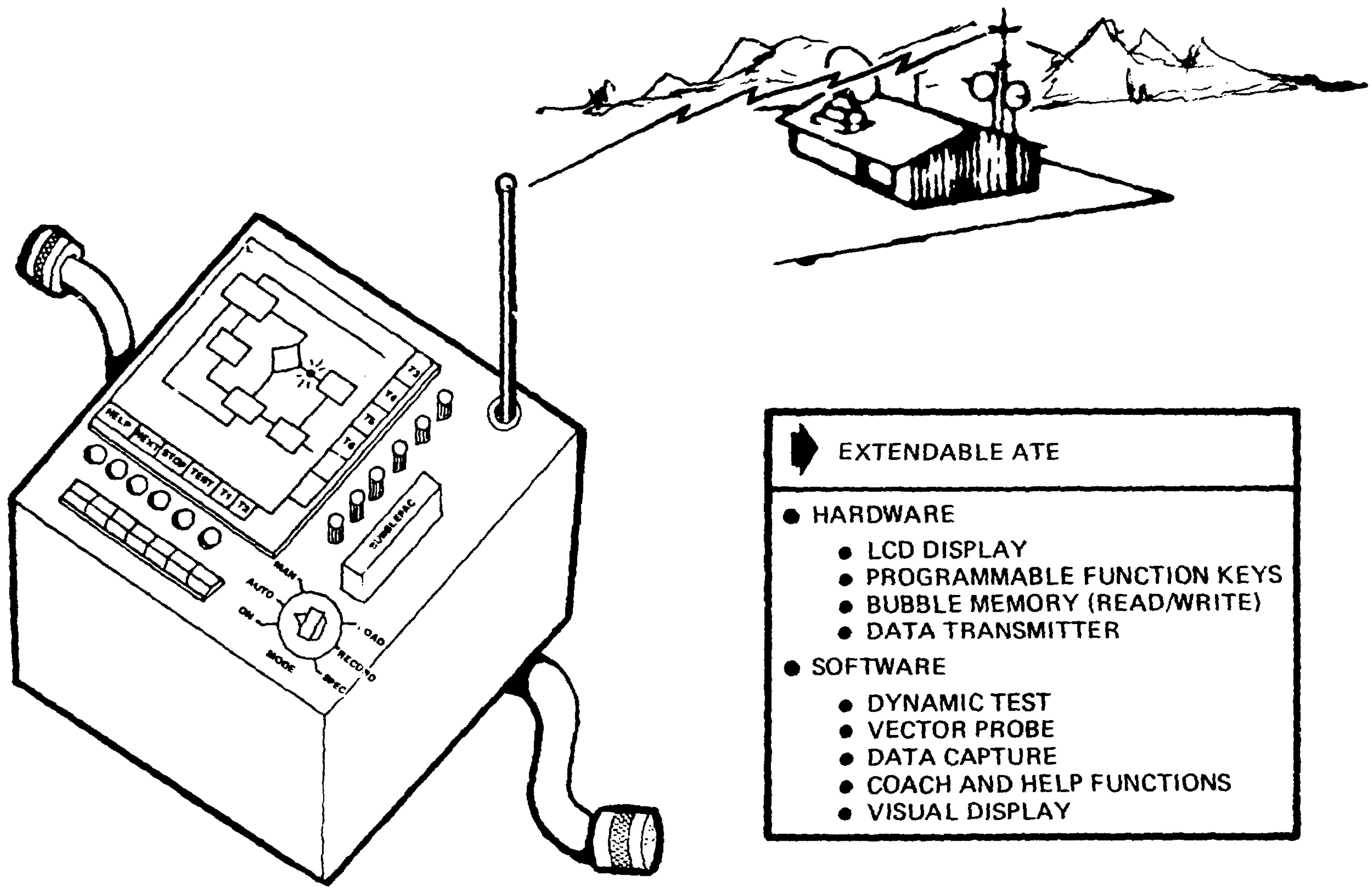


Figure 3-7. Flight Line AISF Capability Example

Table 3-4. Projected Multiple Use of ECS

Aircraft	Embedded Computer Systems: PAVE TACK	ASPJ	ARN-101	LANTIRN	GBU-15	AMRAAM	MRASM	Radar Warning Receiver	ALRXX	Synthetic Aperture Radar	Programmable Signal Processor	JTIDS	GPS	SEEK TALK
F-16		X		X	X	X	X	X	X	X	X	X	X	X
F-15						X		X	X	X	X	X	X	X
F-4E	X		X		X		X	X	X			X	X	X
RF-4C	X		X					X	X			X	X	X
A-10				X	X		X	X	X			X	X	X
F-111	X	X			X		X	X	X			X	X	X
F-4G			X					X	X			X	X	X
E-3A												X	X	X

There are a number of initiatives that AFLC should take to alleviate the problems that will arise from the multiple use of ECS on different aircraft or within the same aircraft. In addition, increased emphasis on initiatives already begun, such as standardization, can reduce the impact of supporting the multi-use ECS. This section presents additional initiatives and recommendations while considering the impact of on-going efforts within the Air Force. It also highlights the changing nature of avionics to digital systems from the previous analog systems. This change has required the ALC's to take new approaches to support the aircraft and avionics on board the aircraft. As an example, Figure 3-8 shows the growth versions of the F-16 avionics architecture. It should be noted that the cross-hatched blocks, which comprise a major number of the components of the integrated avionics, represent digital ECS. This expansion over the avionics on the A and B versions of the aircraft illustrates how rapidly ECS utilization is increasing. By referring to Table 3-4, an indication of the number of ECS the F-16 will share with other aircraft can be observed.

The approach taken here is to logically examine the factors that have a primary bearing on the ALC's support posture as a result of multi-use ECS, postulate a set of approaches to resolve problems caused by these factors, and then use real examples to establish the validity of the approach or initiative. Several of the initiatives are directed at the software contained in the ECS, since one of the prime motivators in going to digital technology is the relative ease with which it can be changed to meet changing operational requirements (e.g., the digital processing of signals based on threat information in the electronic warfare environment, and the weapons release algorithms as new weapons come into the inventory). Figure 3-9 illustrates an idealized approach to establishing the solutions to multi-use ECS problems. For the 1990's, however, inputs such as operational requirements are not totally clear and, thus, may play a lesser part in earlier studies.

3.2.3.1 Support Requirements for Multi-Use ECS

The support requirements for multi-use ECS must provide for the integrity of the avionics system on board a specific aircraft while minimizing support costs due to test facilities, personnel, and training. The cost of replicating simulation facilities at different locations because the system managers for the various aircraft are at different locations can be exorbitant. The item and system managers are physically separated in many cases and ideologically separated in others. The physical separation is by far the most restrictive, however, because it compounds the complexity of supporting a system. Potential solutions exist to reduce the impact due to multi-ECS use. Standardization of architectures, both instruction set as in the 1750A or the new military computer family (MCF) and the 1553 bus architectures, are important to reducing sup-

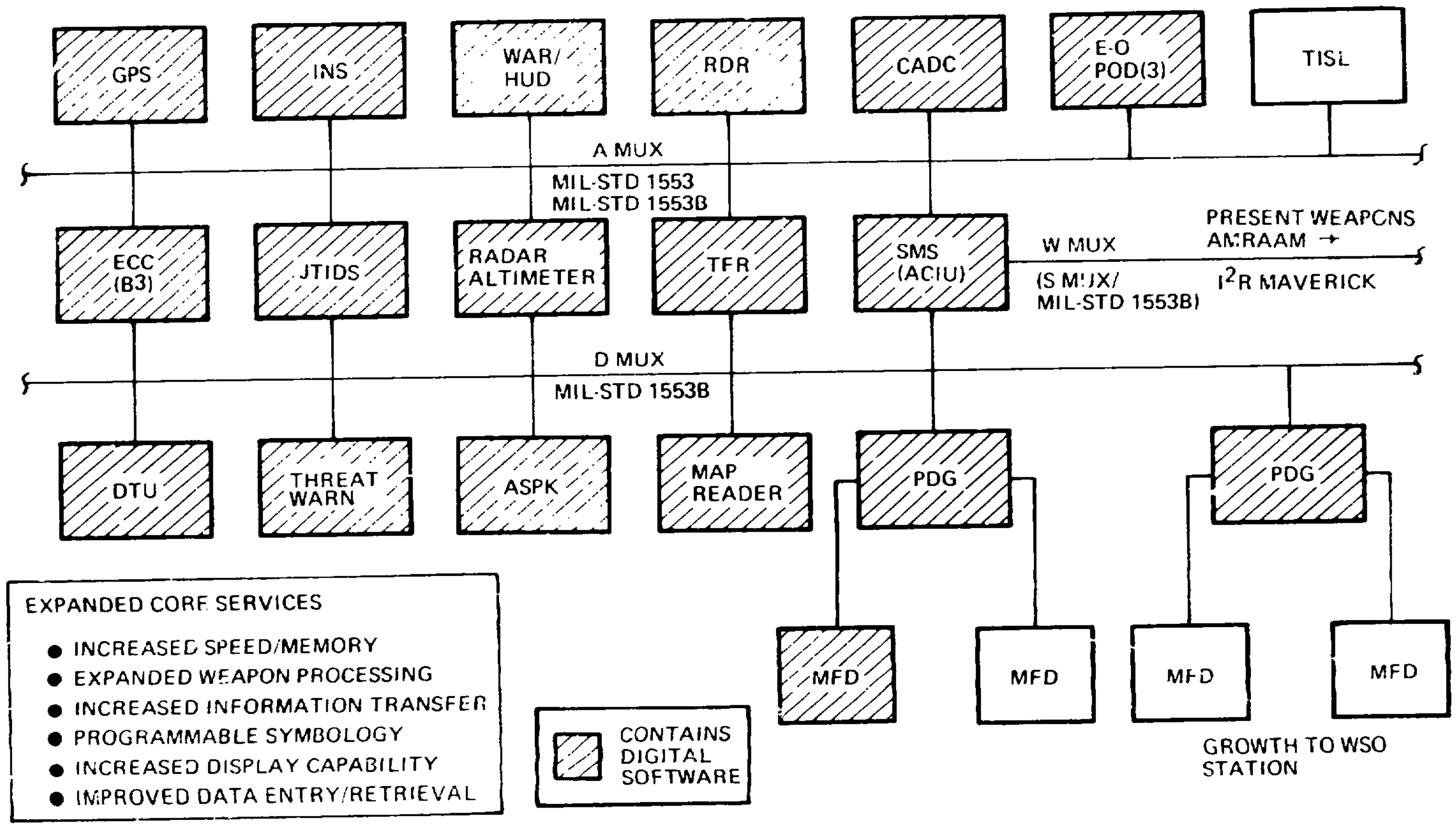


Figure 3-8. F-16 Growth Versions Architecture

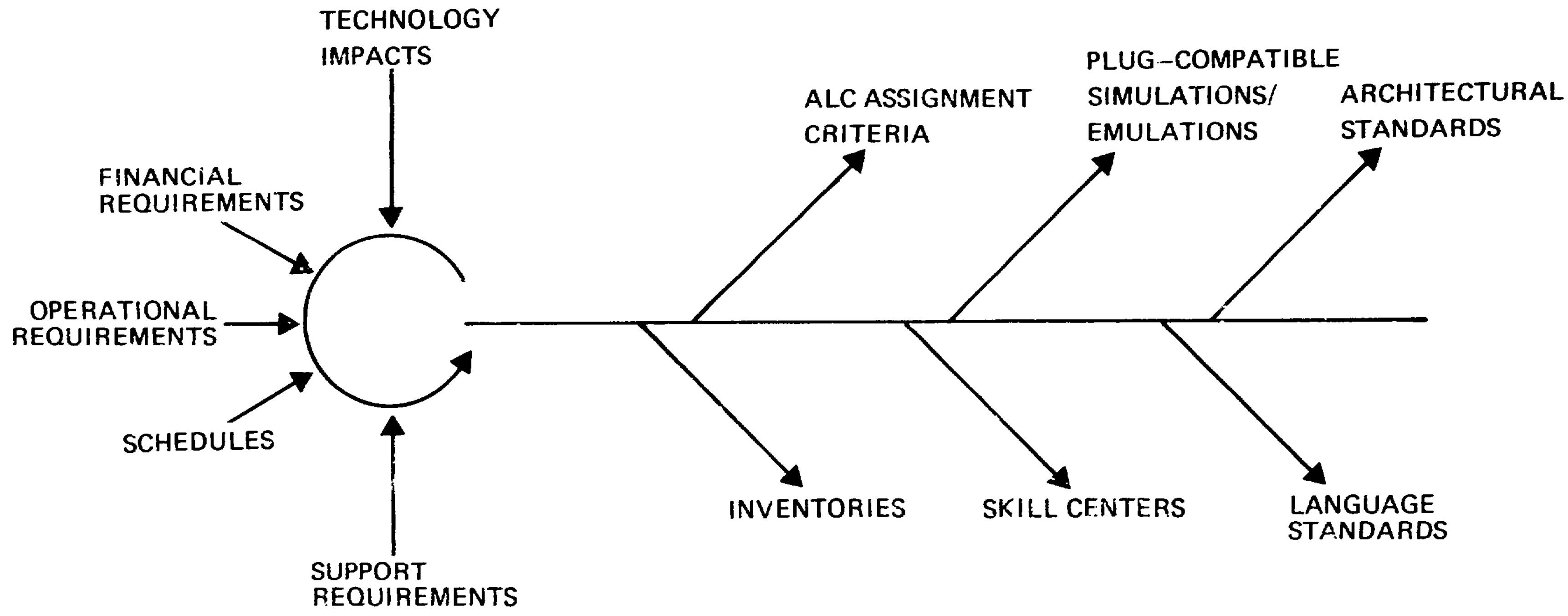


Figure 3-9. Support of Multi-Use ECS

port costs for future aircraft. These standardization issues as they impact multi-use ECS are addressed in subsequent paragraphs of this section.

The criteria for assigning an ECS to an item manager or system manager is not self evident, but several factors have promise as technical measures that will assist in the assignment decision.

Many ECS are integral parts of a closely-coupled system which will possibly preclude separation of ECS from a sensor or a second ECS system from an integrity standpoint. Closely-coupled is defined as two ECS or ECS and sensor combinations which provide feedback to one another. Examples of closely-coupled systems are the radar altimeter and operational flight systems on the cruise missile and the radar and fire control computer on the F-16 system.

However, it does not automatically follow that because an ECS is part of a closely-coupled system, that it should be assigned to the system manager. Historically, the inertial measurement unit (IMU) used on board an aircraft is modeled in software in simulation facilities because of the difficulty in driving a platform designed to provide inputs to the IMU as a function of the simulation. Platforms are used but they are generally independent of the hot bench and specifically designed to test only the IMU. A secondary factor, then, that would be developed as criteria for ECS assignment, is the complexity of the closed-loop system or the capability to simulate the ECS or sensor. The more complex a system in terms of signal processing and interface to other ECS in the closed-loop system, the more difficult it is to model in a host computer with a simulation facility and, consequently, the greater the need for the subject embedded computer to be in the trainer, the avionics integration facility, or the item test stand.

Timing constraints between two or more ECS in an integrated system is one of the primary factors that increases complexity significantly. Two systems which pass data continuously and have required rapid responses, or enter data via Direct Memory Access (DMA) will present problems in an Avionics Simulation Facility if the actual hardware is not employed, especially if the data is input via direct memory access. This will probably be the case in many EW sensors and ECS combinations. The question of data freshness is also important when a continuous data stream is modeled in a simulation. The data may be fed to a digital filter, and the response of the filter or of a function to a discrete signal in the continuous data stream may be incorrectly interpreted during software modifications and checkout if the signals are incorrectly modeled. A closer examination of current and projected systems that provide data directly to ECS or where high data rates or closed-loop interactions are required should be undertaken to establish specific criteria for using hardware in an AISF. The evolving standards for bus architecture will provide a more standard interface in the future, but modernization programs on older aircraft and sensors will dictate the need for hardware-to-hardware interfaces in AISF's for the foreseeable future.

Interrupt driven systems may be more easily separated from other ECS systems if the interrupts follow random patterns, because the checking of software that responds to the interrupts may be done with models employing Monte Carlo techniques or by systematically checking sequencing and timing of the software that should respond to the interrupt. If the traffic between embedded computer systems is light, the support requirements are diminished. Light means total traffic, since a few signals at a very high rate can impose severe processing requirements on an embedded computer system.

Another consideration in the assignment of an ECS and also in the determination of whether an ECS should be included in a simulation facility is the built-in test (BIT) incorporated in the ECS. Built-in test is required in ECS and frequently features wrap-around signals to buffers and/or sensors that are difficult to model in a simulation facility.

Recommended Action

Conduct a study of closely-coupled ECS and of projected sensors and ECS to determine if criteria can be established which will aid in establishing ECS assignments and whether the actual hardware should be included in simulation facilities for avionics integration, operational flight program development, trainers, and electronic warfare. Factors to consider are the types and timing to interfaces, the nature of the processing on the signals, the amount of interrupt processing, the built-in test requirements, standardization, functions of the ECS, and traffic flow.

The assignment of an ECS to an item manager will not automatically mean that a system manager charged with ensuring that a distributed processing system composed of two or more embedded computers will not require the ECS assigned to the item manager to be duplicated in an avionics integration facility. As previously stated, there are numerous factors that will determine whether ECS support is required at both an item manager and system manager level, though there appear to be technical considerations warranting further study to minimize duplication of facilities. In addition, subsequent discussions will examine the extent of emulation of ECS in trainers and integration support facilities.

3.2.3.2 Emulation in Multi-Use ECS

Great strides are being made in emulating computers and the ALC's are actively developing an emulation capability. There are Nano-Data QM-1 emulation computers at WR-ALC and OC-ALC and plans are underway to emulate a target computer at SM-ALC. In addition, an emulation using special boards on the VAX 11-780 is underway on the ALQ-131 verification and validation program. Research is underway in the use of microprocessors for emulation. WR-ALC now has a higher order language compiler for the QM-1 on the Univac 1108 computer which can speed the development of a specific emulation of a target computer. The use of emulations instead of actual ECS in selected applications has the potential of reducing support costs and also minimizing scheduling problems. The primary concern in using an emulation to computers generally can introduce execution times different from the actual embedded computer and consequently, limits the checkout of timing and/or interfaces. However, the actual software for the ECS is run and the sequencing and logic of the real computer is followed.

The ability to use emulations instead of the actual computer could produce a number of positive benefits in support of multi-use ECS and aircrew training devices concurrent with operational flight programs. Figure 3-10 illustrates how this could be achieved. The item manager would effect the block update of an OFP on an independent stand and tapes would be distributed to the trainer sites and to AISF's in the multi-use environment for integration and test. Of course, the actual hardware in each facility would be even better, but hardware availability and cost can make this difficult to achieve. The initial set of hardware requirements should include test stand requirements if actual hardware is to be used. Emulation costs may be significantly cheaper on a life cycle basis. It provides the vehicle to centralize support of an ECS with one ALC. The responsible organization would be charged with updating the OFP, hardware, and the emulations. Scheduling of changes to the multi-use ECS would also be the responsibility of the item manager in the sample chosen. Since the resources, including expertise, are resident in one location, changes can be accomplished to all aspects of the ECS and limited testing against hardware performed prior to being incorporated into weapon systems or aircrew training devices. The organization responsible for maintaining the OFP would also be responsible for maintaining the emulation.

Recommended Action

An experiment should be developed using emulations of an existing ECS that will demonstrate the feasibility of using emulations for multi-use ECS. Consideration should be given to incorporating the emulation in an AISF and a corresponding ATD to establish whether concurrency is possible using emulations. The impacts of timing discrepancies between the emulation and the actual embedded computer execution should be explored and boundaries of acceptable deviations established. Life cycle costing of the two options (emulation versus ECS use) should be derived and compared to establish costing estimates. Microprocessor emulations should be used in the experiment because microprocessors potentially offer a cheaper alternative for aircrew training devices. The QM-1 poses a significant initial investment if the emulation capability will be necessary in several physical locations.

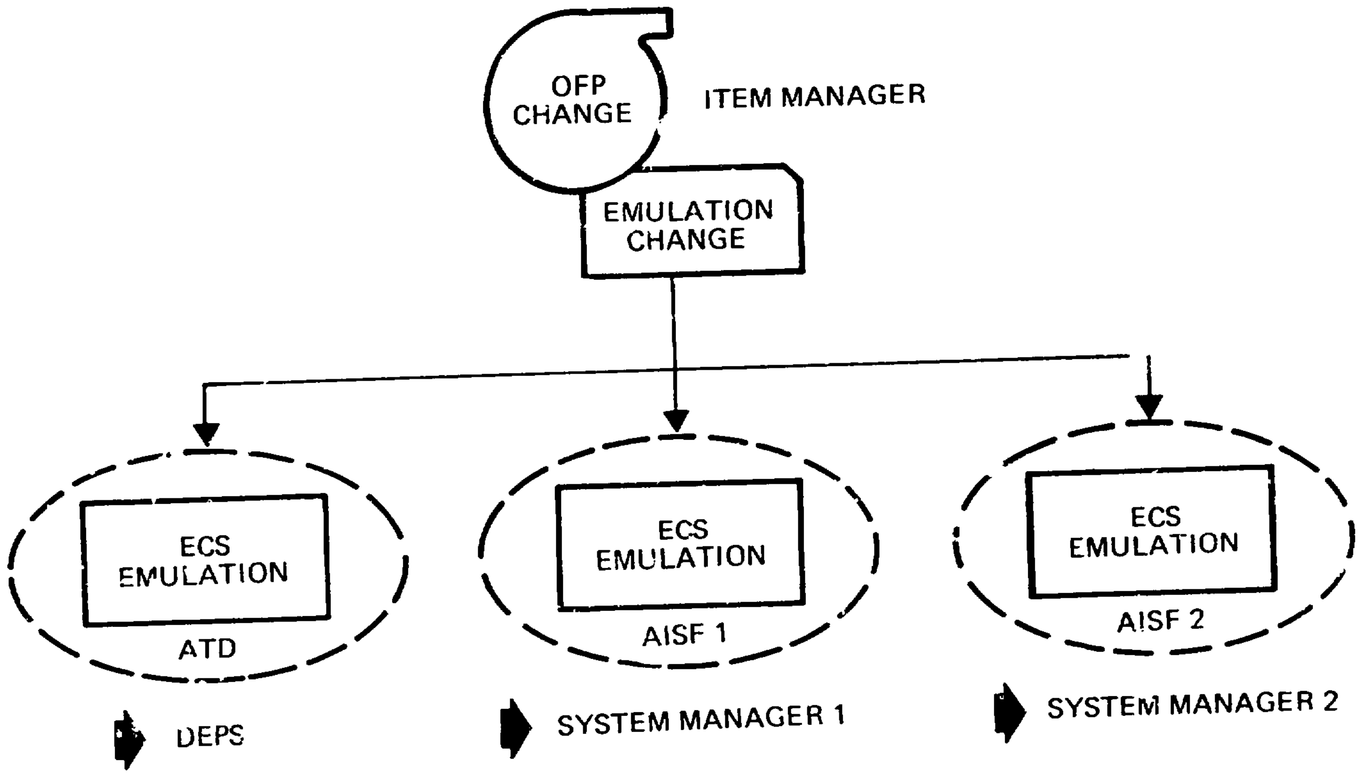


Figure 3-10. Use of Emulation In Multi-Use Environment

3.2.3.3 Architectures and Standards in Multi-Use ECS

Standardization offers increased support capabilities for reduced resources because it potentially provides plug-compatible hardware systems, reduces the disciplines or reservoir of knowledge required to support systems, and makes software more transportable. To achieve the desired support posture in the 1990's, AFLC should assess the impact of the standardization of embedded computer architecture, bus structures, data bases, language, graphics systems, AISF's, networks, documentation, and development standards. The Air Force is making progress toward standardization (e.g., the RD/LE policy letter of 26 April 1981) which establishes standards for languages and instruction set architectures for 16- and 32-bit machines.

The standards currently being developed for military applications (MIL-STD 1750 instruction architecture set, Ada language, AFR 800-14) are oriented to the development of the tactical system with insufficient consideration being given to their impact on support requirements. For example, computer architectures could be designed with interface boards that will permit a standard programmable computer monitor and control (CMAC) device to connect to the computer through and AGE port or in a unique port to the computer. Too often, unique CMAC's have to be designed and developed for each embedded computer in the AISF. The same ports that would be used for the CMAC in a test stand would also be used in flight test aircraft for data collection which would also reduce development and test costs. Because a multi-use ECS would be designated to different aircraft, 'a standard interface would serve both with modifications perhaps due to cable lengths (i.e., line driver changes), cooling, or power requirements. Figure 3-11 illustrates how an ECS with standard interface board to a programmable CMAC would promote multiple uses. The advent of very high speed integrated circuits (VHSIC) can result in devices like the programmable CMAC's becoming more standard as chip densities and speeds are increased. Similary, the disadvantages of standard computer architectures in terms of speed, size, and power requirements may be offset as parallelism, direct memory access, input/output instruction sets, and modules that fit embedded computer requirements are incorporated into the standards.

The standard interface for a programmable CMAC is just one example of how standardization can impact support of ECS. Another area deserving attention is standards for engineering data management. The engineering data management system (EDMS) developed by WR-ALC for the F-15 is a prime candidate for exportation to other weapon systems and ALC's. The use of a proprietary data base management system (TOTAL) and smart terminals was valid for the F-15 or any other multi-use weapon system at WR-ALC (e.g., PAVE TACK) but increases the cost of adapting it to other ALC's that don't have the license for TOTAL, an Interdata-

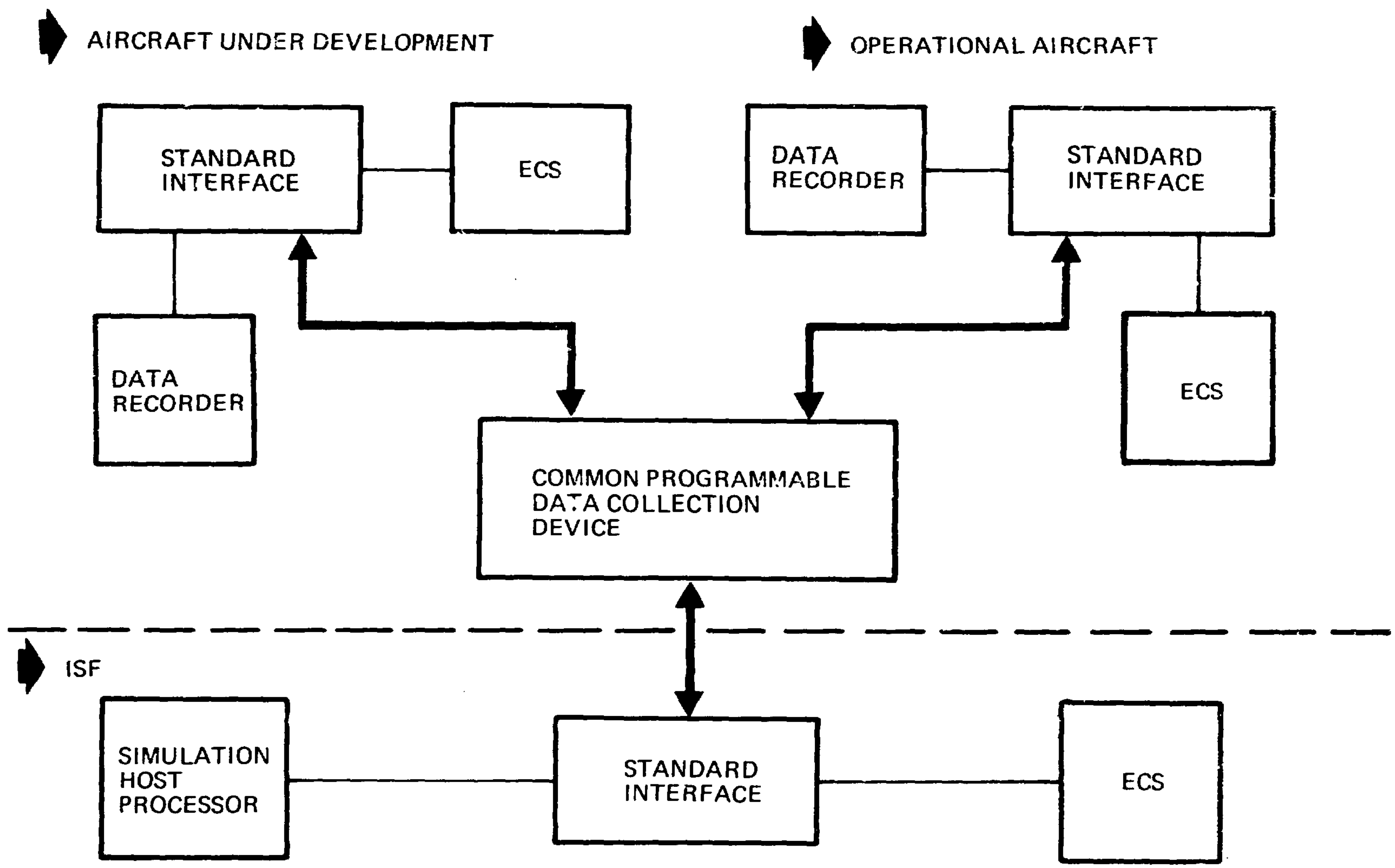


Figure 3-11. Programmable CMAC in Multi-Use ECS Support

equivalent host computer, or the Hewlitt-Packard Smart Terminals. Once adapted for a multi-use ECS such as PAVE TACK, it is logical to extend it to the weapon systems that use PAVE TACK to maintain a common data base. The costs of each, though, must be weighed against additional development costs which generally accrue as development goals are made more general. Certainly, the fact that EDMS works and is relatively easy to transport has to weigh heavily for its adaptation as a standard. The classic case of being too general is O/S-360, as discussed by Brooks in The Mythical Man Month. There, the drive for a general-purpose opertating system for the IBM-360 increased the complexity and development costs significantly. The major point is that a standard engineering data management system is evolving within the ALC community and that the ALC's, in conjunction with AFLC, are capable of developing standards and standard systems for logistics support ECS. This capability should be applied to a wide range of areas such as computer architecture, languages, documentation, support tools, and management directives.

Other examples of items that should be considered for standardization include the following:

- Terminals used with AISF's, since smart terminals may actually reduce development costs because of built-in features. Reduced development costs could, however, be offset by increased rehost costs if the system is to be transportable to different mainframes.
- Simulation host computers and/or languages may become standardized into categories (e.g. 16-, 24-, 32-bit word lengths) making transportability of real-time or support software more readily accomplished. This standardization should be considered for aircrew training devices as well as for operational flight program support facilities to promote maintainability. The languages for many aircrew training devices now in existence are arcane (e.g., the F-4) and, consequently, changes are difficult to make.

Embedded Computer Systems that are used in more than one aircraft (e.g., PAVE TACK, LANTIRN, ARN-101, etc.) or in different versions of the same aircraft (e.g., ARN-101 in the F-4E and RF-4C, IBM 4 pi in the F-111D and FB-111A) have many common software components. Because of different aircraft roles, sections of the software, most commonly in the input/output, may be different. Modular design and development of the software can result in modifications to the ECS being isolated to small portions of the total software/hardware. For example, if the I/O is placed in a common block within the computer, then changes to the I/O have a lesser impact on the program itself and on the support systems for the ECS. By isolating the portions of the ECS that are most likely to change through computer architecture and/or software structure, the impacts of using that ECS in multiple applications can be minimized.

There are many AISF's, ATD's, and EW systems either completed or under development and little similarity between software modules in the AISF's even though an ECS used on multiple aircraft may be involved in more than one AISF. While different aircraft have different characteristics, it may be possible for one model with different coefficients to represent several aircraft. Similarly, the sensor item manager may be able to develop a module in a HOL with variations that can be implemented on the AISF's that require the sensor model. The best approach, given the rapid advance in microprocessors, may be to develop the models on a microprocessor that would be plug-compatible in a distributed AISF. This may have the effect of minimizing changes in software and also takes advantage of standardized interfaces. The size of a central processing unit (CPU) to host the common software could be reduced. Transportability of the software via microprocessors would also be enhanced.

Recommended Action

The AFLC should initiate a series of studies to examine the architectural innovations/structure that will promote testability and supportability of ECS. The studies should formulate a baseline of data and expertise within AFLC that would enable AFLC to shape standards and impact developments to increase testability and supportability. Specific areas that should be examined include: interface ports to be used for test tools such as programmable CMAC, the input/output structure for not only the MIL-STD 1553 bus but also direct memory access of high frequency or continuous data streams, software language development for ECS and support systems, life cycle cost effects of incorporating the support features, standardized modules for aircraft or sensor modules including plug-in microprocessors, and modularity innovations in hardware and software that isolate a change to a specific section of the ECS. This initiative would require some research and development, but the emphasis is on increasing the supportability of transitioned ECS by changing ECS design concepts.

4. PROGRAMMATIC INITIATIVES

The previous section discussed recommended administrative initiatives in the general areas of management and engineering practices and acquisition and support practices. While the administrative initiatives are primarily in the overall policy and guidance domain, they are very closely related to the initiatives addressed in this section and their implementation essentially establishes the direction and framework for addressing the spectrum of ECS support during the 1980's. All of the recommended initiatives are aimed at elimination of current and projected deficiencies; however, the programmatic initiatives in some cases have the additional dimension of accommodating existing resources (equipment and facilities) committed to the various ECS categories, and are designed to capitalize and build upon this investment. The entire approach is based upon attacking ECS support problems on a broad front with both administrative initiatives and deliberate and measured steps in the form of definite programs over a period of time.

The following four programmatic initiatives are described in this section.

- Automation and Standardization of ECS Support Processes (Section 4.1)
- Modular Extendable Integration Support Facilities (Section 4.2)
- ECS Readiness Support (Section 4.3)
- ECS Support Networks (Section 4.4)

Individual and summary implementation detail for each recommended initiative in terms of tasks, resources and schedules is presented in Section 5.

4.1 AUTOMATION AND STANDARDIZATION OF ECS SUPPORT PROCESSES

Rapid increases in computer hardware capability, coupled with its decreasing size, weight, and cost have caused a trend toward employment of embedded computers in virtually all new weapons systems. At the same time, increased weapon system complexity and performance requirements, along with increased ECS hardware capability, has resulted in increased ECS software size and complexity. This increase in ECS software volume causes ECS support productivity improvements to be an essential element in control of the accelerating ECS support costs.

It was noted in the ECS Support Study Phase II Report (Volume III through VII) that current ECS support processes are manpower intensive, and in the aggregate utilize a proliferation of nonstandard support tools, procedures, and nomenclatures. The deficiencies noted were summarized in Section 2 of this volume. The following types of standardized, automated software tools are recommended to eliminate those deficiencies and increase ECS support process productivity.

- Software documentation system
- Configuration management system
- Data base management system
- Management information system
- Software repository
- Improved ECS analysis tools (simulations, diagnostic emulations)
- Comprehensive software development, maintenance, and test tools (specification development system, editors, code syntax checkers, scenario generators, ISF and operational test data reduction software, etc.)

To achieve maximum manpower productivity increase, tools must be designed for ease of operator interface. This means that tool design must incorporate HELP and tutorial features as well as menu selection techniques. Properly built tools used by large numbers of people should, to as great an extent as practical, be self-instructing to the user. Similarly, user interface devices, such as terminals, should be designed with standard keyboard layouts and with standard control codes.

In Section 4.1.1, some factors affecting development of software support tools are discussed. Management support tools are discussed in Section 4.1.2, and tools which support the software developmental process are covered in Section 4.1.3. A summary of Ada language support environment (support system) is presented in 4.1.4. Finally, key AFLC actions leading to development of improved support tools are discussed.

4.1.1 General Considerations

The AFLC ECS support system, which is intended to increase productivity of the ECS support practitioners, is envisioned to be a loosely coupled set of standard tools with predefined interfaces to allow easy inter-tool communication. The tools should be able to operate in standalone support of specific ECS support processes as well as in concert to support the generic ECS change process. Communication between tools should be achieved by designing each tool to generate standard format output files which are accessible by other tools. The total set of ECS support process automated tools will make up the ECS support system.

Automated support tools can be rehosted to a locally available computer at each project location or hosted in a central computer system with user access by network. Tools should be designed to be hosted on a standard computer at each ALC (perhaps an AFLC network interface computer) or built with specific design constraints to facilitate rehosting. The hosting approach needs to be determined based on a detailed requirements analysis during the system definition phase. Factors to consider in determining the hosting approach include

- Cost of data communication versus cost of computational hardware for each approach,
- Cost of rehosting the tools on a variety of local computers versus cost of standard computers,
- Selection of a hosting method that is transparent to the user, and
- Standardized tools regardless of hosting approach.

It is anticipated that data communications cost will continue to drop, but not as rapidly as digital processing costs. If locally used tools are centrally hosted, the network and central computer need to be sized for peak loading to prevent delays and to keep the hosting method transparent to the user. Additional costs will be incurred if it is necessary to rehost each enhancement of the tools on a wide variety of locally available computers. Standardization of tools is an important goal, but standardization of tool interfaces and file formats is required to allow some level of necessary tool communications.

A prerequisite to increased standardization of ECS support tools is greater standardization of ECS support processes. Support process and tool standardization will cause lesser numbers of support tools to be required. The end result is that investments in support tools can be concentrated on the decreased number of tools needed, and higher quality software support systems can be developed.

The RD/LE letter of 25 April 1981 on the subject of Standardization of Embedded Computer Resources is an important step. This letter states that J-73 will be the standard language for avionics systems until Ada is available (about 1984), and that Ada will be the preferred language for all ECS when it is sufficiently mature. It also states a goal of standardization of 16 bit (MIL-STD-1750) and 32 bit (MIL-STD-1862) Instruction Set Architectures (ISA's) for other than ATD and ATE systems. Preliminary data on the Ada support system (support environment) indicates that it will meet most identified Ada language support needs. The Ada support environment now being built is scheduled to be completed by 1984.

An AFLC software support system, which is intended to increase manpower productivity and allow usage of lower skilled personnel through automation of support processes, should contain the types of software support and management tools listed in Table 4-1. This software support system is needed for currently fielded ECS. Examples of tools which would comprise the ECS support system are discussed in Sections 4.1.2 and 4.1.3.

4.1.2 Automated Management Support Tools

Tools addressed in this section are those whose function is to support AFLC in fulfilling its life cycle management support responsiblity for ECS systems. These tools consist of a Data Base Management System (DBMS), a Configuration Management System, and a Management Information System (MIS). Also, there is a need for locally available tools hosted on a microcomputer at individual project locations to allow quick access and to bridge the gap between hand calculator and mini computer capabilities.

4.1.2.1 Data Base Management System

A DBMS is considered an essential element of a software support system. It is used to collect and maintain management and engineering data, such as test scenarios, test results, software ancestry files, tool version/modification status, simulation data bases, project schedules, and resources. The DBMS will provide a transparent interface between the user and the data storage hardware where the various AFLC ECS support system tools reside. It allows more complex relationships between data base elements than is normally available on mini-computer systems.

4.1.2.2 Configuration Management Tools

Configuration management problems were one of the most universal ECS support deficiencies identified in Phase II of the ECS Support Study. Configuration Management Techniques for ECS tend to be based on techniques used for hardware. Since software undergoes frequent and sometimes rapid (few day turnaround) changes, current techniques are not timely and are person-power intensive.

Configuration management processes are, for the most part, currently performed manually or with the aid of various semi-automated tools of limited capability. More capable, and standard configuration management tools which build configuration data bases accessible by management through an MIS would be very helpful in alleviating this deficiency by making configuration data more readily available. One capable tool is the Engineering Data Management System (EDMS) acquired to automate configuration management of the ECS system in the F-15 weapon system. While certain enhancements are needed (Reference 20, May 1981, LOE letter:

Table 4-1. Software Support System

Software Support Tool	Purpose
ECS Management Tools	
• Management Information System	• Generate management reports.
• Project simulation tool at project location	• Establish PERT network analysis including resource needs with graphical outputs to simulate project decisions, problem response, effect of resource or project requirements changes. Allows easy identification of project priorities.
• Status reporting system at project location	• Track status of project completion, resources expended, resources needed to complete
• Data Base Management System	• Provide transparent user interface to data for CM data, management data, simulation and test data, etc.
• Configuration Management System	• Maintain status records of Weapon System and Support System ECS
ECS Documentation Tools	
• Automated software documentation tools	• Provide automated aids to generate documentation of source code
• Auto flowchart generator	• Provide automated flowchart generator based on source code

Table 4-1. Software Support System (Continued)

Software Support Tools	Purpose
ECS Analysis Tools	
• Interactive graphics package	• Provide graphical display of test data
• Support system analysis tools	• Test/debug/readiness test tools for ECS Support Systems
• Simulation/emulation tools	• Provide standard simulations and emulations of multiuse weapon systems and ECS
ECS Specification Tools	
• Requirements definition language	• Aid specification development
ECS Software Development Tools	
• Source code syntax checker	• Provide line-by-line format audit of source code
• Interactive text editors	• Aid in source code and documentation text preparation
• Assemblers/compiler/linkers/loaders	• Convert source code ECS memory load
• Data base consistency checker	• Compare simulation or test data for consistency within the data set
• Module/Subroutine Input-Output parameter usage analysis tool	• Determine module input/output internal-only parameter usage
• Coding Performance Speed/Path Analysis Program	• Determine support system coding execution time and decision paths during real-time execution

Table 4-1. Software Support System (Continued)

Software Support Tool	Purpose
ECS Test Tools	
• Automated scenario generation	• Provide interactive, menu-oriented aid for test input data generation
• Automated test case generator	• Aid in generation of S/W module or H/W test data
• Code branch identifier/instrumenter	• Instrument code for branch execution during dynamic testing
• Data reduction and formatting system	• Provide standard data reduction system for formatted print/plot/display of ISF and weapon system operational test data

ECS Management Information Support System), it should be a candidate for an AFLC standard CM system. This management visibility also allows better management control to assure that CM receives proper priority at the working level.

A standard configuration management tool will interact with the configuration management procedures of systems which employ the tool. For existing systems, the Operational/Support Configuration Management Procedures (O/S CMP) will need to be updated to reflect tool operational procedures and capabilities. For new systems, the availability of a standard CM tool with standard procedures and capabilities will provide an initial baseline for O/S CMP generation, which should significantly speed O/S CMP development and signoff. For some systems, CM tool capabilities may need to be modified or enhanced to support unique requirements.

4.1.2.3 Management Information System

An important element of support process automation and standardization is a Management Information System (MIS). This tool should gather project data from the various AFLC automated tools (e.g., provide user friendly access via the Data Base Management System to configuration management data, project simulation, and status accounting data, etc.) and, based on English language-oriented commands, prepare special management reports to provide needed data for management decisions. An AFLC standard MIS would be even more beneficial if an AFLC network is built, which would allow inter-AFLC access by authorized personnel to any set of project data.

A Management Information System should be used to facilitate flow of the following types of management information, thereby allowing increased AFLC management visibility.

- Sub-project and project schedules and resources employed
- Status and schedules of pending or in-process weapon system changes
- Status, schedule, utilization, users, etc. of AFLC support systems
- Configuration status including documentation versions and test cases associated with a given baseline

Conceptual requirements for a standard AFLC-wide Management Information System are

- The MIS should be capable of accessing output files of standard project tools and building a predefined set of management reports;
- The MIS should have access to an AFLC network for gathering project data from other ALC's;
- The MIS should have an English oriented inquiry language to allow easy specification of custom management reports;

- The MIS should be capable of tracking personnel assignments and resources employed at the MME level (over 100 people, large numbers of projects), allowing management assessment of the impacts of personnel reassignment; and

- The MIS should be able to communicate with the user by a variety of graphical techniques, such as PERT and GANTT charts, as well as time and effort graphs, budget versus expenditure graphs, etc.

4.1.2.4 Local Project Tools

A need exists for a set of local project tools which are interactive and readily available to a local small project manager. In the context of this paragraph, a small project is one requiring perhaps 10 to 100 man years to complete. Ideally, these tools should be locally hosted on an inexpensive microcomputer system. The microcomputer could also be used for editing and interactively updating simulation source code and documentation, as well as for running small user developed scientific analysis programs.

A local microcomputer could bridge the gap between minicomputer and hand calculator analysis capabilities. A minicomputer is relatively powerful but often not available in the project work area. Hand calculators are readily available, but have very limited capability. The local microcomputer would extend a limited minicomputer type of analysis capability to the project work area at low cost.

Conceptual requirements of locally hostable management tools are listed in Table 4-2. The essence of these requirements is that the tools be locally available, interactive and easy to use.

4.1.2.4.1 Project Simulation Tool. Typically, project planning activities begin with the decomposition of project requirements into an activity network (e.g., PERT network) which explicitly contains sequential dependency data on the various activities (which activities must precede others). Overall resource requirements, schedules, and manloading are estimated and for larger projects, functional groups of activities are assigned to lower level (subproject) managers. The project manager may define activities to a level in which many person years of effort are required to complete each activity. The assigned subproject managers need to plan to a greater level of detail, with the finest level of planning detail (to perhaps a few person days per activity) performed by the managers who interface directly with project workers. Various automated and manual project planning and control tools are available to the large project manager, and he can afford to employ considerable resources in planning support to arrive at a competent and complete overall project plan. The subproject manager can afford very limited resources for detailed project planning since the total resources at his disposal are limited. Since detailed planning is time consuming, and automated tools are usually not locally available, the subproject planning

Table 4-2. Conceptual Requirements of Small Project Tools

Requirements	Justification
Interactive	• Planning is iterative. Batch submittals with slow turnaround time cause unacceptable planning delays • Allows quick correction of incorrect data entry
Simple and Efficient Data Input	• Tool will not be used unless it reduces the manager's workload • Complex data input increases errors and incorrect results • Small inexpensive computer systems can be used
Clear Graphical Identification of Project Priorities and Schedule Status	• Data will not be used by manager if it is too hard to interpret • Data will not be understood by project personnel unless it is very easy to interpret
Hardcopy Reports Provided	• Record-keeping requirements
Activity Resources/ Schedule to Technical Progress Correlated	• Needed to track progress and evaluate need for corrective action

frequently do not get performed in great detail. In the limited number of cases where complete and accurate subproject planning is performed, it is frequently not maintained adequately to reflect changes in project requirements, available resources, or schedules. A plan that is not maintained to reflect current realities is of little use. The end result can be that the subproject manager undertakes a partially planned task with inadequate resources and without a thorough understanding of priorities, problems and risks. The observation that the first 90 percent of the typical software project takes 90 percent of planned resources and schedule, and the last 10 percent takes another 90 percent of planned resources and schedule, is all too frequently accurate.

A projecct simulation tool would provide the following data/capabilities to project management.

- Provide clear identification of project activities.
- Allow rapid update of the project plan to reflect changes in project requirements or resources.
- Generate predicted milestone schedules for upper management reporting.
- Forecast resource requirements by category of resource.
- Allow evaluation of the consequences of alternative management actions.
- Be a useful training aid for new project managers.

A project simulation tool would require as input only activity network data (which activities follow others, activity duration, and resource requirements). The manager needs to have this data available, with or without a project simulation tool, to effectively manage his project.

A tool with the capabilities described above would require, at minimum, an 8-bit microcomputer host, with about 48K bytes of memory and online data storage (perhaps two mini-floppy disc drives) for a project of up to 100 person years in size.

4.1.2.4.2 Project Status Accounting Tools. A simple project status accounting tool which would allow a local manager to track activity status, resources expended, resources needed to complete the activity, percent activity completion, etc., would be useful to increase management visibility and control during project execution. A tool such as this would require, as a minimum, an 8-bit microcomputer host with two mini-floppy disc drives for a 100 person year project.

4.1.3 ECS Software Change Support Tools

In the past decade, there has been considerable effort devoted to fabrication of software tools designed to facilitate improved software quality, increase productivity and reduce cost.

These tools have been only partially satisfactory because the support they provided to software practitioners has been too limited. Most of these tools and systems of tools support only very limited portions of the total software maintenance effort and ignore other areas. Further, these tools typically force the tool user to adapt to limitations imposed by deficiencies in tool design and in the philosophies of the tool's creators. This results in tools which are potentially helpful but not being used.

This situation would improve if the software support tools were designed to be continuously supportive to the user in his actual software support activities. Integrated software support systems (support environment) and their benefits have been widely discussed in literature, but there is a need for organized research leading to implementation of improved systems. Development of an AFLC software support system requires the synergistic integration of a collection of tools which provide strong, close support to the software practitioner. The environment must have at least these five characteristics:

- User friendliness,
- Reuseability of internal components,
- Tight integration of capabilities,
- Broad applicability, and
- Central information repository.

Software support systems must accommodate the user rather than forcing the user to accommodate the system. This accommodation must include the usual items: clear diagnostics, fail-safe recovery, easy-to-use input language, and help and tutorial features, but the system must also provide direct and painless support to the user in performing his actual day-to-day activities. The need for user friendliness applies both to the individual tools and to the accessibility and useability of the entire package of tools. Reuseability of internal components implies that the software support environment is flexible enough to accommodate different and changing user needs. Past efforts to collect a set of monolithic tools under control of a common user interface has generally been inflexible and inefficient in meeting diverse and changing user needs, and in addition has been cumbersome to use. Support systems must be integrated via a central base to allow the output of one tool or tool fragment to be directly available to other tools thus reducing the user's burden in communicating with tools.

There are many different dimensions to tool capability and applicability. Support systems are software language dependent as well as user activity dependent, e.g., software requirements, definition, software development, software maintenance, validation and verification, and software management all have different requirements although individuals tools may be applicable to more than one of these different sets of activities. A successful AFLC software support system should be limited to supporting AFLC's management, and supporting maintenance and test activities in perhaps two or three software languages (Ada and/or J-73, and ATLAS). An ECS software support system for problem analysis, requirements definition, development/modification of ECS software, and software test is discussed in the following paragraphs.

4.1.3.1 ECS Documentation Tools

A standard set of AFLC software documentation tools would be a significant ECS automation aid. However, maintenance of ECS documentation using an automated tool requires that the baseline documentation be already available in a format and medium acceptable to the tool. This tends to mean that the documentation must be initially developed using the tool or procured to be compatible with the documentation tools. A joint AFLC/AFSC activity to develop ECS documentation tools is the recommended approach to assure that the tool meets the requirements of both development and support.

Recommended activities to make software documentation less personpower intensive include the following:

- Determine the minimum set of documentation required by AFLC for ECS weapon software support,
- Determine an AFLC format for such documentation,
- Negotiate a standard format and content with AFSC for weapon system documentation,
- Encourage and aid AFSC in developing a standard automated software documentation system, and
- Use the AFSC documentation system for software support.

4.1.3.2 ECS Analysis Tools

A wide variety of ECS analysis tools are needed to support the totality of ECS systems. Historically, software analysis support has been provided by tools such as scientific simulations, interpretive computer simulations, diagnostic emulations, static test stands and ISF's. It is anticipated that in the future, systems engineering analysis support to weapon system ECS will be provided by modular extendable ISF's. However, the technology of microprocessor-based diagnostic emulators should be encouraged. Emulators provide a means of analysis, development, and test of operational ECS software when the operational ECS is unavailable to the support systems because of operational priorities or cost. Microprocessor-based diagnostic emulators for ECS are anticipated to soon be available at a cost of 10 to 50 thousand dollars.

4.1.3.3 Specification Tools

An ECS requirements specification language is potentially of benefit to AFLC for ECS support. Such a tool could be of even greater benefit to AFSC. It is therefore not recommended that AFLC independently develop a specification tool, but instead, support AFSC in such a development. The tool could then be beneficially used by AFLC in maintenance of requirements specifications after PMRT.

4.1.3.4 ECS Software Development and Test Tools

The tools addressed in this section are those that aid in ECS software source and object code development, in static test (as opposed to dynamic execution test) of the code, and static test of the software data communications and data values. It is recommended that AFLC support the development of a set of standard higher order language based software tools for MIL-STD target computer instruction set architectures. A good starting point would be the development of J-73 based tools targeted for MIL-STD-1750 ISA computer. Specific recommended AFLC actions are as follows:

- Encourage upgrade of ISA standards for compatibility with computer interface standards (such as MIL-STD-1553);
- Define a minimum list of software development tools needed;
- Determine the higher order language and target computer ISA to be supported by these tools in coordination with AFSC;
- Determine the hosting approach by designing for hosting on a standard ISA or designing for easy rehosting on general purpose computers;
- Solicit support from other USAF/DOD organizations for a cooperative tool development program; and
- Perform requirements analysis, design, code, and test of the development system.

4.1.4 Software Support System for Ada

The U.S. Department of Defense effort to design a modern high order programming language and its support environment (system) for use in embedded computer systems will be completed in the mid-1980's. This language and its programming support environment had the following four original goals.

- Address the problem of life-cycle program costs
- Improve program reliability
- Promote the development of portable software
- Promote the development of portable software tools

In this section, some of the main goals of the Ada environment are presented. It is assumed that a host/target development approach is used. A host is a computer with adequate storage, processing power and peripherals to support software development for the target machine. Target and host could be the same machine.

The following are key objectives of the Ada support environment.

- Life Cycle Support. This objective implies adequate and comprehensive tools, a data base containing all relevant information, and a configuration management system.
- Configuration Control. This objective requires recording and analysis of the way in which program versions (object code) were created (what source code, what tool versions) and used (test case histories, documentation version, etc.).
- Tool Portability. This objective relates to ability to move tools from one support system to another.
- Hosting Portability. This objective is to allow for easy rehosting of the support environment.
- Targeting Portability. This objective requires that the support environment be designed for easy retargeting.
- Project Team Support. The Ada environment should be built with proper tools to support all members of the software project team.
- Support of the Ada Language. The support environment should allow the project team emphasis to be on software development in the full Ada language rather than on target machine software development.
- Open-Ended Environment. This allows project team members to develop additional tools which are directly supportive of their needs.
- Host Requirements. The Ada support environment should be hostable on a mid- to large-sized minicomputer.

These objectives are all being addressed in the Ada environment now in development. Configuration control is a central objective, and the tree structure data base provides the necessary information. The Ada support environment appears impressive in its objectives and planned content. The efficiency and cost effectiveness of the various support tools, which will initially be contained in the environment, is an open question which will have to be determined by user experience.

4.1.5 Acquisition of Automated ECS Support Tools

This section discusses key AFLC actions needed for acquisition of automated ECS software tools. These tools are intended to provide a standardized, higher quality support to the ECS software practitioner than is currently available, thereby increasing manpower productivity.

The various steps in this plan are presented in the approximate order of accomplishment, although individual steps are not completely interdependent, and some reiteration may be required. For example, the number of locations employing a given tool, the data exchange requirements between various tools, the tool hosting concept, and the degree of tool standardization are all interrelated. Similarly, decisions on network capability, or an extendable ISF implementation may have a profound effect on ECS software support tool requirements.

Action 1. Review of ECS Software Support Processes

Certain of the proposed ECS software support tools are directly supportive of individual ECS support processes (e.g., documentation, configuration management, change distribution, etc.). The procedures for implementation of support process requirements are designed to allow manual support. Therefore, automation of current procedures may not yield optimum support. New support procedures should be considered which are consistent with basic support requirements, and which allow more efficient automation of the process. The definition of new conceptual support procedures will require considerable effort and interaction with support practitioners.

Action [illegible]ine Tool Hosting Concept

A[illegible] Section 4.1.1, ECS support tools could be designed to be rehosted to each locally [illegible] computer, hosted in a central computer system with inter-ALC network access, or perhaps hosted on a standard computer with local network access. The best hosting method may vary depending on the purpose of the individual software tool.

Determination of the hosting concept for the various tools is an important activity which could have significant financial consequences. A thorough understanding of the cost and support effectiveness tradeoffs for various hosting options is needed. Decisions on the approach to and schedule of network development may alter the hosting tradeoffs. Decisions on the approach to extendable ISF development will also affect tool requirements and may provide a local network on which to host tools at each ALC.

Action 3. Evaluate Level of Tool System Integration

A software support tool system could be built with varying possible levels of tool intercommunication. For example, when software source code is updated, should the software documentation and configuration management tools automatically be invoked, or should they be called manually? What amount and type of data should the various tools pass between each other? Under what conditions and controls should intertool data be passed? An organic or contracted study, to determine the recommended method of tool data communication and data communication control is needed.

Action 4. Evaluate Level of Tool Standardization

While standardization of ECS support processes and support tools is a goal, there will be unique and possibly conflicting requirements on some projects which will necessitate departures from standardization. Further, the tool hosting concept has considerable effect on standardization, since rehosting a tool on many different local project computers with different instruction set architectures will tend to cause the tool to have many versions. In any case, a study of the costs and benefits of standardization is indicated.

Action 5. Determine DBMS Conceptual Requirements

This organic or contracted activity would establish a conceptual approach for adequately storing, accessing and maintaining ECS informational support data. This activity must consider the types, location and hosting method of the various ECS support tools, and may cause reiteration of the standardization goals. The end result of the study is a conceptual data base scheme and a conceptual information management system.

Action 6. Determine Support Tool Security Requirements

Certain of the data associated with the various software support tools will be sensitive. Financial data associated with the various projects must be safeguarded. Many of the ECS software programs and test results will be classified. The security of this data within its storage media will have to be safeguarded. Both hardware and software systems needed to safeguard this data need to be developed, and will affect the software support tool cost and schedule. It is necessary that the approach consider both sensitive and classified data, and be consistent with established regulations. AFLC must establish the policy and procedures to be used for automated support tool data security with sufficient clarity to allow identification of necessary equipment and interfaces.

Action 7. Define Tool Maintenance and Management

While this requirements step is administrative in nature, it is important for AFLC to clearly establish the OPR for support of automated ECS tools. All tool sets, no matter how well designed, will require maintenance to correct deficiencies discovered during operations. Additionally, changing operational requirements will produce requirements for tool change.

Action 8. Determine Support Tool Capabilities

At this point, the software support processes considered for automation and the planned tool capabilities need to be reexamined considering decisions made on tool hosting standardization and security. This organic activity should lead to a target list of tools and tool capabilities for the initial configuration of the automated ECS support system.

Action 9. Determine Needed Tool Fragment Sets

This experimental program would probably be contracted by AFLC. Its goal would be to identify the useful sets of multiuse tool fragments and to determine the extent to which they can support tight integration of the desired tool capabilities. This program would be performed by identification of a reasonable set of tool fragments to meet the needs of the set of specific, sharply defined software activities which are intended to be supported by automated tools.

Action 10. Study Automated Tool System DBMS Requirements

This contracted activity would begin with development of precise, detailed models of the various software activities to be supported. From these models, the data communication between the user, the tool and the tool fragments would be identified. From these data handling requirements, the DBMS requirements could be identified.

Action 11. Contract for Support System

In this activity, AFLC will contract for development of the system of AFLC software tools. Contract management will be by normal procurement rules.

4.2 MODULAR EXTENDABLE INTEGRATED SUPPORT FACILITIES

4.2.1 Requirements

The use of embedded computers in weapon systems is a trend which is expected to continue to expand in the late 1980's and early 1990's. By 1990 all weapon systems will use some form of computer control or digital data display. This ever-expanding use of computer controlled weapon systems generates new requirements for capable and responsive support systems. When ECS systems were introduced in the early 1970's, each system was supported in a dedicated facility such as the F-111 Avionics Integration Support Facility. With the introduction of embedded computers, into new or improved weapon systems, the practice of building dedicated support facilities for each new system, or rebuilding an existing AISF to accommodate improved or new avionics systems generates unacceptable ECS support costs. Although this practice is expected to continue for selected major aircraft and missile systems, one method of reducing these support costs is to build multiuse and expandable integrated support facilities. This section describes a conceptual multiuse ISF.

This concept is based on microprocessor technology which will be available in the mid-1980's, with evolutionary growth potential to meet the support demands of the 1990's. Additionally, this design concept recognizes the real world requirements facing todays ECS support planners as well as the future use of standard buses (MIL-STD-1553B), instruction set architectures (MIL-STD-1750A and 1862), and high order languages (MIL-STD-1589B and Ada). In real world terms, existing ECS support tools and facilities must be incorporated into the design of new support systems, and at the same time allow it to satisfy the demands of the 1990's.

In addition to accommodating future support requirements, new support facilities should encourage the development of a standard support system equipped with common components and tools. New designs should also recognize that current in-place embedded computer systems do not have standard buses, instruction sets, or standard high order language support. ECS support systems developed in the 1980's must incorporate life cycle cost reduction features, satisfying today's nonhomogeneous support needs and be reconfigurable as weapon systems are added to or retired from the active inventory.

4.2.1.1 Objectives

An Integration Support Facility (ISF) is defined in AFLCR 800-21 as an "Applied Engineering Laboratory designed to support digital airborne or spaceborne systems and subsystem associated programs and equipments." Avionics Integration Support Facility (AISF) is used as a generic term for most ISF's. This concept is applicable to a broader category of ECS systems, including airborne, spaceborne and ground electronic systems. Therefore, the term Extendable Integration Support Facility (EISF) is used to denote the broader applications. In general, the integration support facility has a twofold purpose; it provides system engineers the means for hardware/software integration and testing and it also provides the tools needed by software engineers to modify, test, and validate ECS computer programs. The extendable ISF concept encompasses both of these requirements, and supports the structured environment described in the preceding section. The primary goal of the EISF concept is to reduce life cycle costs while increasing operator efficiency, resulting in increased productivity and mission responsiveness.

The use of common building blocks for ECS support facilities will reduce the proliferation of different terminals, operating systems, languages, etc within a facility. With a common group of hardware and software to maintain, support system life-cycle cost will be reduced. Operator efficiency will increase as the EISF staff will be working with a common set of tools, familiar operating systems, and terminals with standardized keyboards and displays. When individuals are transferred from one project to the next, it often takes six months to unlearn one system and relearn another. Standards are often viewed as constraining, but when they are applied at the building block level, they can provide the designer with a familiar media. Imagine the cost of aircraft if each part must be custom made and assembled, or public utilities networks, all operating at different voltages and frequencies. The EISF building blocks will allow the builder to rapidly expand and existing ISF or to create a unique design for a specific weapon system. This flexibility is consistent with the 1990 support objectives.

The extendable ISF support system will satisfy the following objectives discussed in Section 1.

- Acquire and maintain a flexible, technical support base . . .
- Provide efficient and effective life cycle management . . .
- Acquire and maintain quality ECS and ECS support systems . . .
- Minimize critical organic ECS engineering, scientific and technical needs . . .
- Influence the control of ECS and ECS Suport System proliferation . . .

This concept in part supports these additional objectives:

- Acquire and maintain ECS technology and intelligence bases . . .
- Accomplish efficient and effective ECS support cost estimating, tracking, and accounting . . .

4.2.1.2 EISF Development Philosophy

To build a mature and robust support system by 1990, EISF designers should concentrate on the capabilities and technologies available within the next five years and capitalize on the economics inherent in standardization. Where possible, all support systems should be selected from off-the-shelf commercial components to reduce the development time, keep costs down and to ensure a mature industrial support base. Single source components without a proven track record should be avoided. Highly advanced unproven technology should not be used in weapon system support systems. Support system designers should focus on standardization and ease of operating to increase reliability, flexibility, and maintainability and to reduce overall support costs. The Extendable ISF described in the following paragraphs incorporates these goals. An Extendable ISF must

- Support multiple systems with a single integrated support facility, including multi-ECS weapon systems;
- Support multiple functions with common modules;
- Support harmonious interconnection of systems with dissimilar architectures, languages, program structures, and input/output requirements;
- Support extension and reconfiguration as the number of systems within the support family are increased or reduced;
- Support combat mission readiness objectives;
- Support weapon system growth and planned product improvements;
- Sustain life cycle management and systems engineering cost objectives, especially for multi-ECS systems;
- Incorporate in-place ECS support assets in the overall design; and
- Meet physical, processor, communications, information, electrical, and personnel security requirements.

4.2.2 Major EISF Elements and Design Alternatives

Integration support facility design requirements are diverse, as they spread across at least three ECS categories (OFP, EW, C-E) and multiple weapon systems, both in the air and on the ground. To satisfy the needs of such a wide range of weapon systems and the requirements and objectives presented earlier, the Extendable ISF must be flexible, have the computing power of large scale processors, and remain affordable. The ECS Technology Forecast, Volume VIII of the baseline Phase II report, suggests some possible solutions to the problem of flexibility and computing power. The envisioned Extendable ISF incorporates the following early 1980' technology.

- VLSI and fiber optics
- Computer nets
- Standard, high order languages
- Emulation/simulation

In the next five years, VLSI will have a major impact on computer design and computer communication. One of the most influential future developments will be a very compact computing system (CCS). The CCS will be the same size and have the features of today's intelligent terminal, with the computing power of a minicomputer, and cost only a few thousand dollars. These computing terminals will be capable of supporting several independent streams of data and control functions at the same time. With the proper physical interconnections and network control programs, CCS terminals can provide the flexible computing power required by the Extendable ISF.

The major subsystems and individual modules and their global relationship are shown in Figure 4-1. The applications subsystem includes the work stations modules, network interfaces, and associated software. The direct support subsystem includes the target system modules and the associated simulation/emulation software, and data collection and analysis software for specific applications. The shared subsystem includes those modules shared with other EISF's or with work stations within the EISF.

The following paragraphs describe the applications subsystem, the shared subsystem, and direct support subsystem. Network system requirements, common to all subsystems, are covered in paragraph 4.2.2.4.

4.2.2.1 Applications Subsystem/Software

The applications subsystem includes both the compact computing work station modules and the network communications and control devices. The components and their projected characteristics are presented in Table 4-3 which lists the hardware components and characteristics and Table 4-4 which lists the general software capabilities needed.

Specific software development and support tools are covered in Section 4.1; however, the expected widespread use of Ada in embedded computer systems in the 1990's must be recognized and planned for. Individual EISF's should have a complete Ada Programming Support Environment (APSE) to provide the required interfaces and programming tools. A typical APSE environment is shown in Figure 4-2.

4.2.2.2 Shared Subsystem and Software

The shared subsystem includes distributed data base management systems, file servers, intercenter network gateways, long term data storage units, and peripheral devices, such as line printers, paper tape readers, character printers, programmable read only memory systems, etc. The shared systems central to this concept are the data base machines and file servers. The network gateway is an optional device and will be developed as an ECS Network component. The

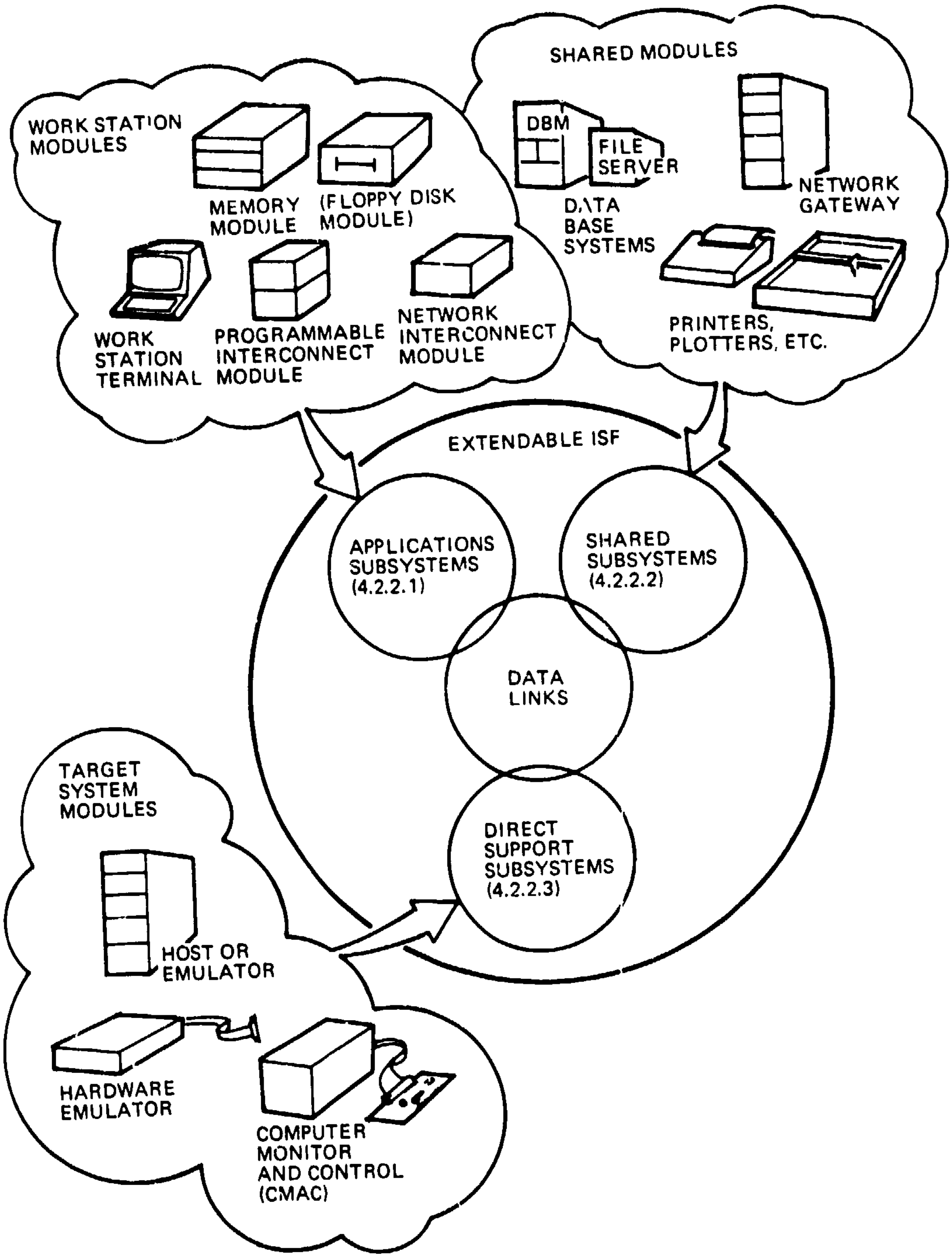


Figure 4-1. EISF Modules

Table 4-3. Typical Applications Hardware*

Work Station Terminal

- CPU: 32 bit, 256K memory, 64K I/O buffer, 10 MHz clock, MIL-STD-1862 preferred
- Display: Min 80 column, 32 lines, 128 programmable character set, 9 x 7 matrix in 11 x 9 field, line graphics, optional color graphics
- Keyboard: Typewriter style with numeric key pad, editing and special function keys, programmable keys

Memory Module

- Memory: Expendable from 1 to 16 megabytes in 64 blocks
- Features: Provisions for bubble memory cards

Floppy Disk Module

- Disks: 8 inch double sided, double density floppy and/or 8-inch Winchester disk

Network Interconnect Module

- Media: Optical fiber, double link, bi-directional
- Characteristics: Wideband, 1 to 10 megabytes per second
- Topology: Ring, star or combination
- Message Format: Fixed priority, data packets

*Some of these work station modules are shown in Figure 4-1.

Table 4-4. Typical Applications Software

Operating System

- Kernel: Real time process and communications management

  System: task, file, device, and memory management, including OS subroutines

- Security: Access control, passwords, including accounting

Development Tools

- Executive: Utility routines, command files, graphics invocation, display format
- Editor: Text entry, character modification, strings search substitution, etc.
- Debugger: Breakpoints, single step, memory/register examination, assembler/disassembler, etc.
- Languages: FORTRAN, JOVIAL/J73, Ada, cross-assemblers, etc.
- Linker: Object module linking, overlay utilities, etc.

Network Communications

- Protocol: Appropriate to design
- Fault Detect/Recovery: Self-test and dynamic reconfiguration control

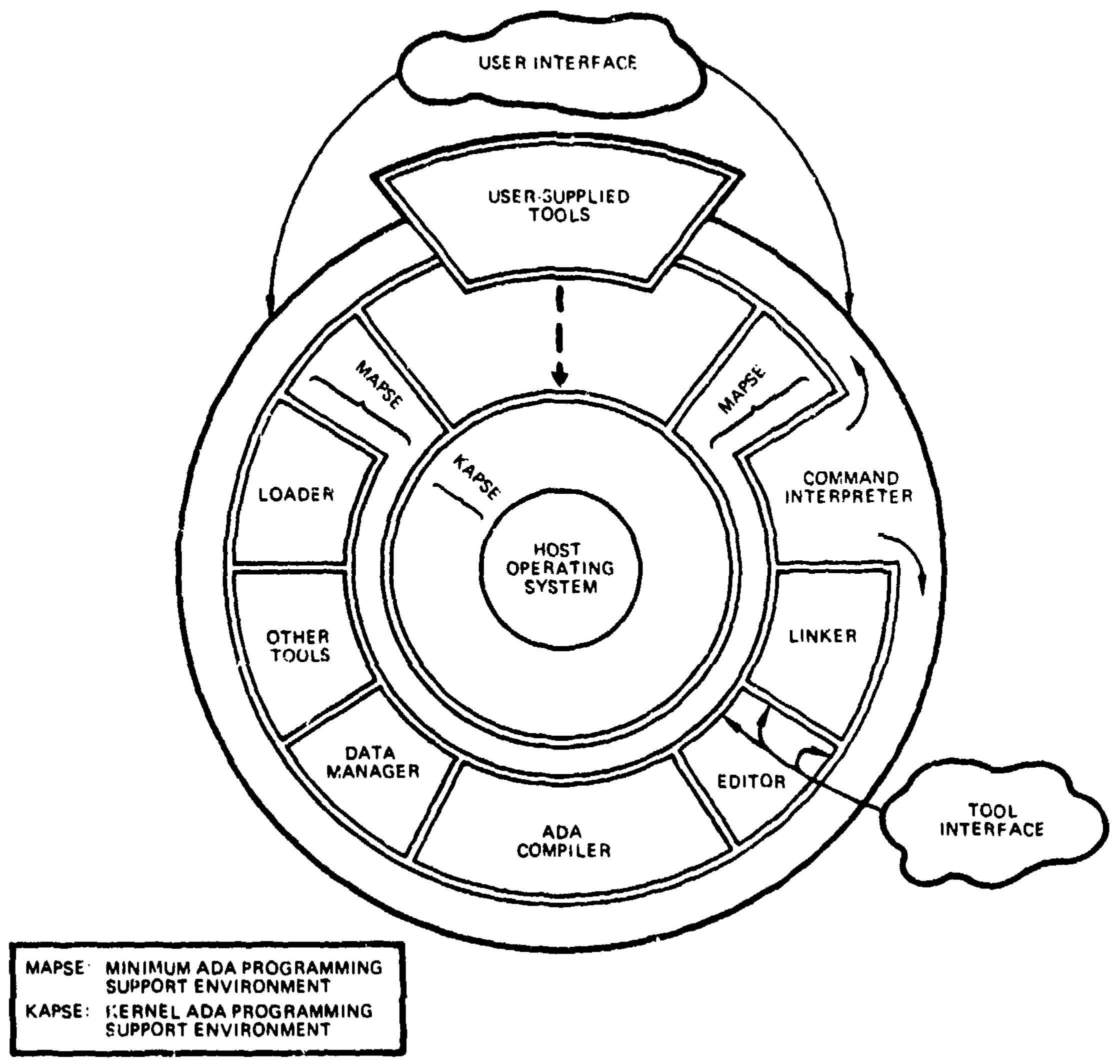


Figure 4-2. Ada Programming Support Environment

sharing of peripherals is not a new concept and can be easily implemented with simple switch networks, therefore, this section will focus on data management concepts.

The use of a data base machine (DBM) frees the work station CPU for performing the data base management system functions and provides multiple work stations to access a common data base. The data base machine is a specialized processor with dedicated software which does all the data base functions such as storage, retrieval, search and compare, and reports and results. Commands and/or data are routed over the network to the DBM, and when the data base functions are complete, the DBM answers or responds with the data. All communications are from commputer to computer over the high speed network. Where data base functions are not required and only file creation, storage, and retrieval are required, a file server is used. This function is similar to having a mass storage unit hooked directly to the work station; however, the file server allows all network users access to the files, if they satisfy the security and access controls. It is also possible to make the files available to the direct support subsystem via the network. If the network encompasses more than one EISF, then multiple EISF's can use a single DBM/file server. When connected through a network gateway, the DBM can serve geographically-distributed users. This feature will be vital to the configuration management of systems used on multiple aircraft or ground based weapon systems, JTIDS, IFF, comm systems, etc. Table 4-5 lists the features and characteristics of the EISF DBM and file server. Table 4-6 presents a list of peripheral devices which could be shared by EISF's or compact computing work stations.

4.2.2.3 Direct Support Subsystem and Software

The direct support subsystem modules include both laboratory and weapon systems resources needed to analyze, modify, and test ECS software. These subsystems have been given a variety of names; software test stands, software work benches, hot bench/test stands, etc. The complexity and capability of these test stands depends on the specific applications and ranges from a stand-alone commercial development system to complete one-of-a-kind dynamic simulation systems with operator consoles and cockpit to provide interactive man and machine inputs/outputs. Implementation of various applications is shown in Figures 4-3 and 4-4. These devices provide the tools needed to:

- Analyze proposed changes to the ECS software,
- Develop proposed changes to the ECS baseline,
- Test the changes prior to implementation in the baseline,
- Analyze the results of testing,

Table 4-5. Shared Data Base Systems

Data Base Machine • CPU: Application dependent, single or multiple processor design depends on specific DBMS requirements • Mass Storage: Multiple disk systems, both fixed and removable • Interface: High level, complete transaction transmitted, supports multiple machine access. • Security: Multilevel access control for both classified and unclassified data File Server • CPU: Work station module dedicated to file service applications • Mass Storage: Multiple disk system, both fixed and removable • Interface: Low level, create, fetch, store • Security: Multilevel access control for both classified and unclassified files

Table 4-6. Shared Hardware (Peripherals)

Printers
• Character
• Line
• High speed
• Letter quality
• Color
Plotters
• Graphic
• Flatbed
• Drum
Tape Drives
• 7/9 track
• Cartridge
Paper Tape Devices
• Punch
• Reader
Miscellaneous
• PROM programmers
• Digitizers

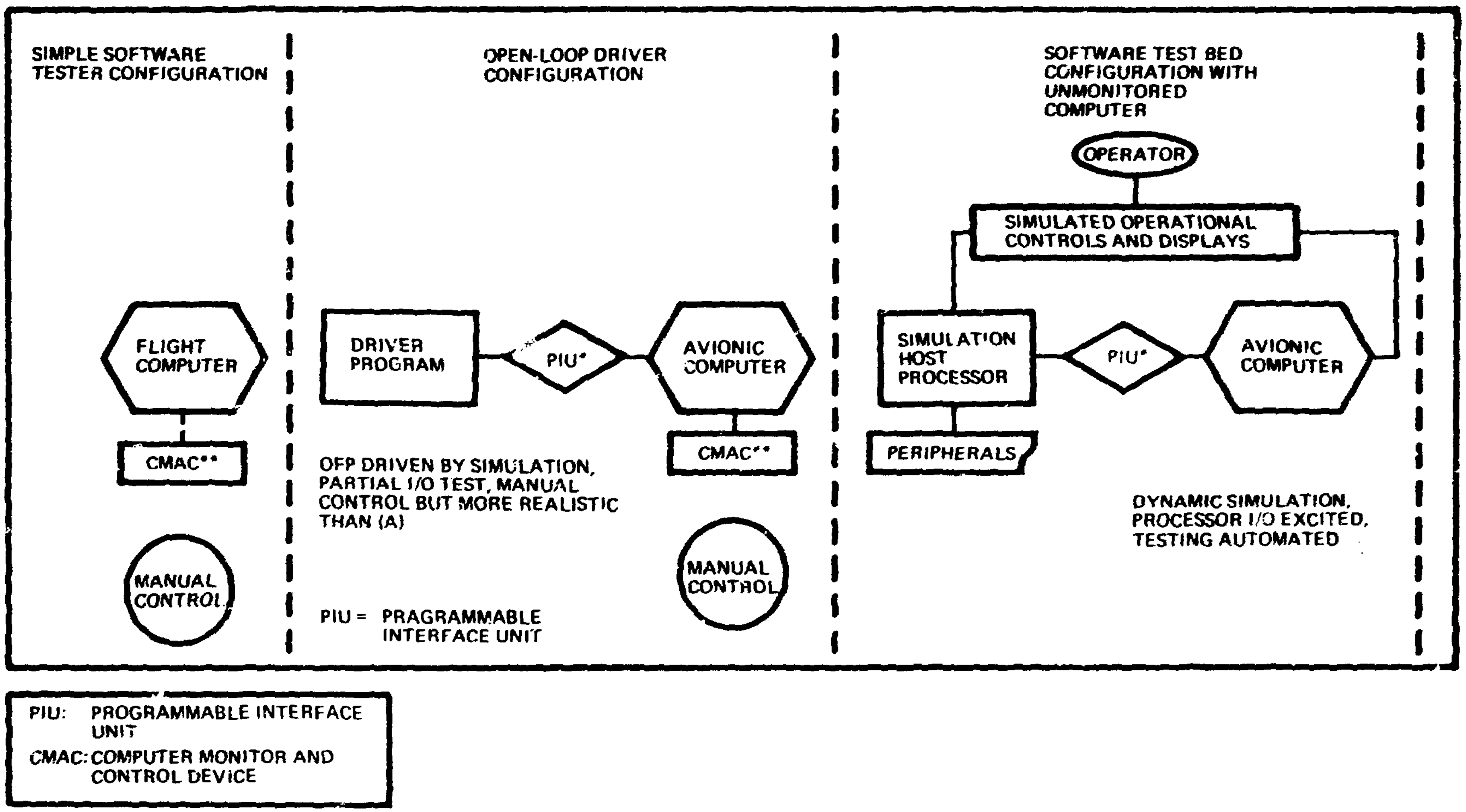


Figure 4-3. Example Software Test Bed Architectures

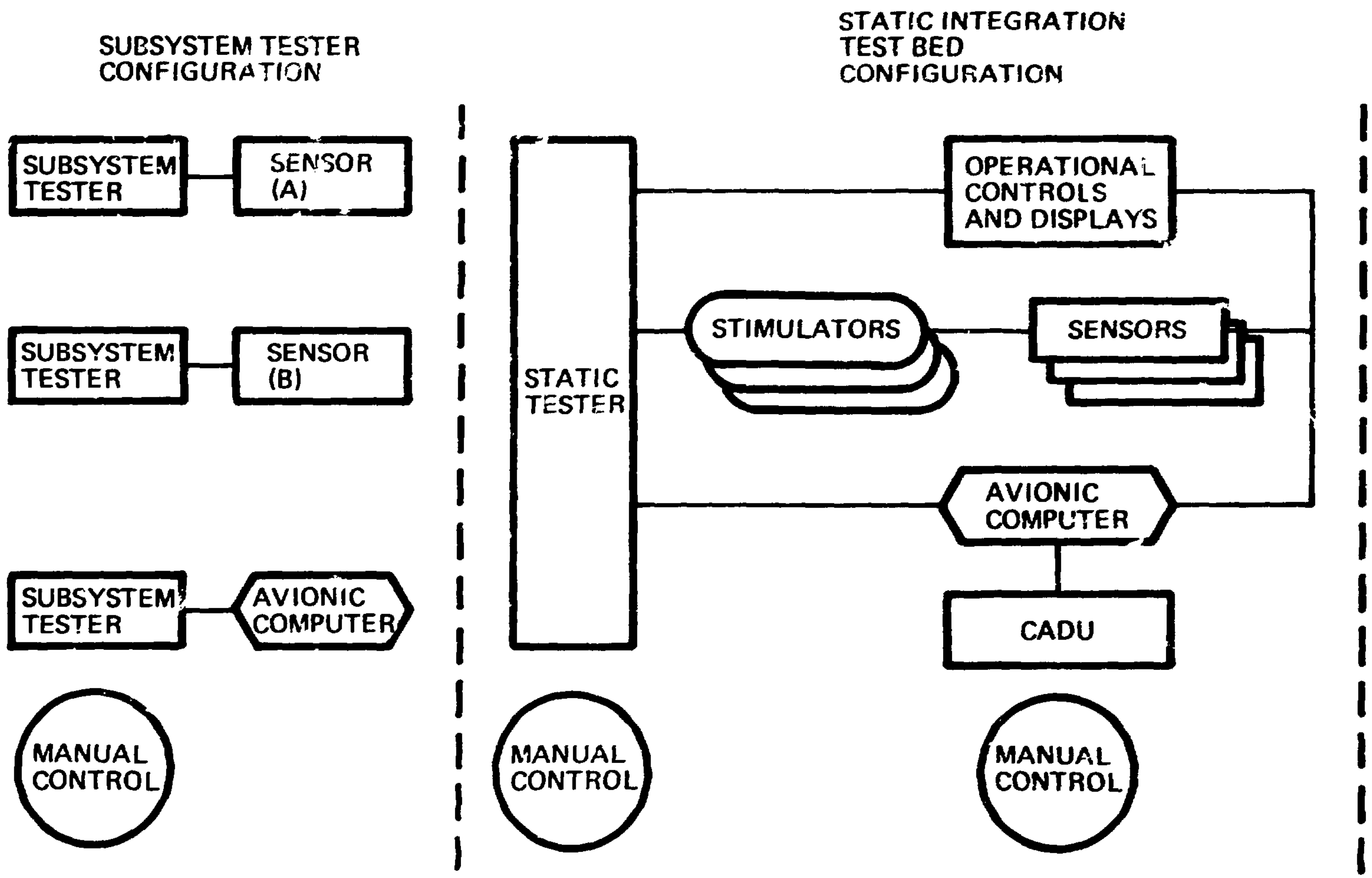


Figure 4-4. Example Integration Test Bed Architectures

- Verify ECS performance after the baseline has been changed, and
- Test system avionics in a controlled environment.

4.2.2.3.1 EISF Primary Support Tools. In the Extendable ISF the primary ECS support tools are system hot benches, emulators, simulators, and computer monitoring devices. In most cases, system hot benches are unique to the individual ECS application, whereas, the simulator/emulators/monitors are more general purpose tools. The following is a list of some of the general purpose tools required by the EISF.

- Interpretive Computer Simulation (ICS). The ICS is bit-for-bit simulation of the target computer via software and a general purpose computer. It allows test and diagnostic analysis of the actual operational program, however most are very slow and do not run in real time.
- Diagnostic Emulation (DE). The DE performs functions similar to the ICS but its run time is much faster. Microcoded instructions provide the capability for real or near real time operation.
- Hardware Simulation Kernels (HSK). HSK's are used to simulate/stimulate inputs to the target system and process outputs to calculate future input stimuli.
- Programmable Interface Units (PIU). PIU's are used to interface dissimilar buses to the HSK's and to computer monitor and control devices.
- Computer Monitor and Control Devices (CMAC). CMAC's are used to observe and record target computer operation on a hot bench.

Special purpose hot benches or software test stands normally are unique to the application. However, they have general requirements to demonstrate functional performance of the ECS software on the actual test weapon system computer, and to provide real time simulation of the weapon system computer environment to include generation of input signals, plus evaluation and interpretation of output signals. Recommended EISF hot bench configurations are presented in Figures 4-5 and 4-6. Figure 4-5 is a software test bench and Figure 4-6 is an integration test bench. Other configurations which emphasize diagnostic capabilities can be constructed from the basic EISF building blocks are shown in Figure 4-7.

4.2.2.3.2 Programmable Interface Units (PIU). Programmable interface units will allow the interconnection of a wide variety of nonstandard computer buses to the EISF network. In turn, the standard network interfaces allow all the devices on the network to interact with the target computers. To enhance standardization, the PIU's should be built from commercially available single-board computers which have a mature industrial support base and are part of an upwardly compatible family of microprocessors. Examples include Intel's Multibus, Motorola's Versabus, or similar single board computer systems.

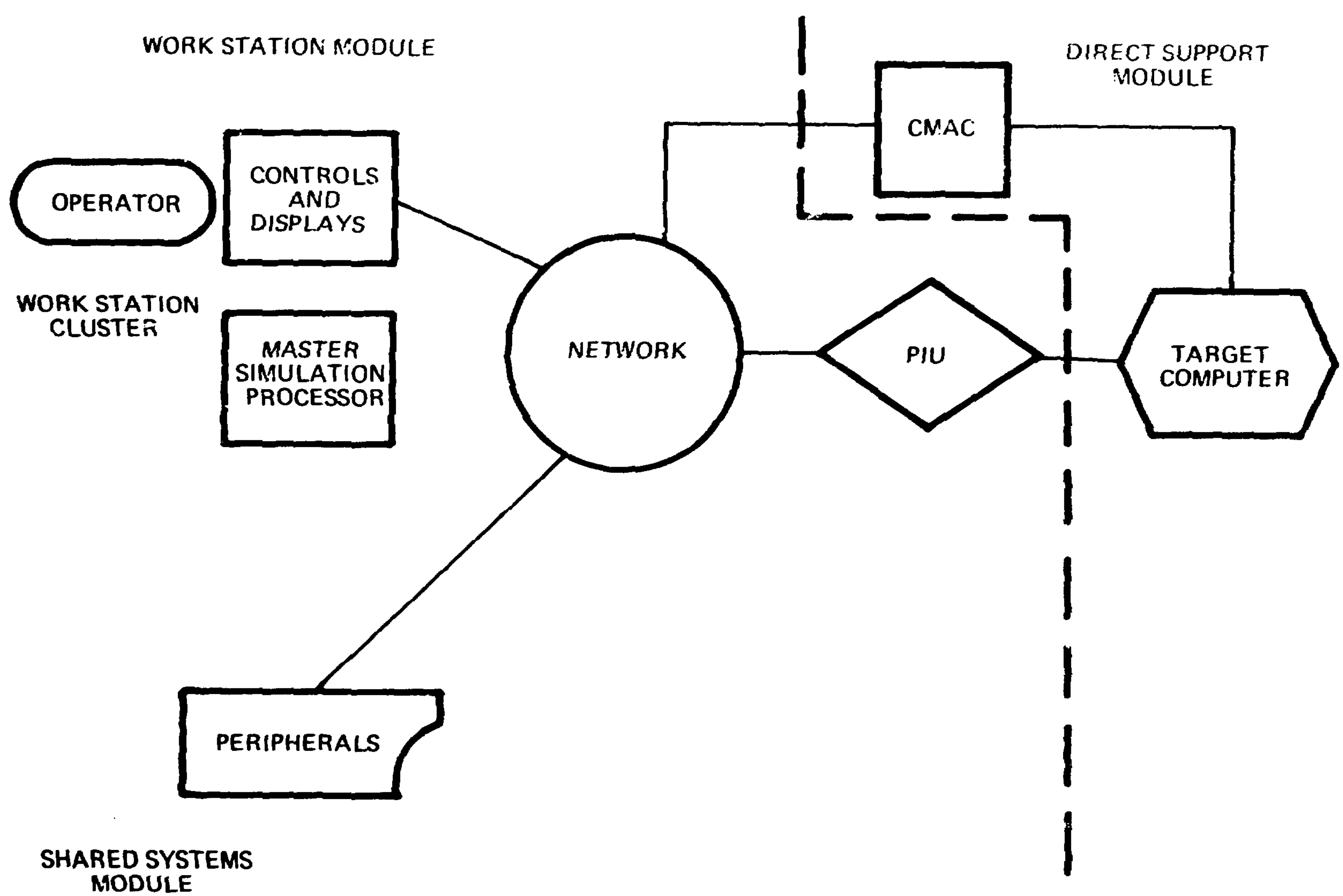


Figure 4-5. Software Test Bench

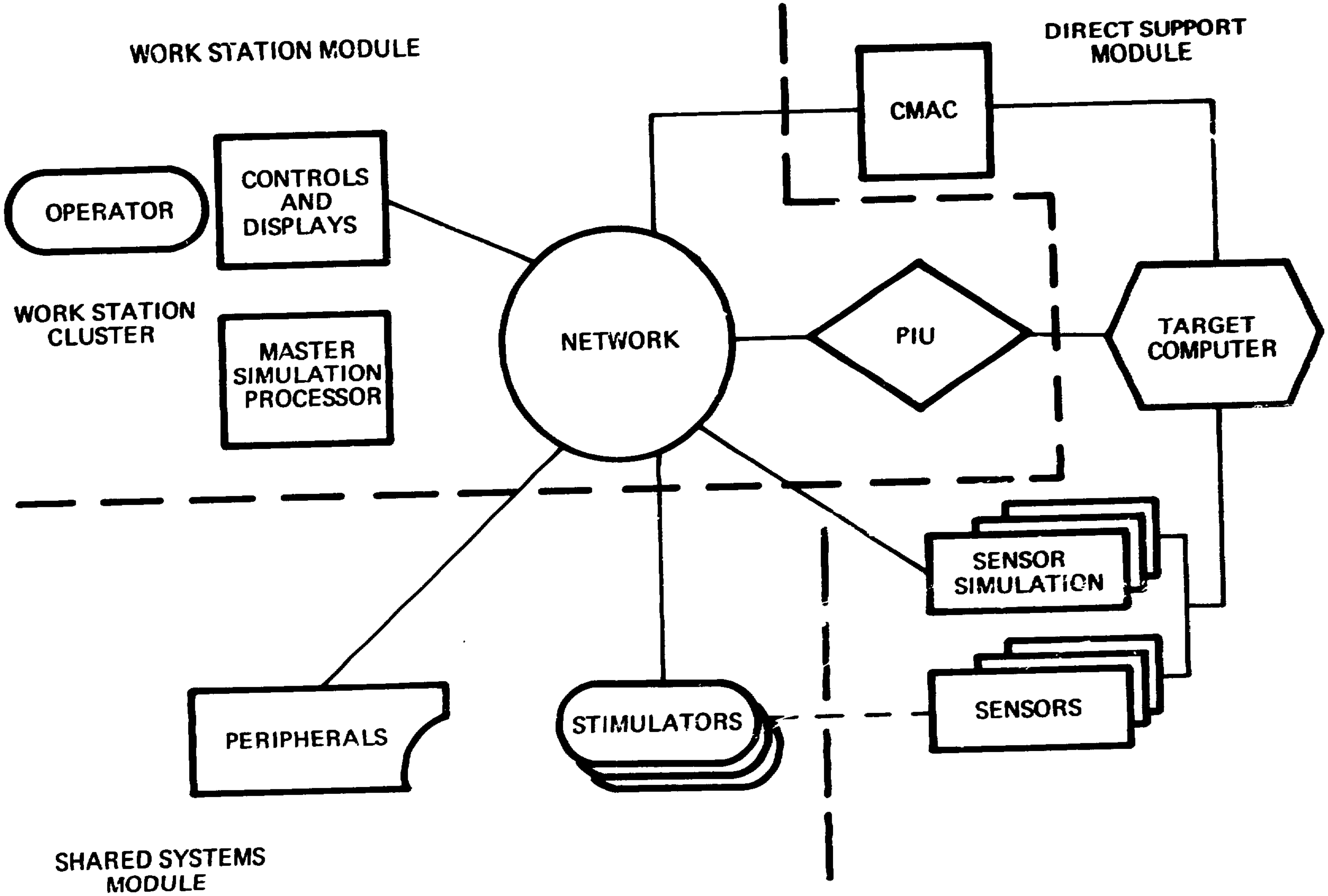


Figure 4-6. Integration Test Bench

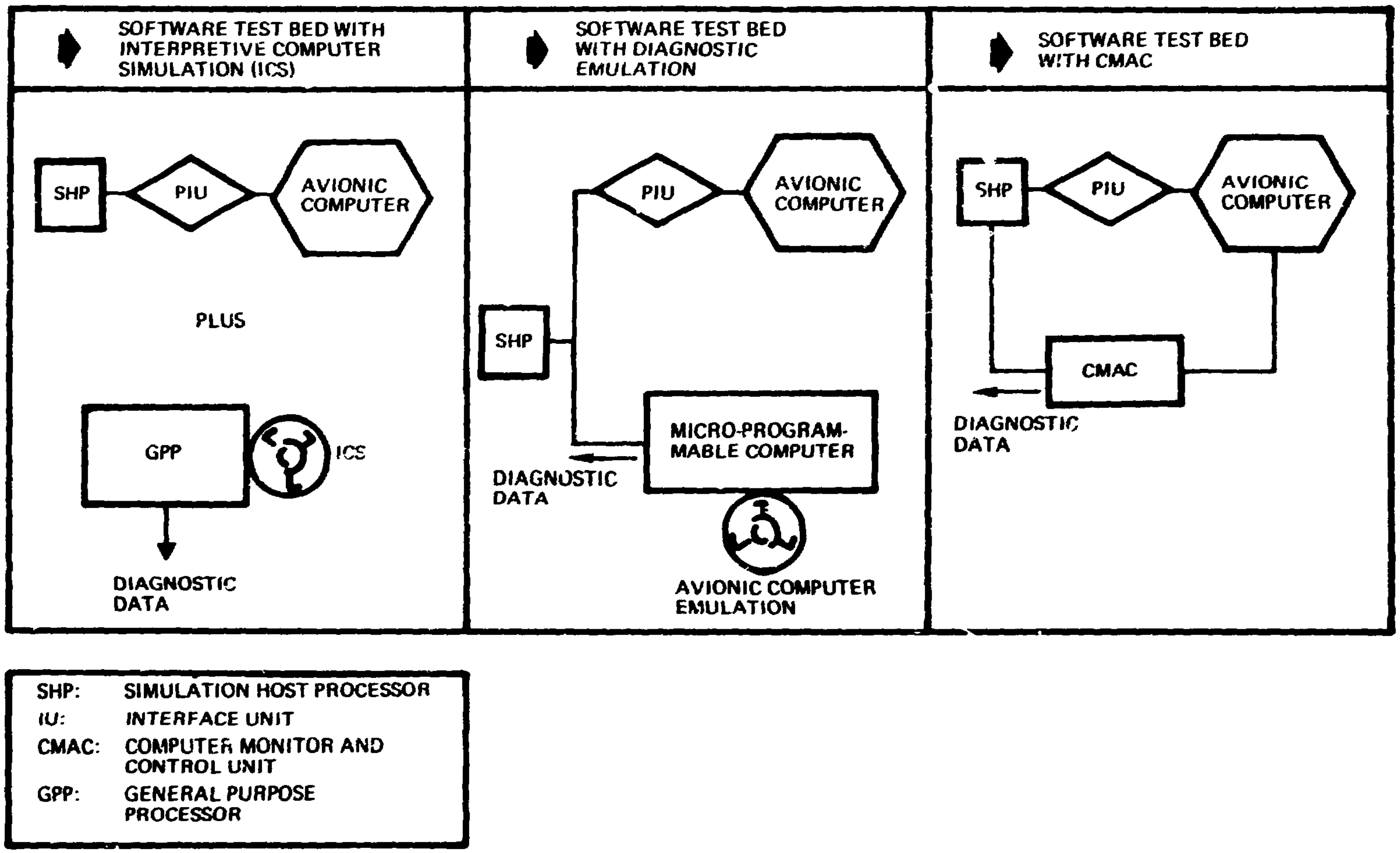


Figure 4-7. Diagnostic Capability Hot Bench Alternatives

The PIU is designed with sufficient logic to mask the distinguishing characteristic of one system bus from another, without restricting the data flow. By using a built-in microprocessor to control all interface and formatting functions, the host and target computers are unburdened from interface tasks. A block diagram of a typical microprocessor-controlled formatter or interface unit is shown in Figure 4-8. The use of these standard PIU modules will significantly reduce the need for costly dedicated interfaces. More advanced designs will use dedicated single chip VLSI and VHSIC computers with onboard memory for this interface function. The onboard memory can be mask programmed to convert any of the standard data exchange protocols to a wide variety of internal bus structures or network interconnect standards. To change the protocols serviced by any one PIU would only require the removal of the preprogrammed microprocessor and replacement with an appropriate coded one. Electrical compatibility could be maintained with jumpers or dipswitches. The PIU's, whether on a PC card or integrated circuit, should be compatible with the I/O requirements of the network interface, the computer monitor control device, the hardware simulators, and the environmental stimulations. To maximize standardization, a standard PC card to target systems interface should be used, enabling the PIU to support a wide variety of interface requirements. Due to the number of different systems in use today, it may be necessary to build PIU's for a specific family of processor buses. When military standard buses are widely used in air, ground, and space systems, only a small number of PIU types may be required. Figure 4-9 illustrates how a programmable interface could be combined with a hardware simulation kernel to form a hardware simulation module.

4.2.2.3.3 Hardware Simulation Kernels (HSK). Programmable hardware simulator kernels are dedicated devices capable of simulating the digital, and selected portions of the analog environment. which surrounds the target system. Each simulator consists of a microprocessor, A/D and D/A card, memory card, and disk controller, plus one of the programmable interface cards discussed in previous paragraphs and shown in Figure 4-8. By using programmable interface cards with standard electrical connections, it will be possible to use the actual hardware or a hardware simulator on the hot bench. This interchangeability allows the hot bench to be configured for integration testing or reconfigured for software development tasks requiring only simulated inputs. In cases where digital simulation is not possible, a digital controlled stimulator is used to provide inputs to the avionics hardware.

4.2.2.3.4 Computer Monitor and Control Device (CMAC). A CMAC device collects data on the internal operation of the target computer when it is running an application program. The ability to observe ECS operation without altering the applications software or halting the target computer makes the CMAC a powerful software maintenance and test tool. CMAC's can be programmed to selectively collect target computer data. Typical data collection capabilities include

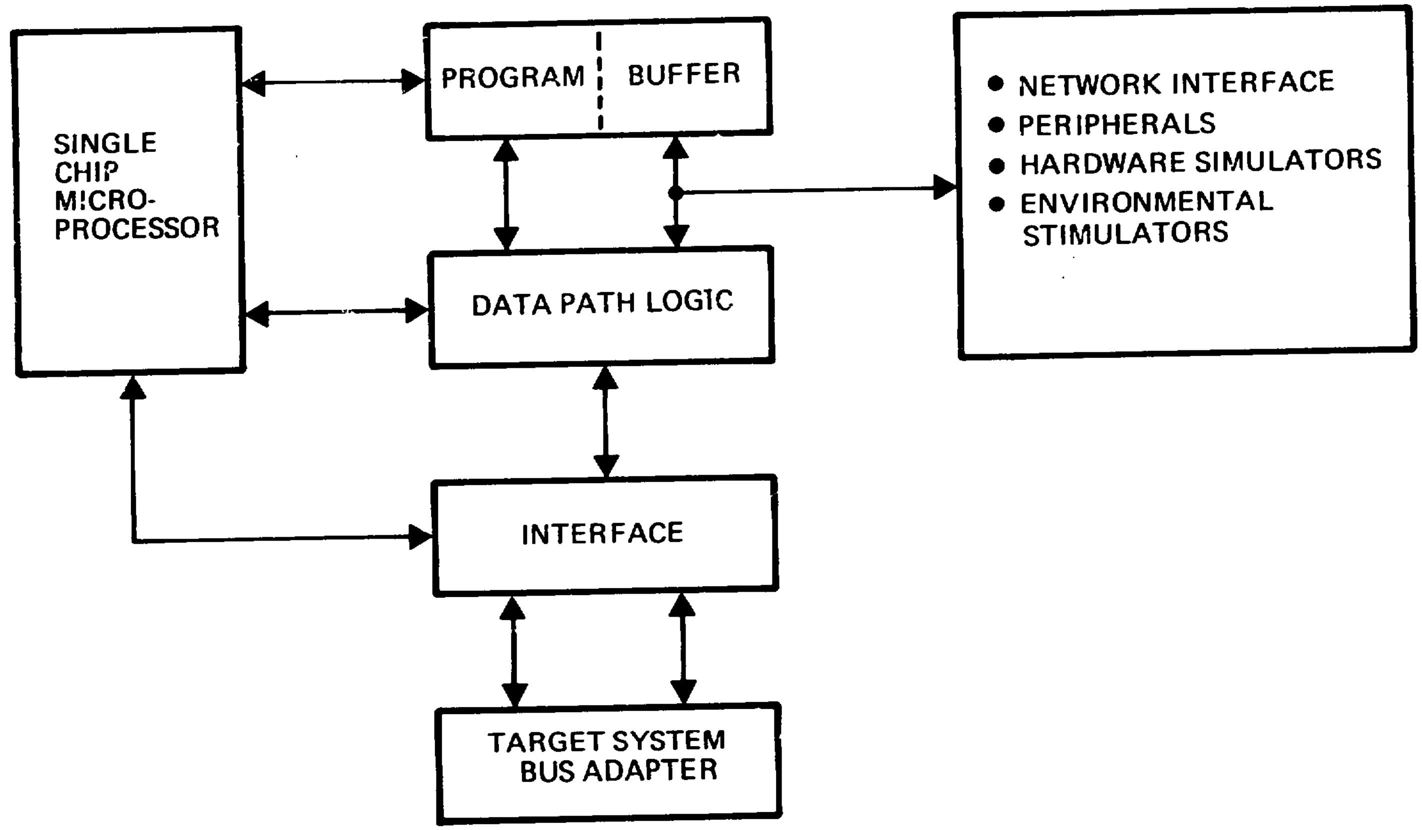


Figure 4-8. Programmable Interface Unit (PIU)

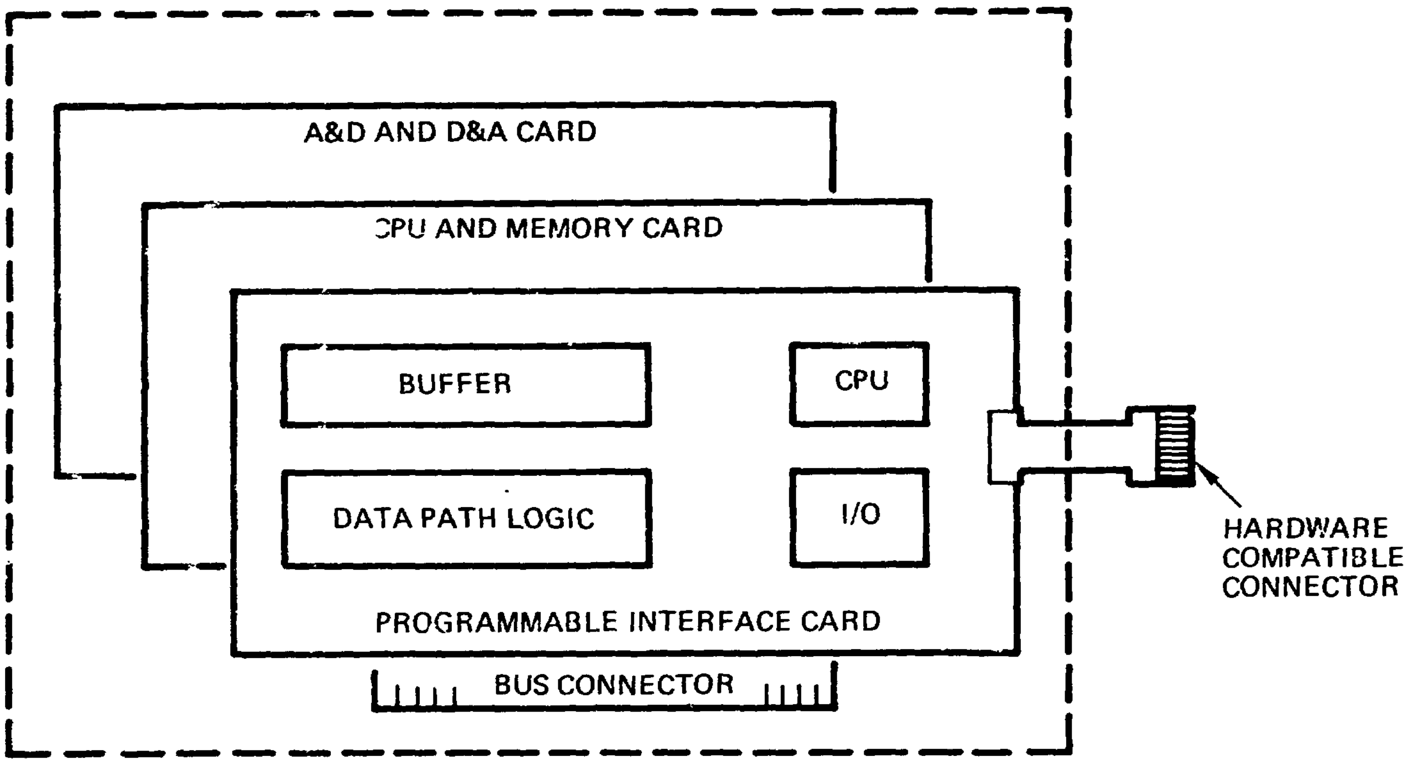


Figure 4-9. Reprogrammable Hardware Simulator

- Collect data value based on memory unit,
- Collect data value when it exceeds limit checks,
- Collect data value based on instruction/memory read,
- Trace register operations based on instruction access,
- Trace nonsequential program counter values, and
- Issue interrupts based on condition.

To date, CMAC's have been custom designed to a unique, but similar set of requirements and for compatibility with particular target computers. Generally they are custom fabricated largely out of discrete components, with little or no use of standard off-the-shelf microprocessor controlled boards. Differences in CMAC design are driven by the following:

- Designer pereference or technology available at design time,
- Target computer interface differences,
- ISF host computer interface differences, and
- Data collection capabilities.

If a standard set of CMAC data collection capabilities were selected, a standard CMAC core unit could be developed, based on off-the-shelf, relatively low cost standard modules. Only the interfaces to the target and host computers would have to be custom tailored to specific systems and applications. It is estimated that approximately ¾ of a CMAC could be standardized. Target and host computer interface problems could be further reduced by building target computer family oriented interfaces, e.g., DEC PDP-11, Data General NOVA, ROLM 1600, IBM 4 Pi, IBM AP101C, etc.

A block diagram of a programmable CMAC is shown in Figure 4-10. Data is collected through the programmable target computer interface, and stored in a first in-first out buffer approximately 4000 words long. The processor unit consists of a set of processor boards programmed to scan the input buffer for data to be collected/acted upon based on CMAC control breakpoints loaded by the operator in the breakpoint buffer. Desired output data is loaded by the processor section into the real time buffer, and collected through the programmable target computer interface.

4.2.2.4 Network Structure

The central feature of the EISF is a network which serves as the bridge between the applications, support, and service environments. This network will support the interconnection of a

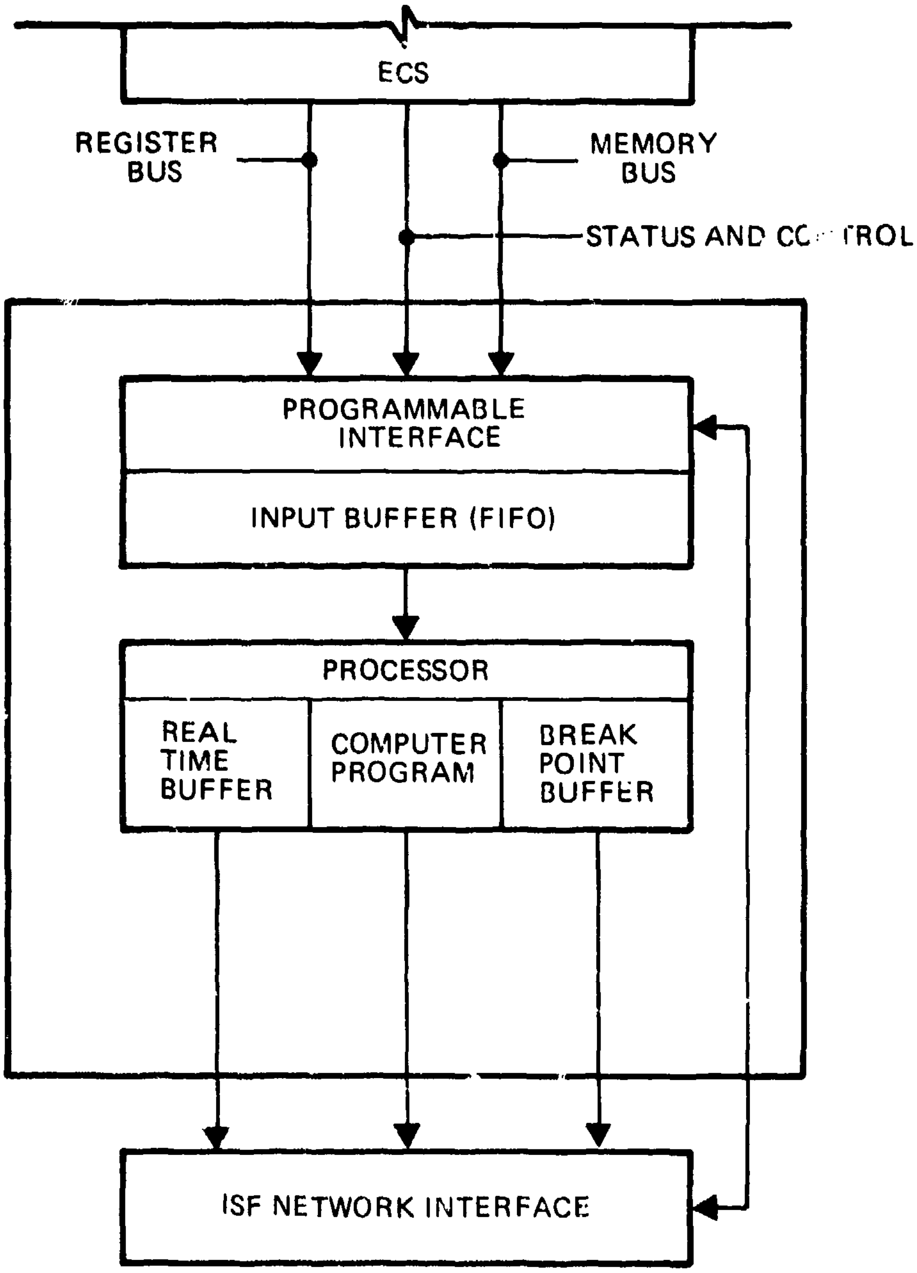


Figure 4-10. Programmable CMAC

wide variety of non-homogeneous computing systems and systems built specifically for network operations. This is a crucial EISF feature if it is going to support the multitude of existing ECS systems, as well as new systems designed under current military standards. Additional network features include

- Simple low cost standard access methods;
- Virtual[†] connection of functions;
- High speed noise free data transfer;
- High reliability in laboratory environment; and
- Security from EMI, TEMPEST, and interception.

Most of these network features are determined by the transportation medium; coaxial cable, optical fibers, or twisted pair. Table 4-7 compares the available transport media against the above criteria. It is evident fiber optics will have payoff when connector costs are reduced. The current trend is toward more economical interconnections.

Currently available off-the-shelf network designs have focused on the use of coaxial cable to interconnect systems functions. Examples include, Ethernet, HYPERchannel, Net-one, Localnet, etc. The principal advantage of coaxial cable is its superior cost effectiveness, flexibility, and performance when compared with the twisted cable pairs currently in use. Initially, EISF networks may use available coaxial technology due to cost; however, the focus in 1985 through 1990 should be on fiber optics. Figure 4-11 projects that the use of optical transport medium will grow rapidly from 1985 to 1990. The principal benefit of optical fibers are wide bandwidth, immunity from EMI crosstalk, and ground loops. These advantages result in highly reliable low error rate, and relatively secure communications systems. The wide bandwidth, immunity from EMI, lack of crosstalk and ground loops are definite assets in an EISF environment. Therefore, the EISF designer must weight the additional cost of fiber optics against its accrued benefits. It should be pointed out, however, that the EISF design is not dependent on any single transport medium, but can be implemented using a variety of systems, combining all three media into a single system if necessary.

Another feature of local networks which impacts on the EISF design is the network topology. Figure 4-12 illustrates the four basic local computer network topologies and points out the relative merits of each.

[†] A virtual circuit is one which appears to provide a sustained sequence of transmissions or a logical channel.

Table 4-7. Network Transport Medium

Criteria	Base Band Coax	Broad Band Coax	Fiber Optics‡	Wire Pair
Connection Cost	Low	Med	High	Low
Standard Access	Yes	Yes	No	Yes
Virtual Connection†	Yes	Yes	Yes	Yes
Reliability	High	High	Med‡	High
High Speed (>10 Mbps)	Yes	Yes	Yes	No
Noise/EMI Immunity	Med	Med	High	Low
Security	Med	Med	High	Low

†Virtual Circuit, appears to provide a circuit then a sustained sequence of transmissions on a logical channel.

‡Trend is toward lower cost connectors.

‡Connector reliability is increasing.

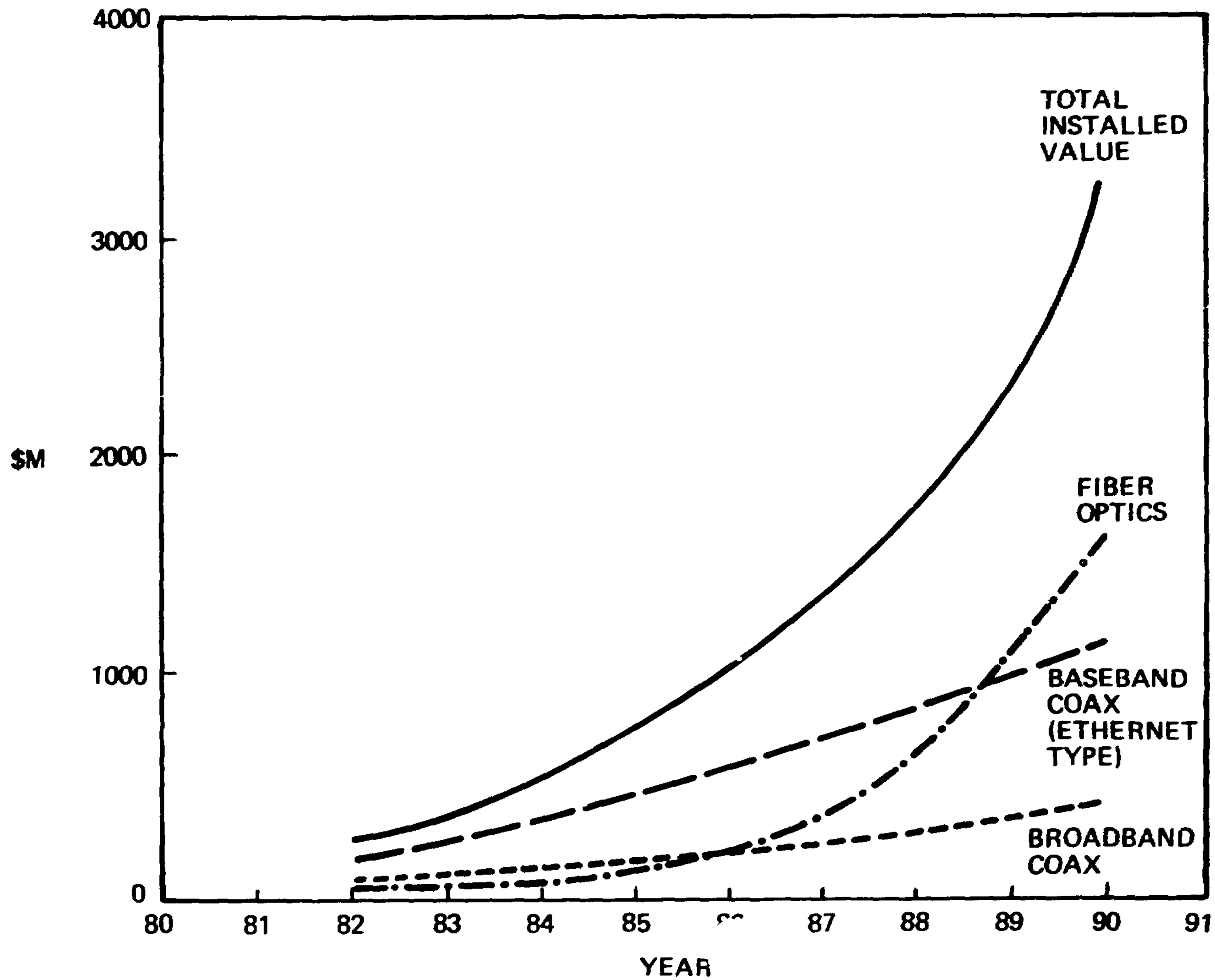
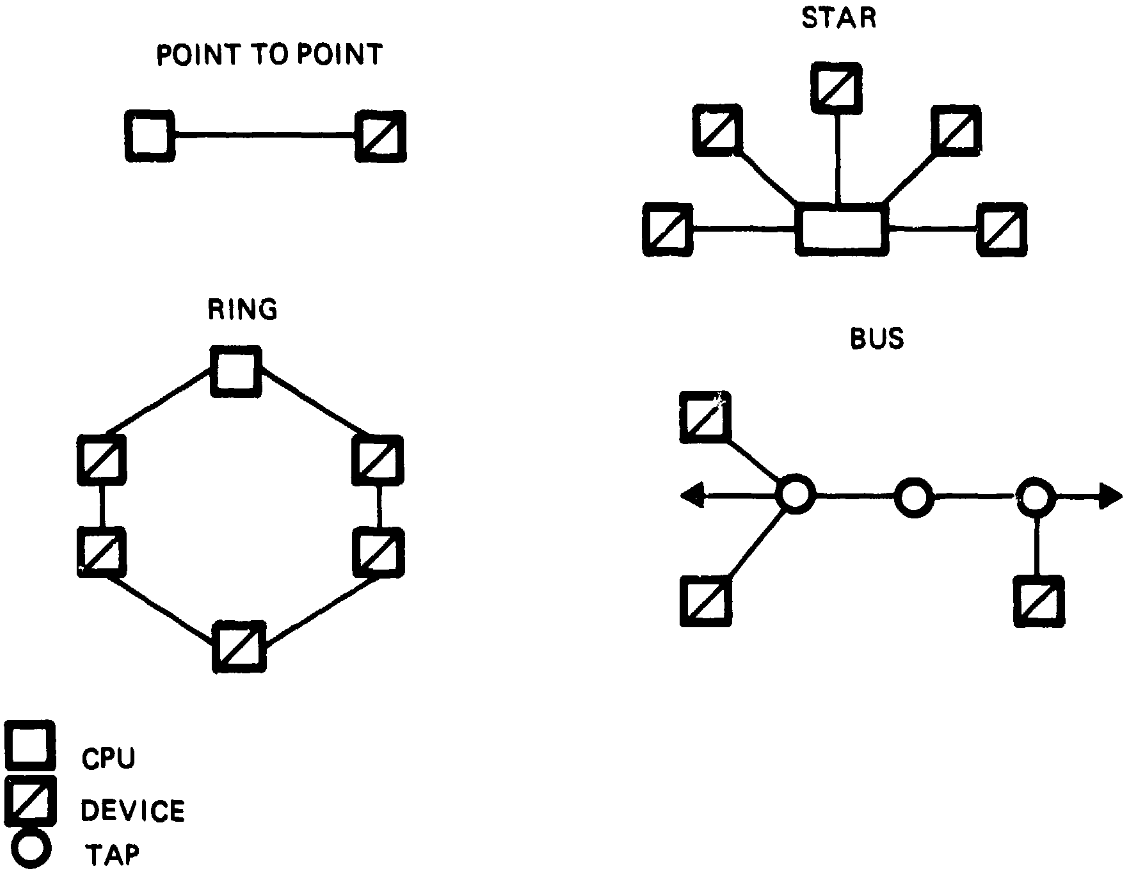


Figure 4-11. Value of Installed Base of Local Nodes by Medium



TYPE	ADVANTAGES	DISADVANTAGES
POINT TO POINT	SIMPLICITY	COSTLY, LEAST VERSATILE
STAR	SIMPLICITY	CENTRAL NODE FAILURE
RING	NO CENTRAL NODE, SIMPLE	UNDIRECTIONAL, NODE FAILURE
BUS	NO CENTRAL NODE, SIMPLE	UNDIRECTIONAL

Figure 4-12. Basic Computer Network Topologies

The choice of topology will depend on the application, the transportation medium, and the methods used to distribute data. However, in EISF applications, the ring and bus topology have some significant advantages.

- Simple structure
- No central node
- Multiprocessing supported
- Higher efficiency and productivity
- Easily expanded

The ring and bus configurations avoid the problems and inefficiencies associated with central processing. Centralized architectures, such as the star configuration, require every bit of information to pass through the CPU, typing up the system bus as well as the processing power of the system. In a single CPU multitasking environment only one task can have the CPU's attention at any one time. In the generic EISF multiprocessor environment each computer runs autonomously at its own application, transferring information between functions only as necessary keeping the network available for priority use. Adding or subtracting functions or processes does not significantly impact other functions on the network. Messages enter the network and are passed from node to node until it reaches its destination. There are no routing decisions to be made by a central CPU. The only routing requirements are that each node recognizes those messages intended for it. This design is not without problems. When two or more nodes attempt to enter messages onto the network at the same time they collide with each other. To prevent this from destroying the efficiency of the network, there is a control mechanism.

The control mechanism used by emerging networks such as Ethernet, HYPERchannel, Net-one, etc. is Carrier Sense Multiple Access with Collision Detection (CSMA/CD). Under this scheme a node listens and if the network is clear transmits its message packet. During transmission each node listens for a collision. If a collision occurs it waits and tries again. The period each node waits is determined by a probabilistic algorithm. This method of determining who has control of the network is highly efficient, but does not meet the needs of an EISF network. The EISF requires a virtual circuit to ensure real time processes can be serviced on a predetermined schedule or priority. There are a variety of deterministic control strategies that will support the generic EISF design. The most effective of these strategies are associated with the ring topology, however, the bus structure can also be used. In general, these strategies are based on a mechanical whereby control is passed sequentially around the ring from node to node.

- Daisy Chain: Dedicated wires pass control information from node to node.

- Control Token: Control information is passed in a special bit pattern over the regular data channel.

- Message Slots: Control is continuously transmitted around the network in a series of message slots which are filled or emptied as required.

The bus structured network is difficult to implement using a deterministic scheme without making one node the controlling node, which, in turn, detracts from the EISF multiprocessing environment. As stated earlier, the most commonly used bus control strategy is CSMA/CD which is not appropriate to this requirement.

Protocols are also part of the control structure. As in the long haul networks discussed in Section 4.4, local network protocols are layered, proceeding from the most basic level of transferring groups of bits without knowledge of their meaning, to higher level applications which use the bits to communicate remote actions. Local networks must support a wide variety of hosts, ranging from dedicated microprocessor to large data base machines. To simplify communications processing, larger headers can be used. For example, headers with fixed fields, in fixed locations; and address which translates directly to queues, buffers, ports, or processes without consulting look up tables can simplify data handling.

Another feature of local networks supporting low level protocols is the inherent short transmission delay. Low transmission delays can eliminate the need for complex buffers, flow control, and network congestion mechanisms. However, there are other data rate considerations. While the data rate can make exchanges essentially instantaneous, its speed cannot eliminate the problem of two systems on the network communicating at different rates. Therefore, it is still necessary to design protocols with sufficient generality to cope with communication disparities. Such disparities include

- Data rate mismatch,

- Receipt and acknowledge delay mismatch, and

- Sender/receiver buffer length mismatch.

Another aspect of the protocol which must be discussed is its structure and its compatibility with higher level structures. The EISF network is projected to interface with long haul networks as well as data base machines and large scale hosts. These interfaces require high level, more elaborate protocols, therefore the EISF needs a two-level protocol. The lower level provides the basic functions of delivering an addressed message to one or many destinations whereas the higher level performs complete functions. These lower level protocols can be implemented entirely in hardware in contrast to the higher levels which must be software implementable. To maintain the flexibility of the PIU a software approach is recommended for both levels. A software controlled PIU with both low and high level protocols will also enhance the decentralized computing capability of the EISF network. The high level protocols can be used to communicate through long haul gateways, data base machines, and in some cases shared memory and files.

Protocol efficiency can be increased when dealing with larger, more sophisticated systems by integrating portions of the networks file handling system within the individual operating systems on the EISF network. By incorporating the protocol and user authentication mechanisms in individual operating systems, the interchange of information between the various machines can be accomplished with minimum user intervention.

Once the individual EISF's are developed and prior to implementation of the long haul network, it is advisable to fully develop local area networks encompassing all EISF's located on a single ALC. These local area networks would be composed of a collection of local network (subnetworks) that have been implemented with various technologies and perhaps different transmission rates, but using identical software protocols, compatible packet sizes, and a single overall homogeneous address space. Figure 4-13 is a graphic representation of multiple loop interconnected through a common data base machine which in turn is interconnected to other ALC local networks through long-haul gateways. These long-haul networks are discussed in Section 4.4.

4.2.2.5 Summary

This section of the report discusses the generic design of an ISF capable of supporting multiple ECS categories, multiple weapon systems, and single weapon systems employing multiple ECS systems. Appendix D presents a high level view of how the generic design could be applied to ground EW systems using available technology and currently in-place assets.

EISF development and physical plant development are discussed in the next section. However, prior to reaching this phase in the procurement cycle there are a number of studies and evaluations which should be conducted to further define the specification for individual components of the EISF.

These studies include

- Work station definition and selection;
- Network design to include transport medium, topology, interface, and protocol (this is part of the EISF Requirements Definition Phase);

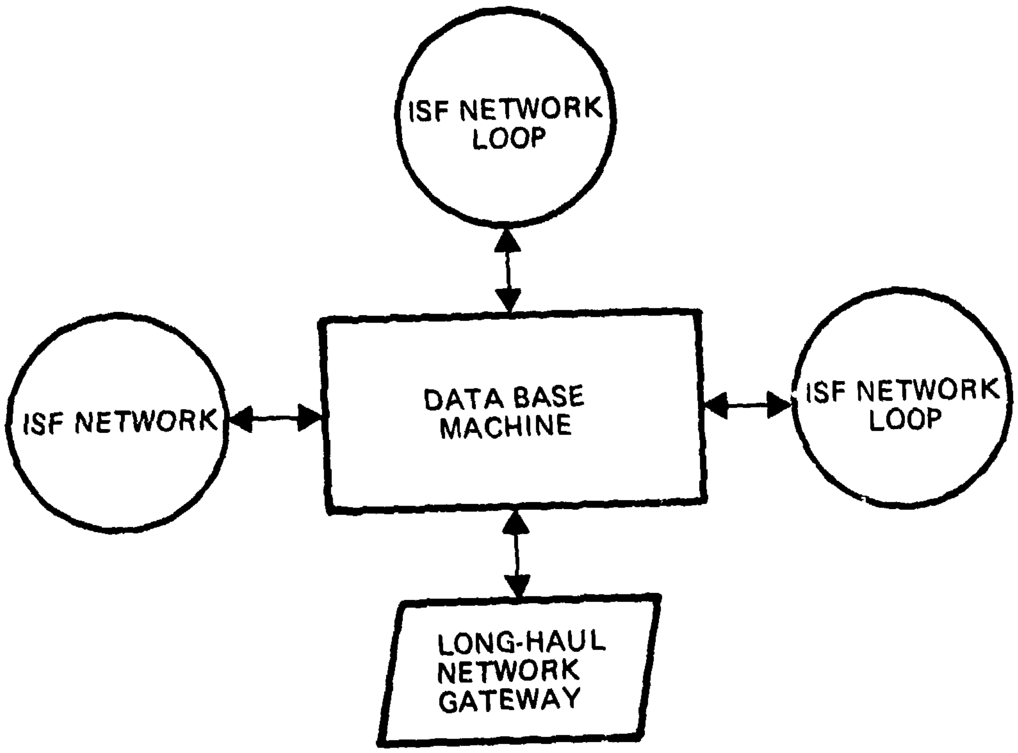


Figure 4-13. ISF Network Interconnects

- Programmable hardware simulator design;
- Programmable computer monitor and control design; and
- Selection of a stand-alone data base machine.

Recommended activities include

- Develop prototype local network for EW, OFP, and ATD using current technology and where possible available assets;
- Expand prototype into full scale EISF; and
- Interconnect individual EISF's through a data base machine.

4.2.3 EISF Development and Integration Considerations

The development of an EISF from modular building blocks which will satisfy the needs of multiple users supporting a wide variety of ground, air, and spaceborne weapon systems, is highly complex and requires extensive planning. This planning must extend throughout the life cycle of the support systems and must address the need for long term budgeting cycles. Initially the extended ISF must be funded as a line item with its own PMD. After the program has matured and the major modules are in the inventory, individual ISF's can be funded incrementally as part of the weapon system.

In the past ECS support planning has been generally inadequate and should be strengthened in the future, as the flexibility provided in this conecpt is not achievable unless all components are available to the EISF builder. Once the modules are available, builders can tailor EISF capabilities to meet specific weapon system requirements without having to go through an extensive development cycle. To achieve this goal the overall EISF concept must have a detailed plan and long term financial support.

The planning and acquisition activities necessary for the procurement of EISF subsystems are summarized in Section 5, paragraph 5.2.2. In addition to these activities, the development of a physical plant to house the EISF must be planned and coordinated with other Air Logistic Center support activities. Buildings must be prepared to accept the EISF's and staffs trained to operate the support systems. Training recommendations are discussed in Section 3. Facility design and security requirements are summarized in the following paragraphs.

Facility requirements are concerned with the space and physical allocations necessary to implement the EISF. Prime considerations are floor space, power requirements, cooling requirements, and special security requirements.

To determine the floor space requirements, the itemized equipment must be located on a scaled floor plan in order to help determine the needed structure. The floor space should consider

- Room for personnel expected to provide support (office space, security control),
- Any added requirements for power/cooling equipment,
- Hall and aisle ways,
- Special vaults and libraries,
- Equipment maintenance room, and
- Growth.

To prevent premature technical obsolescence, the planned facility should have raised floors, relocatable walls, open core design, floor-to-floor chases, environmental and industrial standard electrical distribution systems. Building flexibility into the initial design will allow the facility to be reconfigured to meet future requirements.

The electrical power requirements for each of the avionics, commercial, and special equipment must be considered together to determine the total power requirements for the facility. Sufficient margin should be provided for growth. Power requirements for avionics equipment generally require different types of power including: 230/400 Vac 400 Hz, 115/200 Vac 400 Hz, 115/200 Vac 60 Hz, and 28 Vdc. Conventional 60 Hz building power is adequate to support area requirements such as lighting, convenience outlets, office equipment, etc. This building power should be kept separate from the equipment power. In some cases where security is a concern, filtered power may be required.

Avionics equipment generally requires special cooling which must be considered on an item-by-item basis. Various categories of cooling systems may be required such as liquid, forced air, and draw-through types.

The environmental control requirements (lighting, heating, ventilation, and air conditioning) must be in accordance with AFM 88-15. The heat load generated by the equipment can be estimated from the electrical requirements of the individual equipment.

Various special requirements must be included based on the specific application. Raised floors can be specified to facilitate under-floor, air ducts, power, grounding, and signal cable runs. A special fire protection system may be included. If an IMU test table is included in the facility, benchmarks must be provided with a measurement (to a specified accuracy) of latitude, longitude, altitude, and direction of true north.

The growing trend to include classified intelligence data in the ECS software and the need to protect weapon systems software from sabotage will drive increased EISF security requirements. The EISF concept incorporates a number of security features, including the use of multilevel file access controls, log-in control, fiber optic data transmission, and TEMPEST approved peripherals. Even with these built-in features each facility housing an EISF must meet specific DOD security standards. The following summarizes DOD policies with respect to ADP security requirements. (Specific guidance is contained in AFR 300-8.)

- Each facility system must obtain an initial written approval from the cognizant government security agency prior to processing.
- A closed area is to be established for each classified facility. To maintain the integrity of the system, the closed area controls are to be maintained even during those periods when there is no classified material in the system.
- Classified material is not to be transmitted to or from a remote terminal except by means of approved methods. If cryptographic methods are used, AFKAG-1 procedures apply.
- The personnel having access to classified equipment are to possess a security clearance and need-to-know for the highest classification and most restrictive category of classified material contained or processed in the system. If it becomes necessary for maintenance personnel not possessing such clearances to access the system, they are to be accomplished by an escort, duly designated for that purpose.
- If computers of computer-like devices and associated peripheral equipment are used in processing, displaying or forwarding national security or security-related information, then TEMPEST controls must be applied (IAW AFR 100-45).

4.3 ECS READINESS SUPPORT

As outlined in Volume II and further detailed in a classified section of the Phase II report, the ECS readiness support issue involves the requirement for AFLC to maintain Air Force weapon systems in a combat ready condition through modifications to be associated ECS software. These modification requirements may come as the result of: 1) outdated/inoperative ECS software at PMRT transition; 2) desire/necessity to change or increase the weapon systems initial design capabilities after PMRT; and/or, 3) respond to a changed or new threat environment in which these systems must perform during their operational life span. Of the above listed three reasons, the requirement to "respond to a changed or new threat environment" is by far the most urgent and pressing requirement. In fact, this requirement, in almost all cases, is the basic reason for all ECS readiness changes.

To fully appreciate the impact the readiness issue is having and will continue to have on AFLC, one must understand: 1) the functions required to perform this support task; 2) the data, tools, and resources necessary; and 3) the responsible agencies either tasked or, by the nature of the job, required to perform the various functions.

To better illustrate the problem while amplifying on the material contained in Volume II of the Phase II report, a structured methodology is used for the analysis. This type approach allows one to

- Think in a structured way about the readiness support issues and their accompanying complex support problems;
- Break the total problem into several lower and less complex issues wherein analysis of support resources, equipment, and responsibilities may be identified; and
- Communicate the analysis and the resulting recommendations in clear, concise, and traceable fashion.

Prior to discussion of the analysis, a short introduction into the analysis methodology is appropriate. The methodology to be used is to construct, on paper, a model of the readiness support issue. The readiness issue is decomposed into its constituent parts. To accomplish this decomposition, boxes are interconnected with arrows. Starting with the most general or abstract description of the issue represented in a single box, decomposition or breakdown of that box into a number of more detailed boxes begins. Each of these boxes represents a major function of that single "parent" box.

In addition to partitioning the problem into activities/nodes which are shown as boxes and then decomposing the higher order nodes into sublevel ones, another important aspect of this analysis involves the use of arrows entering and exiting each box.

The side of the box at which the arrow enters or leaves denotes its interface role as an input, output, control/constraints, or responsibility as shown in Figure 4-14.

More specifically, arrows entering to the left of the box indicate inputs, while those to the right indicate flow of data† out of the box. Arrows entering the top of the box represent constraints placed upon the responsible agency's ability to accomplish the activity. Arrows entering the bottom of the box represent/depict the agencies responsible for the activity.

†The exiting data is a result of the activity taking place within the box.

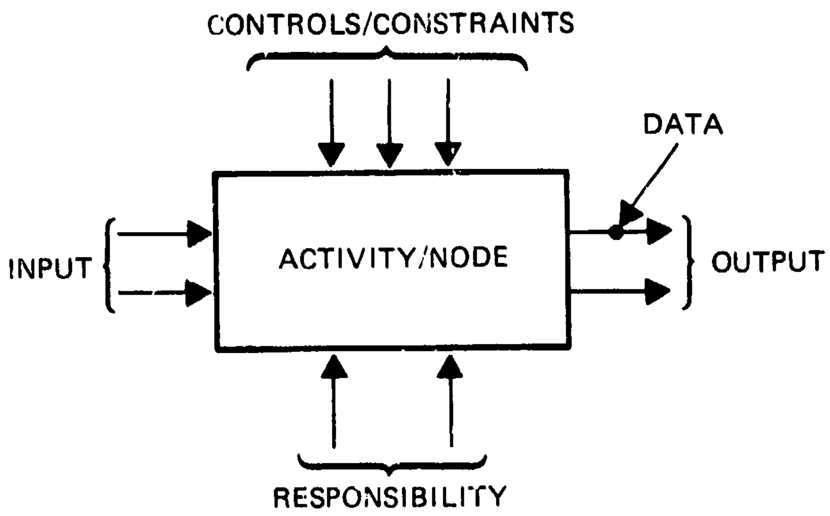


Figure 4-14. Box/Interface Arrow Definition

Having described the methodology to be used in Figures 4-15 through 4-19, the analysis of the readiness issue will be presented. The reader should bear in mind that the ultimate purpose of this analysis is to identify: 1) the facilities, equipment and resources required; and, 2) the Air Force agency† responsible for accomplishing the readiness support functions.

Figure 4-15 depicts the basic activity associated with this issue, i.e., "Combat Readiness Support for ECS Based Weapon Systems." Input factors which affect this activity are the environment in which the system must operate and the level of technology impacting at any point in time.

The following are constraints placed upon the Air Force's ability to perform this activity.

- Weapon system design and the ECS's role within this weapon system.
- Resources, facilities, and equipment available to provide this support. (Embedded within the equipment aspect are the classic software tools and yet-to-be-defined data bases. Resources available refers not only to manpower and monies, but also expertise.)
- Time available to provide this support. A classic example is in the EW category where response time must be in a matter of hours or days in order to support the operational use of these systems. The initial investigation into the readiness issue leads to the belief that OFP's of Fire Control Radars, certain Navigation equipment (i.e., Terrain Following Radars), and individual Command and Control Systems (i.e., AWACS, JTIDS), will also have a very rapid support reaction time associated with them. In conjunction with changing the OFP's, the training ranges and exercise evaluation systems must also be changed to provide realistic training.

Arrows entering from the bottom of the box show that the Air Force is the organization responsible for accomplishing this activity; however, within the Air Force, AFLC has the primary responsibility for providing this support. As the analysis will show, this responsibility requires AFLC to assume several new and nontraditional roles in order to provide the required support. As a result, it is important that roles and missions be fully understood so that critical AFLC resources are not expanded in duplicating either Operational (User), AFSC, or the Intelligence Communities mission. In some cases where it would appear that the responsibility, according to "classic" Air Force roles and Mission definitions, would correctly rest with other than AFLC, such factors as unique system knowledge, and available facilities and equipment dictate that AFLC assumes the roles. This is particularly true in the areas of intelligence support

† Reference is made to the "Air Force agency" due to the fact that although most of the responsibility is AFLC's, certain other Air Force organizations play a key role in this process.

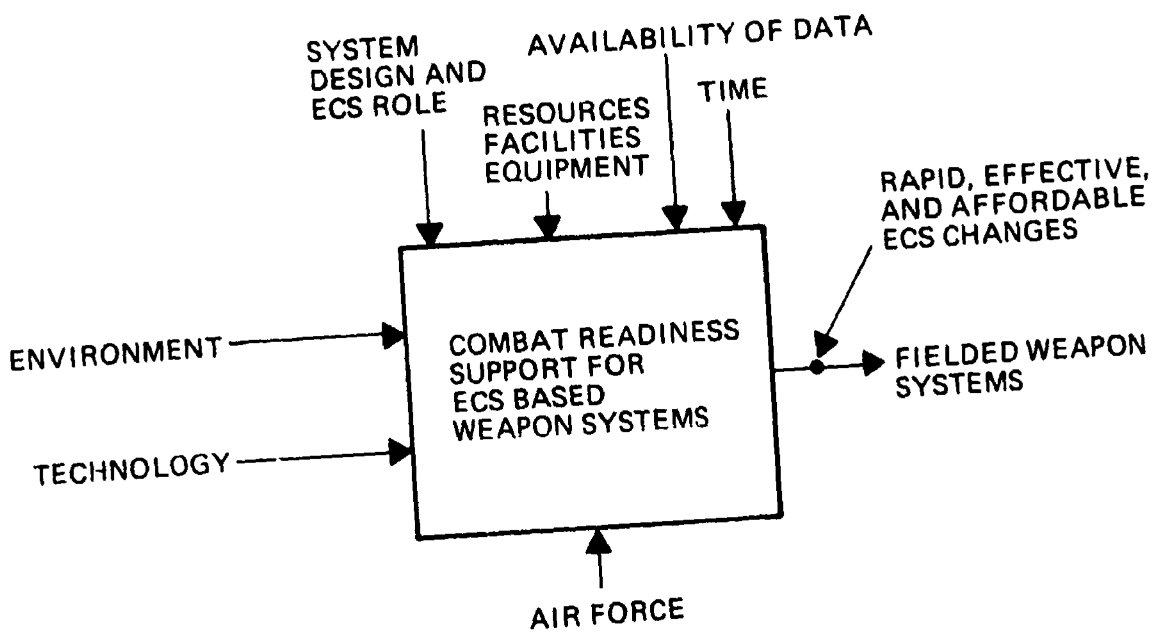


Figure 4-15. Analysis Methodology

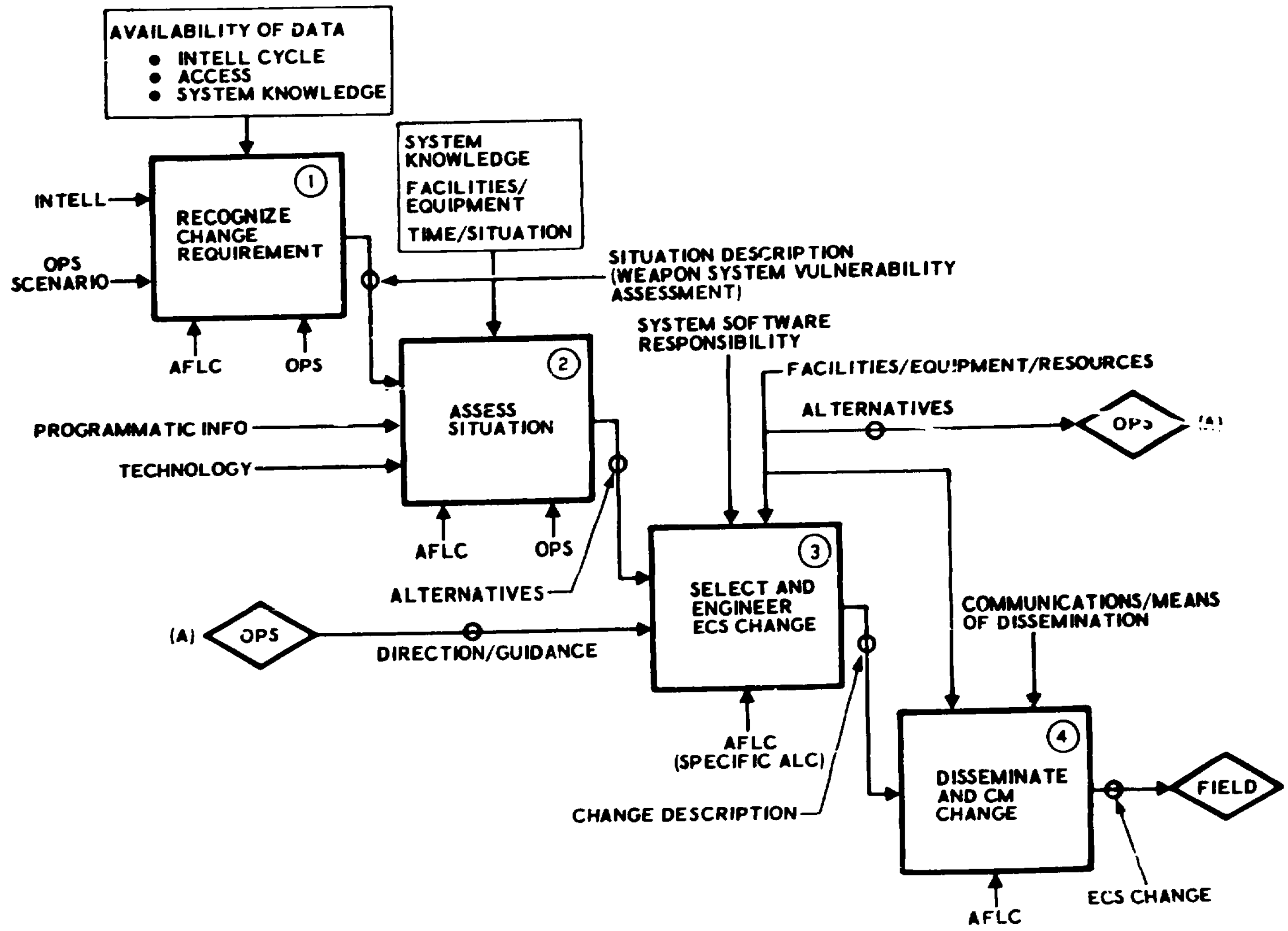


Figure 4-16. ECS Readiness Support

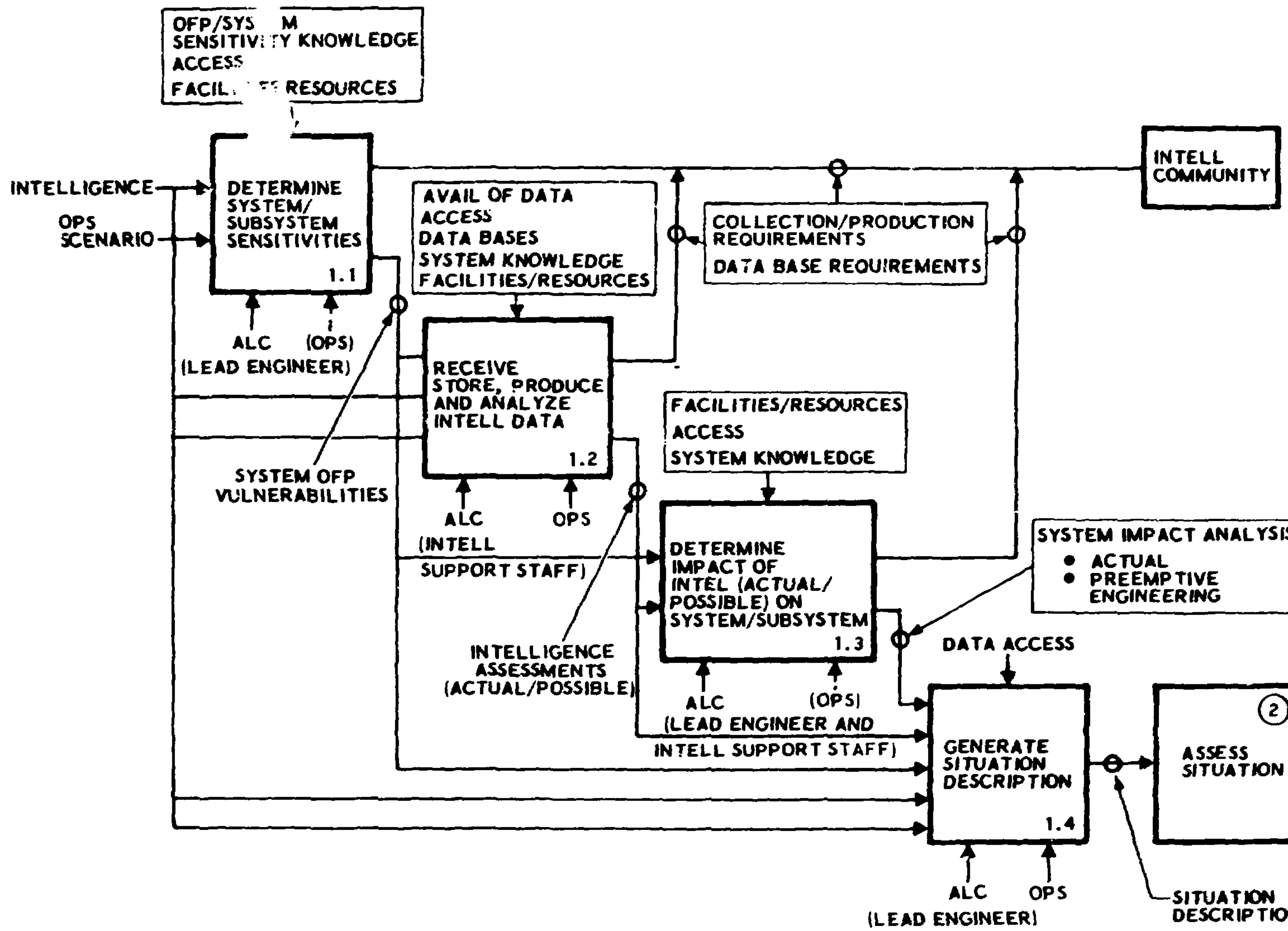


Figure 4-17. Recognize Change Requirement

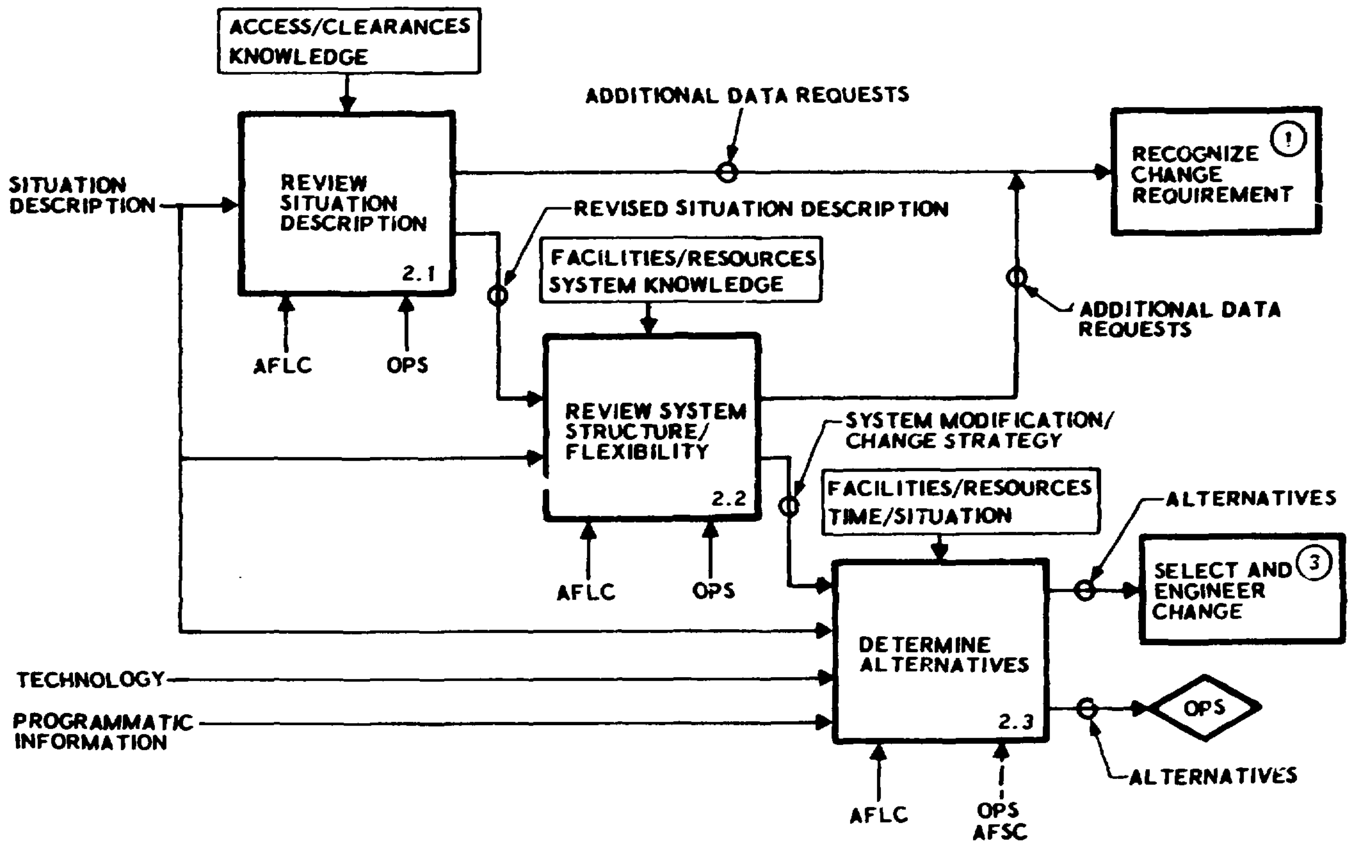


Figure 4-18. *Assess Situation*

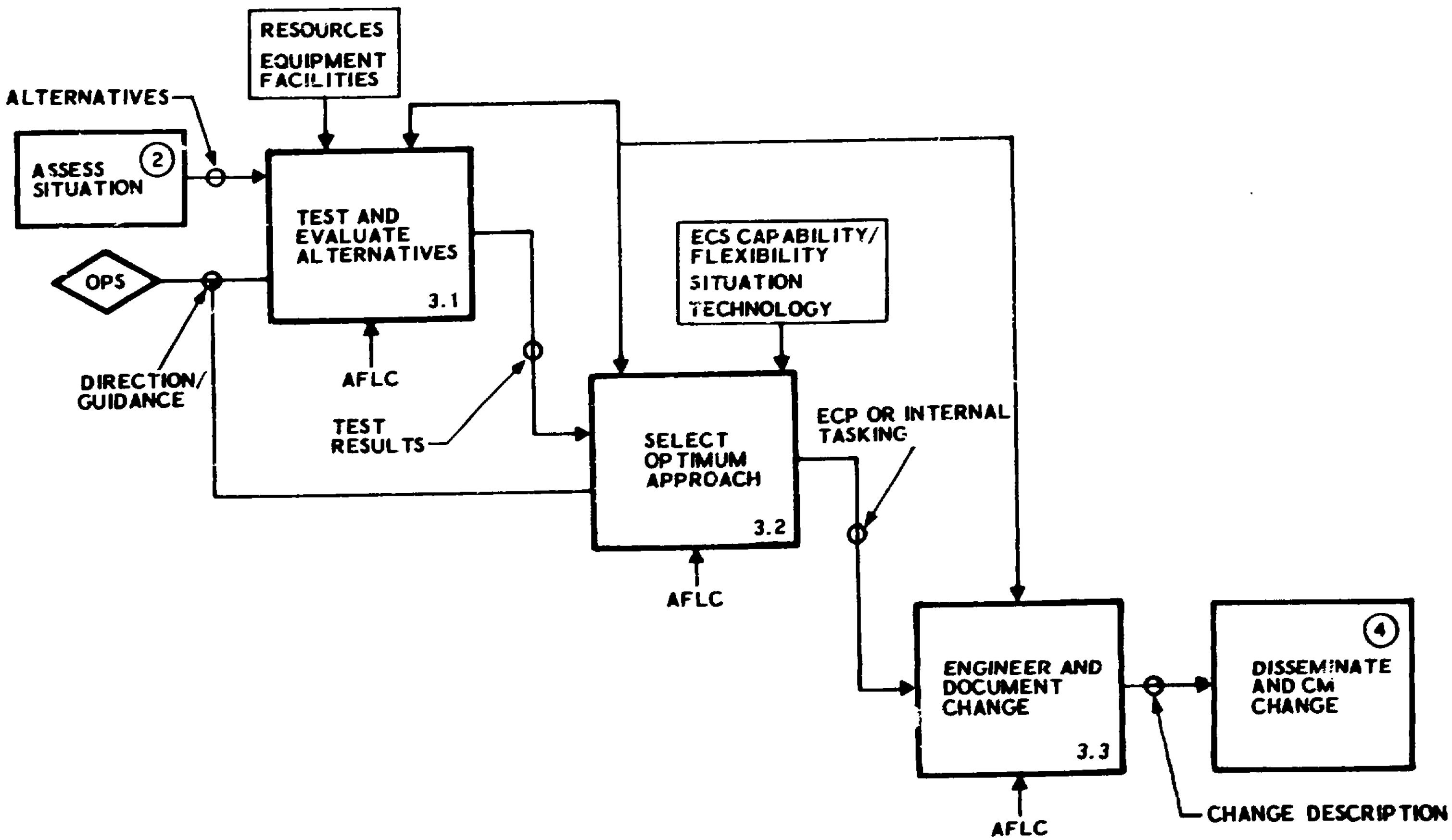


Figure 4-19. Select and Engineer Change

and threat impact analysis work. These new support requirements carry with them their asociated investment in equipment, facilities, and resources.

The output of the activity is rapid, effective, and affordable ECS changes to the fielded weapon systems (arrow to right of box illustrates this flow).

Figure 4-16 is a Level 2 breakdown of the basic "Combat Readiness Support for ECS Based Weapon Systems" activity. At this level we see that the four activities required are:

1. Recognize change requirement (Node ①)
2. Assess the situation (Node ②)
3. Select the engineer ECS change (Node ③)
4. Disseminate and configuration manage the ECS Change (Node ④)

4.3.1 <u>ECS Readiness Support Activities</u>

The following paragraphs amplify on the ECS readiness support activities.

4.3.1.1 <u>Recognize Change Requirement (Node ①)</u>

The recognize change requirement activity requires inputs related to the intelligence situation and the operational use of the weapon system. The constraints placed upon ones ability to perform this activity relates to the availability of data in the areas of intelligence and system knowledge. Closely aligned with these constraints is the access the people required to perform this activity have to this data. The responsibility for performing this activity rests with AFLC and the operations community. The output from this activity is labeled "Situation Description" and would be in the form of a statement of the intelligence situation and the systems associated vulnerability.

4.3.1.2 <u>Assess the Situation (Node ②)</u>

The assessing the situation activity involves taking the output from Node 1, the situation description, and combining it with programmatic and technology inputs. The programmatic inputs refer to such things as POM funding considerations, weapon system modification schedule, and the weapon system's life span expectancy. The constraints imposed upon the activity of assessing the situation are in the areas of weapon system knowledge[†], available facilities and equipment, and the time available for the assessment. The responsibility for accomplishing

[†]System knowledge refers to knowledge of the current OFP configuration and the system's ECS flexibility.

this activity rests with both AFLC and the operations community; however, the previously discussed constraints clearly show that the majority of this responsibility lies with AFLC. The operational communities responsibilities are more in the line of direction and guidance once alternative approaches have been determined. (Discussed in detail in Section 4.3.3.) Outputs from this activity in the form of alternatives† will be provided to the operational community and the Node 3 activity.

4.3.1.3 Select and Engineer ECS Change (Node ③)

The list of alternatives provided from Node 2 are combined with the operational communities direction and/or guidance in the select and engineer ECS change Node 3 activity. One of the primary constraints placed upon the Node 3 activity is the AFLC software responsibility taskings. Specifically, the ALC tasked with this responsibility and their associated facilities, equipment, and resources will largely determine the success of this activity. As depicted, AFLC and more specifically the particular ALC charged with the weapon system/subsystem support, is the responsible agency.

4.3.1.4 Disseminate and Configuration Manage the ECS Change (Node ④)

Once the ECS change has been determined and engineered, AFLC continues to have the responsibility to disseminate and exercise CM control. The output from this activity is the actual ECS change, the associated T.O.'s and installation guidance.

Generally, this level of definition of the problem has not permitted the identification of all of the resources, equipment, facilities, and/or specific responsibilities. Therefore, the problem is broken down into the next functional portion.

By further partitioning the first three activities/nodes depicted in Figure 4-16, a level exists where additional ALC responsibilities, resources, equipment, facilities, and actions for accomplishing readiness support can be identified. Figures 4-17 through 4-19 depict this partitioning. Following a brief discussion of these figures and their associated activities, a specific set of requirements for accomplishing these activities is provided.

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†Alternatives could include: hardware modifications, ECS software changes, and/or tactics considerations. For the purposes of this discussion, only the ECS software change alternative will be considered and further examined.

As depicted in Figure 4-17, the recognize change requirement node is composed of the following four activities.

Determine the System/Subsystem Sensitivities (Node 1.1). This activity involves the task of technically evaluating the system/subsystem as to its sensitivity to the anticipated/actual threat. Classically, this task is accomplished through a series of sensitivity analysis activities in the form of studies and evaluation. The ability to accomplish these evaluations is highly dependent upon detailed system knowledge, technical skills, availability of necessary equipment, available resources, and availability of operational scenario data. The responsibility for accomplishing this task is clearly the ALC's system/subsystem lead engineer's; however, support is required from the operational user in the form of current operational scenario data. The outputs of this activity are: first, a description of the system's/subsystem's OFP vulnerabilities; and, secondly, intelligence collection, production, and distribution requirements. The final output is especially significant in that it provides the basis for national intelligence support. Currently, AFLC's lack of participation in the classic intelligence cycle represents a serious gap in the Air Force's intelligence collection and production requirements listings. Significant from another viewpoint is the fact that only the ALC system/subsystem lead engineer has the technical insight into the system/subsystem OFP which would allow the actual statement of these requirements. Follow-on recommendations will amplify on this area.

Receive, Store, Produce, and Analyze System/Subsystem Related Intelligence Data (Node 1.2). In order to accomplish the task of determining the ECS software change necessary to offset changes in the threat environment, the ALC lead engineer and his supporting staff must have access to both historical and daily intelligence data. This requires access to a current and complete system/subsystem related technical intelligence data base†, appropriate clearances, data storage, work facilities, secure communications, inclusion on existing intelligence document/message distribution lists, and intelligence staff support within the ALC's. (See Volume II, Phase II report for additional data in this area.) The output from this activity is in the form of intelligence assessments and intelligence data base, collection, and production requirements.

Determine Impact of Intelligence (Actual/Possible) on System/Subsystem (Node 1.3). This activity represents the heart of the "recognize change requirement" process. In this activity, the actual system/subsystem limitations are determined as a function of: first, the system's/subsystem's OFP sensitivities; and, secondly, the actual or suspected threat environment in which the system/subsystem may be operated. Up to this point how the classic intelligence assessment process supports this activity has been shown; however, there are at least two other very significant methods of determining actual or suspected threat impact on the system/subsystem ECS software. These are through the use of flight data, wherein the system/subsystem software is exposed to either the actual environment or a simulated range environment; and the use of laboratory stimuli device wherein the system/subsystem OFP is

†In the EW area, the Air Force has developed the Electronic Warfare Integrated Reprogramming (EWIR) data base for this purpose. The effort to develop this data base was extensive and required a great deal of technical insight into the EW systems' software structure.

subjected to either actual or suspected environmental conditions. Both of these approaches are necessary and require specific tools, facilities, and resources which will be discussed in the form of requirements in follow-on paragraphs. The responsibility for accomplishing the above tasks rests with the system/subsystem lead engineer and his staff with support from the operational user in the form of scenario/concept of operations data.

Generate Situation Description (Node 1.4). While this activity on the surface appears to be an administrative function and in some cases not an actual requirement, it is included for the following reasons.

- Cases wherein a subsystem (item) manager wants to communicate his findings to the system manager need depiction.
- The documentation at this level could very well be reflected in either an ECP request, a SOW, or serve as the foundation for additional resource requests.
- At a minimum, historical data as a result of this recognize change requirement activity should be documented and stored for future reference.

4.3.2 ECS Readiness Support Requirements

The overall requirements for readiness support are depicted in Figures 4-15 through 4-19 as activities. The following paragraphs discuss these activities in the form of requirements. These requirements in turn must be satisfied through a series of actions on the part of AFLC. The format used is to first identify and discuss the basic requirement and then describe the action recommended to accomplish this requirement.

The following paragraphs present the basic requirements which AFLC must satisfy in order to initially provide readiness support. This list of requirements and actions is not intended to be all inclusive; rather, it represents a minimum list of activities necessary to place AFLC in an initial position to provide readiness support. Additional requirements and actions can only be identified through an evolutional process based upon day-to-day support needs.

4.3.2.1 Requirement 1: Determining Those Systems/Subsystems Which Should be Included Under the Readiness Support Concept

This determination activity should include not only those system/subsystems which have actually transitioned to AFLC, but also those which are in development. Once this listing of systems/subsystems is established, it should be maintained within an AFLC data base management system. Purpose for establishing this listing is twofold; first, to obtain a comprehensive listing of these systems/subsystems and the specific AFLC responsible for their support; and secondly, to lay the groundwork for future resource justifications.

Recommended Actions

1. Generically identify the characteristics of the system/subsystem ECS which qualify them for inclusion under the Readiness Support Concept. Use these characteristics to facilitate actions 2 and 3 below.

2. Initiate action with the ALCs to obtain initial listing of the system/subsystems for inclusion under Readiness Support Concept.

3. Initiate AFLC interface with AFSC to explain the Readiness Support Issue and request status of ECS under development. Criteria for selecting ECS to be identified should be developed and distributed to all AFLC organizations for their use in this effort (see 1 above).

4. In coordination with the operational users, consolidate and approve a listing of these systems/subsystems which should be included under the Readiness Support Concept. On a yearly basis, this listing should be renewed and prioritized in preparation for the POM cycle.

5. Designate responsible Headquarters agency for consolidation/maintaining Readiness Support system/subsystem listing.

4.3.2.2 Requirement 2: Determining the Systems/Subsystems ECS Software Sensitivities Through Appropriate Sensitivity Analysis Studies and In-House Efforts

Typical systems which fall under this category are OFP's of fire control radars, AWACS, E-4, JTIDS, GPS, Seek Talk and the various cruise missiles. Specifically, the studies should address the following functions.

1. System/subsystem vulnerabilities as a function of changes in the actual/expected/possible adversary ECM waveform, numbers of systems, and tactical employment of these systems.

2. Possible generic ECS software alternative which could be used to offset the changes discussed in 1.

3. Specific intelligence collection and analysis efforts which should be initiated in order to: complete 1 and 2; alert the system/subsystem manager of significant changes in the threat environment which could impact on system/subsystem perfromance; and, protect against adversary technological surprise while laying the foundation for preemptive engineering efforts.

Recommended Actions

1. Using prioritized listing obtained from actions in support of Requirement 1, funding for sensitivity analysis studies should either be identified from existing sources or programmed into future POM requests.

2. Issue Statement of Works (SOW's) for selected systems/subsystems sensitivities analysis studies. (Headquarters oversight of these SOW's should be maintained to ensure different studies are supportive, minimize duplication, and request similar actions/deliverables.)

3. Include as part of all future PMD's the requirement that sensitivity analysis data be provided as part of the development process.

4.3.2.3 Requirement 3: Establishing the Capability and Resources Required to Receive, Store, Produce and Analyze System/Subsystem-Related Classified Intelligence Data

This effort should be accomplished in conjunction with AF/IN, Foreign Technology Division (FTD), National Security Agency (NSA), Defense Intelligence Agency (DIA), and the operational users. In the area of AFLC resources required to support this capability, the following comments are offered.

1. AFLC Headquarters. Currently AFLC has within the AFLC/XR organization, a core capability to build the necessary Headquarters support around. Areas this group should address include: policy formulation and AFLC/Air Force regulation writing/modifications; interface with AF/IN in the areas of ALC engineer and staff access justification, "billet" authorizations, and ALC vault and secure communication requirements; consolidation and formulation of AFLC collection and analysis requirements; consolidation and formal submissions of AFLC data base and distribution requirements; and training and guidance to ALC staff and engineers in the intelligence process covering the spectrum from requirements definition to information dissemination and storage. Exact size and specific makeup of this headquarters staff cannot be determined without the formal assistance of AF/IN.

2. ALC. Within the various ALC's, a staff function must be established to perform the following:

   a. Receiving, processing, storing, and safeguarding classified intelligence;

   b. Actually writing the "billet" justification requests, providing access briefings/debriefings, and maintaining access authorization;

   c. Writing and submission of the ALC's intelligence collection/analysis requirements;

   d. Intelligence data base storage and access support;

   e. Day-to-day screening and processing of new intelligence data; and

   f. Interface on behalf of the ALC management and engineers with "classic" intelligence organizations.

Recommended Actions

1. Initiate formal discussions/briefings with AF/IN. Purpose is to inform AF/IN of the problem and solicit support in the following areas.

   a. "Billet" justifications

   b. Clearances

   c. Secure communication, storage, and vault requirement definition

   d. Intelligence AFSC identification and authorization procedures

   e. POM support in Programs 3 and 6

   f. Training

   g. Understanding of sources of data and access requirements

   h. Foreign Technology Division and National Agencies responsibilities and support roles

   i. Data base(s) status and procedures for establishment/modifications

   j. Air Force Intelligence Service (AFIS) operating locations (OL) responsibilities and available support; specifically, AFIS OL-F and OL-N at TAWC and Electronic Warfare Center have AF/IN support responsibilities which may be directly applicable to the AFLC problem

   k. AFLC Headquarters and ALC Staff responsibilities and functions as they relate to the Air Force Intelligence Support Mission

   l. Collection, analysis, and production requirements process

   m. Definition of roles and missions

   n. Idenification of special access requirements

2. Established contact with NSA/WO7 and DIA/DT-4C. These organizations are specifically tasked within their respective agency with the responsibility of interface with their operational users. It is important that the Headquarters AFLC and ALC staff understand these organizations responsibilities and support roles.

3. Establish contact with the operational users (TAC, SAC, MAC, ADTC) for purpose of making them aware of the readiness support issue and intelligence requirements. This is extremely important due to the fact that these users historically have stated the Air Force intelligence require-

ments for collection, analysis, production and data base definition. They are, therefore, very much aware of the procedures and problems in this area and can serve as a great source of information and assistance.

4.3.2.4 Requirement 4: Obtaining the Necessary Access to the Required (3 Above) Classified Intelligence Data

Volume II (Phase II report), provides insight into the type access required. Specific justification must be written for the necessary engineers and managers. AF/INS and AF/INY can provide valuable assistance in this area; however, prior to initiation of activity in this area, Headquarters AFLC should ensure that AF/IN fully understands the AFLC initiatives and needs in this area. Formal message traffic and appropriate educational briefing/discussion between Headquarters AFLC and AF/IN should be initiated. (Actions required in this area are outlined under Requirement 3.) A clear understanding of the AFLC requirements and full AF/IN support is essential in this area due to the physical constraints associated with current Air Force "billet" authorizations. It is very possible that a formal Air Force request for additional Air Force billets, along with proper justifications, may be necessary. In such a case, AF/IN must fully understand and be in a position to submit, justify, and defend such a request.

4.3.2.5 Requirement 5: Establishing the Capability to Determine the Impact of Actual or Suspected Threat Data on the System/Subsystem ECS Software

This includes the establishment or modifying of Integrated Support Stations (ISS)/Integration Support Facilities (ISF) to allow the stimulation of the system/subsystem software by representative threat data. In addition, appropriate data reduction capabilities must be developed/modified to support this effort. Required ECS change/modification response time†

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†Refers to the maximum length of time available to accomplish the four activities depicted in Figure 4-16 and provide the ECS change to the field. In most cases, this "response time" will include considerations of the following factors:

a. Operational users requirements based upon: the systems/subsystems mission; operational scenario; and system/subsystem numbers and backup procedures. (In almost all cases, the Operational Users Requirements dictate the response time.)

b. Communications availability and mediums.

c. AFLC/ALC system/subsystem support capabilities. [Careful consideration must be given in this area to ensure that limited support capabilities do not unrealistically restrict (a) above. In most cases, (a) dictates the modification/development of the required support capabilities and serve as justification for these capabilities.]

of the various systems/subsystems identified under Requirement 1 is a key factor in determining the type ISS/ISF development/modification effort necessary in this area.

Recommended Actions

(Same as those for Requirement 6.)

4.3.2.6 Requirement 6: Developing Within the Various ISF a Stimulus Device for Simulating the Actual/Suspected Threat Environment

The readiness support requirement dictates that parametric stimulus devices be used in conjunction with and in preparation for ECS software evaluation/modification work. These stimulus devices can range from very elaborate open loop/close loop simulation systems which support an entire ALC or system, to straightforward simulation at the subsystem IF level. The type device/devices required must be determined as a function of: ALC responsibility, system/subsystem relationship and physical support locations, and system/subsystem complexities and readiness support priority.

Recommended Actions

1. Using the approved system/subsystem list from Requirement 1,† the operational users, at the command level, should be queried for their response time requirements on a system/subsystem-by-system/subsystem basis.

2. Initiate HQ AFLC actions to consolidate and obtain user coordination on the required response time for each system/subsystem. This list should be reviewed periodically (yearly) and forms the basis for future resource justification and PMD actions.

3. Current support capabilities for the system/subsystem identified in 1 and 2 should be solicited from the various ALC.

4. Contractual efforts should be initiated by the various system/subsystem managers to ascertain current support deficiencies in the form of specific recommendations and top level specifications for individual support station (ISS) data reduction capabilities, software tools development, and stimulus devices acquisition/development. In addition, this contractual activity should provide recommendations as to the ALC approach to this problem as far as individual ISS, ISF, and/or ALC requirements. For example, these recommendations should address the issues of individual stimulus, software tools, data reduction capabilities on an ISS versus ISF versus ALC basis.

†The results from the various sensitivity analysis studies (Requirement 2) will also have an impact in satisfying Requirement 6; however, it is not necessary to await the results prior to initiating activities associated with this requirement.

5. Data obtained from 4 should be consolidated by HQ AFLC and used for POM considerations.

6. Initiate contact with the ASD Simulator SPO to obtain support in future stimulus development efforts. Specific areas of support include: providing inputs as to desired results of 4, and funding support in 4 and future development efforts.

7. HQ AFLC as a participating command in the Air Force simulation validation should ensure that any/all stimulus devices developed in support of this concept are included in the Air Force simulation validation program.

4.3.2.7 Requirement 7: Use of Flight Test Data in Evaluating System/Subsystem Software in a Threat Range Environment

In many cases, this requires the development and installation of flight data recording and associated data reduction equipment onboard various aircraft. With the development of the Electronic Warfare Close Air Support (EWCAS) Range, and future SAC and TAC range development programs, this requirement becomes even more important. Embedded within this requirement is a necessity to investigate the feasibility of designing the capability to record ECS memory and register data during actual flight tests. This would allow the systematic evaluation of actual system/subsystem performance against the ECS's operation/performance at both the Blue Tape (Mission Data) and Red Tape (OFP) level in a dynamic range environment. The advantages of this approach versus the traditional ISS approach are in the area of system/subsystem performance as a function of the actual flight environment; provided, of course, the flight environment includes a realistic simulation of true combat conditions, especially the electronic environment. (See Requirement 12.)

Recommended Actions

1. As this area may require both advance technology and actual avionics system development efforts, AFLC should initiate contact in the form of a request for support with both Air Force Avionics LAB and the ASD development community. Specific AFLC requests should be in the form of requirements for ASD/AFAL to investigate the feasibility of designing the capability to record ECS memory and register data during execution of the ECS (Blue Tape) and OFP (Red Tape) under actual flight conditions. The feasibility study should address

   a. State of technology in this area,

   b. Complexity of retrofitting such a capability to systems/subsystems identified in Requirement 1, and

   c. Desirability of including such a requirement as a basic element in the development of all future ECS systems.

2. Initiate actions at the system/subsystem manager level to install flight data recording and associated data reduction equipment aboard the key aircraft.†

3. Initiate actions to modify existing ISS/ISF in response to 2.

4.3.2.8 Requirement 8: Obtaining Operational User Support

As Figures 4-15 through 4-19 illustrate, a key player in this area is the operational user. With one possible exception, the investigation of this issue indicates that the operational user is largely unaware of the significance and magnitude of the readiness support issue on his combat capability. The one exception is in the EW category, wherein the operational community is heavily involved and knowledgeable of the WR MMR EW support role. To be successful in obtaining the resources required to perform this readiness support and to ensure Air Force organizational roles and mission are understood and accomplished, AFLC should solicit immediate involvement by the operational user and Air Staff in this area. In addition to conducting an educational dialogue with the operational user concerning the complexity, expense and criticality of the readiness support issue, AFLC must obtain timely operational scenario data for use in determining/evaluating ECS software changes.

Recommended Actions

1. Initiate formal discussions/briefings with the operational users (TAC, SAC, MAC and ADTC). Purpose would be to inform the operational users of the issue/problem and solicit support in the areas of

   a. Future POM requests,

   b. Operational scenario data, and

   c. Assistance and coordination on the prioritized system/subsystem list obtained from Requirement 1.

2. Request the operational users to identify this issue as a readiness support requirement in future POM activities. In addition, support for the particular system/subsystems identified under Requirement 1 should be ranked accordingly in the operational users POM request.

3. Request definitive partitioning of responsibilities in this area. Figures 4-14 through 4-19 should be used to articulate this partitioning.

†Key aircraft can be obtained by reviewing the prioritized list obtained from Requirement 1 along with discussion/coordination with the operational community.

4. Request parallel action within the operational user community to support this activity. This action could take the form of identification of focal points/responsible agencies along with their specific functions. An example would be the designation/establishment of an organization within the TAWC similar to TAWC/ERW whose responsibility is operational support to fire control radars ECS mission data.

4.3.2.9 Requirement 9: Establishing Preemptive Engineer Capabilities

Preemptive engineering involves the "art and science" of preemptively engineering expected ECS software changes based upon predicted/postulated and highly classified technical intelligence data. To accomplish this activity requires most of the capabilities discussed in Requirements 1 through 8 above with the key ingredient in all these areas being access to highly sensitive intelligence data at the ALC lead engineer/staff level.

Recommended Actions

1. Initiate the required actions under Requirement 1 through 8.

2. Initiate formal action with the Air Staff, the operational users and Air Force Intelligence to define a coordinate Air Force concept of operations in this area. Following are specific areas which should be addressed under this concept of operation.

    a. Systems/subsystems to be included. Requirement 1 provides the basis for this list.

    b. Sources of the intelligence estimates the procedures for obtaining Air Force approval of the estimates. This is especially important due to the funding impacts and DOD Directive 4600.3 and 3100.9

    c. Roles and mission and associated responsibilities.

    d. Air Force Regulation impact. To be supportable, this concept must be included in the appropriate Air Force Regulations. Regulations which should be renewed and possibly modified are the 800 series and 200-1.

    e. Funding options and POM procedures.

4.3.2.10 Requirement 10: Enhance/Develop the Integrated Support Stations/Integrated Support Facility Concept to Respond to the Readiness Support Requirement

This requirement is illustrated in Figures 4-17, 4-18, and 4-19 with its subelements discussed in the following paragraphs.

1. The Recognize Change Requirement Function and its implications on the ISS/ISF concept is discussed under Requirement 1.

2. Figure 4-14 and the activities of: reviewing the situation description (Box 2.1); reviewing the system/subsystem ECS software flexibility (Box 2.2); and determining the ECS software alternatives (Box 2.3), require additional software tool development in the area of analysis, data base management, emulation, and data reduction. Of the tools mentioned, the development of the ones associated with emulation and data reduction are the most critical in the near term. Automated data base management tools should be developed/enhanced to provide historical engineering data associated with the recognize change requirement and assess the situation (Figures 4-17 and 4-18) activities and also to provide access/storage of programmatic and technology related data (Figure 4-18, Box 2.3). Correctly constructed, the data management tool discussed should provide the AFLC manager, and the system/subsystem lead engineer and his staff with fingertip access to historical data associated with the system/subsystem of concern. The time of response associated with such systems/subsystems as fire control radars, OFP's, AWACS, E-4, JTIDS, GPS, EW, and ATD dictates the development of such tools.

Recommended Actions

1. Initiate the actions required to develop emulation and data reduction software tools for these systems/subsystems listed as a result of Requirement 1

2. Initiate contractual activities to develop the top level specifications for an ECS automated data base management system. As discussed in other sections of this study, such an automated data base management system is required to support the entire ECS effort. Readiness support is only a subset of this larger requirement.

4.3.2.11 Requirement 11: Ability to Provide ECS Software Configuration Management Control During Crisis/Quick Reaction Periods

To appreciate the significance of this issue under the readiness support concept versus the routine day-to-day AFLC operation, one must envision changing ECS software to various system/subsystem MODS in a matter of hours or days while attempting to maintain CM procedures. The EW category again is a prime example of the complexity associated with this area, particularly in a crisis/conflict environment where WR MMR must rapidly modify and CM the various radar warning receiver versions/MODS. Loss of CM during this type of activity could be detrimental to the combat capability of a particular weapon system. From another respect, consider the F-16 and F-15 radars and their various MODS and the requirement to quickly modify and CM changes to these systems. To fully understand this area, AFLC should initiate efforts to monitor and document exercises associated with ECS software changes under stress conditions associated with QRC/limited time response. EW "Loud Byte" exercises offer an excellent "first cut" insight into this problem area.

Recommended Actions

1. Initiate efforts to conduct a "Loud Byte" exercise for the purpose of documenting CM problems.

2. Develop and conduct an exercise of a rapid change to a fire control radar OFP. Use the timing data developed under Requirement 6 for establishing the exercise scenario.

3. Based upon this documentation, draft top level requirements for a CM system specifically tailored to the readiness support requirements. Again, the purpose is to document CM problems.

4. As the final products of this effort are top level specifications, AFLC should consider contractual efforts to satisfy this requirement.

4.3.2.12 Requirement 12: Develop a Compatibility to Rapidly Update Training Ranges, Threat Simulators, and Aircrew Training Devices

Without a highly trained operator, familiar with the electronic battlefield, the most up-to-date weapon system cannot meet the challenge of todays needs. If it is possible to change OFP parameters in hours or days, then training facilities should receive similar attention. The need for realistic training was clearly stated by the Joint Chiefs of Staff in MOP-185. "Training, exercises, and testing are essential elements of military preparedness and must receive continued emphasis during peace time." AFLC should initiate efforts to keep range simulations, jammers, and evaluation tools up-to-date with enemy capabilities.

Recommended Actions

1. Establish a system for identifying potential training range equipment deficiencies by comparing the baseline with enemy threat data. (See Requirement 9.)

2. Develop a capability to support the TAF/SAC/ECS by providing realistic EW and C^3 countermeasure training and exercise evaluation tools.

3. When new threats are encountered, develop a quick reaction capability to update ECS software in threat simulations.

4.4 ECS SUPPORT NETWORKS

There is an ever-growing need for information exchange between the various ECS support elements of AFLC. Technological improvements in recent years have pregressively made data networks more cost effective. The purpose of this section is to present information to facilitate AFLC's consideration of the kind of networks needed and an approach to acquiring these networks.

The first data communications systems, established some two decades ago, used the telephone voice network. The telephone network is an invaluable resource capable of bringing computer power to wherever there is a telephone. Certain problems prevent the telephone from being the panacea to all networking requirements. An example of these problems is noise. The human ear is a magnificant terminal, thus it filters out extraneous noise and accepts only the relevant information. Computer terminals are not that discerning and often misinterpret noise as meaningful data which result in errors. Just as the telephone network was established for voice communications, AFLC's networks should be established for data communications.

A computer network is a tool. It is a provider of a service that is used by the programs running on the network. In contrast to a computer operating system which provides such services as a file system and program schedules, a network provides the service of communications. Networks provide or create a mechanism whereby programs and resources residing in computers attached to the network may communicate and exchange information. To design a network without taking into account the characteristics of this communication and the requirements of the communicating resources would be a fruitless task.

The ideal network design approach begins with an examination of user-level requirements. These requirements must take into account the functions and performance as well as availability and flexibility. In other words, user task requirements are extended into a set of network functional requirements. The functional requirements are decomposed into layers using the decomposition criteria of physical boundaries and available technology. Specific algorithms are designed for the functions while considering the degree of centralization, level of dynamic operation, and supported topologies. All this is done with the goals and requirements of the users and the network system in mind. For the functions that are now distributed, protocols are designed meeting the requirements of the algorithms. The layers are then placed one upon another, their interactions examined, available technologies and services investigated, and the design process reiterated until a balance or compromise is reached between the user interfaces, system goals, and available service mechanisms. This is the process of designing a network architecture. In reality, the process must also deal with individual personalities, political interests, parochailism, and other possibly conflicting goals.

Although the material presented in this section may seem to apply more broadly to long distance networks, the actual difference between local and long distance is so small that the discussion can apply to both network types.

A local network is a data-communications system designed to interconnect computers and terminals over a restricted geographical area. At a technical level, the problems involved in designing local networks are not very different from long distance networks, but the parameters are different. Some of the differences are

- Higher transmission rates (the communications network and transmission medium are generally not bottlenecks),
- Lower delay (delivery delays are shorter),
- Lower error rates compared with typical long distance transmission media,
- Lower cost to interconnect terminal and computer equipment, and
- Greater use of broadcast or multi-address communications.

From an organizational perspective, a local network is likely to be designed and implemented by a single organization. Likewise, a single organization is likely to be responsible for its operation. This results in a much higher degree of control than can be expected in a long distance network, eliminating such problems as coordinating changes among several different groups, the "finger-pointing" problem of fault diagnosis, etc.

It is clear that there is no sharp division between long distance and local networks; rather there is a continuance in which smaller geographical areas are served with higher speed, lower cost interfaces.

The outline of this network section is depicted in Figure 4-20. This pictorial description shows that the current ECS support posture coupled with long range objectives combine into total ECS support requirements for the future. Networking can assist in the solution of a portion of the total ECS support requirements. The actual network design will result from consideration of the elements of design shown as contrasted with each other and with the network requirements themselves. Finally, a recommended sequence of necessary activities to acquire the data network(s) is listed.

4.4.1 ECS Support Networks Requirements

The requirements for AFLC data networks are the product of the composite of automation of ECS support processes, modular ISF's, training system, and all other considerations which alleviate current and projected ECS support deficiencies. This requirements section translates all these items into functional requirements for data networks. Specifically, each ECS support requirement will be reviewed for its applicability to a partial or whole data networking solution.

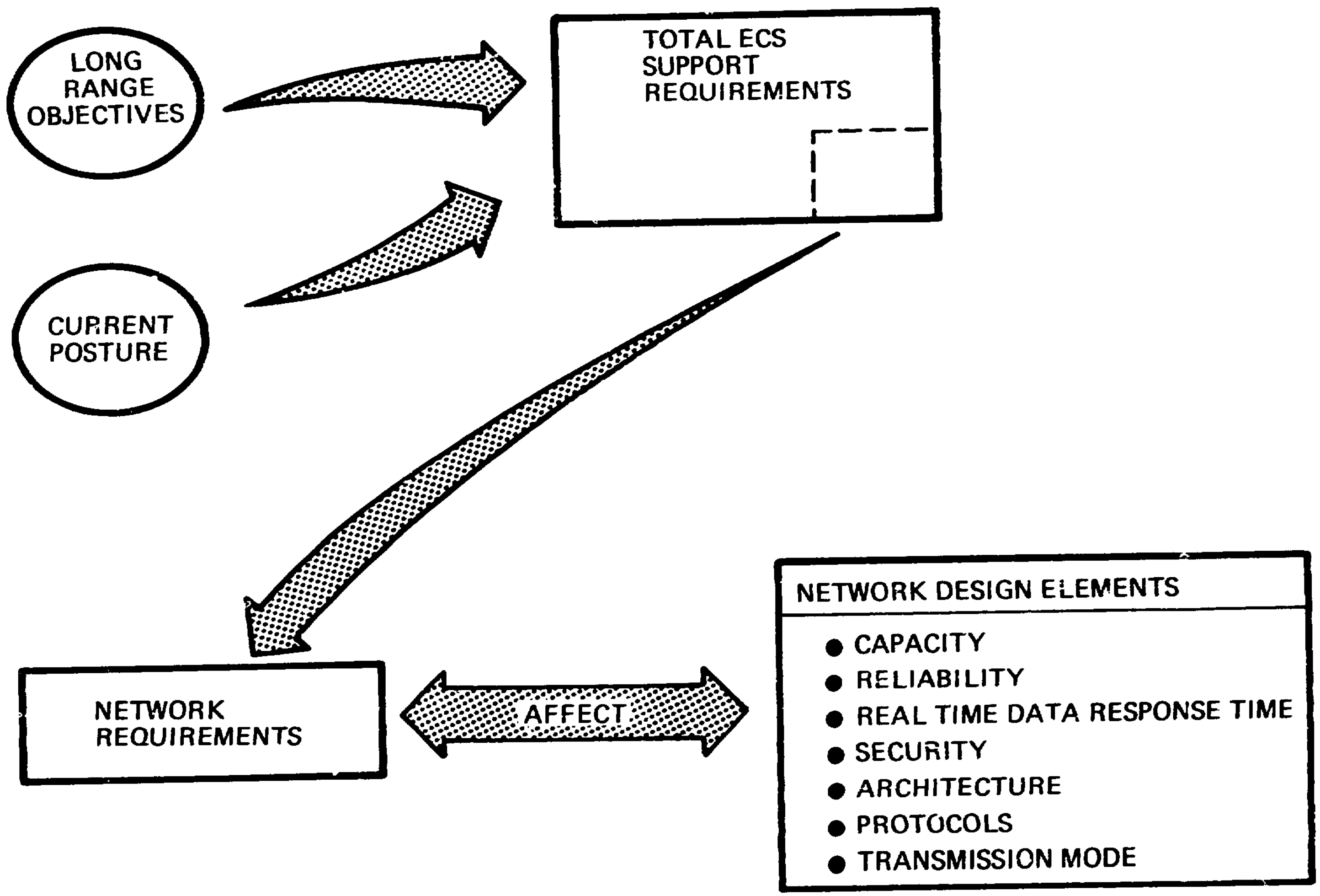

Figure 4-20. Evolution of Network Design

The composite of these requirements reviews indicates the total network requirements. For ease of reference purposes, each requirement reviewed is assigned an identifying number. Functional ECS support requirements for data networks will be related to these identifying numbers.

4.4.1.1 Requirement 1: ECS Change

This requirement is made up of the subelements of : receive and process change ECS software requests, preliminary analysis and problem/deficiency definition, and preliminary resource allocation and scheduling. Each of these subelements implies use of a large data base located at either a local and/or AFLC site. There is a further implication of data and software exchanges between two or more locations. Data networks could provide some support to all of these subelements via providing easy accesses to data bases and an expedient communications media for exchanging intelligence information, system status, and software algorithms.

4.4.1.2 Requirement 2: Change Analysis and Specification

This requirement involves an examination of the ECS change for its feasibility, definition, design and a proposal. Primarily the envisioned design must be related to an existent baseline and broken into work packages. Data networks could provide support by providing a repertoire of software tools, configuration management assistance, management information, documentation assistance, and access to common and unique data files. This appears to most readily apply at a local network level because of the high degree of local control and accessibility.

4.4.1.3 Requirement 3: Engineering Development and Unit Test

This requirement develops the ECS change and performs engineering tests. Networking can apply primarily at a local level to provide access to analysis software, tests, and development activities. Command-wide networks offer little promise except where the desired software may exist at an alternate geographical location.

4.4.1.4 Requirement 4: System Integration and Test

This requirement reflects a testing of the amended ECS to ensure the previous capabilities were not adversely impacted by adding the ECS change. Both the original and the updated baselines are often checked against a test scenario, the performance noted, and the results published. Networking can provide significant support capability to all of these activities by maintaining baseline description data, change description data, test scenarios, and linking various levels of data bases.

4.4.1.5 Requirement 5: Change Documentation

This requirement actually accomplishes baseline documentation revisions. Networking can apply through: interfacing user elements to baseline description contained in repositories and working sites, supplying management information, ensuring that approval of the revised documentation is accomplished, and ensuring that revised data is properly linked to the appropriate data bases.

4.4.1.6 Requirement 6: Certification and Distribution

This requirement is primarily an administrative one, however, networking can easily support this type of requirement.

4.4.1.7 Requirement 7: Rapid Reprogramming

This requirement applies to all ECS categories except ATE. It further indicates that routine changes or support may be reprioritized if proper urgency exists and that tools may need to be quickly available. Additionally, some data may need treatment as classified data. Networking at local levels will significantly enhance prioritization of tasks, sharing of resources, and classified processing/storage.

4.4.1.8 Requirement 8: Respond to Frequent Changes

This requirement stems from a rapid accumulation of change requests which exceeds the reaction or development time for the changes. A block change approach can be used to alleviate the problem and thus networking can readily contribute by: providing quick access to a general data base, configuration control of baselines and the block changes, quick access to change tools, and an expedient exchange of information.

4.4.1.9 Requirement 9: Improved Intelligence Responsiveness

This requirement indicates direct linkages are required from intelligence data sources to ALC's so that accurate, rapid interpretation of the data may be applied to the ECS weapon system. Networks can provide: the ready access required, a classified data handling capability, automatic routing of message and data traffic, a commonly accessible data base. Local and long distance networks have some application.

4.4.1.10 An Improved Documentation System

This requirement is related to automating documentation to a practical extent. A large, easily accessible data base is necessary with quick transfer of data to user points. Certain software programs should also be transferable to users to allow added documenting capability. Networking at both local and command levels can significantly aid in satisfying this requirement.

4.4.1.11 Requirement 11: Improved Configuration Management System

This requirement is related to a standardized configuration management for all of AFLC with maximization of automation capabilities. A large, easily accessible data base is necessary with quick transfer of large amounts of data to user locations. Configuration control of master software can be accomplished by confining data base update capability to the master controller only. Networks can significantly assist in meeting this requirement.

4.4.1.12 Requirement 12: Improved Management Information System

This requirement encompasses that set of data that provides status, progress, and/or accountability information to all management levels. The data must be kept current and in an easily decipherable format. A large data base is envisioned that minimizes daily or periodic update efforts by worker levels. Networking can significantly assist in meeting this requirement.

4.4.1.13 Requirement 13: Software Support Tools

This requirement includes software routines, algorithm, and models to enable more expedient changes and/or development. The total data may be dispersed to several geographic locations or at one large data base. Networking can enable ALC-to-ALC transfer of these tools plus expedient access to any common data base.

4.4.1.14 Requirement 14: Software Repository

This requirement exists to ensure that copies of master software are located at multiple geographical locations. The software dispersement precludes calamitous results to a development or support program should the master be inadvertently destroyed. Networking car facilitate a dispersed repository with the capability of rapid transfer of any needed software from network nodes.

4.4.1.15 Requirement 15: Modular Integration Support Facility (ISF)

This requirement, by its nature, inherently contains a local network. If more than one modular ISF is used, then a long distance network can be used to link them together.

4.4.1.16 Requirement 16: Skill Concentrations

This requirement indicates some coagulation of expertise, manning, hardware, and/or software will occur at the various ALC's. The expedient exchange of data between the ALC's will necessitate some form of networking.

4.4.1.17 Requirement 17: Improved Training System

This requirement is an attempt at gaining productivity without expanding manning resources. Productivity is to be gained by enhancing individual or group expertise through training efforts. Networking can enable extensive and expedient data exchanges between teachers and pupils or between data bases and data users.

4.4.1.18 Requirement 18: Improved Management Communication

This requirement includes such capabilities as teleconferencing, electronic mail, and automatic routing of data. Primarily, these capabilities can assist in management decision making plus provide a more cost effective approach to group meetings than air or ground travel. Networking can accommodate these capabilities, at both local and long distance levels.

4.4.1.19 Requirement 19: Other

This requirement includes considerations for modularity, standard equipments where practical, interoperability, network extendability, etc. Any or all of these can be assisted by properly designed networks.

Table 4-8 indicates a list of the network task requirements concluded from examining the 19 ECS support requirements in view of the relationship of the long range support objectives defined by Appendix A. From the table, one can conclude the tasks which a local or command-wide network will be required to accomplish or support. These tasks are relatable through the ECS support requirements directly to the overall support objectives as indicated in Table 4-8. Table 4-9 indicates the results of consolidating the network tasks requirements together.

4.4.2 ECS Support Networks Elements and Design Alternatives

Network design decisions are generally based on network performance requirements, number of nodes in the network, the method of nodal interconnectivity, operating parameters, and any special considerations such as availability, configurability, and network security. Once network requirements have been defined, a set of specifications can be developed which, in turn, are used to design the network. The network may either have to be developed from scratch or existing communications capabilities may be used to form the backbone or starting point for a full capability.

The following sections describe the key elements on design considerations used to scope the network performance. Parameters discussed are network capacity, reliability, responsiveness in real time, architectural software and hardware layering, teleconferencing capabilities and security features. In addition, several network categories and network components are described

Table 4-8. List of Network Requirements

Support Requirements*	Individual Support Requirement Related to Network Requirements	Command Wide	Local
1	• Large data base • Expedient communications (intelligence, information, system status, software, algorithms)	X	
2	• Repertoire of software tools • Configuration management info. } Data Base • Management information } Data Base • Unique and common data files } Data Base • Documentation assistance	X	X
3	• Software analysis tools • Test software		X
4	• Test scenarios • Baseline data • Change data	X	X
5	• Repository data • Configuration management system • Documentation assistance • Data base revision	X	X
6	• Nodal linkages • Status accounting data	X	X
7	• Prioritization • Classified processing • Software tools access		X
8	• General data base • Configuration management • Software tools • Rapid data exchange		X
9	• Intelligence data exchange • Commonly accessible data base • Classified processing • Automatic message or data routing	X	
10	• Large data base • Transferable software • Rapid data transfer	X	X
11	• Large data base • Rapid data transfer • Master control (restricted data base update)	[illegible]	X
12	• Large data base • Easily updated and accessed	X	X
13	• Software tools • Possibly geographically dispersed • Rapid copy and exchange	X	X
14	• Large data base • Control of masters • Geographical dispersement	X	
15	• Modularity • Data bus		X
16	• Localized specialization • Expedient data exchange	X	X
17	• Remote instruction • Expedient data exchange • Large block data exchanges	X	
18	• Electronic mail • Teleconferencing • Automatic routing • Large data base	X	
19	• Modularity • Standardization • Interoperability • Network expansion	X	X

*Numbers refer to individual requirements discussed on previous pages.

Table 4-9. Summary of Network Task Requirements

• Develop a readily accessible, large data base
• Provide an expedient communications link between nodes
• Provide support to such ECS support capabilities as configuration management, management information system, automated documentation, training, system engineering, modular ISF's
• Provide classified data handling capability
• Provide prioritization capability
• Support activities such as electronic mail, teleconferencing, automatic routing
• Provide gateway linkage to local networks
• Provide modular expandability
• Emphasize standardization and commonality where practical
• Provide common, shared, and node-dedicated data storage capabilities

including an overview of interrelationships between the previously discussed major elements.

4.4.2.1 Network Capacity

Each of the 19 ECS support requirements summarized in Table 4-8 affect network data capacity to some degree. Network capacity is defined by both communication data exchange rates and total storage. Also, capacity is a function of memory/disk size and communications bandwidth. At this point, the purpose is not to develop specific capacity figures but to present an approach whereby these figures may be derived.

Figure 4-21 illustrates the procedures to be followed to determine network capacity. Step 1 in determining necessary capacity is to define the tasks to be accomplished or supported by the network. Examination of the AFLC support requirements addressed in Section 4.4.1 indicates the networks must accommodate a large data base made up of configuration management, documentation, software tool descriptions, master software, management information, etc. The requirements further indicate many rapid data transfers are likely between various network nodes. These task related parameters must be determined prior to ascertaining exact network capacities. The level of data base distribution must be determined in terms of one or more locations and the management information system, automated documentation system, configuration management system, training system, etc. must be conceptualized to develop a top level design.

Step 2 in determining the network capacities is to establish the communication interface capabilities. Beyond the basics of single or stream message transmission to support the task requirements, the communication mechanism may vary depending on implementation scheme. Because these choices affect the characteristics of the user interfaces and the structure and design of the network itself, there is an iteration and reiteration necessary between the choices and the target network tasks before specific capacity is determined. The key characteristics determining the optimal communications scheme are based on answers to the following tradeoffs.

1. Error Control. Does the communication mechanism detect errors, correct errors, notify the user of errors, or does it pass data with undetected bit errors? Does it deliver duplicate messages or does it lose messages? It appears that for most AFLC usages, a user notification of errors detected plus the message transmission would be adequate. Another request could be used to retransmit until a correct transmission is received.

2. Addressing. How is the destination of the message or virtual circuit addressed? Is addressing only to a single address, a group address, or is a complete broadcast possible? Single addressing will suffice for any AFLC or ALC inquiries to one other node and for the responding

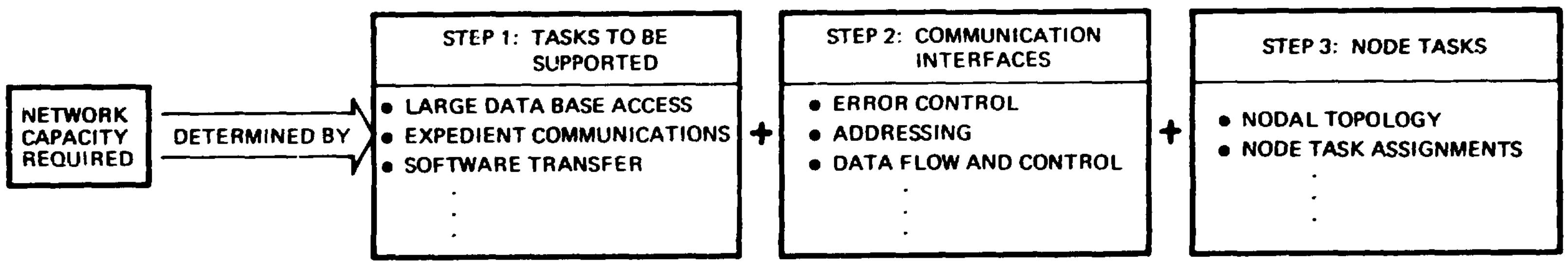

Figure 4-21. Elements Used to Determine Network Capacity

answer. Certain tasks such as configuration management, management information, etc. may require group addressing. Procedural changes or administrative data may require a complete broadcast addressing scheme.

3. Data Flow and Control. Can data be sent simultaneously in both directions? Is a flow-rate technique available? Does the communication channel provide a synchronization mechanism whereby the communicating users can identify a common time or state? AFLC support requirements do not appear to require two-way data flow, however, certain uses of group addressing appear to require simultaneous flow from a transmitting node to several receiving nodes.

4. Priority. Are there any options for priority service, multiple levels of priority, and/or preemption? Rapid reprogramming support implies use of some sort of priority scheme. The possibilities range all the way from simply revising the queue of requests to actual message interruption with recognition of the point where interrupted to allow continuation of the original tasks after the priority task is completed.

5. Security. Does the communication service offer any security mechanisms such as data encryption or password validation? The requirement for increased focus on intelligence data indicates that networking, in some manner, will likely be required to support encrypted data. Current intelligence data networks used by FTD, DIA, etc. use encryption devices. AFLC can justify itself as a user and thus be included as an add-on to one or more of the existing networks. For disseminating intelligence data among AFLC nodes, encryption devices will be necessary at the appropriate nodes and exchange rates will likely be affected.

6. Delivery Guarantees. Does the mechanism guarantee delivery of messages? Can the sender obtain a receipt of delivery or a notification of failure or inability to deliver a message? This is a similar consideration for error control except it is more oriented toward the transmitting side of a message exchange. The concept used to alleviate this problem could impact data exchange rates.

7. Topology. (Topology defines the specific nodal interconnectivity, i.e., ring, star, etc.) Are there any restrictions based on location or topology? Who is addressable from a particular user? Can users on nonadjacent nodes communicate via the mechanism? The topology of the network is an important factor to consider in the design of the AFLC network architectural structure as well as the placement of the data base and processing functions. The amount of centralization or distribution relates to the efficiency of network operation and control. This interconnectivity determines where any switching nodes or routing functions are incorporated into the network.

The choice of options at the communications interface level is obviously dependent on the task or application requirements and the technology from which the communication mechanism will be constructed. A general purpose design must take into account a wide range of tasks and examine their communication requirements. AFLC local networks may use only specialized networks dedicated to a single task or function. However, it appears a command-wide network should be based on a more general purpose architecture.

In step 3 where network capacities are determined, tasks are allocated to individual nodes. The task distribution consideration includes both the communications interfaces as well as task requirements. Furthermore, there is a need to solidify the topology of the network. Hence, the combination of topology, assigned tasks to each node, and communications interfaces between nodes define the capacity demands on channels between any two nodes or sets of nodes. This combination means that nodes (or ALC's) must be assigned responsibilities for items such as configuration management, automated documentation, etc. Also, the concept of data exchange between the various nodes should be defined. Once the data exchange concept is determined, the topology (nodal interconnectivity) can be defined.

In summary, the three steps to determine network capacity are; definition of network task requirements, establishment of communication interface mechanisms, and assignment of tasks to nodes. These steps will provide a preliminay determination of capacity.

4.4.2.2 Network Reliability

Reliability is a quality of networking that should be an inherent consideration during network design and development. This implies that the generalized goals of reliability are known and published prior to the design phase. Experience has proven that improved reliability is achieved where design goals were established prior to development rather than where reliability was a fallout of the system design process.

The following points are realistic design goals in terms of reliability.

1. Failure of any particular node will not render the network inoperative.

2. Optional or alternative interconnection paths between nodes can be established and ensured if the primary or direct path is inoperative.

3. Stored data will be preserved in spite of electical failure.

4. Communication must occur between two nodes without store-and-forward functions at any other station (only for circuit switching).

5. Master data can be accessed with an inquiry but cannot be changed except via an approval/change loop.

Unless these design goals are considered, the network will potentially lack adequate reliability. Reliability along with ease of use and cost effectiveness are all key factors in acquiring a network that will be willingly and widely used.

4.4.2.3 Real Time Data Operations

Real time data operations is defined as activities and/or support functions which, without any significant time delays, use data as it evolves or changes. Examples of real time applications are video conferencing and high density graphics. In either example the data generated at one location has an immediate effect upon another location or node. It is apparent that this kind of data must be transferred reliably and accurately or such capabilities are prone to be of limited value.

Local networks promise to make broad use of real time data operations. The modular ISF discussed in Section 4.2 is an example of this use.

The extent of intended use of real time data operations (RTDO's) has a significant effect upon network availability for other activities. For example, if there is a continuous need to support RTDO and the network is also used for other activities, it may be necessary to design a network with parallel channels to allow the two types of data (real time and nonreal time) to flow. A parallel channel network will be much more expensive to design and implement than a single channel. Even if a single channel design is used, there may be periods of operation for RTDO which would conflict with prioritization, regular data base updates, etc. This tradeoff must be recognized in the initial design or the network may degrade in terms of efficiency.

4.4.2.4 Network Architecture Layers and Protocols

Computer network architecture can be defined in terms of communications protocols which provide a specific set of communication services. This subsection addresses protocols and network aarchitecture.

A protocol is a set of mutually agreed upon conventions for handling the exchange of information between computing elements. These elements may be circuits, modems, terminals, hosts, processes, or people. Initially, most protocols were designed to be application-specific and were structured to perform all network operations from lowest to highest. Most recent protocol designs consist of a hierarchical multilayered structure with implementation details of each layer transparent to all other layers in the hierarchy. This aproach provides a broad (and standardized) applications base. Specifically, the multilayered structure provides the advantages of: separation of functions, segregation of responsibility for resource management, and support of evolutionary change. There has previously been considerable deviation in methods of decomposing network protocols; however, both industry and standards committees are focusing onto the same basic division of layers. The resulting model is shown in Figure 4-22. An examination

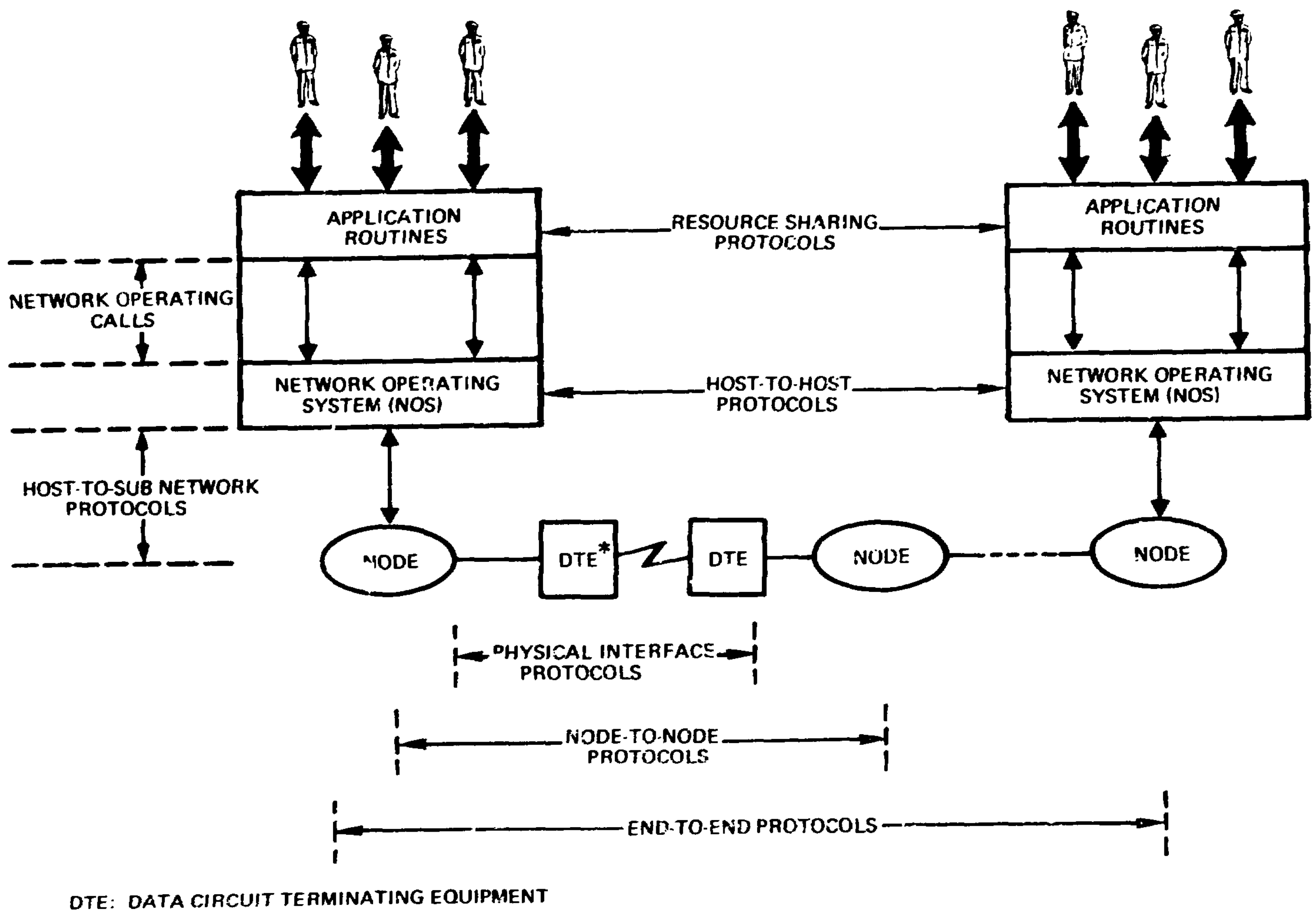

Figure 4-22. Typical Model of a Protocol Hierarchy

of the model reveals that there is substantial overlap between the various types of protocols. This has prompted the International Standards Organization (ISO) to discuss and adopt standards based upon the various protocol types. As uses of these standards become more common, refinements will be made to them until, sometime in the next few years, the various interfaces within a network can be more efficiently designed. The lowest protocol level is identified as the physical interface followed by node-to-node, end-to-end, host-to-host, and up to the highest protocol of resource sharing. This lowest to highest ranking will be referred to later in this section.

4.4.2.5 Network Architecture Structure

It is useful to address why network architectures have become so important in considering the type of network required for AFLC ECS support. Network architectures are driven primarily by changes in user requirements and the cost of computing technology. Before network architectures, individual applications were designed with unique communication interfaces. This allowed the user to communicate only with his counterpart at the other end of the network. Any attempts to connect to different I/O devices or other applications were met with difficult, if not impossible, interface and communications problems. A common communication interface was needed. (This type of interface is recommended for AFLC use.) Even though the answer was apparent, the specific parameters defining such an interface were vague; each application had differing requirements, communication was desired among heterogeneous computers, and different communication technologies were used to connect systems together. Additionally, rapid changes were occurring in relative costs of computing and communications. Computing costs were, and still are, declining rapidly, while the costs of communications were decreasing very slowly. Instead of computers being the dominant cost of a computing system, it is now the communications. This implies that more attention must be paid to communications, even at the added impact to computing, if a cost effective network is to be developed. The three factors—the desire for common communication mechanism, the development of standard interfaces, and the sharing of communication equipment-were the driving forces that led to advances in computer network architectures.

Just as in the design of large application systems and operating systems, current network design philosophy is based upon the concept of modularity and hierarchical layered structuring. The complex network design problem is divided into smaller manageable pieces or modules. These modules are chosen for easy expandability. That is, lower-layer modules create a foundation upon which higher-level modules are placed. Each layer or level in the structure uses the functions provided by the level below and provides new or additional functions to the next higher levels.

Structuring systems in this way has a number of advantages. First, it results in a simple, well-structured design. The interfaces between layers must be well-specified and documented. This helps create and enforce standards so that others can build to these interfaces and communicate through such mechanisms. Layered structures also provide the flexibility to replace layer modules with equivalent ones without affecting other layers in the structure simply by making the replacement layer compatible with the established interfaces. Figure 4-23 is a simplified example of a layered network structure.

Beyond the basic structuring concept, the design issues then become: how to decompose the functions into layers, how to determine the interface between the layers, and how to design the architectural structure to accomplish user requirements and stay within state-of-the-art technology.

As indicated earlier, this is an iterative process and the initial functional decomposition may bear little resemblance to the final layered structure. Figure 4-24 is included as an example of an already iterated structure. If the application programs represented the configuration management, training, and automated documentation systems, each application would have to interface with a routing algorithm. The routing algorithm would ensure that queries and/or data from any application would be addressed and forwarded to the proper node. The security function is an algorithm interfaced to the routing algorithm which assures protection of sensitive data. A data base management system could make up the intermediary layer between security and the physical device, such as a disk stroage. This is only given as an example and either the applications or functional layers could be something else. Note that each layer must interface upward or downward and, therefore, a protocol must be established to span each interface. With that in mind, the following discussion on protocols is offered.

4.4.2.6 Protocols

A protocol is the set of message formats and exchange rules that the layers use for control and synchronization of their communication functions. The functions performed by a layer are reflected in the interfaces to that layer. Each layer is concerned with its own function plus the interface to either an upward and/or downward layer. The following are protocol elements common to protocols at all levels.

1. Addressing. The specification or representation of the name of the source and the destination of information.

2. Error Control. The detection and recovery from errors introduced by the lower-level functions.

3. Flow Control. The management of the flow of information from the source to the destination.

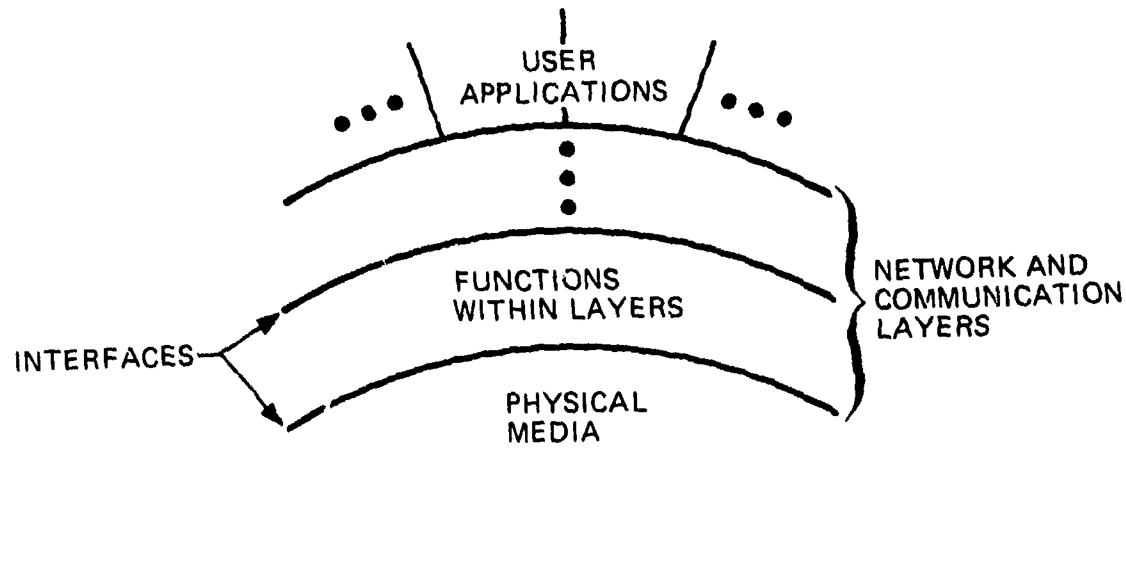

Figure 4-23. Layered Network Structure

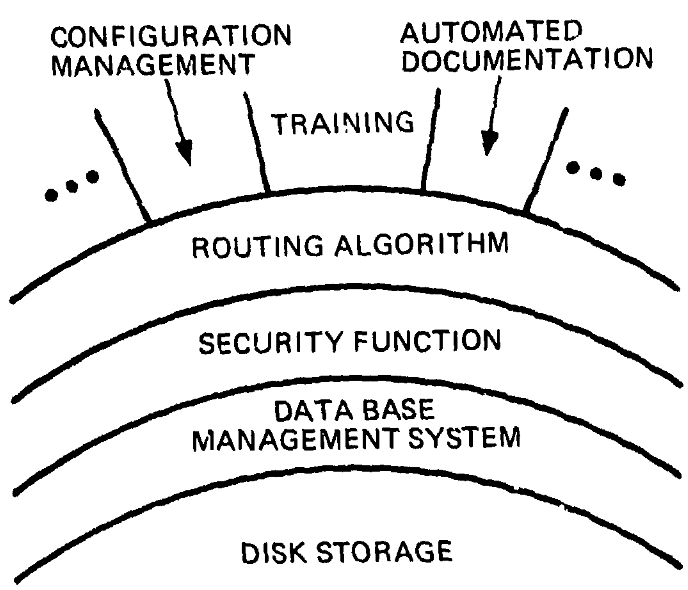

Figure 4-24. Example of AFLC Layered Network Functions

4. Synchronization. The control and/or knowledge of the state of each layer to provide a consistent state and avoid any deadlock conditions.

In addition to these elements, specific protocols may have others, depending on the particular functions they perform. Some of these are:

5. Circuit Management. The connection and disconnection of message paths or circuits.

6. Sequencing. The management of an ordered sequential flow of information.

7. Message Management. The segmenting and reassembly of messages and the management of buffers.

8. Priority. Providing differing grades of service through the communication mechanism.

9. Switching or Routing. The selection of a path from source to destination.

10. Security. Providing secure communications.

11. Accounting. Accounting for the use of network resources.

12. Information Representation. The management of the format, code set size, etc. of any information transferred through the communication mechanism.

At each level in the layered structure the requirements of the communication mechanism must be examined with respect to each protocol element. Their design will include decisions on whether functions should be completely localized or distributed across several nodes, whether resources are statically or dynamically allocated, and whether the topology of the network warrants specific considerations. Protocols are then designed accordingly.

4.4.2.7 Further Design Considerations

The two additional considerations addressed in this section are teleconferencing and security. Since each of these areas is currently under intense scrutiny in the DOD networking community, a discussion is offered here to acquaint the reader with them.

4.4.2.7.1 Teleconferencing

A teleconference is an organized interaction, through a communication system or network, of geographically separated members of a group. This term has been used mainly to refer to interactions organized or presided over by or with the aid of programmed computers. In some teleconferences, the members of the group participate concurrently; in others, each member logs in when it is convenient for him to do so, reviews what has happened in his absence, makes his contribution, and logs out, perhaps returning later in the day or week.

In recent years, a considerable amount of experience has been gained with computer-facilitated teleconferencing†, but it is a complex and subtle art, and teleconference programs still have a significant way to go before teleconferences approach the naturalness of face-to-face interaction. This capability is projected to be a reality prior to 1990 and thus lends itself to an AFLC capability. The inefficiency of traveling to meetings, the inefficiency of letting one participant take up the time of other participants when all are not interested in his comments, and the projected higher costs of travel combine to make teleconferencing attractive to AFLC. As it is further perfected, teleconferencing will be an extremely useful, important technique.

For teleconferencing to displace the conventional telephone and/or travel, it will probably have to offer speech, writing, drawing, typing, and possibly some approximation to television, all integrated into synergic pattern with extensive computer support and facilitation. Two or more communicators will then be able to control displays in certain areas of each others display screens and processes in certain sectors of each others computers. Each communicator will be advised by his own programs and will use information from his own data bases. The effect will provide each user with a wide choice of media for each component of his communication and with a very fast and competent supporting staff. The use for AFLC and Air Force management information exchanges, ICWGs, training, etc. is apparent. Planning for an AFLC network should include considerations for teleconferencing as this evolving technique solidifies into a valid capability.

Although electronic mail does not qualify as a portion of teleconferencing, it is a very desirable feature enabled by networking and its function can supplement teleconferencing. Electonic mail provides each node participant the option of sending and receiving text files to other network nodes. Users regularly "link" to each other for assistance or simply to chat. This feature will provide an invaluable assistance to generating "joint user prepared" documentation.

4.4.2.7.2 Network Security

The three basic categories of security that should be covered in a comprehensive review of the topic are

1. Physical security,
2. Administrative controls, and
3. Computer system and network security controls.

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† "Teleconferencing Systems Expected to Reduce Costs," Jay C. Lowndes, Aviation Week and Space Technology, June 8, 1981, pp. 322-333.

Physical security is comprised of those measures for protecting the physical assets of a system and related facilities against environmental hazards or deliberate actions. Facility entry contols, fire protection and magnetic media storage protection are examples of controls commonly included as physical security.

Administrative controls ensure that a system is used correctly and comprise the proper procedures for collecting, validating, processing, controlling, and distributing data. Included under this heading are data processing practices, programming practices, classified handling procedures, assignment of responsibilities, and procedural auditing.

Computer system and network security controls are the techniques available in the hardware and software of a computer system or network, for controlling the processing of and access to data and other assets. A complete discussion of this topic should include accuracy controls, personal identification, authorization, operating system security, encryption, and computer security auditing.

In addition to adequate physical, personnel, and administrative security, data in the computer system must be protected against unauthorized disclosure, modification, restriction or destruction of types shown in Table 4-10. Attacks on the data security of a system may be accidental or intertional. More accidental attacks are reported; however, these statistics are suspect because no estimates are available on the intentional (but unreported) attacks.

The protection of the data from attack through the instruction streams or programmable portions of the computer and communications systems which comprise a network is provided by the data security features of the network. The protection provided within the system may be accomplished through many types of implementation, but functionally it must include at least the following: a method for identification of a user requesting service; authorization techniques to establish a security relation between users and data to which they are entitled; controlled access methods to determine whether the user has been previously authorized to access the data and to use the requested services or programs; and a surveillance procedure to provide a record of all attempts whether authorized or not. Assurance is also required that the system itself is not modified by the user to subvert the protection features. In current systems, this integrity of the system is usually provided through combined hardware and software facilities provided by the computer architecture and the operating system design. For networks, these functions are also exactly appropriate, however, individual nodes procedures may vary slightly form other nodes and a certain amount of security responsibility dispersement is inherent in any network design.

These basic functions are intended to deter, prevent, or at least detect all of the attack listed in Table 4-10. Complete protection or absolute security cannot be achieved, because one can

Table 4-10. Categories of Attacks on Data Security

Category		Definition
UNAUTHORIZED DISCLOSURE	EXPOSURE	Accidental disclosure of data to unauthorized persons
	INTERCEPTION	Deliberate seizure of data by unauthorized persons
UNAUTHORIZED MODIFICATION	ALTERATION	Accidental change of data
	DECEPTION	Deliberate change of data
UNAUTHORIZED RESTRICTION	INTERRUPTION	Accidental denial of proper access
	DISRUPTION	Deliberate denial of proper access
UNAUTHORIZED DESTRUCTION	ERASURE	Accidental expunging of data
	ELIMINATION	Deliberate expunging of data

never be sure that some newly-developed method of attack will not succeed in penetrating the data protection mechanism of any computer system. The practical objective of data security must be to make penetration so difficult and costly that a security violator is deterred. The minimum desired protection, which may not always be attainable, is that any attack be detected. A serious difficulty is that a successful attack may leave no evidence that the system was compromised. Unlike the theft of property, the theft of data from a computer system leaves the data in the system and apparently untouched.

Before a user is permitted to transact data processing functions in a secure system, identification and authorization must be made and recorded in the access control tables. The access control tables, often called the security profile, when subverted, can be used to deny authorized users legitimate access to data, resources, or programs. The subverted profile can be used by a penetrator to give himself access to everything in the computer system. To prevent subversion, the programs which control the profile must be accessible only to the security office whose members are responsible for control of access to the organization's data.

In a secure system with a security profile, a user must first sign on and establish his identify. Upon identifying the user, the system has available (from the security profile), a list of all devices, data files, programs, and other resources to which the user has been authorized.

After sign on and proper identification, the authorized user's program is given access to the system (storage is allocated, system control tables are assigned, etc.) and program execution begins. When the user program requests status information, additional system resources, input/output devices, or access to data, the request is verified through the data security functions. The operating system matches the user's identification against his security profile to assure proper authorization. Each security profile indicates security level and the type of data access. Security levels permit discriminating among devices or data with respect to sensitivity or classification of the data. It is important to ensure that neither programs nor users declassify data by reading it at a high security level and outputting it at a low security level. The type of access allowed determines what users may do about the data: some may read, others may read and write, others may delete or alter data. A request which fails a security check may cause job termination depending upon data importance and the established procedures. Surveillance for maintenance of security is provided by recording all access requests for subsequent audit by the security office.

In a computer network, no one of the nodes is necessarily predominant in terms of controlling the system or maintaining security. Each node can contain several levels of data storage both directly addressable and input/output addressable. Protection of this multiplicity of data introduces a real challenge to a data security system. Special problems with networking stem from the remote location of terminals, increased resource sharing, distributed intelligence, and/or distributed data bases. The dispersion over wide geographic areas of many individuals capable of using the large number of devices to access computers multiplies the danger of security compromise.

As ALFC develops a network, the accessibility and sharing of data is obviously desirable. Yet security precautions and procedures tend to inhibit both accessibility and data sharing. This conflict indicates that security considerations must be factored into early network design. Attaching security to an existent "nonsecure" network will likely produce an inefficient network.

4.4.2.8 Network Concepts

An AFLC network must provide, as a minimum, three basic categories of capabilities: each of the three categories of networks is discussed in the following paragraphs.

Resource sharing networks. In these networks, resources on one computer are made available to or shared with another system. The resources may be physical devices such as line printers or virtual devices such as disk files. Network communications make it appear as if the remote resources are locally available. Examples of resource sharing activities include remote file access, intercomputer file transfer, distributed data base queries, and remote use of printer output devices. Communication in these networks usually occurs between a program executing in one computer and an input/output resource executing in another. In some cases, the communication involves a stream of related sequential data (such as a file transfer), while in others, short independent messages are exchanged (such as in transaction-oriented data base access). The applicability to AFLC use is in the area of shared software, common data base information, configuration management, management information system, and other uses.

Distributed computation networks. In these systems, cooperating programs or processes executing in different computers in the network communicate and exchange information in the performance of an overall larger task. This communication between the program parts is analogous to the communication between subroutines or procedures comprising large modular programs. In networks, messages are used to exchange information, while in modular programs, parameter lists or shared locations in memory are used for this purpose. Examples of distributed computation networks include real-time process control systems, specialized multiple processor systems such as a data base computer, and parallel processing structures. In these networks, communication occurs between programs executing in distinct systems. The communications may consist of short message exchanges or of transmitted streams of data. The applicability to AFLC use is in the area of AISF's, skill center concentrations, intelligence systems, data base management systems, and other uses.

Remote communication networks. These networks connect remote interactive terminals and batch entry/exit stations to processing capabilities. They usually share the communications facilities of the network in the movement of information to and from host computers. Interactive terminals usually communicate via short transaction like message sequences while batch stations transfer sequential message streams. The primary uses of these networks to AFLC requirements are interactive graphics systems, interactive training system, automated testing scenarios, and many other uses.

All these network types address comminications between the users; e.g., resources or components, residing in or connected to the network. In resource sharing network, I/O devices communicate with programs. In distributed computation networks, programs communicate with each other. In remote communications networks, terminals communicate with remotedly located host programs.

As can be seen from the discussion throughout Section 4.4, the networking capabilities to improve AFLC's ECS support are complex and very interwoven with the network tasks. Several activities have been indicated which require AFLC accomplishment of tradeoffs and/or answers prior to any valid attempts at designing a network. Since AFLC task requirements address needs which span all the categories of networks, it is important to further consider some other areas which also impact upon specific network design. Selection of one or more of these areas would, in effect, indicate a different network concept. Thus discussion is offered in the following pages concerning

- Network processors,
- Circuit switching versus packet switching communication methods, and
- Distributed data base systems.

4.4.2.9 Network Processors

Many previous attempts at networking have been to link several large capacity, general purpose computers together. Advances in computer technology and diminishing hardware costs have enabled smaller computers to segment some of the tasks of larger machines into manageable tasks to be accomplished in a cost effective manner by the smaller machines. The discussion presented here is to indicate the applications of smaller computers to some networking tasks. This consideration presents an approach at acquiring a network augmented by smaller machines as a design consideration for an AFLC network.

Simple multiplexing is implemented as an economy measure to increase the cost-effective utilization of communication facilities. More complicated algorithms and the declining cost of programmable processors have made it attractive to replace hardwired multiplexers with minicomputers. The inherent flexibility of these computers in turn made other functions possible. For example, by using the small processors as programmable interfaces or concentrators, the dialogue between these and the front end processor may be more complex. This can improve the network efficiency by permitting more sophisticated line control procedures which might enable recovery from some failure situations as an example. Some of the functions previously performed by the main computer, or front end processor, may be delegated to the concentrator giving a more immediate response to the terminal. The polling of local lines, or resolution of contending terminals, message checking and formatting, error correction, guidance to operators, and similar tasks are typical of those conveniently performed by a concentrator with a reasonable degree of processing power.

Front End Processors. In network communication many of the tasks performed are relatively simple, but highly repetitive and can make considerable demands on the time of a computer. It often proves more economic to perform these functions by a small separate computer called a front end processor. The following are main advantages of this approach.

1. The cost of hardware to attack lines is often less with a small computer, possibly because different constructional methods are used.

2. The processing load removed from the main computer will considerably increase the power available for computational purposes.

3. It becomes possible to separate the complete system clearly into two parts: the main processor and the communications network. This gives increased flexibility and may allow one part to be enhanced or replaced without affecting the other.

Concentrators. When synchronous (fixed time slot) time division multiplex concepts are extended to adaptive asynchronous behavior, a concentrator is required. Concentration basically involves store-and-forward operation wherein a buffer in the concentrator is employed to accumulate characters coming from a terminal until buffer overflow or an end of message segment signal is received. The accumulated message is then transmitted over the high speed network circuit, thus taking optional advantage of the available capacity. Error control procedures and message reassembly may be implemented in the concentrator as well as terminal speed recognition and code conversion. The concentrator may reformat the data in order to interface the different speeds and protocols of the network and terminal circuits.

Switching Processors. Switching computers are also relevant to the discussion of communications hardware. In order for a user to establish a connection with a particular computer, he can dial a unique number to make that connection or by requesting a computer to dial it by using an automatic calling unit. If a user is to dial only one number, or be connected to one leased line regardless of which computer he wishes to communicate with, then a switching computer must be employed in the network architecture. The switching computer performs the store-and-forward function, that is, a message is received en route, stored only until the proper outgoing line is available, and then retransmitted. Besides the inherent flexibility in software switching, the store-and-forward technology allows for optimum line utilization, since interprocess messages can be mixed with interprocess messages involving different host computers and terminal devices on the network. Also, the switching computer can perform other functions such as concentrating terminals and interfacing to service computers.

4.4.2.10 Circuit Switching and Packet Switching

The term "circuit" is usually used to refer to a point-to-point physical or seemingly physical path which can support continuous communications in one or both directions. For data transmission purposes, the actual transmission may employ either analog or digital technique, and, if analog, require a modern (modulator-demodulator) at each end of the circuit. Circuits are supported using a variety of media, such as copper wire; microwave links; HF, VHF, and UHF radio links; satellite links; and two-way cable TV installations. The design consideration for an AFLC network is not initially driven by the physical media so much as it is by the type of messages and data to be transmitted over the media. There have always been two fundamental and competing approaches to message exchages: pre-allocation and dynamic-allocation of transmission bandwidth. Simply stated, circuit switching relates to pre-allocated transmission bandwidth and packet switching to dynamic-allocation. The telephone, telex, and TWX networks are circuit-switched systems, where a fixed bandwidth is preallocated for the duration of a call. Most radio usage also involves preallocation of the spectrum. Conversely, message, telegraph, and mail systems have historically operated by dynamically allocating bandwidths or space after a message is received, one link at a time, never attempting to schedule bandwidth over the whole source-to-destination path. Before the advent of computers, dynamic-allocation systems were necessarily limited to nonreal time communications, since many manual sorting and routing decisions were required along the path of each message. However, the rapid advances in computer technology over the last two decades have not only removed this limitation but have even made feasible dynamic-allocation communications systems that are superior to preallocation systems in connect time, reliability, economy, and flexibility. This newer communications technology, called "packet switching" divides the information into small segments, or packets, which move through the network in a manner similar to the handling of mail but at immensely higher speeds. Economic and performance advantages over circuit switching systems have resulted in widespread acceptance of packet switching for low-speed interactive data communications networks.

The question facing AFLC is to choose which concept of switching is most cost effective and desirable. The answer to this question is derivable from the type of predominate message traffic expected on the AFLC networks. A packet-switched network only allocates bandwidth when a block of data is ready to be sent, and only enough for that one block to travel over one network link at a time. Depending on the nature of the data traffic being transferred, the packet-switching approach is an estimated 3 to 100 times more efficient than preallocation techniques in reducing to wastage of available transmission bandwidth resources. To do this, packet systems require both processing power and buffer storage resources at each switch in the network for each packet sent. The resulting economic tradeoff is straightforward: if lines are cheap, use circuit switching; if computing is cheap, use packet switching. Circuit switching is suitable for relatively long message trasmission such as message communication, bulk data transmission and digital facsimile. Packet switching is suitable for short message transmission such as inquiry response and terminal communications.

Previous discussion has indicated that, currently, communications is the larger costs (versus computing) in a network. However, if existing communication lines can be used, then perhaps there is a closer balance between the costs of communications versus computers.

4.4.2.11 Distributed Data Bases

Whenever multiple processing devices are configured in an information network, the possibility of a distributed data base exists. In the broadest sense, the data stored at all locations could be considered to form a distributed data base. However, for practical purposes, a distributed data base exists only when the data elements at multiple locations are interrelated, or if a process (program execution) at one location requires access to data stored at another location.

A distributed data base may consist of a single cor a set of information, divided into increments which reside at multiple locations. This fo... is called a partitioned data base. An AFLC example of this could be part of the configuration management system "unique" to each ALC or a training program residing partially at more than one ALC.

A distributed data base may also consist of a set of information all or selected parts of which is copied at two or more locations. This form is called a replicated data base. An AFLC example is the "common" part of the configuration management system that resides at each of the ALC's.

A partitioned data base exists when a conceptual data is separated into sections and spread across multiple computers. "Conceptual" is used because in general a single data base is not created and then partitioned; instead, the data base is designed as a logical entity but actually only created in the form of its partitions. The separate sections, because of their interrelationship, logically form a single data base. Data base partitioning often follows the natural distribution of data base access requirements. It is important in a multinode network to not partition so that a single node (or nodes) is overloaded by constant accessing. Another distribution of the data is possible which will allow a more equitable accessing load. Accessing can be parallel to the organizational hierarchy, that is vertically through organizational levels; or it can be horizontal, from one peer element to another. Data can travel down the hierarchy or across the hierarchy.

AFLC applications for a network indicate that both partitioned and replicated data will be present. It is also apparent that horizontal and vertical accessing will be used. The mixture of using these four terms should be determinate in conjunction with the other early design considerations for and AFLC network. Additional to the desired design considerations are the cost factor of a distributed system. These costs are

1. Cost of computers (equipment cost),
2. Cost of data bases (software cost),

3. Cost of communication lines,
4. Storage cost of data bases,
5. Storage cost of programs,
6. Communication cost of queries and updates from users to programs, and
7. Communication cost of queries and updates from programs to data bases.

4.4.2.12 Summary of AFLC Network Design Considerations

The totality of elements affecting the design for an AFLC network are summarized in Figure 4-25. Although the "bubbles" are shown as individually affecting network design, there is realistically an interdependency between the bubbles themselves. In other words, none of the elements are completely independent of the other elements. The basic steps in arriving at a useful design incorporating all these elements or features, are discussed in the following section.

4.4.3 ECS Support Networks Design, Development, and Integration

This section contains detailed discussions of some of the steps to be taken in the performance of subtasks during the network definition phase. A more comprehensive summary overview of all the ECS Support Network design, development and integration phases is provided in Section 5. The intent here is to relate individual actions to key issues discussed in the previous section. These "actions" are related to subtasks as defined on sumary sheet 5.2.4, Section 5 as shown in Table 4-11. The attempt has been to show the "vertical" relationship between "actions" and the actual subtasks to be accomplished, culminating in a subtask deliverable item. Due to the scope of the project, no attempt has been made to provide a detailed description of all actions but rather to highlight some key steps in order to provide the reader with a flavor of task complexity.

Needless to say is that these tasks are not altogether independent of each other. Also, more than one iteration through each step may be required due to their interrelationship.

Action 1. Specify tasks to be accomplished by networks or to be supported by networks. Efficient use of any capability presupposes that the capability is designed to accomplish certain tasks. Thus the tasks are defined prior to designing a capability to accomplish them. Networking is no exception to this and, therefore, any efficient network will have been designed with specific task accomplishment in mind. Section 4.4.1 of this document addressed network requirements and summarized them into Table 4-9. Additional requirements will undoubtedly emerge prior to the design activity. The additional information should be furnished by AFLC to further define,

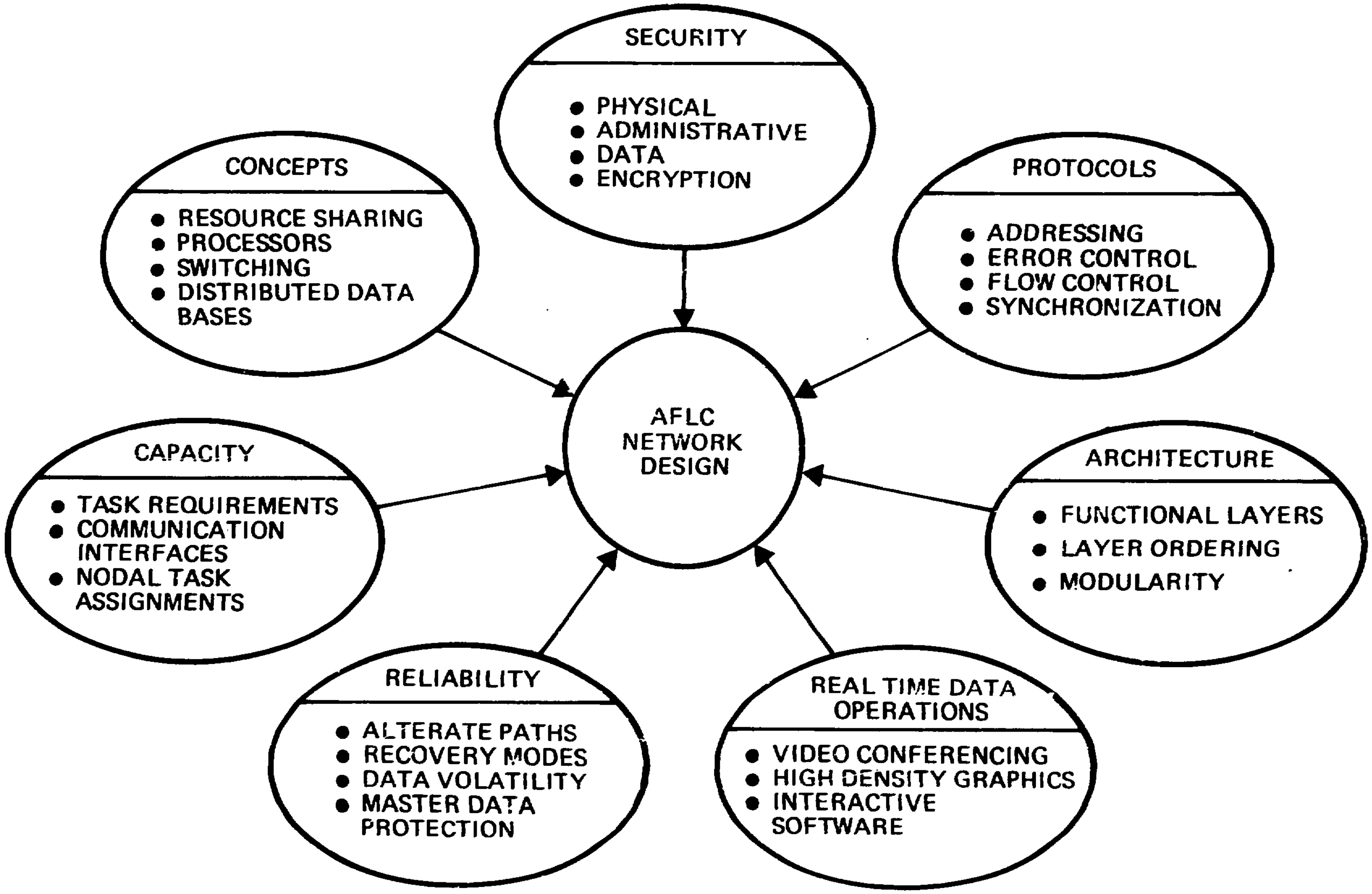


Figure 4-25. AFLC Network Design Considerations

Table 4-11. Relationship Between Network Design Steps or Actions and Task Deliverables

Phase	Task No.	Task Deliverable	Action No.
System/Segment Requirements Definition	3	Node communications support function requirements analysis	1, 3, 4, 5, 14, 16, 17
	5	Operational scenarios, concept of operations; ECS Support Network	9
	6	Definition of interconnect structure and network topology	2, 8, 10, 11, 12, 13
	7	ECS Support Network definition	6, 7, 10
	8	ECS Support Network segment requirements definition	15
System/Segment Requirements Validation	1	System specification	18
Network Design	3	Issue of RFP	19

as an example, the specific procdures, methods, and format by which configuration management or training will be accomplished. Thus, a better understanding is needed or just what data will be contained within a large data base; the type of DBMS necessary to access, change or update the data base; and the data to be exchanged via networks to provide support to these capabilities. It is apparent that the totality of all ECS support tasks for which networks will provide some support will define the network requirements and thus move one step closer to defining an efficient network. These definitions of requirements must be accomplished prior to proceeding to any other actions. If a particular capability, i.e., and automated documentation system, requires a study effort prior to final definition, then consideration for the study results must be factored into any network definition efforts.

Action 2. Determine the number of nodes. Many networks are not indefinitely extendable to additional nodes without degradation to the network system. Those networks that are designed for particular applications, such as AFLC's, are perhaps more susceptible than other networks designed specifically for expansion or to include additional nodes. Although some allowance can be made for additional nodes to be added to a network, it is advisable to design with a specific number of initial nodes plus a maximum expandable number. For examples for AFLC, begin with nodes at the command headquarters plus each of the five ALC's with an expansion factor to include no more than 5 additional nodes. With this target in mind, the network can be designed for 11 nodes and optimized for efficient operation. Geographical location of nodes is also important so that a communications media can be established to support the network node data exchanges. Even beyond the node indentifications and locations there is the designation of the local network focal point (organization) who will be responsible for interfacing each node to the network.

Action 3. Allocate tasks to nodes. The first two actions have identified which tasks are to be accomplished by the network and how many nodes are to be used. This action simply divides and assigns the AFLC support tasks to specific nodal locations thus enabling one to see which data exchanges are necessary between the various node pairs. Allocation of tasks should be done with the thought in mind of which nodes will be the primary focal point for individual tasks as well as which nodes are the users of that task. Overall, the task allocations should be structured so that no single node is overloaded or unnecessarily burdened. On the other hand, consideration should be given to communications path loading and any peculiarities of either tasks or communications links. This action is primarily an administrative one for AFLC, and its completion can amount to allocation of overall responsibilities to the ALC's for various ECS support tasks such as configuration management.

Action 4. Establish internodal data exchanges. Now that individual tasks have been assigned to all nodes, it is necessary to estimate the data exchanges between all node pair combinations. This action is very helpful in determining communication path capacity per task per node pair and, when all task data exchanges are combined, overall capacity requirement for any node pair. The results will help provide an indication of the topology to be used in connecting the network althrough other subsequent steps will also influence both capacity and topology. This action will require AFLC to establish a policy for the various data to be exchanged between node pairs.

Action 5. Determine extent of Real Time Data Operations (RTDO). This action is necessary for accomplishment at this time because several subsequent step accomplishments are dependent upon the outcome of how much real time data operation is required. Section 4.4.2.3 addresses this consideration and, in one sense, the extent of RTDO affects the networks tasks as well. If, for example, it is deemed necessary or desirable that video conferencing will be used by AFLC in the 1990's then the extent of RTDO is increased so the network must accomplish this task. The extent of RTDO is essentially an AFLC management decision depending upon whether or not tasks requiring RTDO are to be implemented. If the decision is yes, then the network design must factor this into consideration.

Action 6. Determine Network Implementation Concept. This action establishes whether or not microprocessors are established at the interface of each node, the kind of switching to be used, and whether existent leased lines will be used, etc. In view of having answered questions embedded within the first five steps, the determination of the concept to implement is a function of cost-effectiveness versus what is necessary to implement the first five actions. The emphasis toward more resource sharing, distributed computation, data base distribution, etc. all affect the answer to this step

Action 7. Define security hardware and software. Almost all data in the future will likely be sensitive either from a proprietary, classified, or need-to-know perspective. This fact will dictate that more and more encryption (or its substitue) will be used. Even the security of the data within its storage media will be safeguarded against intentional or inadvertent alteration or compromise. Both the hardware and software used for these purposes affect network design and acquisition/development costs. It is necessary that the approach to treating sensitive data include consideration for procedures also. Subsection 4.4.2.7.2 addresses several considerations for safeguarding data and information. AFLC must establish the policies and procedures to be used for network security thus identifying necessary equipments and interfaces.

Action 8. Establish gateways to local networks. It is assumed that each network node will interface with a local network. The interface or gateway must be established to enable data exchanges, queries, etc. from one local network to another. If the local gateways are standardized, this will provide a more efficient network (proven by the National Software Works experiments). However, each and every local network may not accommodate a standardized gateway. In any case, the gateways must be established because they affect the communications path from one local network through the AFLC network to another local network. Internoda' protocols cannot be established until the gateways are established. See the section on modular ISF's for more details. This action is comprised of both technical and management considerations. Its completion is necessary to enhance network efficiency.

Action 9. Define network maintenance and management responsibilities. Although this step is primarily an administrative one, its completion is very important to the efficiency and results of an AFLC network. The answer to this question indicates where network status data and procedures are focused as well as the agency responsible for fixing a network problem. Maintenance and management responsibilities should be kept in mind in accomplishing all other steps. This action amounts to establishing an office of primary responsibility for network maintenance and operations control.

Action 10. Determine architectural layers (by node). Actions completed to this point have mixed technical and managerial decision making. Action 10 is the first of several steps that are almost entirely based upon technical considerations. For certain of these actions, the completion may depend upon a study effort, however, the actions are still roughly arranged in sequential order. The determination of the architectrual layers for each and every node is primarily assiciated with the expected or required functional accomplishment of the node. (Subsection 4.4.2.5 addressed several considerations in this area.) Nodal architecture directly relates to efficiency, accuracy, ease of use, and reliability of each node. A well-planned architecture will allow functional improvements to a node without usurping other functions assigned or accomplished by that node. This action can be completed only after in-depth technical considerations of the various nodal functions such as would be accomplished by a study effort.

Action 11. Establish ordering of architectural layers at each node. This action is another purely technical consideration which determines the lowest to highest ordering of the various functions to be done at a particular node. Coverage of this subject is contained in Subsection 4.4.2.5 although the specific ordering is relate to the actual functions themselves. As an example, refer to Figure 4-24 and postulate that not every automated documentation task would be affected by a routing algorithm. Then the functional architecture layer (routing) could be deleted between the security function and the automated documentation tasks at those nodes which did not require routing. There will be literally dozens of such considerations for each node, so an in-depth consideration should be given to each node and its functional tasks.

Action 12. Define protocols between all layers. This action establishes the format and exchange rules between the various architectural layers at a node. Again this is a technical consideration which affects the efficiency and reliability of each network node. Completion of this action can only effectively be done by the network designer.

Action 13. Define internodal protocols. This action establishes the format and exchange rules between network nodes. Internodal protocols are affected by gateways, communications media, node processors, node tasks, and other considerations. These protocols can also be envisioned to communications path and conditions. Action 13 is a technical consideration which affects efficiency, reliability, and actual capability of network to perform. Although this is primarily a technically based action. AFLC should formulate any standardization policies to address internodal protocols for current and future use.

Action 14. Define data base disribution. This action establishes the extent of centralization of a data base. It further allocated dedicated portions of the entire network data to individual nodes for control, accessibility, and processing reasons. The distinction between this action and Action 3 is that Action 3 is based upon operational rationale. This action considers additional distribution based upon improving the network for technical reasons and can only be satisfactorily completed by the network designer in conjunction with the DBMS.

Action 15. Define processor types. If the processor to be used is GFE, this action should have been considered earlier, perhaps as Action 3. The difference has to do with making the network conform to use of a previously defined processor type as opposed to establishing the network then defining processors to enable the network to function as established. This is a technical step and it can be carried only to the extent where a procesor type is generally addressed or to a specific processor nomenclature. An answer to this action question is very dependent upon almost every previous action.

Action 16. Consolidate all previous actions into capacity requirements.
All previous actions have addressed: what the network is to accomplish, how it is to accomplish it, what rules goven its use, what equipment is necessary, and where the tasks are assigned. The composite of all these interrelated considerations yields an answer to what capacity is needed for the communications media, how much data storage is necessary and where the storage is located, what processing is necessary, and how the nodes interface. This is a technical action plus a possible affect on the desired operational capability of the network. Its completion

depends upon a joint consideration of AFLC and the network designer.

Action 17. Reiterate actions until tradeoffs are determined. Certain of the actions are very interrelated such that completion of them by their sequence may result in a "less than desired" capability for one or more functions. It is a good idea to retrace through all the actions, again in sequence, but with a look toward the final result. The purpose of this is to provide a more optimal design. This action is primarily a technical consideration by the network designer, however, its ramifications may require operational adjustments which are controlled by AFLC policies, i.e., standard network internodal protocols.

Action 18. Prepare a network system specification. All questions should be answered to enable a quality cut at preparing a system specification for the AFLC network. This action should be primarily an administrative one since previous actions should have rectified or solved most of the technical considerations as well as the overall policy and procedural guidances.

Action 19. Prepare a request for proposal. This is the action which culminates in a solicitation for bids to develop and acquire a network in accordance with the system specification.

The previously described 19 actions lead to an efficient network for AFLC use. Completing these actions produces a network system specification and a bid package by which to contract for development of the network. See Section 5 for details of how these actions are time-phased and translate to resource estimates for their completion.

5. ECS SUPPORT CAPABILITIES ACQUISITION

The use of an organized approach essential in applying the technical management and engineering disciplines required at all levels for the total Air Force Logistics Command ECS support effort. The organized framework described in this section points out the time-phased actions required to attain the required 1990 ECS support capability. The first and probably most difficult task is the commitment to a disciplined step-by-step acquisition/development approach. Secondly, those tasks that are clearly beyond the capability of existing manpower and facility resources or outside existing or planned areas of expertise should be addressed through system engineering/integration contractor support. Finally, those issues that are clearly beyond the management prerogatives of the Air Force Logistics Command must be identified and addressed through coordination and higher management approval. A guiding philosophy in the planning phase is the careful allocation of available and planned resources to avoid excessive concentration upon details at the expense of understanding and management of the acquisition/development effort. The dynamic nature of the development process for a weapon system and its ECS support facility coupled with the complexity encountered during the introduction and use of this system in the operational environment requires the full attention of the management structure of the Air Force Logistics Command. The acquisition and operation of ECS support facilities is engineering intensive and often requires augmentation in the form of technical assistance.

Approach to Support Capability Acquisition

Weapon systems containing ECS and associated support systems are acquired according to public laws, Defense Acquisition Regulations (DAR), with various Department of Defense, Air Force and subordinate command regulations, policy, and guidance. Collectively, these systems and rules are massive, complicated, and often cumbersome because they were not designed, and are not maintained, as a system. In spite of this, a central theme in all of them is a need for management attention and discipline.

The systems approach to the acquisition/development of ECS support capability offers no magical solution, but it is consistent with the time honored acquisition/development process, and does provide a means to intelligently allocate resources where they are most needed, participate in the weapon and support system development process to the degree necessary to ensure its manageability/supportability and, most important of all, to acquire and maintain flexible weapon and ECS support systems that are reliable, accessible, and maintainable at reasonable cost throughout their life cycle. Figure 5-1 shows an overview of the approach to implementation of the recommended administrative and programmatic initiatives and provides a framework for subsequent detail for acquiring a responsive long term ECS support capability.

Administrative and Programmatic Initiatives

The initiatives are divided into two groups. The first group, referred to as administrative initiatives, are those which lend themselves to implementation with little initial impact on or within existing resources. Some of these initiatives will most likely evolve to program status depending upon policy decisions but the administrative initiatives are, for the most part, a collection of diverse interrelated activities with high potential for both near and long term benefits as well as establishment of context and direction for other longer term initiatives. Although there are obvious interrelationships and interdependencies between the two groups, this distinction is made because policy and guidance initiatives are clearly in the Government's domain, and therefore are presented separately in the form of recommendations in the following areas.

- Management and Engineering Practices
- Acquisition and Support Practices

The second group, called programmatic initiatives, are those which address the very structure and procedure for accomplishing the ECS support process. Although they depend upon policy and direction for implementation they are primarily longer term and require concentrated programs with considerable resources to build upon or augment existing capability as well as acquire new capabilities. Implementation detail in the form of activities, schedules, and resources are presented for each of the following programmatic initiatives.

- Automation and Standardization of ECS Support Processes
- Modular Extendable Integration Support Facilities
- ECS Readiness Support
- ECS Support Networks

5.1 ADMINISTRATIVE INITIATIVES

The administrative initiatives which encompass management, engineering, acquisition, and support practices are discussed in detail in Volume II of the Phase II report and in Section 3 of this report. As discussed in the Phase II report, these issues were selected through a filtering process as the issues with the most prominent impact and with the most promise of resolution. The same process was applied to the additional ECS support issues discussed in Section 3. The

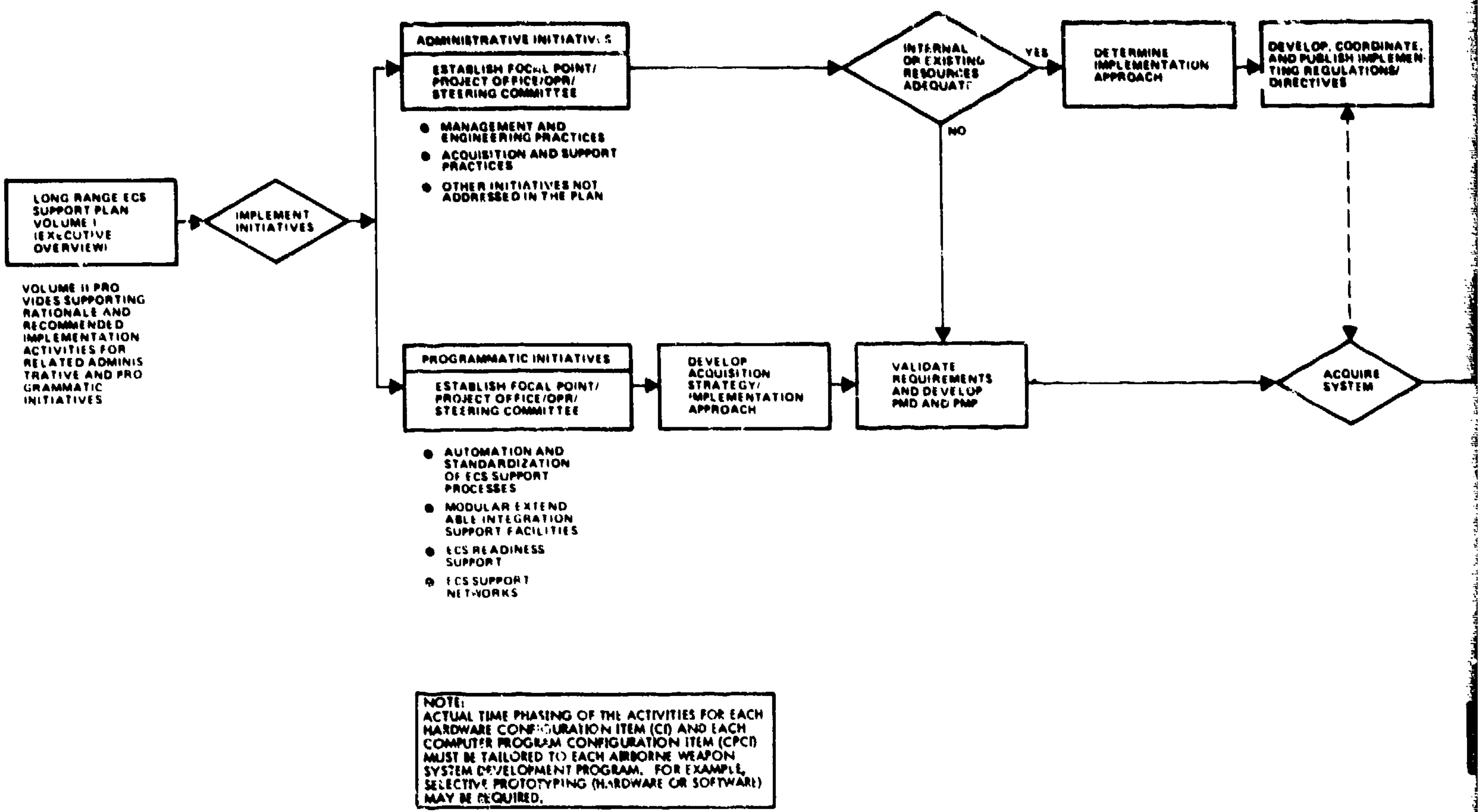
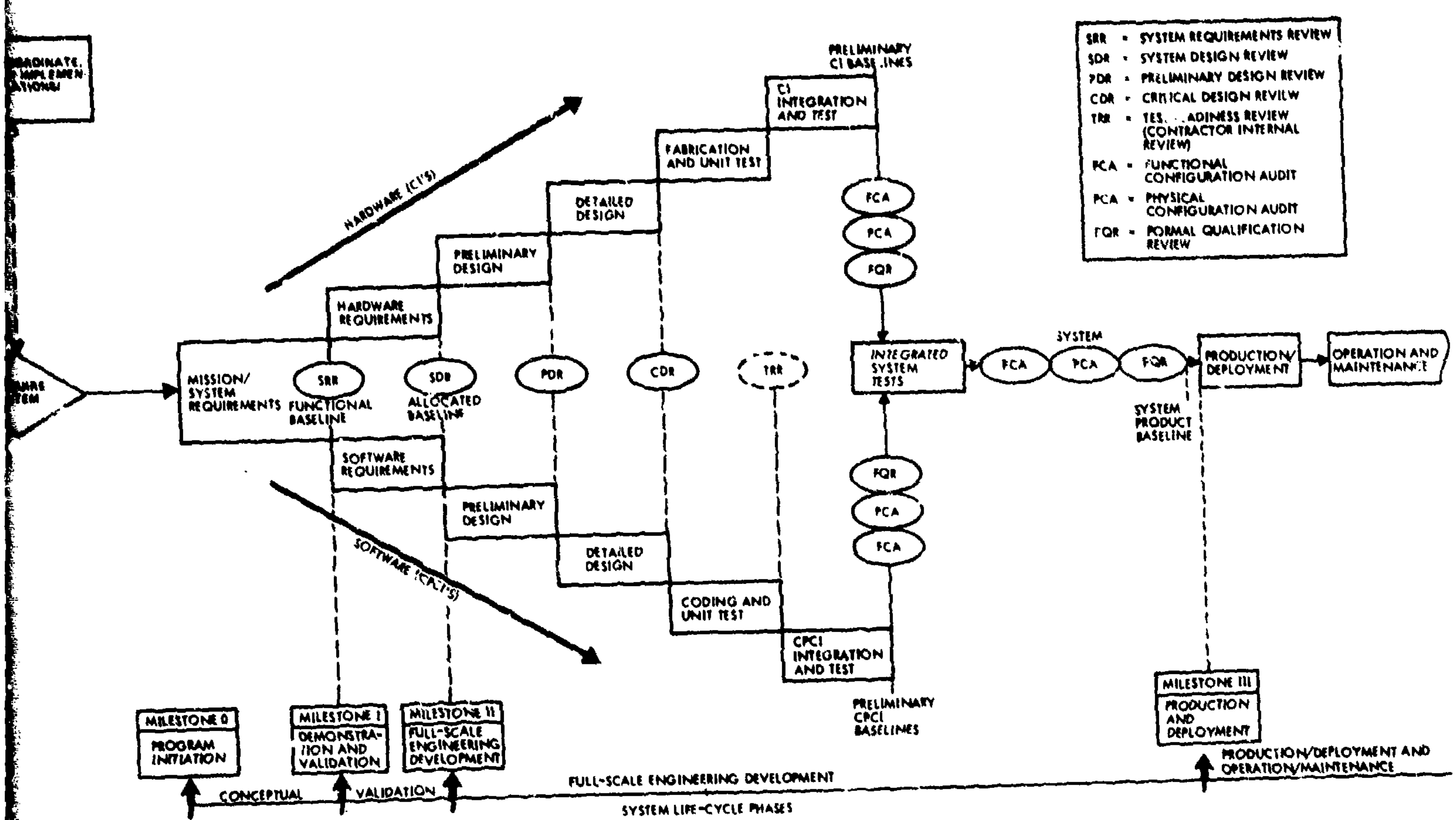


Figure 5-1. Overview/Approach to E



oach to ECS Support Capability Acquisitior.

administrative initiatives and corresponding recommendations are presented in Tables 5-1 through 5-8. The relationships of the various initiatives are shown in Table 5-9. The recommendations are focused on the following ECS support areas.

- Personnel and training
- Funding
- Configuration management
- Organizational structure
- Microprocessors and firmware
- ECS support facilities
- Multi-ECS support systems
- Product and data quality at transition

5.2 PROGRAMMATIC INITIATIVES

Modernization of AFLC command-wide ECS support capability over the next decade is dependent upon implementation of the previously discussed administrative initiatives combined with implementation of specific programs over a period of time to augment existing capabilities and acquire new capabilities. The implementation detail presented in the following sections is supported by and coupled to the Phase II report and the discussions in Section 4 of this report. Together, they provide planners and implementors a long range plan for support of the five ECS categories.

Implementation detail for each of the four programmatic intiatives follows the overall acquisition approach shown previously in Figure 5-1 with definite phases, activities, and schedules which are presented in the form of activity flows and task sheets. Each initiative is introduced with a graphic depiction of its conceptual evolution followed by overview and summary task sheets and individual phase or activity task sheets which are related to the acquisition or development process. In those cases where the initiative contains several elements, separate summary task sheets or summary and individual phase task sheets are provided. In addition, where the activities are closely coupled as in the acquisition of local and command-wide ECS support networks, the overall dependencies are graphically displayed. Specifically, the remaining sections are formatted as follows.

Table 5-1. Administrative Initiatives Related to Personnel and Training

Administrative initiatives oriented towards management and engineering practices which are primarily related to ECS support personnel and training.

Recommendations

- Develop an optimum approach version of the logic paths sketched for the AFLC GLDT in AFLCR 400-XX.
- Develop specific guidance/AFLC policy regarding the consolidation of resources (including cross-training) across ALC's and ECS's.
- Develop a generic breakout of functions and activities required in the software O&S job for a given ECS as well as for a multi-ECS environment.
- Develop a step-by-step, time-phased trace depicting the manpower acquisition (authorization) process.
- Conduct a study to evaluate traditional support roles and missions of the various AFLC organizations as they relate to computer resources.
  - Develop roles and missions pertinent to AC, MMR, MMC MMEC, MMET, MA-T, and management organizations.
  - Consider the matrix management concept in the above effort.
  - Provide guidance to the ALC's regarding organizational structure in the MMEC organization and definition of interface functions within other organizations.
  - Clarify and definitize in USAF level guidance (i.e., AFR 800-14), the roles of the using and support commands insofar as software O&S are concerned.
- Establish a recruiting activity within each ALC, thus reducing the engineering role in this regard to one of conducting technical interview and deciding amongst candidates.
- Take steps to have software manpower removed from the "additive" category and placed in the manpower baseline with other O&M functions.

Table 5-1. Administrative Initiatives Related to Personnel and Training (Continued)

Administrative initiatives oriented towards management and engineering practices which are primarily related to ECS support personnel and training.

Recommendations

- Continue attempts to establish special categories and high grade authorizations for software engineers.
- Establish OPR's for ECS software O&S training at HQ AFLC/LOE and at each ALC.
- Encourage rotation of key personnel across ECS's (and even ALC's) to help keep these invaluable resources challenged as well as to accelerate the training process for the more junior employees.
- Develop more definitive AFLC career incentives and progression paths to attract and retain competent ECS personnel.
    - Adjust classification and qualification standards to meet ECS requirements.
    - Develop a means to track ECS skilled personnel.
    - Develop and implement a career management program
    - Develop and implement SEI's for civil service.
    - Develop and communicate a career progression ladder.
    - Provide engineering management and technical skills career paths.
    - Make assignments within the career path.
    - Ensure engineers are utilized in engineering positions.
- Institute a more structured training program which cycles available software and hardware engineers through a set of formal courses and a controlled job training program.
    - Develop a formal training program targeted to continued education for ECS engineers including identification of specific courses to be studied.

Table 5-1. Administrative Initiatives Related to Personnel and Training (Concluded)

Administrative initiatives oriented towards management and engineering practices which are primarily related to ECS support personnel and training.
Recommendations • Develop training alternatives for beginning and experienced engineers in the following areas: • Expand the AFIT School of Logistics Management courses to include a specific section on ECS systems management. • Develop a short course on ECS engineering management for the teleteach systems and follow-on communications media to include video networks and video disks. • Develop a series of basic computer science courses for wide area use on video networks or local use of video disk teaching systems. • Develop a basic systems engineering course for wide area use on video networks or local use on video disk teaching systems. • Encourage AFIT EE and CS students, projected for AFLC assignments, to specialize in subjects relating to ECS support. • Where economically feasible, use off-the-shelf video instruction and telecommunication services offered by commercial companies or public utilities. • Develop a comprehensive instruction and training plan for ECS support personnel which complements the career ladder. • Develop communication resource centers at each ALC.

Table 5-2. Administrative Initiatives Related to Funding

Administrative initiatives oriented towards management and engineering practices which are primarily related to budgeting and funding for life cycle support of ECS.
Recommendations • Definitize funding sources for participation in life cycle ECS support activities required by AFR 800-14. • Establish definitive guidance within AFR 800-14 and funding lines in the PMD's to route facility and IV&V funds to AFLC agencies to establish support capabilities. • Provide for full funding to accomplish the AFLC assigned mission within EEIC 583. • With full funding under EEIC 583, reduce the split funding now inherent in the software block change concept. • Support the Joint Logistics Commander's (JLC) efforts to reduce restrictions to multi-year contracts including incremental funding. • Develop a comprehensive set of funding procedures to include any of the above alternatives in the form of an AFLC regulation and keep it current rather than disseminating direction through memorandums, messages, and letters.

Table 5-3. Administrative Initiatives Related to Configuration Management

Administrative initiatives oriented towards management and engineering practices which are primarily related to life cycle configuration management of ECS.
Recommendations • Review the suitability of the Computer Program Identification Number (CPIN) system for controlling baseline documentation, particularly for computer programs employed in a multi-version environment involving more than a single ECS and a single weapon system. • Review the Operational Support Configuration Management Procedures (O/S CMP) outline recommended in AFLCR 800-21 to reorient it more toward specific, detailed procedures rather than toward top level planning. • Formulate a generic set of software change activities and asociated operations and support functions which are applicable for standardized configuration management across the five ECS categories. • Re-examine the requirements set forth in AFLCR 800-21 and 66-15 regarding the use of Material Deficiency Reports (MDR's), Materiel Improvement Projects (MIP's), and TCTO's to report, track, and release ECS software changes. • Re-evaluate the manpower and staffing plans for each ECS currently entering the inventory to ensure that proper CM resources such as tools, personnel, equipment, and facilities are programmed. • Ensure that training plans adequately address configuration management requirements.

Table 5-4. Administrative Initiatives Related to Organizational Structure

Administrative initiatives oriented towards management and engineering practices which are primarily related to organizing for efficiency in the conduct of the life cycle support of ECS.

Recommendations

- Develop a generic systems engineering methodology similar to a systems engineering management plan (SEMP) to be used as a program model for all organic efforts.
  - Perform an organic study to define existing ALC system engineering practices/procedures.
  - Develop a common methodology to be used throughout AFLC.
  - Publish this methodology in an easy-to-understand generic SEMP as a guide to be followed for all organic engineering efforts.
  - Develop a plan by which systems engineering expertise will be developed or acquired.
- Consolidate software and hardware engineering personnel in a single organization at each ALC to facilitate a more economical/responsive system engineering relationship within and across ALC's.
  - Conduct a study to determine the most efficient organizational structure to maintain system engineering quality at the ALC's.
  - Reorganize to the results of the above study.
- Establish skill centers for concentrated specialities across the ALC's to better accommodate emerging technologies and to heighten the advantages afforded through a matrix structure.
  - Investigate the applicability of skill concentrations in speciality areas (suggested candidates are networks, standardization, technology, etc.)
  - Select appropriate sites for individual skill concentrations.
  - Develop formal plans for implementing the skill centers and supporting facilities.

Table 5-4. Administrative Initiatives Related to Organizational Structure (Concluded)

Administrative initiatives oriented towards management and engineering practices which are primarily related to organizing for efficiency in the conduct of the life cycle support of ECS.
Recommendations • Replace the manpower evaluation function in the software O&S manpower authorization loop by establishing a manpower screening function within HQ AFLC/LOE to approve ALC software O&S ECR requirements. • Establish in HQ AFLC/LOE a special position (e.g., GS-14 or GS-15) for an expert in ECS O&S who has first-hand experience in the problems confronted by ALC's. • Establish a more structured communications loop between HQ and the ALC's through inhouse status/problem reviews.

Table 5-5. Administrative Initiatives Related to Microprocessors and Firmwares

Administrative initiatives oriented towards management and engineering practices which are primarily related to the acquisition and life cycle support of microprocessors and firmware.
Recommendations • Formulate a joint AFSC/AFLC regulation concerning acquisition and support of microprocessors and firmware. • Provide support for the development of an Ada language for microprocessors. • Provide guidance for the incorporation of microprocessor and firmware implications into the logistics planning process. • Establish a need for AFSC to provide data on microprocessors and firmware, sparing requirements, storage environments, shelf life, and parts agreements during the acquisition process. • Establish well-equipped, growth-oriented support facilities.

Table 5-6. Administrative Initiatives Related to ECS Support Facilities

Administrative initiatives oriented towards acquisition and support practices which are primarily related to acquiring and operating ECS support facilities.
Recommendations • Develop a coordinated set of AFLC/AFSC guidelines for establishing, and operating post-deployment software support facilities. • Establish the need for an ECS support facility concept and requirements study to be performed during the conceptual/validation phases of each major program where embedded computer systems are involved. • Modify AFR 800-14 and other appropriate guidance to more clearly identify the funding responsibilities associated with post-deployment software support facility acquisition and support. • Develop a PMD/PMP/ILSP checklist which can be used by HQ USAF, AFLC, AFALD, and field agencies participating in ECS acquisition to ensure that these documents properly address support facilities. • Incorporate ECS support facility planning and funding as part of the DSARC process. • Establish through channels, a means to provide sufficient pre-PMRT manpower and funding for post-deployment posturing, DT&E, IOT&E support, etc. • Treat the CRISP as a USAF-wide memorandum of agreement (MOA) for establishing for post-deployment ECS resources. • Develop an expansion of the CRISP content to include contingency planning for ECR's in the event manpower, funding, MCP's inherent in the primary support concept are delayed or denied.

Table 5-7. Administrative Initiatives Related to Multi-ECS Support Systems

Administrative initiatives oriented towards management and engineering practices which are primarily related to developing criteria for life cycle support of multi-ECS support systems.
Recommendations • Conduct a study of closely-coupled ECS and of projected sensors and ECS to determine if criteria can be established which will aid in establishing ECS assignments and whether the actual hardware should be included in simulation facilities for avionics integration, operational flight program development, trainers, electronics warfare, etc. Factors to consider are the types and timing of interfaces, the nature of the processing on the signals, the amount of interrupt processing, the BIT test requirements, standardization, functions of the ECS, and traffic flow. • Develop an experiment using emulations of an existing ECS that will demonstrate the feasibility of using emulations for multi-use ECS. Consideration should be given to incorporating the emulation in an AISF and a trainer to establish whether concurrency is possible using emulations. The impacts of timing discrepancies between the emulation and the actual embedded computer execution should be explored and boundaries of acceptable deviations established. Life cycle costing of the two options (emulation versus ECS use) should be derived and compared to establish costing estimates. • Initiate a series of studies to examine the architectural innovations/structure that will promote testability and supportability of ECS. The studies should formulate a baseline of data and expertise within AFLC that would enable AFLC to shape standards and impact developments to increase testability and promotability. Specific areas that should be examined include: interface ports to be used for test tools such as programmable CMAC; the input/output structure for not only the MIL-STD 1553 bus but also direct memory access of high frequency or continuous data streams, software language development for ECS and support systems, life cycle cost effects of incorporating the support features, standardized modules for aircraft or sensor modules including plug-in microprocessors, and modularity innovations in hardware and software that isolates a change to a specific section of the ECS. This initiative would require some research and development, but the emphasis is on increasing the supportability of transitioned ECS by changing ECS design concepts.

Table 5-8. Administrative Initiatives Related to Product and Data Quality at Transition

Administrative initiatives oriented towards acquisition and support practices which are primarily related to ECS supportability and the quality of ECS products and data at transition.

Recommendations
 	
• Update the minimum set of data requirements listed in AFLCR 800-21 to include a system specification and software development/support facility description documents.
 	
• Develop content standards and/or guidance for documents not covered under MIL-STD 490 and MIL-STD 483.
 	
• Eliminate, through discrimination in the source selection process and through contractual terms in the production phase, proprietary software which is either integral to or used in support of a USAF-maintained ECS.
 	
• Establish joint AFSC/AFLC regulatory guidance that requires AFLC approval prior to the reprogramming of funds earmarked for AFLC requirements to other acquisition areas.
 	
• Continue to encourage AFLC participation in the requirements definition phase of the acquisition cycle to ensure adequate resources for post-deployment support are defined from the onset.
 	
• Conduct independent verification and validation of emerging systems by the eventual support organization.
    • Develop rationale for accomplishment of IV&V within AFLC.
    • Develop a sound IV&V methodology to be accomplished on selected programs.
    • Acquire AFTEC and USAF/LE/RD concurrence on the selected methodology.
    • Mount a campaign to have the concept made a part of AFR 800-14.
    • Request Air Staff funding allowances and planning for AFLC to conduct of IV&V of new programs.

Table 5-8. Administrative Initiatives Related to Product and Data Quality at Transition (Continued)

Administrative initiatives oriented towards acquisition and support practices which are primarily related to ECS supportability and the quality of ECS products and data at transition.

Recommendations
• Limit system proliferation through commonality and planning emphasis.
  • Develop a viable module approach to systems architecture.
  • Develop an approach to standard interfaces.
  • Gain AFSC concurrence on utilization of the above approaches.
  • Formalize the approaches through regulations
• Emphasize design for testability.
  • Initiate a team effort involving the systems integrator, hardware engineer, test engineer, and the systems software engineer.
  • Extend the above team effort to be compatible with integrated logistics support planning.
  • Develop maintenance strategy in parallel with system design concepts.
  • Specify how things fail as well as how they work.
  • Incorporate test disciplines into the design so that system architecture, interfaces, and accessibility are beneficially influenced.
  • Develop a set of standard methodologies for incorporating testing capability into systems design
  • Gain AFSC concurrence with the above methodology.
  • Formalize the above approach in AFLC/AFSC regulations.
  • Stress verification of product testability as a part of acceptance testing.

Table 5-8. Administrative Initiatives Related to Product and Data Quality at Transition (Concluded)

Administrative initiatives oriented towards acquisition and support practices which are primarily related to ECS supportability and the quality of ECS products and data at transition.

Recommendations
• Stress better documentation.
  • Establish a focal point for documentation at HQ AFLC.
  • Revise AFLCR 800-21 to reflect a realistic set of "minimum documentation".
  • Insist, through AFALD, CRWG, and other interfaces, that documentation standards are met by acquisition agencies.

Table 5-9. Interrelationship of Administrative Initiatives

Administrative Initiative	Personnel and Training	Funding	Configuration Management	Organizational Structure	Micro-Processors and Firmware	ECS Support Facilities	Multi-ECS Support Systems	Product and Data Quality at Transition
Personnel and Training		L	L	H	L	L	L	L
Funding	L		L	M	M	H	M	L
Configuration Management	L	L		L	M	L	H	M
Organizational Structure	H	M	L		L	M	L	M
Microprocessors and Firmware	L	L	M	L		L	L	M
ECS Support Facilities	L	H	L	M	L		H	M
Multi-ECS Support Systems	L	M	H	L	L	H		L
Product and Data Quality at Transition	L	L	M	M	M	M	L	

H: High

M: Medium

L: Low

5.2.1 Automation and Standardization of ECS Support Processes

- Conceptual evolution (Figure 5-2)
- Overview and summary task sheet (Figure 5-3)
- Individual phase task sheets (Figure 5-4 through 5-9)
- Summary task sheet for local project tool development (Figure 5-10)

5.2.2 Modular Extendable Integration Support Facilities

- Conceptual evolution (Figure 5-11)
- Overview and summary task sheet for Work Station Module (Figure 5-12)
- Individual phase task sheets for Work Station Module (Figures 5-13 through 5-17)
- Summary and individual phase task sheets for Simulation Kernels (Figures 5-18 through 5-23)
- Summary and individual phase task sheets for Reprogrammable Computer Monitor and Control (Figures 5-24 through 5-30)
- Summary task sheet for Programmable Interface Unit (Figure 5-31)

5.2.3 ECS Readiness Support

- Conceptual evolution (Figure 5-32)
- Overview and summary task sheet (Figure 5-33)
- Individual activity task sheets (Figures 5-34 through 5-44)

5.2.4 ECS Support Networks

- Conceptual evolution (Figure 5-45)
- Overview and summary task sheet for Command-Wide Network (Figure 5-46)
- Individual phase task sheets for Command-Wide Network (Figures 5-47 through 5-52)
- Task interrelationships, Command-Wide and Local Networks (Figure 5-53)
- Summary and individual phase task sheets for EISF/Local Networks (Figures 5-54 through5-64)
- Summary task sheet for Data Base Machine (Figure 5-65)

AFLC Primary ECS Support Locations								
ECS Support Categories	AGMC	OC-ALC	OO-ALC	SA-ALC	SM-ALC	WR-ALC	HQ AFLC	ECS Support Requirements
Aircrew Training Devices (ATD)			x				x	Common to All ECS Categories • Life Cycle • Management, System Engineering, Training • Pre-PMRT ECS Support • Support System Requirements, Supportability Design Criteria • Post-PMRT ECS Support • ECS Change, Change Analysis and Specification, Engineering Development and Unit Test, System Integration and Test, ...ange Documentation, Certification and Distribution Category Unique • Post-PMRT ECS Support • Concurrency with Weapon System, Interagency Shared Software Support, Intelligence Data Usage, Rapid Reprogramming Capability, High Frequency Change, Nuclear Safety Criteria
Automatic Test Equipment (ATE)	x	x	x	x	x	x	x	
Communications-Electronics (C-E)		x			x	x	x	
Electronic Warfare (EW)					x	x	x	
Operational Flight Programs (OFP)	x	x	x	x	x	x	x	

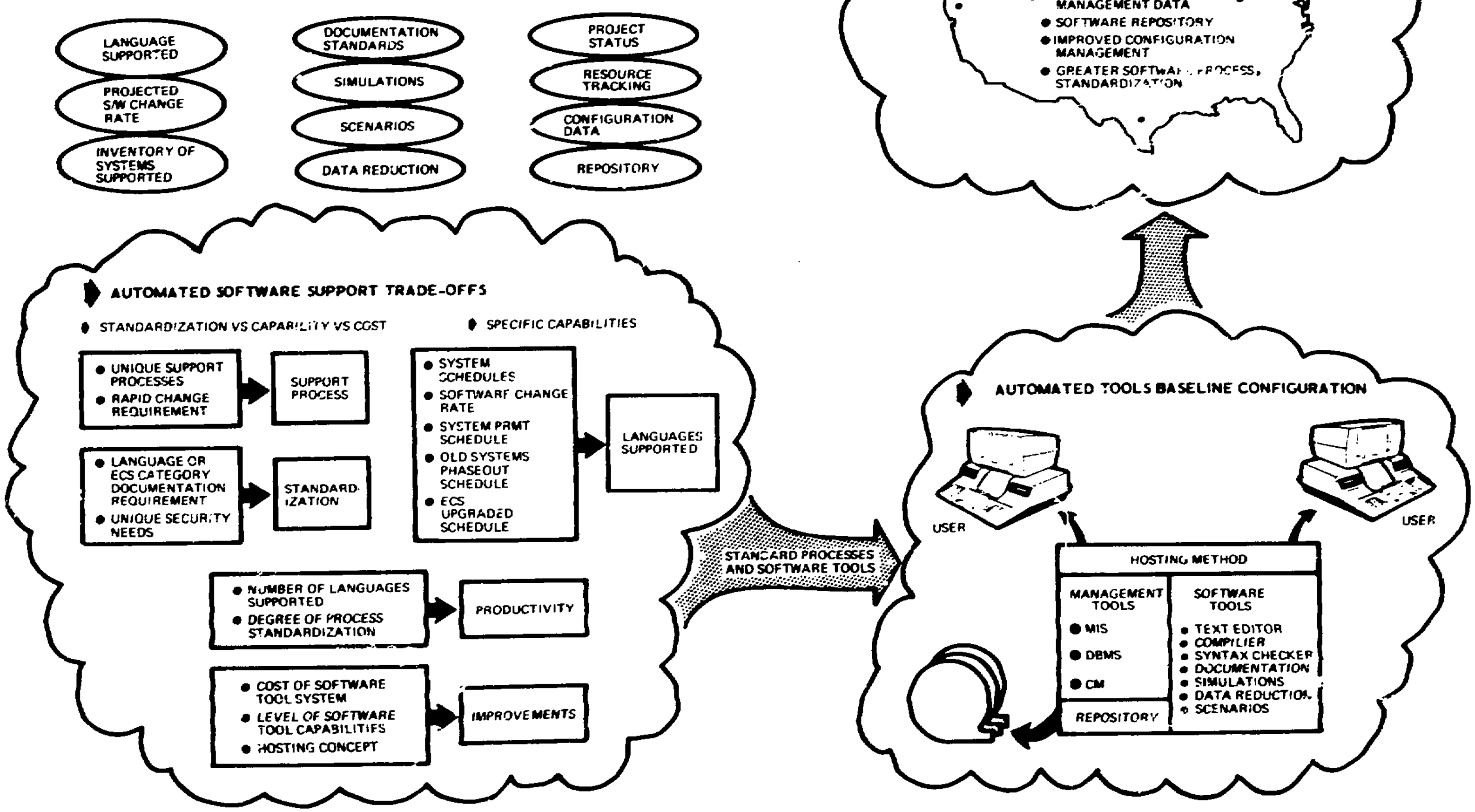


Figure 5-2. Automation and Standardization of ECS Support Processes Conceptual Evolution

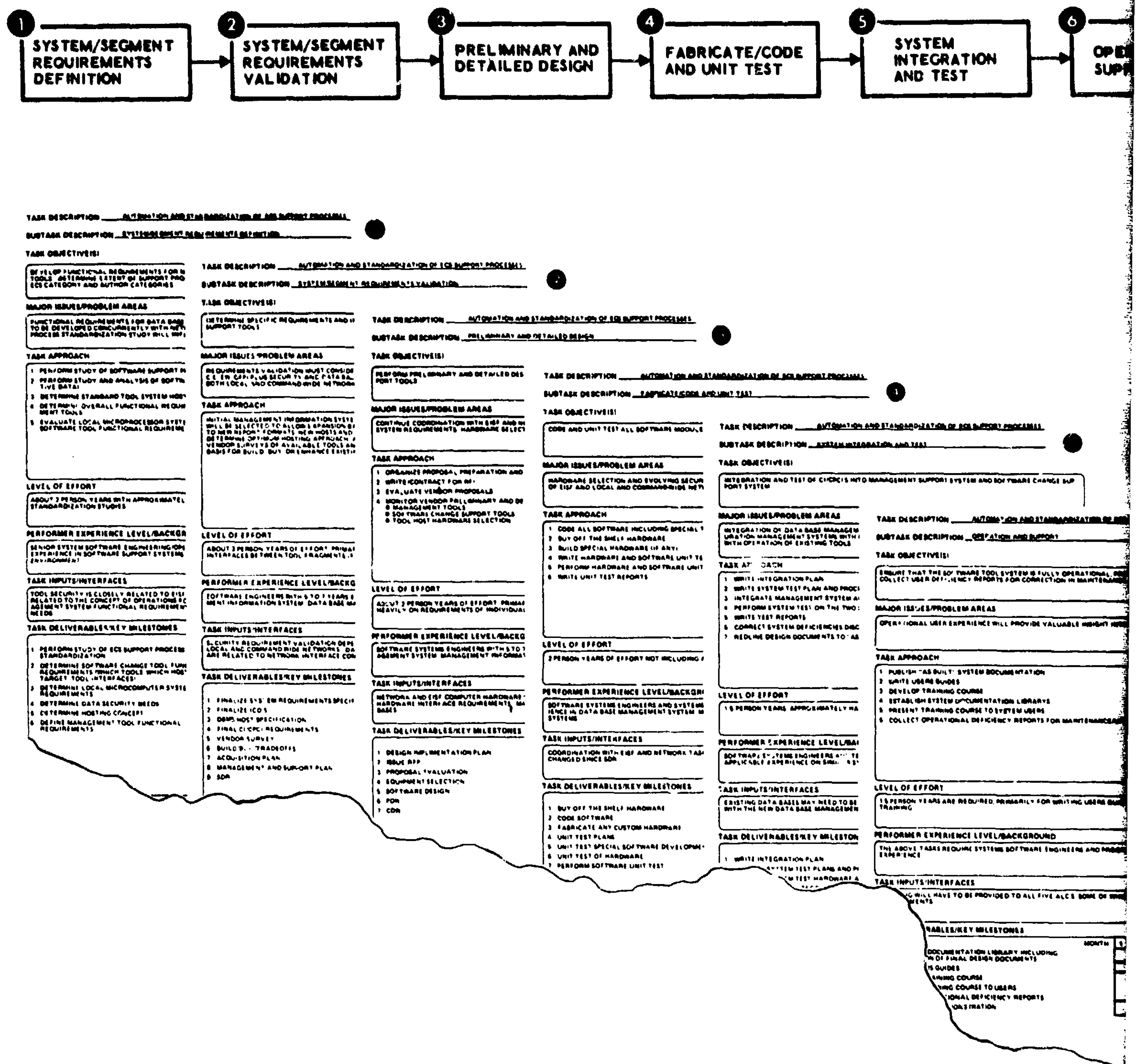


Figure 5-3. Automation and Standardization of ECS Suppo[rt]
Overview and Summary Task Sheet

...TEM ...GRATION TEST → 6 OPERATION AND SUPPORT

TASK DESCRIPTION AUTOMATION AND STANDARDIZATION OF ECS SUPPORT PROCESSES

SUBTASK DESCRIPTION SUMMARY TASK SHEET

TASK OBJECTIVE(S)

DEVELOP AUTOMATED SOFTWARE TOOLS TO AID MANAGEMENT AND INCREASE AUTOMATION AND STANDARDIZATION OF ECS SUPPORT PROCESSES. OVERALL TASK ALSO INCLUDES DEVELOPMENT OF LOCAL PROJECT TOOL.

MAJOR ISSUES/PROBLEM AREAS

THE SIZE OF THE TASK IS CLOSELY RELATED TO SUPPORT PROCESS STANDARDIZATION AND HOW MUCH MODIFICATION EXISTING VENDOR TOOLS NEED TO PROVIDE REQUIRED CAPABILITIES.

TASK APPROACH

1. ESTABLISH, AS FAR AS PRACTICAL, STANDARDIZATION OF SOFTWARE SUPPORT PRACTICES.
2. DETERMINE CONCEPTUAL ARCHITECTURE OF SUPPORT SYSTEM.
3. BASELINE REQUIREMENTS AND INTERFACE SPECIFICATIONS AT SDR.
4. PERFORM PRELIMINARY AND DETAILED DESIGN, CONDUCT PDR AND CDR.
5. FABRICATE, INTEGRATE, TEST, HOLD FCA, PCA, FQR.
6. PROVIDE TRAINING, USERS GUIDES, PLACE IN OPERATIONAL USE.
7. COLLECT DEFICIENCY REPORTS FOR FUTURE ENHANCEMENTS.

LEVEL OF EFFORT

12 PERSON YEARS OF EFFORT SPREAD OVER A 4.5 YEAR PERIOD. TWO PERSON YEARS WILL BE REQUIRED FOR DEVELOPMENT OF LOCAL PROJECT TOOLS FOR A TOTAL OF 14 PERSON YEARS.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

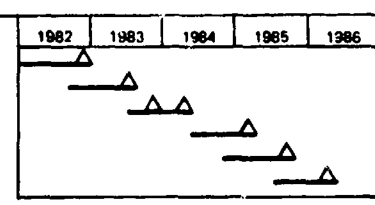
SENIOR SOFTWARE SYSTEMS ENGINEERS/SYSTEM PROGRAMMERS WITH 6 TO 10 YEARS OF APPLICABLE EXPERIENCE.

TASK INPUTS/INTERFACES

SOFTWARE TOOLS TIED CLOSELY TO LOCAL AND COMMAND-WIDE NETWORKS, EISF ARCHITECTURE, DATA BASE MANAGEMENT SYSTEM, AND SECURITY NEEDS.

TASK DELIVERABLES/KEY MILESTONES

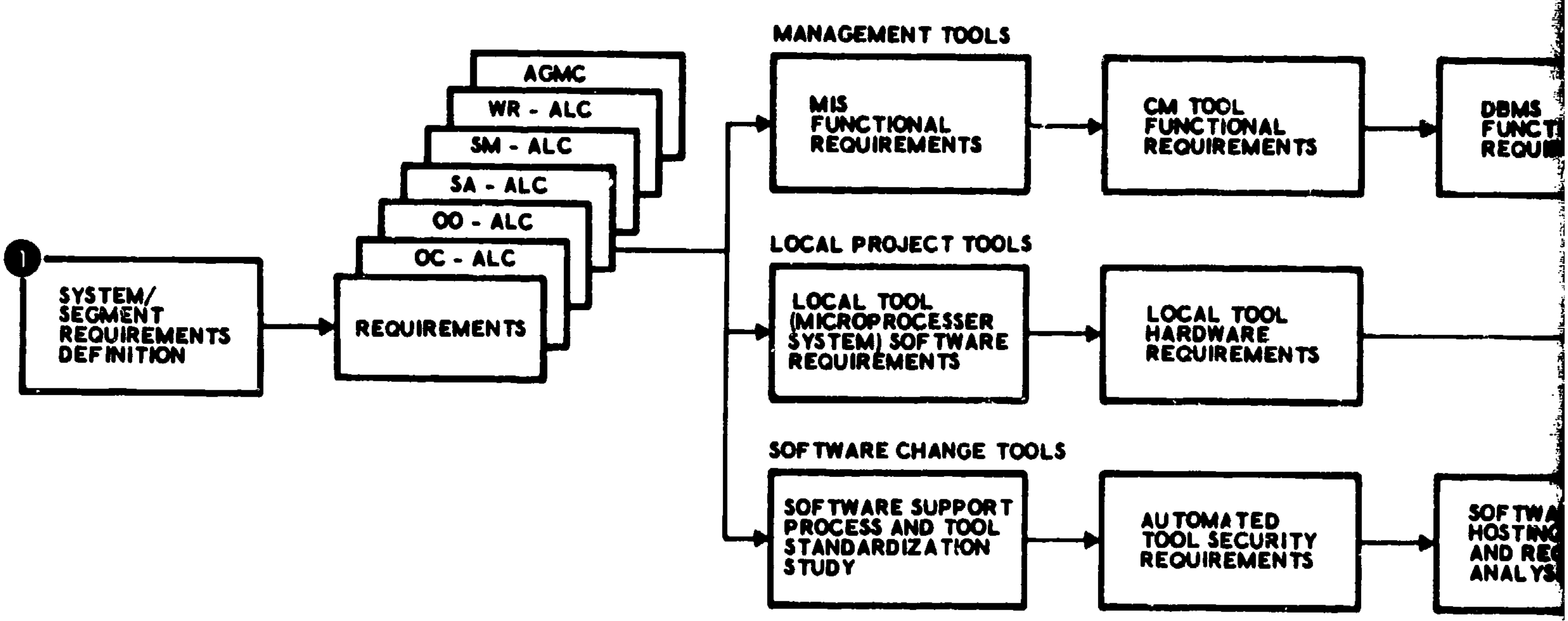
1. REQUIREMENTS DEFINITION (SRR)
2. REQUIREMENTS VALIDATION (SDR)
3. SYSTEM DESIGN (PDR/CDR)
4. FABRICATE AND UNIT TEST
5. INTEGRATION AND TEST (FCA, PCA, FQR)
6. OPERATIONAL AND SUPPORT DEMONSTRATION



...ion of ECS Support Processes:
...k Sheet

INPUT FROM RELATED ACTIVITIES

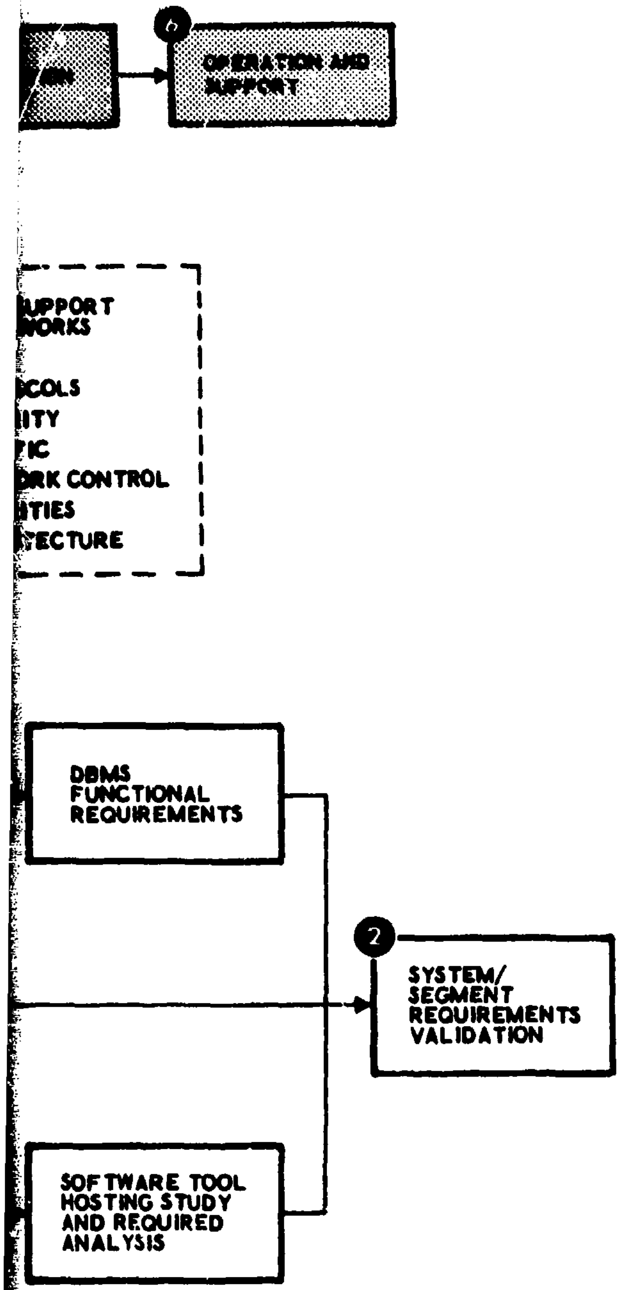
MANAGEMENT, ENGINEERING, ACQUISITION, AND SUPPORT PRACTICES	MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITIES	ECS READINESS SUPPORT	ECS SUPPORT NETWORKS
• MANAGEMENT, DIRECTION	• ARCHITECTURE	• INTELLIGENCE	• PROTOCOLS
• PLANNING	• SECURITY	• SECURITY	• SECURITY
• POLICY	• DATA BASE	• DATA BASE	• TRAFFIC
• GUIDANCE	• SIMULATION	• PRIORITIES	• NETWORK CONTR
• BUDGET	• COMMUNICATION	• THREATS	• PRIORITIES
• RESOURCES	• LOCAL NETWORK	• TRAINING	• ARCHITECTURE



PRODUCTS

- SOFTWARE SUPPORT PROCESS STANDARDIZATION REPORT
- SOFTWARE CHANGE TOOL HOSTING CONCEPT REPORT
- SOFTWARE DATA SECURITY REPORT
- SOFTWARE CHANGE TOOL SOFTWARE FUNCTIONAL REQUIREMENTS
- LOCAL PROJECT REQUIRED ANALYSIS
- DBMS, MIS, CM SYSTEM FUNCTIONAL REQUIREMENTS

Figure 5-4. Automation and Standardization System/Segment Requirements



TASK DESCRIPTION AUTOMATION AND STANDARDIZATION OF ECS SUPPORT PROCESSES

SUBTASK DESCRIPTION SYSTEM/SEGMENT REQUIREMENTS DEFINITION **1**

TASK OBJECTIVE(S)

DEVELOP FUNCTIONAL REQUIREMENTS FOR MANAGEMENT SUPPORT TOOLS AND SOFTWARE CHANGE TOOLS. DETERMINE EXTENT OF SUPPORT PROCESS STANDARDIZATION WHICH IS PRACTICAL FOR EACH ECS CATEGORY AND ACROSS CATEGORIES.

MAJOR ISSUES/PROBLEM AREAS

FUNCTIONAL REQUIREMENTS FOR DATA BASE MANAGEMENT SYSTEM (DBMS) AND TOOL HOSTING NEED TO BE DEVELOPED CONCURRENTLY WITH NETWORK AND EISF FUNCTIONAL REQUIREMENTS. SUPPORT PROCESS STANDARDIZATION STUDY WILL INFLUENCE OVERALL TOOL NEEDS.

TASK APPROACH

1. PERFORM STUDY OF SOFTWARE SUPPORT PROCESS STANDARDIZATION.
2. PERFORM STUDY AND ANALYSIS OF SOFTWARE DATA CONTROL REQUIREMENTS (SECURITY, SENSITIVE DATA).
3. DETERMINE STANDARD TOOL SYSTEM HOSTING APPROACH.
4. DETERMINE OVERALL FUNCTIONAL REQUIREMENTS OF SOFTWARE CHANGE TOOLS AND MANAGEMENT TOOLS.
5. EVALUATE LOCAL MICROPROCESSOR SYSTEM HARDWARE, PERIPHERALS, SUPPORT SOFTWARE, AND SOFTWARE TOOL FUNCTIONAL REQUIREMENTS.

LEVEL OF EFFORT

ABOUT 2 PERSON YEARS WITH APPROXIMATELY HALF OF THIS EFFORT DEVOTED TO SUPPORT PROCESS STANDARDIZATION STUDIES.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

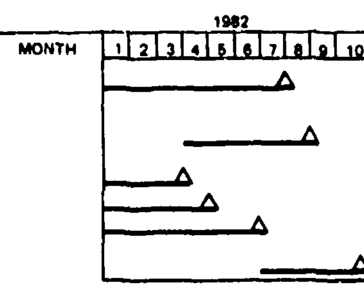
SENIOR SYSTEM SOFTWARE ENGINEERING/OPERATIONS RESEARCH PERSONNEL WITH TEN (10) YEARS EXPERIENCE IN SOFTWARE SUPPORT SYSTEMS AND FAMILIARITY WITH AFLC SOFTWARE SUPPORT ENVIRONMENT.

TASK INPUTS/INTERFACES

TOOL SECURITY IS CLOSELY RELATED TO EISF AND NETWORK SECURITY. TOOL HOSTING IS CLOSELY RELATED TO THE CONCEPT OF OPERATIONS FOR EISF AND ECS SUPPORT NETWORKS. DATA BASE MANAGEMENT SYSTEM FUNCTIONAL REQUIREMENTS ARE RELATED TO EISF AND NETWORK DATA HANDLING NEEDS.

TASK DELIVERABLES/KEY MILESTONES

1. PERFORM STUDY OF ECS SUPPORT PROCESS STANDARDIZATION
2. DETERMINE SOFTWARE CHANGE TOOL FUNCTIONAL REQUIREMENTS (WHICH TOOLS, WHICH HOST AND TARGET, TOOL INTERFACES)
3. DETERMINE LOCAL MICROCOMPUTER SYSTEM REQUIREMENTS
4. DETERMINE DATA SECURITY NEEDS
5. DETERMINE HOSTING CONCEPT
6. DEFINE MANAGEMENT TOOL FUNCTIONAL REQUIREMENTS



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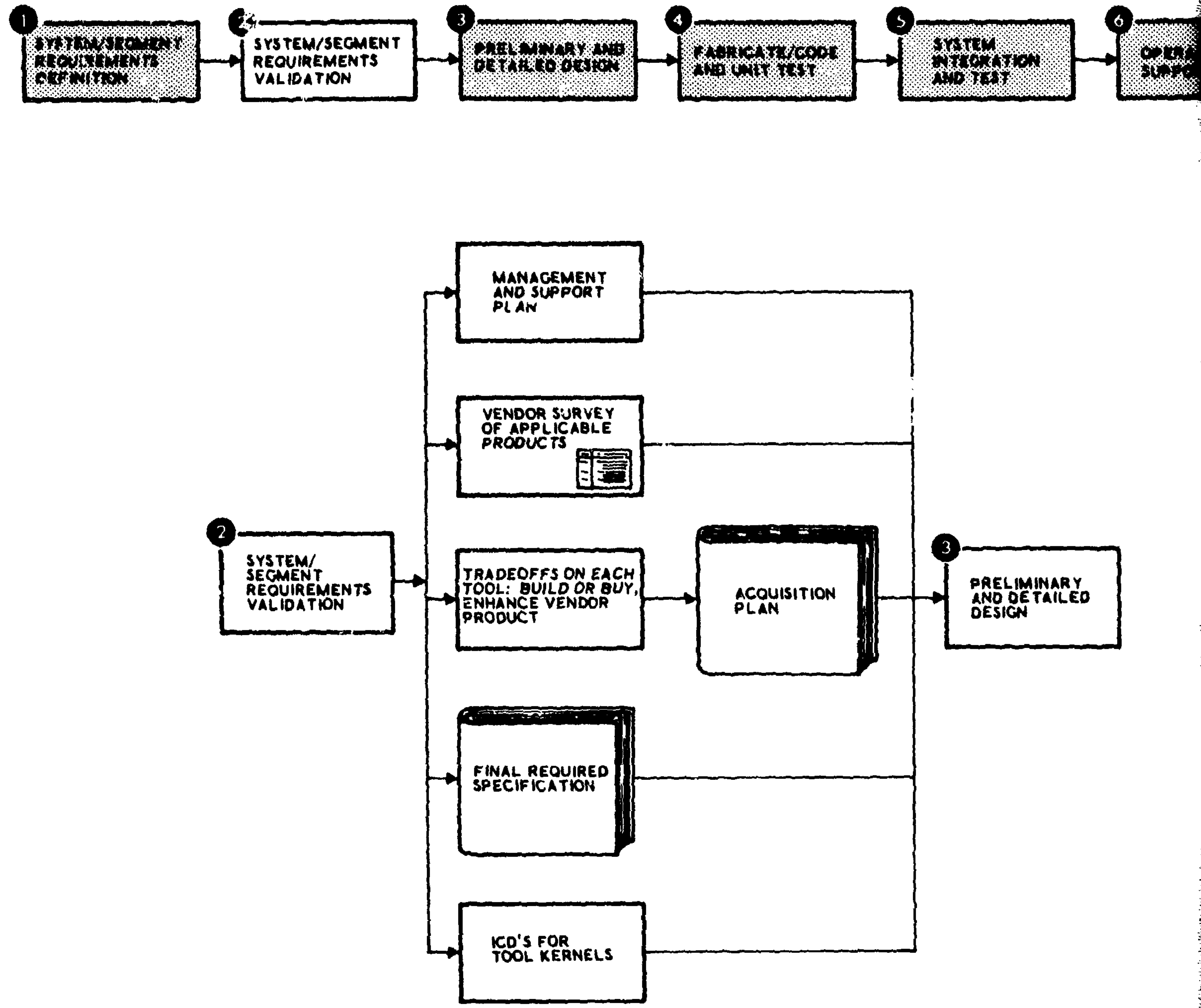
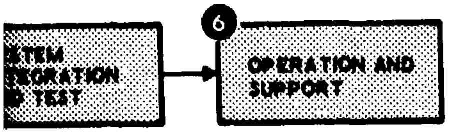


PRODUCTS

- VENDOR SURVEY REPORT
- ACQUISITION STRATEGY PLAN
- SPECIFICATIONS
- ICD'S
- MANAGEMENT PLAN
- SUPPORT PLAN

Figure 5-5. Automation and Standardization o
System/Segment Requirements V



TASK DESCRIPTION AUTOMATION AND STANDARDIZATION OF ECS SUPPORT PROCESSES

SUBTASK DESCRIPTION SYSTEM/SEGMENT REQUIREMENTS VALIDATION

2

TASK OBJECTIVE(S)

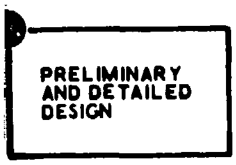
DETERMINE SPECIFIC REQUIREMENTS AND INTERFACE CRITERIA FOR AUTOMATED STANDARDIZED SUPPORT TOOLS.

MAJOR ISSUES/PROBLEM AREAS

REQUIREMENTS VALIDATION MUST CONSIDER SUPPORT TO ALL FIVE SOFTWARE CATEGORIES (ATD, ATE, C-E, EW, OFP) PLUS SECURITY AND DATA BASE MANAGEMENT SYSTEM REQUIREMENTS OF THE EISF AND BOTH LOCAL AND COMMAND-WIDE NETWORKS.

TASK APPROACH

INITIAL MANAGEMENT INFORMATION SYSTEM (MIS) AND SOFTWARE SUPPORT SYSTEM CONFIGURATIONS WILL BE SELECTED TO ALLOW EXPANSION BASED ON USER EXPERIENCE WITH SYSTEM, NEED TO EXPAND TO NEW REPORT FORMATS, NEW HOSTS AND TARGET COMPUTERS. COST TRADEOFFS ARE REQUIRED TO DETERMINE OPTIMUM HOSTING APPROACH, AND THE INITIAL LANGUAGE AND TARGET ECS SUPPORTED. VENDOR SURVEYS OF AVAILABLE TOOLS AND THEIR APPLICABILITY TO REQUIREMENTS WILL FORM THE BASIS FOR BUILD, BUY, OR ENHANCE EXISTING CAPABILITY DECISIONS.



LEVEL OF EFFORT

ABOUT 3 PERSON YEARS OF EFFORT, PRIMARILY IN DEFINING DETAILED TOOL REQUIREMENTS AND INTERFACES BETWEEN TOOL FRAGMENTS (FUNCTIONAL BUILDING BLOCKS).

PERFORMER EXPERIENCE LEVEL/BACKGROUND

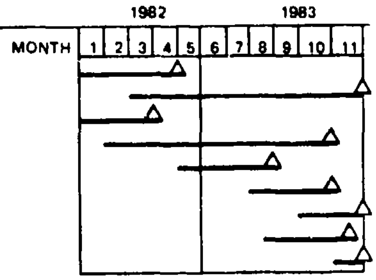
SOFTWARE ENGINEERS WITH 5 TO 7 YEARS EXPERIENCE IN THE APPROPRIATE SPECIALTIES (MANAGEMENT INFORMATION SYSTEM, DATA BASE MANAGEMENT SYSTEM, SOFTWARE CHANGE TOOLS).

TASK INPUTS/INTERFACES

SECURITY REQUIREMENT VALIDATION DEPENDS ON CONCEPTUAL ARCHITECTURE OF EISF AND BOTH LOCAL AND COMMAND-WIDE NETWORKS. DATA BASE MANAGEMENT SYSTEM SPECIFICATIONS ARE RELATED TO NETWORK INTERFACE COMPUTER SPECIFICATIONS.

TASK DELIVERABLES/KEY MILESTONES

1. FINALIZE SYSTEM REQUIREMENTS SPECIFICATIONS
2. FINALIZE ICD'S
3. DBMS HOST SPECIFICATION
4. FINAL CI/CPCI REQUIREMENTS
5. VENDOR SURVEY
6. BUILD/BUY/TRADEOFFS
7. ACQUISITION PLAN
8. MANAGEMENT AND SUPPORT PLAN
9. SDR



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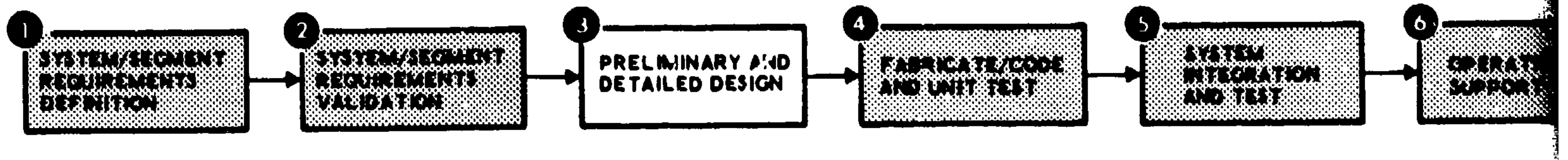
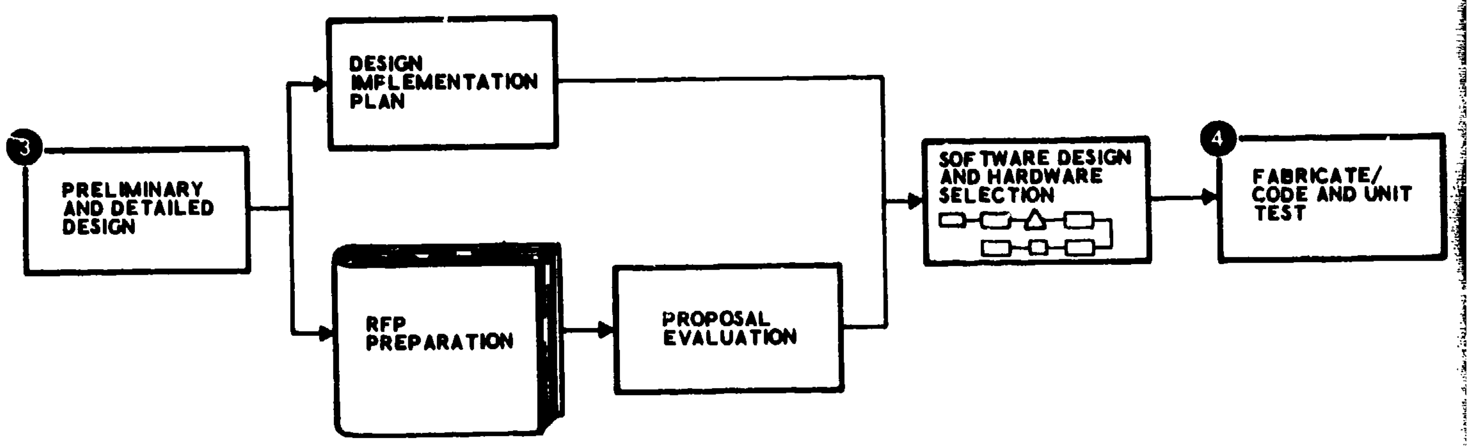
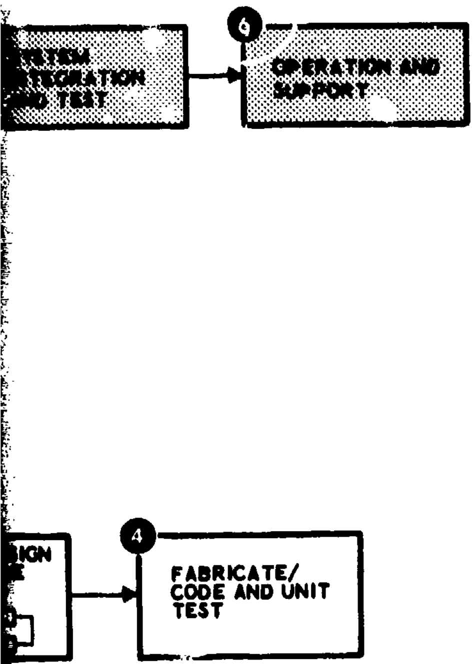




PRODUCTS

- DESIGN IMPLEMENTATION PLAN
- RFP PACKAGE
- VENDOR PROPOSALS
- DESIGN DOCUMENTS
  - HARDWARE
  - SOFTWARE

Figure 5-6. Automation and Standardization of ECS Supp
Preliminary and Detailed Design



TASK DESCRIPTION AUTOMATION AND STANDARDIZATION OF ECS SUPPORT PROCESSES

SUBTASK DESCRIPTION PRELIMINARY AND DETAILED DESIGN

3

TASK OBJECTIVE(S)

PERFORM PRELIMINARY AND DETAILED DESIGN OF SOFTWARE CHANGE TOOLS, AND MANAGEMENT SUPPORT TOOLS.

MAJOR ISSUES/PROBLEM AREAS

CONTINUE COORDINATION WITH EISF AND NETWORK AREAS ON SECURITY, DATA BASE MANAGEMENT SYSTEM REQUIREMENTS, HARDWARE SELECTION DECISIONS.

TASK APPROACH

1. ORGANIZE PROPOSAL PREPARATION AND EVALUATION TEAM.
2. WRITE/CONTRACT FOR RFP.
3. EVALUATE VENDOR PROPOSALS.
4. MONITOR VENDOR PRELIMINARY AND DETAILED DESIGN.
   - MANAGEMENT TOOLS
   - SOFTWARE CHANGE SUPPORT TOOLS
   - TOOL HOST HARDWARE SELECTION.

LEVEL OF EFFORT

ABOUT 2 PERSON YEARS OF EFFORT, PRIMARILY IN SOFTWARE DESIGN. EFFORT NEEDED DEPENDS HEAVILY ON REQUIREMENTS OF INDIVIDUAL SYSTEMS.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

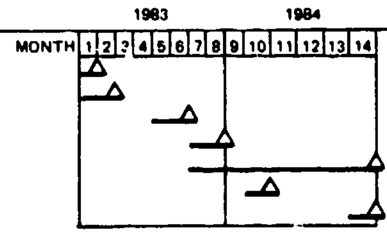
SOFTWARE SYSTEMS ENGINEERS WITH 5 TO 7 YEARS OF APPLICABLE EXPERIENCE IN DATA BASE MANAGEMENT SYSTEM, MANAGEMENT INFORMATION SYSTEM, SOFTWARE SUPPORT SYSTEMS.

TASK INPUTS/INTERFACES

NETWORK AND EISF COMPUTER HARDWARE SELECTION HAS SIGNIFICANT IMPACT ON SOFTWARE/HARDWARE INTERFACE REQUIREMENTS. MANAGEMENT SYSTEMS SHOULD PLAN TO USE EXISTING DATA BASES.

TASK DELIVERABLES/KEY MILESTONES

1. DESIGN IMPLIMENTATION PLAN
2. ISSUE RFP
3. PROPOSAL EVALUATION
4. EQUIPMENT SELECTION
5. SOFTWARE DESIGN
6. PDR
7. CDR



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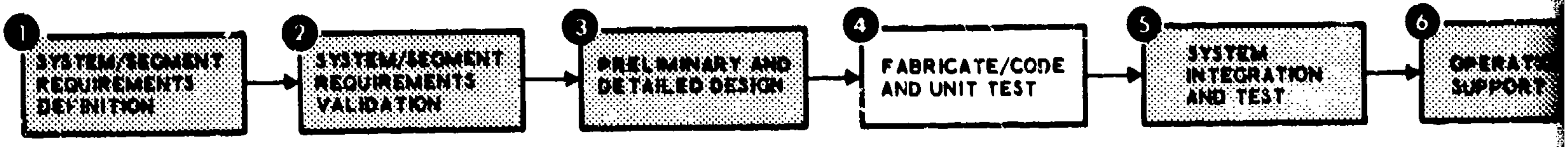
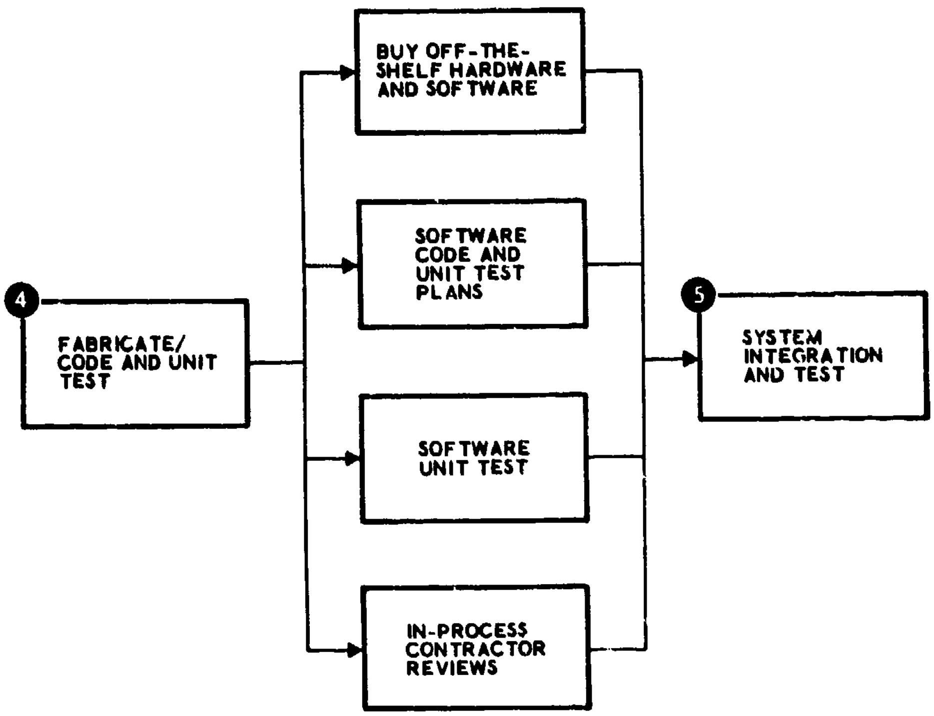
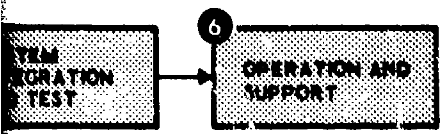




PRODUCTS

- ASSEMBLED HARDWARE
- CODED SOFTWARE
- UNIT TEST PLANS

Figure 5-7. Automation and Standardization of ECS Supp
Fabricate/Code and Unit Test



TASK DESCRIPTION AUTOMATION AND STANDARDIZATION OF ECS SUPPORT PROCESSES

SUBTASK DESCRIPTION FABRICATE/CODE AND UNIT TEST

4

TASK OBJECTIVE(S)

CODE AND UNIT TEST ALL SOFTWARE MODULES. BUY OFF-THE-SHELF HARDWARE.

MAJOR ISSUES/PROBLEM AREAS

HARDWARE SELECTION AND EVOLVING SECURITY AND DATA BASE MANAGEMENT SYSTEM REQUIREMENTS OF EISF AND LOCAL AND COMMAND-WIDE NETWORKS.

TASK APPROACH

1. CODE ALL SOFTWARE INCLUDING SPECIAL TEST SOFTWARE.
2. BUY OFF-THE-SHELF HARDWARE
3. BUILD SPECIAL HARDWARE (IF ANY).
4. WRITE HARDWARE AND SOFTWARE UNIT TEST PLANS.
5. PERFORM HARDWARE AND SOFTWARE UNIT TEST.
6. WRITE UNIT TEST REPORTS.

LEVEL OF EFFORT

2 PERSON YEARS OF EFFORT NOT INCLUDING ANY CUSTOM HARDWARE FABRICATION AND TEST.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

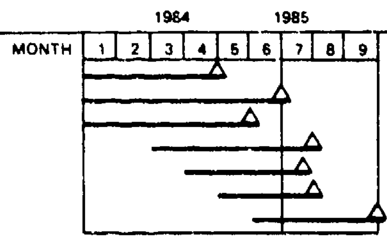
SOFTWARE SYSTEMS ENGINEERS AND SYSTEMS PROGRAMMERS WITH 5 TO 7 YEARS OF APPLICABLE EXPERIENCE IN DATA BASE MANAGEMENT SYSTEM, MANAGEMENT INFORMATION SYSTEM, SOFTWARE SUPPORT SYSTEMS.

TASK INPUTS/INTERFACES

COORDINATION WITH EISF AND NETWORK TASKS NEEDED TO ASSURE THESE INTERFACES HAVE NOT CHANGED SINCE SDR.

TASK DELIVERABLES/KEY MILESTONES

1. BUY OFF THE SHELF HARDWARE
2. CODE SOFTWARE
3. FABRICATE ANY CUSTOM HARDWARE
4. UNIT TEST PLANS
5. UNIT TEST SPECIAL SOFTWARE DEVELOPMENT
6. UNIT TEST OF HARDWARE
7. PERFORM SOFTWARE UNIT TEST



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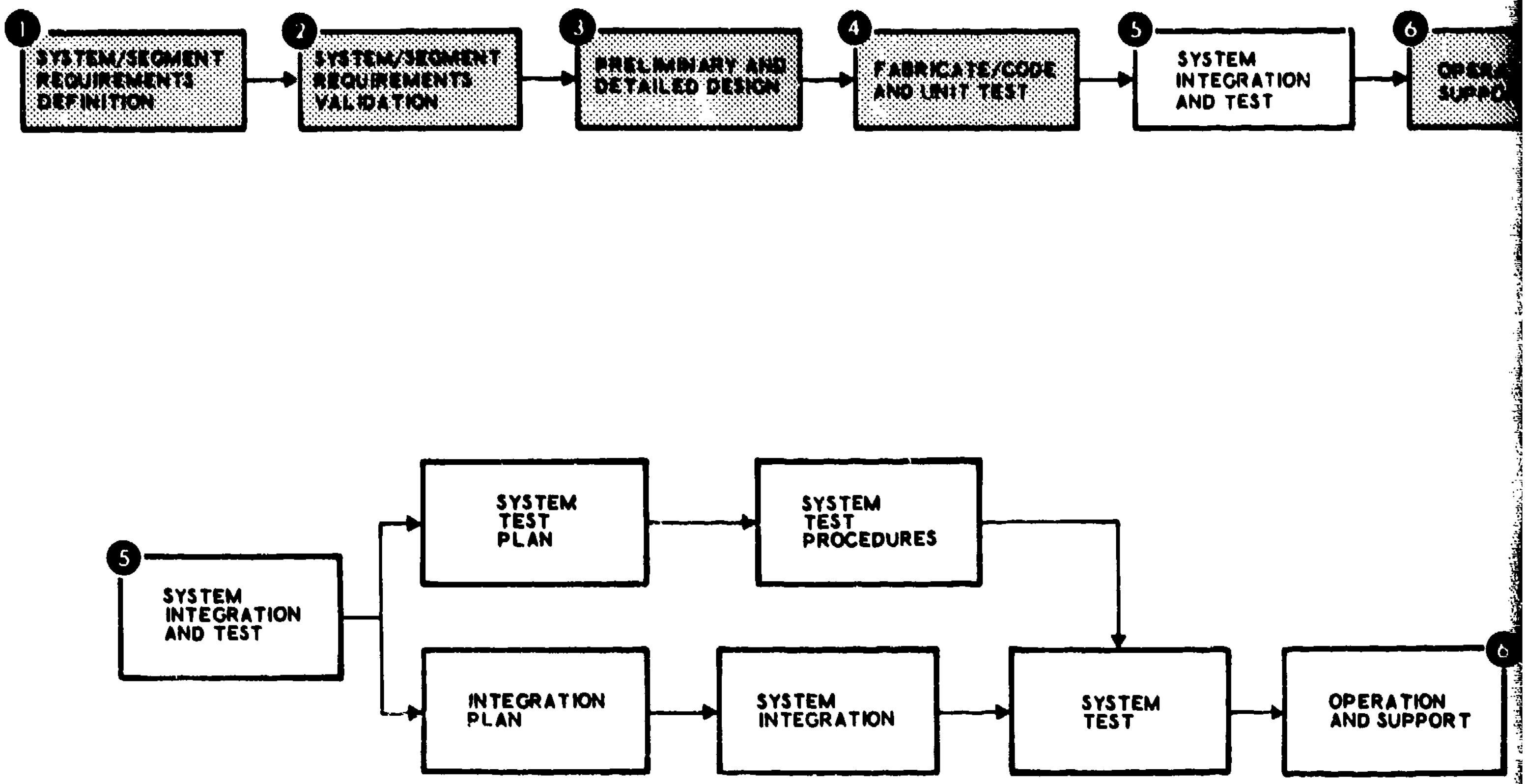
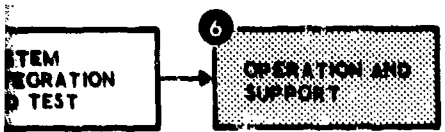


PRODUCTS

- INTEGRATION PLAN
- TEST PLAN
- TEST PROCEDURES
- SPECIAL TEST HARDWARE AND SOFTWARE
- TEST REPORTS
- "RED-LINED" DESIGN DOCUMENTS

Figure 5-8. Automation and Standardization of E
System Integration and Test



TASK DESCRIPTION AUTOMATION AND STANDARDIZATION OF ECS SUPPORT PROCESSES

SUBTASK DESCRIPTION SYSTEM INTEGRATION AND TEST

5

TASK OBJECTIVE(S)

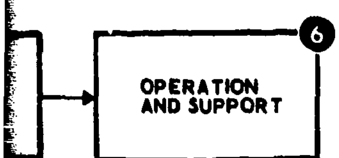
INTEGRATION AND TEST OF CI/CPCI'S INTO MANAGEMENT SUPPORT SYSTEM AND SOFTWARE CHANGE SUPPORT SYSTEM

MAJOR ISSUES/PROBLEM AREAS

INTEGRATION OF DATA BASE MANAGEMENT SYSTEM, MANAGEMENT INFORMATION SYSTEM, AND CONFIGURATION MANAGEMENT SYSTEMS WITH EXISTING DATA BASES MUST BE DONE WITHOUT INTERFERING WITH OPERATION OF EXISTING TOOLS.

TASK APPROACH

1. WRITE INTEGRATION PLAN.
2. WRITE SYSTEM TEST PLAN AND PROCEDURES.
3. INTEGRATE MANAGEMENT SYSTEM AND SOFTWARE CHANGE TOOLS.
4. PERFORM SYSTEM TEST ON THE TWO SYSTEMS.
5. WRITE TEST REPORTS.
6. CORRECT SYSTEM DEFICIENCIES DISCOVERED DURING TEST.
7. REDLINE DESIGN DOCUMENTS TO "AS-BUILT" CONFIGURATION.



LEVEL OF EFFORT

1.5 PERSON YEARS, APPROXIMATELY HALF OF WHICH IS DEVOTED TO SYSTEM INTEGRATION.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

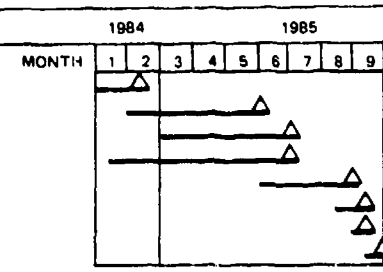
SOFTWARE SYSTEMS ENGINEERS AND TEST ENGINEERS/PROGRAMMERS WITH A MINIMUM OF 5 YEARS APPLICABLE EXPERIENCE ON SIMILAR SYSTEMS.

TASK INPUTS/INTERFACES

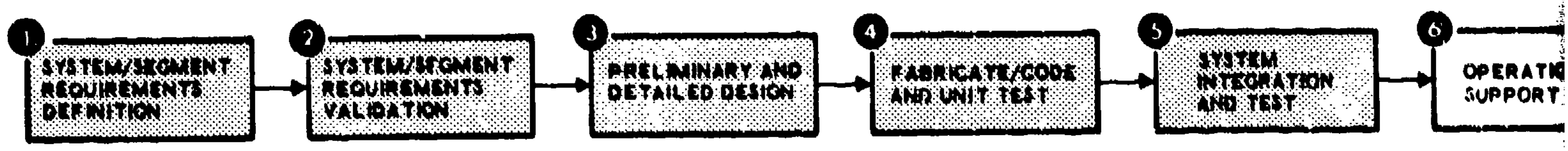
EXISTING DATA BASES MAY NEED TO BE CHANGED IN FORMAT (CONVERSION PROGRAMS) TO INTERFACE WITH THE NEW DATA BASE MANAGEMENT SYSTEM.

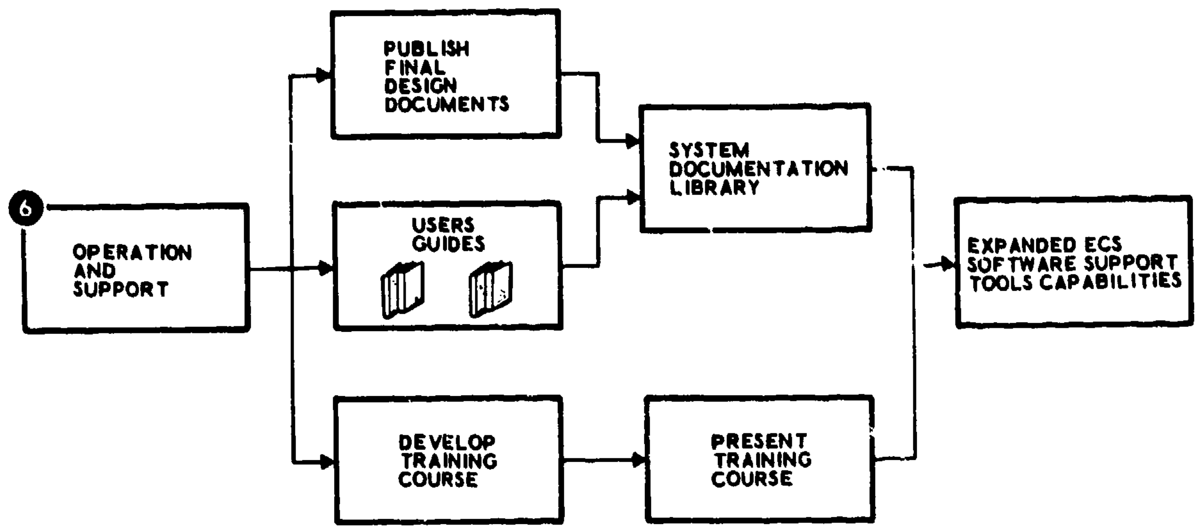
TASK DELIVERABLES/KEY MILESTONES

1. WRITE INTEGRATION PLAN
2. DEVELOP SYSTEM TEST PLANS AND PROCEDURES
3. DEVELOP SYSTEM TEST HARDWARE AND SOFTWARE
4. PERFORM CI/CPCI INTEGRATION AND TEST
5. PERFORM SYSTEM TEST
6. FUNCTIONAL CONFIGURATION AUDIT (FCA)
7. PHYSICAL CONFIGURATION AUDIT (PCA)
8. FORMAL QUALIFICATION REVIEW (FQR)



Standardization of ECS Support Processes:
on and Test

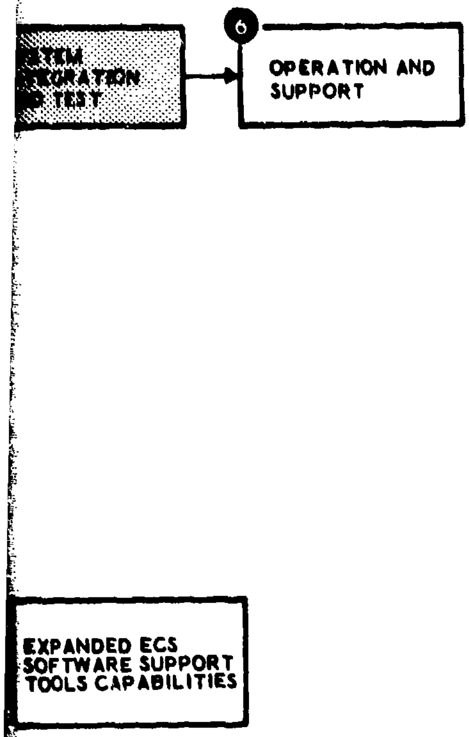




PRODUCTS

- "AS-BUILT" DOCUMENTATION
- TRAINING COURSE MATERIALS
- USERS GUIDES
- DEFICIENCY REPORTS

Figure 5-9. Automation and Standardization of
Operation and Support



TASK DESCRIPTION AUTOMATION AND STANDARDIZATION OF ECS SUPPORT PROCESSES

SUBTASK DESCRIPTION OPERATION AND SUPPORT

6

TASK OBJECTIVE(S)

ENSURE THAT THE SOFTWARE TOOL SYSTEM IS FULLY OPERATIONAL, PROVIDE USER TRAINING, AND COLLECT USER DEFICIENCY REPORTS FOR CORRECTION IN MAINTENANCE UPDATES.

MAJOR ISSUES/PROBLEM AREAS

OPERATIONAL USER EXPERIENCE WILL PROVIDE VALUABLE INSIGHT INTO UPGRADE REQUIREMENTS.

TASK APPROACH

1. PUBLISH "AS-BUILT" SYSTEM DOCUMENTATION.
2. WRITE USERS GUIDES.
3. DEVELOP TRAINING COURSE.
4. ESTABLISH SYSTEM DOCUMENTATION LIBRARYS.
5. PRESENT TRAINING COURSE TO SYSTEM USERS.
6. COLLECT OPERATIONAL DEFICIENCY REPORTS FOR MAINTENANCE/UPGRADE ACTIONS.

LEVEL OF EFFORT

1.5 PERSON YEARS ARE REQUIRED, PRIMARILY FOR WRITING USERS GUIDES AND PROVIDING TRAINING.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

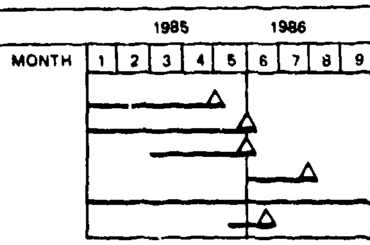
THE ABOVE TASKS REQUIRE SYSTEMS SOFTWARE ENGINEERS AND PROGRAMMERS WITH 4 TO 6 YEARS OF EXPERIENCE.

TASK INPUTS/INTERFACES

TRAINING WILL HAVE TO BE PROVIDED TO ALL FIVE ALC'S, SOME OF WHICH MAY HAVE UNIQUE REQUIREMENTS.

TASK DELIVERABLES/KEY MILESTONES

1. ESTABLISH DOCUMENTATION LIBRARY INCLUDING PUBLICATION OF FINAL DESIGN DOCUMENTS
2. WRITE USERS GUIDES
3. DEVELOP TRAINING COURSE
4. PRESENT TRAINING COURSE TO USERS
5. COLLECT OPERATIONAL DEFICIENCY REPORTS
6. OPERATIONAL DEMONSTRATION



...nd Standardization of ECS Support Processes:
...d Support

TASK DESCRIPTION AUTOMATION AND STANDARDIZATION OF ECS SUPPORT PROCESSES

SUBTASK DESCRIPTION LOCAL PROJECT TOOL DEVELOPMENT SUMMARY TASK SHEET

O

TASK OBJECTIVE(S)

PROCURE AND INSTALL MICROCOMPUTER SYSTEMS IN ENGINEERING WORK AREA FOR SPECIFIC LOCAL PROJECTS. PROVIDE MANAGEMENT AND ENGINEERING SUPPORT TOOLS FOR THESE SYSTEMS.

MAJOR ISSUES/PROBLEM AREAS

SYSTEM CONFIGURATION IS THE MAJOR ISSUE (PROCESSER, MEMORY, MASS STORAGE, PRINTER, PLOTTERS, MODEMS) SOFTWARE CAPABILITY (SOFTWARE LANGUAGES SUPPORTED, MANAGEMENT TOOLS, ENGINEERING TOOLS, ETC.) HARDWARE AND SOFTWARE ARE MOSTLY OFF-THE-SHELF.

TASK APPROACH

1. PERFORM A STUDY TO DETERMINE CANDIDATE SYSTEM CAPABILITY AND CONFIGURATION.
2. PERFORM COST/BENEFIT TRADEOFFS ON SYSTEM HARDWARE AND SOFTWARE CONFIGURATION BASED ON VENDOR PRICE LISTS. DEVELOP FINAL REQUIREMENTS SPECIFICATIONS.
3. PREPARE MANAGEMENT AND SUPPORT PLAN.
4. PURCHASE AND INSTALL THE SYSTEM.
5. PROVIDE USER TRAINING COURSE ON SYSTEM CAPABILITIES AND OPERATION (VIDEO TAPE).

LEVEL OF EFFORT

2 PERSON YEARS TO DEFINE AND VALIDATE SYSTEM REQUIREMENTS AND TO DEVELOP CUSTOM MANAGEMENT AND ENGINEERING SUPPORT SOFTWARE. VENDOR HARDWARE COSTS $4,000 TO $10,000 PER SYSTEM DEPENDING ON CONFIGURATION

PERFORMER EXPERIENCE LEVEL/BACKGROUND

DIGITAL SYSTEMS ENGINEER/PROGRAMMER WITH 3 TO 5 YEARS OF MICROPROCESSOR EXPERIENCE.

TASK INPUTS/INTERFACES

COORDINATION WITH THE CISF ENGINEERING/PROGRAMMER WORK STATION DEVELOPMENT IS REQUIRED, SINCE THE WORK STATION MODULES SHOULD EVENTUALLY FULFILL PART OF THE LOCAL TOOL REQUIREMENTS.

TASK DELIVERABLES/KEY MILESTONES

1. SYSTEM FUNCTIONAL REQUIREMENTS
2. CAPABILITY COST/BENEFIT TRADEOFF
3. FINAL SPECIFICATIONS
4. ORDER AND DELIVERY
5. TRAINING COURSE PREPARATION
6. CUSTOM SOFTWARE DEVELOPMENT

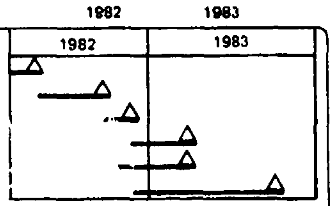
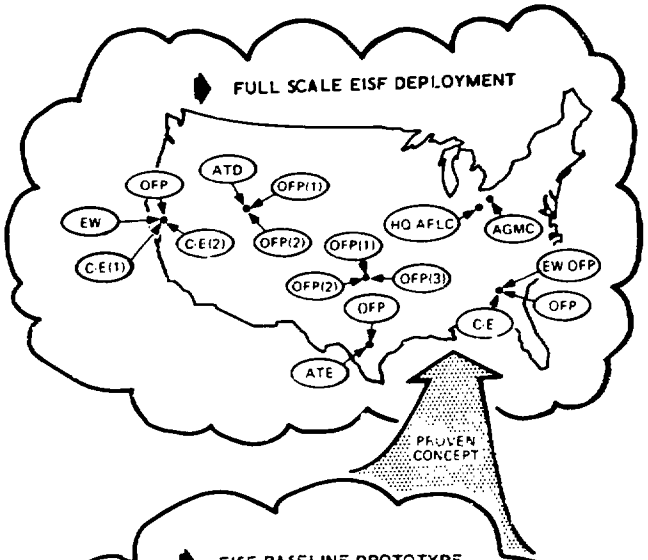


Figure 5-10. Automation and Standardization of ECS Support Processes: Local Project Tool Development Summary Task Sheet

ECS Support Categories	AGMC	OC-ALC	OC ALC	SA ALC	SM ALC	WR ALC	HQ AFLC	ECS Support Requirements
	AFLC Primary ECS Support Locations							
Aircrew Training Devices (ATD)			X				X	Common to All ECS Categories • Life Cycle • Management, System Engineering, Training • Pre PMRT ECS Support
Automatic Test Equipment (ATE)	X	X	X	X	X	X	X	• Support System Requirements, Supportability Design Criteria • Post PMRT ECS Suppc
Communications-Electronics (C E)		X			X	X	X	• ECS Change, Change Analysis and Specificat on, Engineering Development and Unit Test, System Integration and Test, Change Documentation, Certification and Distribution
Electronic Warfare (EW)					X	X	X	Category Unique • Post PMRT ECS Support • Concurrency with Weapon System, Interagency Shared Software Support, Intelligence Data Usage, Rapid Reprogramming Capability, High Frequency Change, Nuclear Safety Criteria
Operational Flight Programs (OFP)	X	X	X	X	X	X	X	



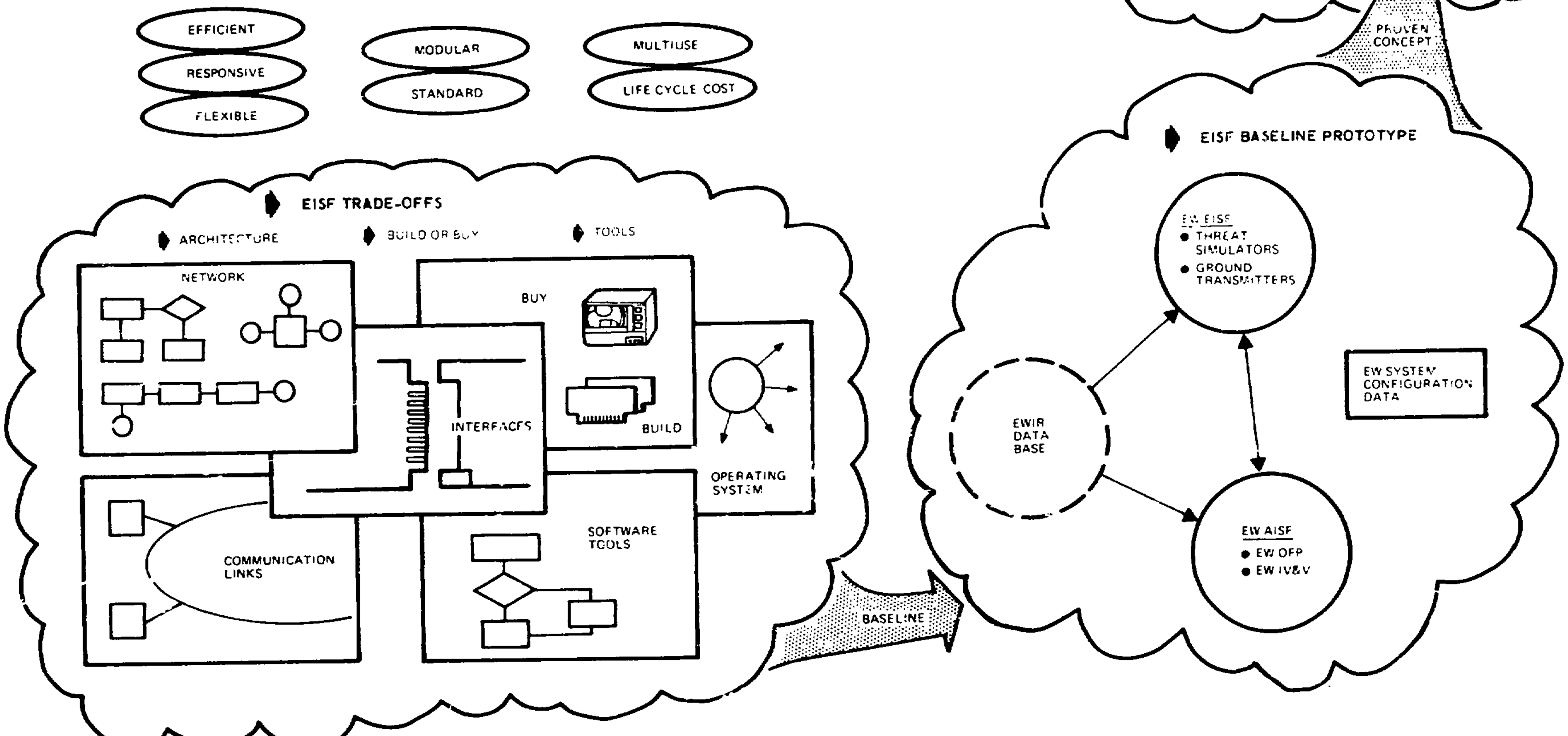


Figure 5-11. Modular Extendable Integration Support Facility Conceptual Evolution

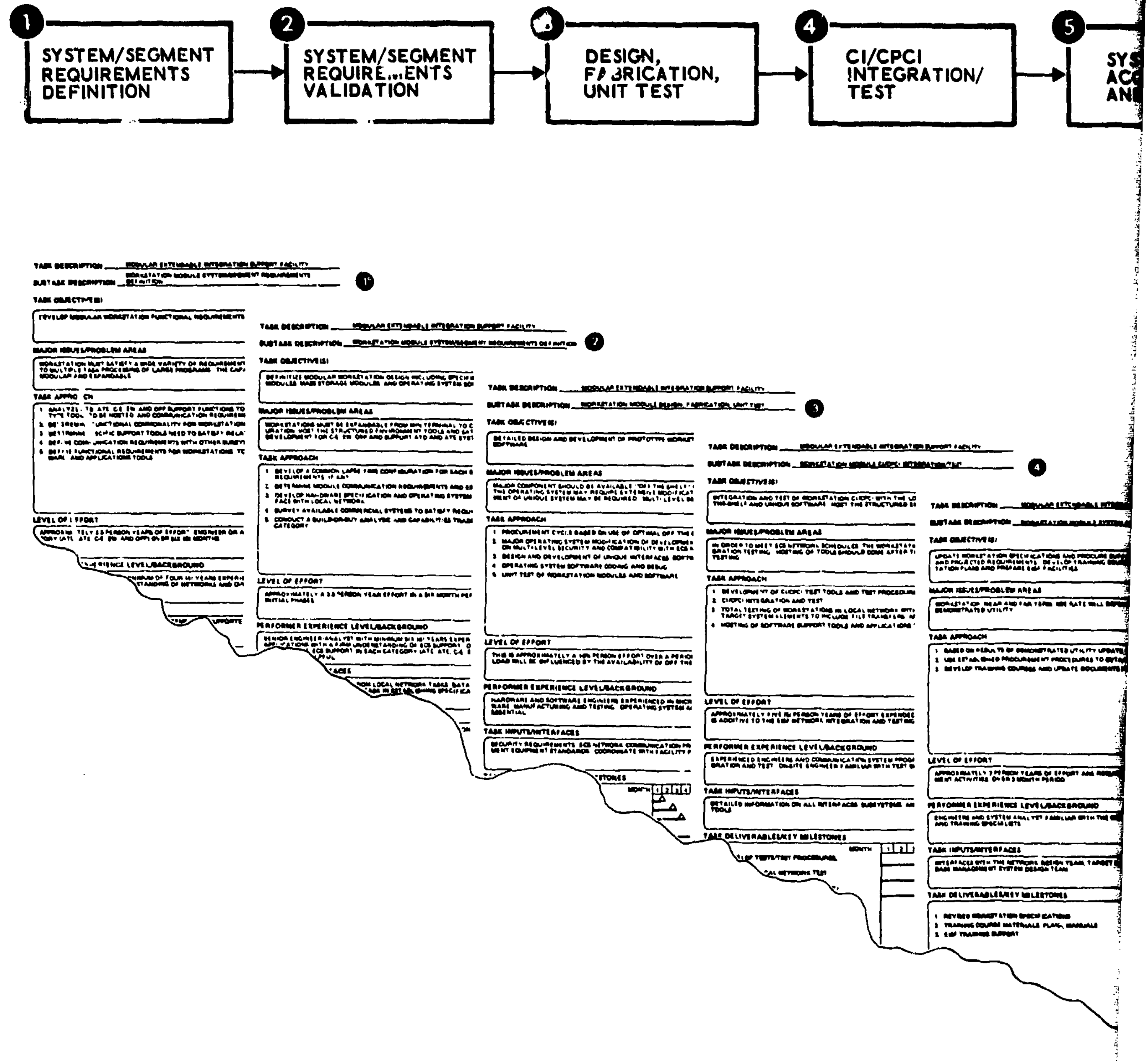


Figure 5-12. Modular Extendable Integration Support Overview and Summary Task Sheet

TION/ → **5** SYSTEM ACQUISITION AND SUPPORT

TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION WORK STATION MODULE SUMMARY TASK SHEET

TASK OBJECTIVE(S)

DEVELOP MULTI-USE EISF WORKSTATIONS FOR USE IN A DISTRIBUTED PROCESSING ENVIRONMENT. OVERALL TASK ALSO INCLUDES DEVELOPMENT OF SIMULATION KERNELS, REPROGRAMMABLE CMAC, AND PROGRAMMABLE INTERFACE UNIT. LOCAL ECS SUPPORT NETWORKS ARE INCLUDED WITH ECS SUPPORT NETWORKS INITIATIVE.

MAJOR ISSUES/PROBLEM AREAS

THE WORKSTATIONS SHOULD BE DEVELOPED FROM OFF-THE-SHELF COMPONENTS WHENEVER POSSIBLE AND SHOULD BE CAPABLE OF SUPPORTING MULTIPLE EISF COMPUTING AND COMMUNICATIONS TASKS. WORKSTATIONS WILL HOST STANDARD ECS SUPPORT TOOLS.

TASK APPROACH

1. DEVELOP COMPREHENSIVE UNDERSTANDING OF EISF PROCESSING REQUIREMENTS.
2. DEFINE WORKSTATION SPECIFICATIONS FOR DEVELOPMENT OF BASELINE SYSTEM, INCLUDING HARDWARE AND SOFTWARE.
3. DESIGN AND FABRICATE PROTOTYPE SYSTEM.
4. INTEGRATE WORKSTATION CI/CPCI AND INTEGRATE WORKSTATION TO EISF NETWORK. TEST AND DEMONSTRATE WORKSTATION UTILITY.
5. REVISE SYSTEM SPECIFICATION AND BUY WORKSTATION MODULES.

LEVEL OF EFFORT

APPROXIMATELY 24 PERSON YEARS OF EFFORT WILL BE REQUIRED TO BUILD THE WORKSTATIONS, DESIGN OPERATING SYSTEM, AND INTEGRATE SYSTEMS INTO TWO BASELINE EISF'S WITH DIFFERENT ECS SUPPORT TASKS. OVERALL INITIATIVE IS 61 PERSON YEARS WITH 12 FOR SIMULATION KERNELS, 10 FOR REPROGRAMMABLE CMAC AND 15 FOR PROGRAMMABLE INTERFACE UNIT.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

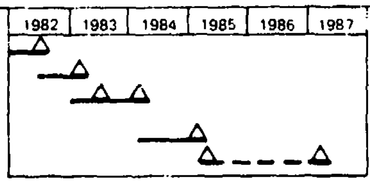
SYSTEM DESIGN, INTEGRATION TEST, OPERATIONAL SUPPORT INVOLVING ELECTRONIC, ELECTRICAL, AND MECHANICAL ENGINEERING DISCIPLINES WITH EMPHASIS ON MICROPROCESSOR TECHNOLOGY

TASK INPUTS/INTERFACES

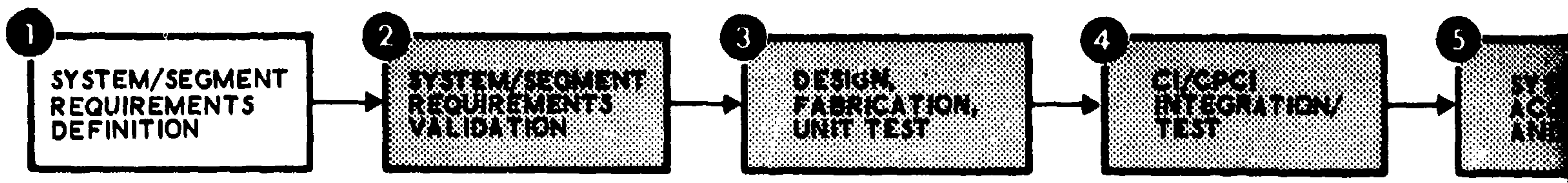
DOD AND IEEE STANDARDS, COMMUNICATION PROTOCOLS, ECS SUPPORT TOOL REQUIREMENTS, TARGET SUBSYSTEM PROCESSING AND CONTROL REQUIREMENTS, AND SUPPORT SUBSYSTEM DATA EXCHANGE REQUIREMENTS.

TASK DELIVERABLES/KEY MILESTONES

1. REQUIREMENTS DEFINITION, SRR
2. REQUIREMENTS VALIDATION, SDR
3. DESIGN, FABRICATION AND UNIT TEST, PDR
4. CI/CPCI INTEGRATION, AND NETWORK INTEGRATION
5. PROCUREMENT AND OPERATIONS SUPPORT

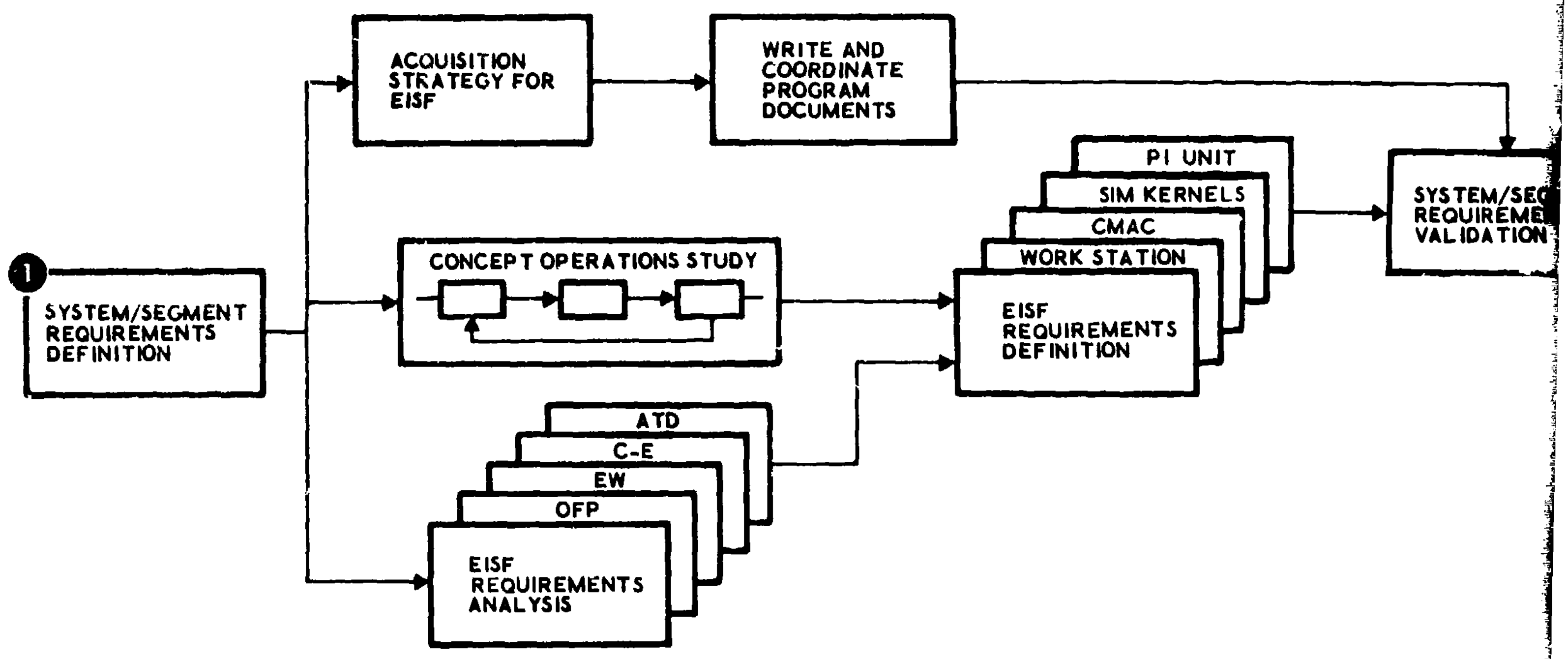


tegration Support Facility: Workstation Module
y Task Sheet



INPUT FROM RELATED ACTIVITIES

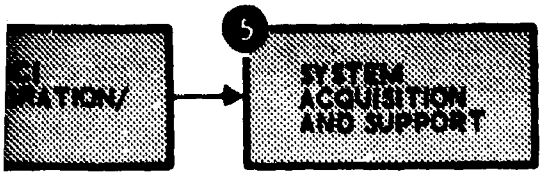
MANAGEMENT, ENGINEERING, ACQUISITION, AND SUPPORT PRACTICES	AUTOMATION AND STANDARDIZATION OF ECS SUPPORT PROCESSES	ECS READINESS SUPPORT	ECS SUPPORT NETWORKS
• MANAGEMENT, DIRECTION	• MANAGEMENT TOOLS	• INTELLIGENCE	• PROTOCOLS
• PLANNING	• SUPPORT TOOLS	• SECURITY	• SECURITY
• POLICY	• PROJECT TOOLS	• DATA BASE	• TRAFFIC
• GUIDANCE	• PROCEDURES	• PRIORITIES	• NETWORK CONTROL
• BUDGET	• DATA BASE	• THREATS	• PRIORITIES
• RESOURCES	• INTERFACE	• TRAINING	• ARCHITECTURE



PRODUCTS

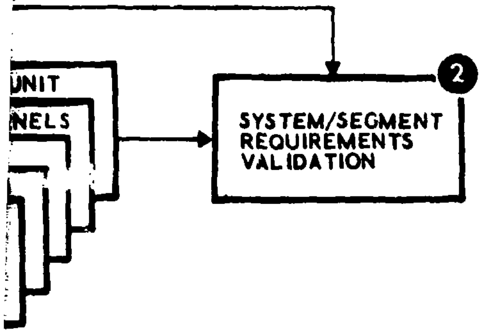
- ANALYSIS REPORTS
- SURVEY REPORTS
- CONCEPT OF OPERATIONS
- EISF REQUIREMENTS BY ECS CATEGORY
- ACQUISITION/FUNDING PLAN
- PROGRAM MANAGEMENT DOCUMENTS

Figure 5-13. Modular Extendable Integration S
Workstation Module System/Segn



ECS SUPPORT NETWORKS

- PROTOCOLS
- SECURITY
- TRAFFIC
- NETWORK CONTROL
- PRIORITIES
- ARCHITECTURE



TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION WORKSTATION MODULE SYSTEM/SEGMENT REQUIREMENTS DEFINITION

1

TASK OBJECTIVE(S)

DEVELOP MODULAR WORKSTATION FUNCTIONAL REQUIREMENTS FOR A BASELINE SYSTEM

MAJOR ISSUES/PROBLEM AREAS

WORKSTATION MUST SATISFY A WIDE VARIETY OF REQUIREMENTS, FROM TERMINAL COMMUNICATIONS TO MULTIPLE TASK PROCESSING OF LARGE PROGRAMS. THE CAPABILITY OF THE WORKSTATION MUST BE MODULAR AND EXPANDABLE

TASK APPROACH

1. ANALYZE ATD, ATE, C E, EW, AND OFP SUPPORT FUNCTIONS TO IDENTIFY WORKSTATION APPLICATIONS, TYPE TOOLS TO BE HOSTED, AND COMMUNICATION REQUIREMENTS
2. DETERMINE FUNCTIONAL COMMONALITY FOR WORKSTATIONS
3. DETERMINE SPECIFIC SUPPORT TOOLS NEED TO SATISFY RELATED FUNCTIONS
4. DEFINE COMMUNICATION REQUIREMENTS WITH OTHER SUBSYSTEM VIA LOCAL NETWORK
5. DEFINE FUNCTIONAL REQUIREMENTS FOR WORKSTATIONS, TO INCLUDE HARDWARE, SYSTEM SOFTWARE, AND APPLICATIONS TOOLS

LEVEL OF EFFORT

APPROXIMATELY 3.5 PERSON YEARS OF EFFORT, ENGINEER OR ANALYST FROM EACH ECS SUPPORT CATEGORY (ATD, ATE, C E, EW, AND OFP) OVER SIX (6) MONTHS

PERFORMER EXPERIENCE LEVEL/BACKGROUND

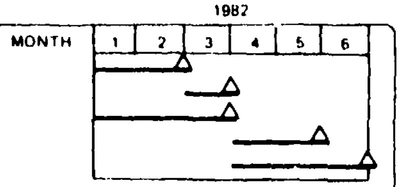
ENGINEER/ANALYST WITH MINIMUM OF FOUR (4) YEARS EXPERIENCE IN WORKSTATION DESIGN AND APPLICATIONS. A FIRM UNDERSTANDING OF NETWORKS AND OPERATING SYSTEMS HIGHLY DESIRABLE

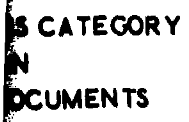
TASK INPUTS/INTERFACES

KEY INPUTS REQUIRED FROM ALL SUBSYSTEMS TO BE SUPPORTED BY THE EISF NETWORK, FILE SERVERS SIMULATION KERNELS, PROGRAMMABLE CMAC'S, ETC

TASK DELIVERABLES/KEY MILESTONES

1. ANALYSIS OF ECS SUPPORT FUNCTIONS
2. FUNCTIONAL COMMONALITY SURVEY
3. COMPILATION OF SUPPORT TOOLS
4. DEFINITION OF WORKSTATION COMMON REQUIREMENTS
5. WORKSTATION REQUIREMENTS DEFINITION





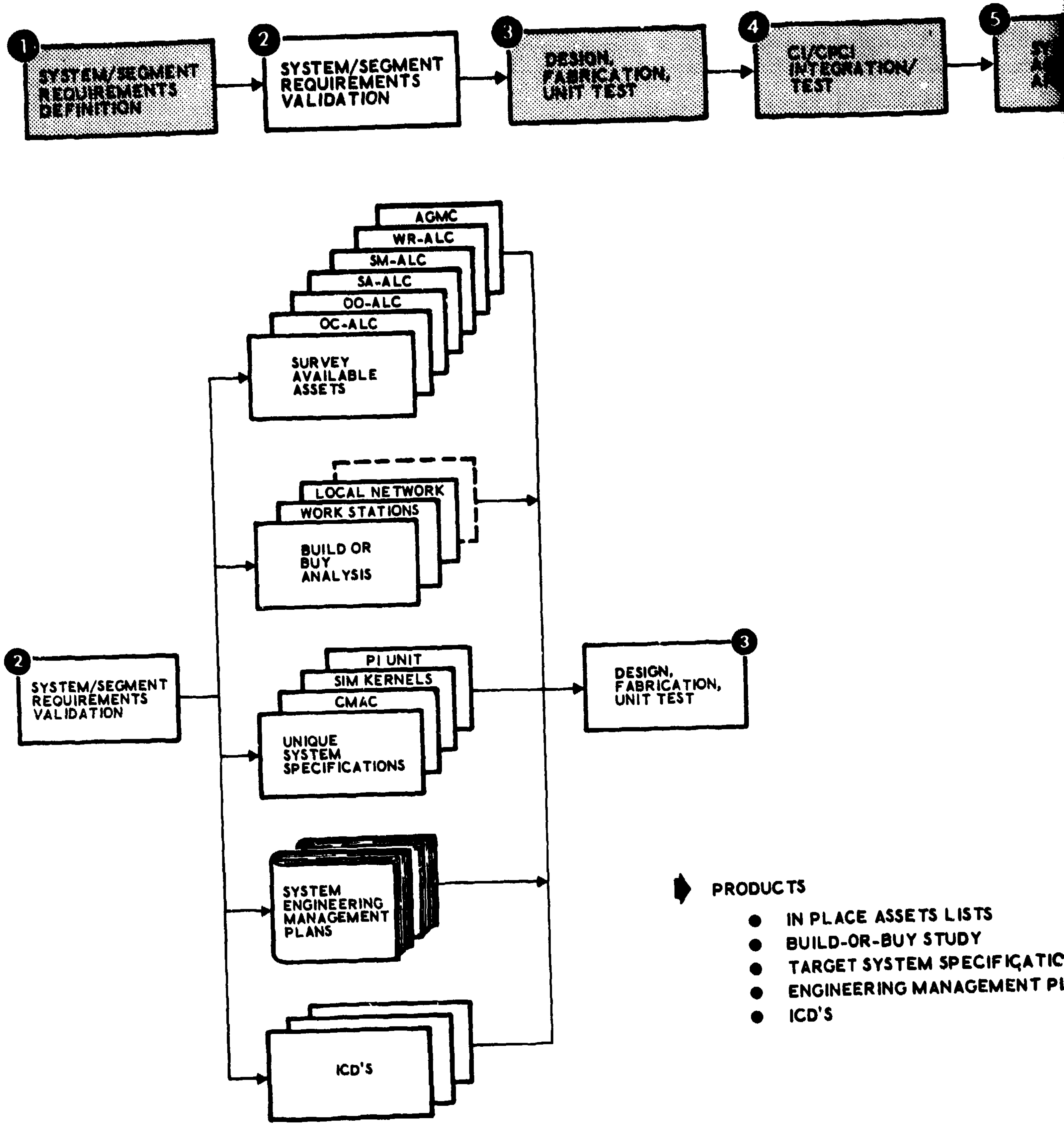
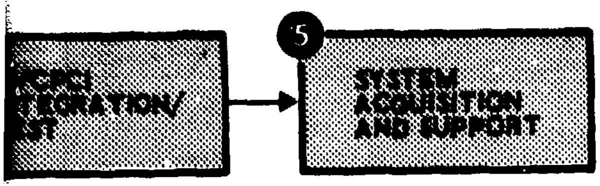


Figure 5-14. Modular Extendable Integration Support Facil
Workstation Module System/Segment Requirem



TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION WORKSTATION MODULE SYSTEM/SEGMENT REQUIREMENTS VALIDATION (2)

TASK OBJECTIVE(S)

DEFINITIZE MODULAR WORKSTATION DESIGN INCLUDING SPECIFICATIONS FOR TERMINALS, MEMORY MODULES, MASS STORAGE MODULES, AND OPERATING SYSTEM SOFTWARE. ADDRESS SECURITY ISSUES.

MAJOR ISSUES/PROBLEM AREAS

WORKSTATIONS MUST BE EXPANDABLE FROM A MINIMUM TERMINAL TO A COMPACT COMPUTING SYSTEM CONFIGURATION, HOST THE STANDARD ECS SUPPORT TOOLS AND SATISFY THE REQUIREMENTS OF ECS DEVELOPMENT FOR C-E, EW, OFP AND SUPPORT ATD AND ATE SYSTEM DEVELOPMENT.

TASK APPROACH

1. DEVELOP A COMMON LAPSE TIME CONFIGURATION FOR EACH ECS CATEGORY AND IDENTIFY UNIQUE REQUIREMENTS, IF ANY.
2. DETERMINE MODULE COMMUNICATION REQUIREMENTS AND ESTABLISH INTERFACE SPECIFICATIONS.
3. DEVELOP HARDWARE SPECIFICATION AND OPERATING SYSTEM SPECIFICATIONS TO INCLUDE INTERFACE WITH LOCAL NETWORK.
4. SURVEY AVAILABLE COMMERCIAL SYSTEMS TO SATISFY REQUIREMENTS.
5. CONDUCT A BUILD-OR-BUY ANALYSIS AND CAPABILITIES TRADEOFF ANALYSIS FOR EACH ECS CATEGORY.

LEVEL OF EFFORT

APPROXIMATELY A 3.5 PERSON YEAR EFFORT IN A SIX MONTH PERIOD WITH MAJOR WORK LOAD DURING INITIAL PHASES.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

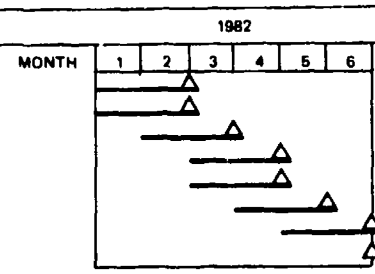
SENIOR ENGINEER/ANALYST WITH MINIMUM SIX (6) YEARS EXPERIENCE IN WORKSTATION DESIGN OR APPLICATIONS WITH A FIRM UNDERSTANDING OF ECS SUPPORT. ONE ENGINEER/ANALYST MUST BE KNOWLEDGEABLE IN ECS SUPPORT IN EACH CATEGORY (ATE, ATE, C-E, EW, AND OFP. ADP SECURITY SYSTEM KNOWLEDGE HELPFUL.

TASK INPUTS/INTERFACES

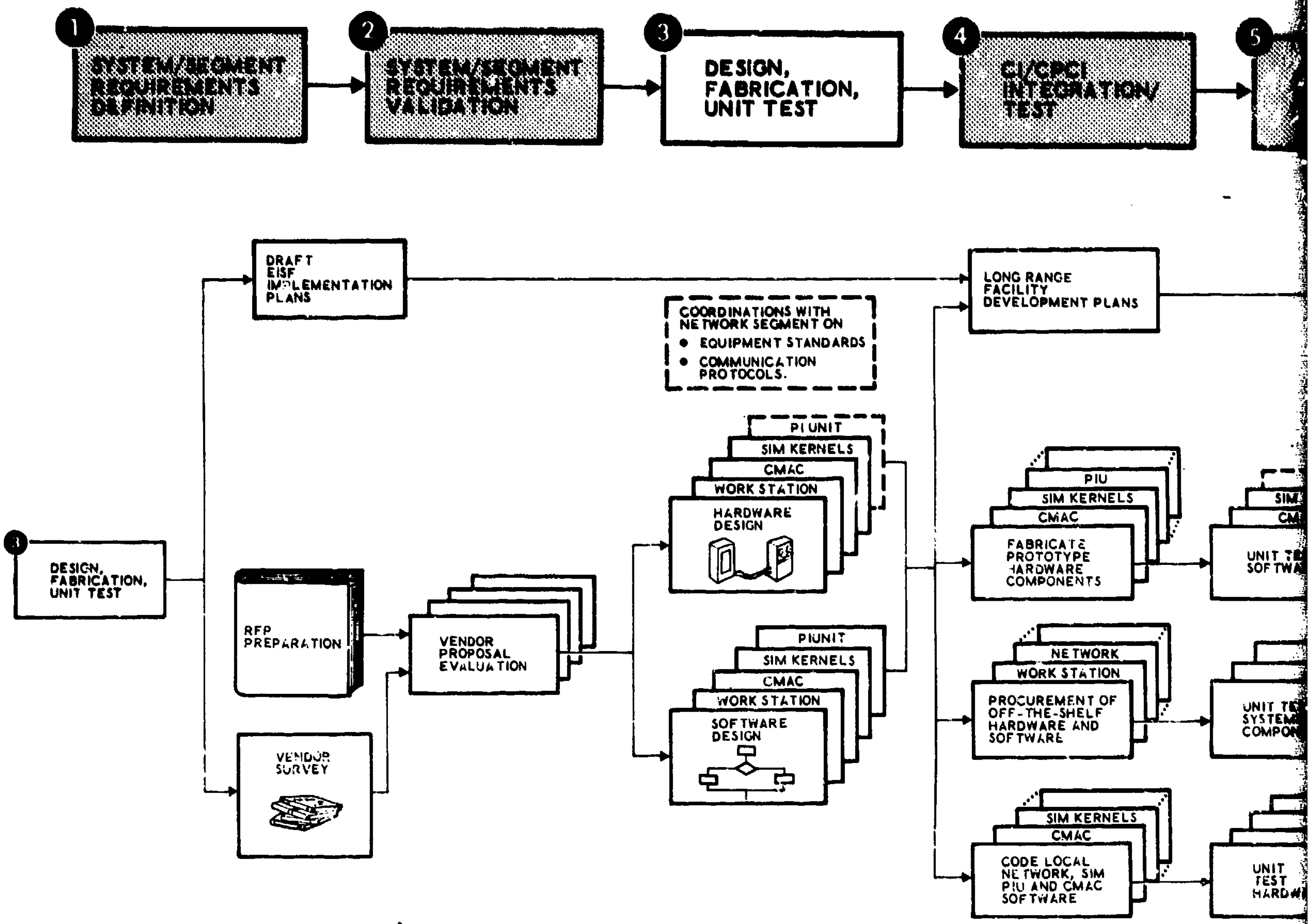
KEY INPUTS ARE REQUIRED FROM LOCAL NETWORK TASKS, DATA BASE MANAGEMENT SYSTEM TASK, AND FROM THE TARGET SUBSYSTEM TASK IN ESTABLISHING SPECIFICATION AND CONDUCTING TRADEOFF ANALYSIS.

TASK DELIVERABLES/KEY MILESTONES

1. BASELINE DOCUMENT BY ECS CATEGORY
2. SYSTEM REQUIREMENT SPECIFICATION
3. INTERFACE SPECIFICATION
4. CI DEVELOPMENT SPECIFICATION
5. CPCI DEVELOPMENT SPECIFICATION
6. COMMERCIAL SURVEY RESULTS
7. BUILD-OR-BUY ASSESSMENT
8. SDR



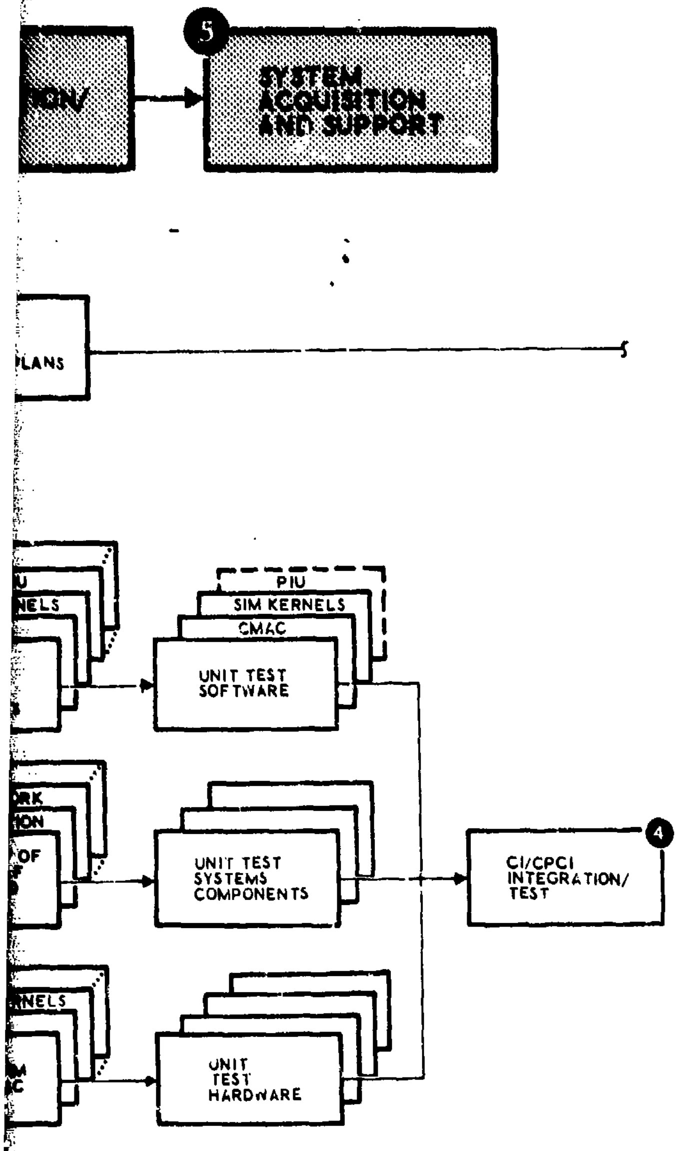
PLACE ASSETS LISTS
ILD-OR-BUY STUDY
RGET SYSTEM SPECIFICA N
GINEERING MANAGEMENT PLAN
'S



PRODUCTS

- DESIGN IMPLEMENTATION PLANS
- RFP PACKAGE
- VENDOR SURVEY REPORTS
- DESIGN DOCUMENTS
  - HARDWARE
  - SOFTWARE
- FACILITY DEVELOPMENT PLANS
- FABRICATE BOARDS, RACKS STAND ENCLOSURES, CONSOLES AND OTHER SUBSYSTEMS
- PROCURE OFF-SHELF-EQUIPMENT AND SYSTEM SOFTWARE
- CODE EISF SOFTWARE
- TEST REPORTS
- AUXILIARY EQUIPMENT, CABLES
- SPECIAL TEST EQUIPMENT

Figure 5-15. Modular Extendable Integ
Workstation Module Desig



TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION WORKSTATION MODULE DESIGN, FABRICATION, UNIT TEST

TASK OBJECTIVE(S)

DETAILED DESIGN AND DEVELOPMENT OF PROTOTYPE WORKSTATION MODULES AND OPERATING SOFTWARE.

MAJOR ISSUES/PROBLEM AREAS

MAJOR COMPONENTS SHOULD BE AVAILABLE "OFF-THE-SHELF" WITH A MINIMUM OF HARDWARE DESIGN. THE OPERATING SYSTEM MAY REQUIRE EXTENSIVE MODIFICATION OF AVAILABLE CPCI OR DEVELOPMENT OF UNIQUE SYSTEM MAY BE REQUIRED. MULTI LEVEL SECURITY MUST BE CONSIDERED.

TASK APPROACH

1. PROCUREMENT CYCLE BASED ON USE OF OPTIMAL OFF-THE-SHELF HARDWARE.
2. MAJOR OPERATING SYSTEM MODIFICATION OF DEVELOPMENT ANTICIPATED, WITH SPECIAL EMPHASIS ON MULTI-LEVEL SECURITY AND COMPATIBILITY WITH ECS NETWORK PROTOCOL.
3. DESIGN AND DEVELOPMENT OF UNIQUE INTERFACES, SOFTWARE DRIVERS, CABLING, ETC.
4. OPERATING SYSTEM SOFTWARE CODING AND DEBUG.
5. UNIT TEST OF WORKSTATION MODULES AND SOFTWARE.

LEVEL OF EFFORT

THIS IS APPROXIMATELY A 10.5 PERSON EFFORT OVER A PERIOD OF 14 MONTHS, HOWEVER, TOTAL WORK LOAD WILL BE INFLUENCED BY THE AVAILABLITY OF OFF-THE-SHELF COMPONENTS AND SOFTWARE.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

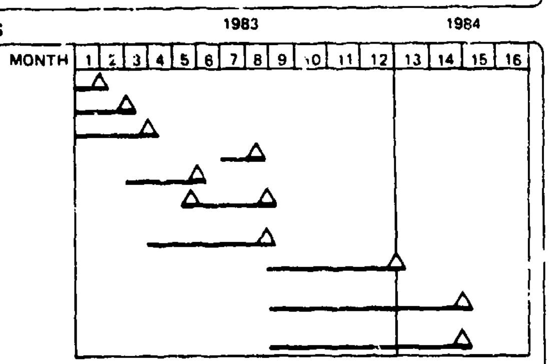
HARDWARE AND SOFTWARE ENGINEERS EXPERIENCED IN MICROPROCESSOR, OPERATING SYSTEM SOFTWARE, MANUFACTURING AND TESTING. OPERATING SYSTEM AND MULTI-LEVEL SECURITY EXPERTS ESSENTIAL.

TASK INPUTS/INTERFACES

SECURITY REQUIREMENTS, ECS NETWORK COMMUNICATION PROTOCOL SPECIFICATION, NETWORK SEGMENT EQUIPMENT STANDARDS. COORDINATE WITH FACILITY PLANNERS.

TASK DELIVERABLES/KEY MILESTONES

1. DESIGN IMPLEMENTATION PLAN
2. MANUFACTURE/VENDOR SUPPLY
3. PREPARE AND ISSUE RFP'S
4. VENDOR PROPOSAL EVALUATION
5. UNIQUE INTERFACE DESIGN
6. PDR AND CDR
7. OPERATING SYSTEM SOFTWARE DESIGN
8. FABRICATE UNIQUE HARDWARE
9. OFF-THE-SHELF EQUIPMENT PROCUREMENT AND TEST
10. OPERATING SYSTEM SOFTWARE CODE AND TEST



TWARE

Extendable Integration Support Facility:
on Module Design, Fabrication, Unit Test

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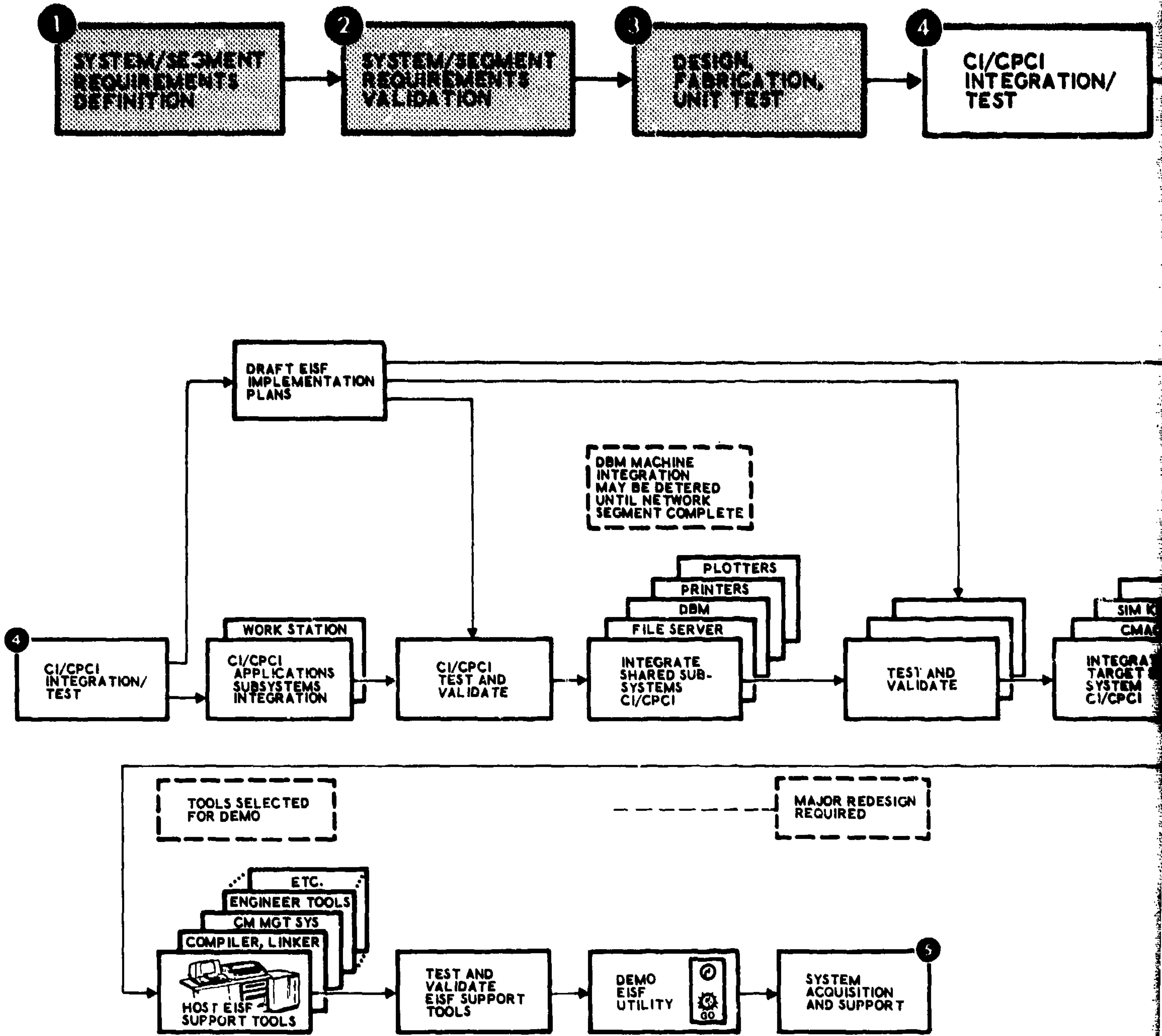
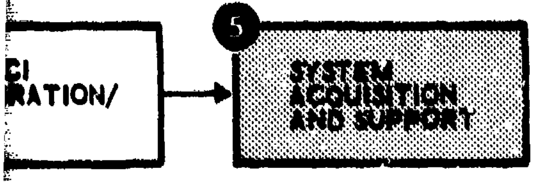
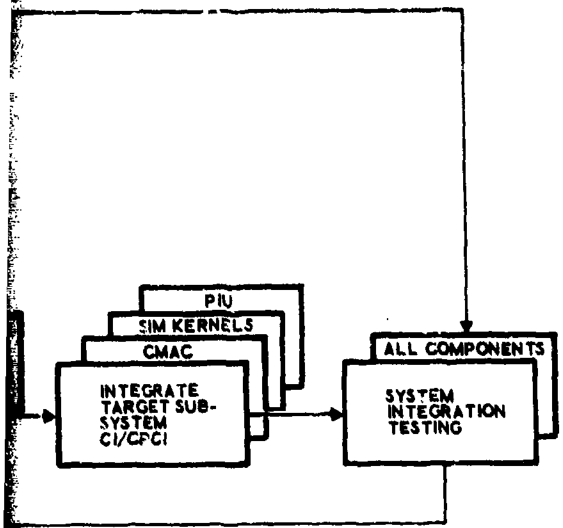


PRODUCTS

- TEST PROCEDURES, UNIQUE TEST EQUIPMENT
- TEST REPORTS
- SYSTEM MODIFICATION RECOMMENDATIONS
- OPERATIONAL EISF'S (MINIMAL OF TWO)
- EISF TOOL CAPABILITIES REPORT

Figure 5-16. Modular Extendable In
Workstation Module CI





TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION WORKSTATION MODULE CI/CPCI INTEGRATION/TEST (4)

TASK OBJECTIVE(S)

INTEGRATION AND TEST OF WORKSTATION CI/CPCI WITH THE LOCAL NETWORK. CI/CPCI'S INCLUDE OFF-THE-SHELF AND UNIQUE SOFTWARE. HOST THE STANDARD ECS SUPPORT TOOLS.

MAJOR ISSUES/PROBLEM AREAS

IN ORDER TO MEET ECS NETWORK SCHEDULES, THE WORKSTATION MUST BE AVAILABLE FOR EISF INTEGRATION TESTING. HOSTING OF TOOLS SHOULD COME AFTER THE LOCAL NETWORK INTEGRATION AND TESTING.

TASK APPROACH

1. DEVELOPMENT OF CI/CPCI TEST TOOLS AND TEST PROCEDURES.
2. CI/CPCI INTEGRATION AND TEST.
3. TOTAL TESTING OF WORKSTATIONS IN LOCAL NETWORK WITH SHARED SUBSYSTEM ELEMENTS AND TARGET SYSTEM ELEMENTS TO INCLUDE FILE TRANSFERS, APPLICATIONS CONTROL, ETC.
4. HOSTING OF SOFTWARE SUPPORT TOOLS AND APPLICATIONS TESTING AND DEMONSTRATIONS.

LEVEL OF EFFORT

APPROXIMATELY FIVE (5) PERSON YEARS OF EFFORT EXPENDED OVER A 12 MONTH PERIOD. WORK LOAD IS ADDITIVE TO THE EISF NETWORK INTEGRATION AND TESTING

PERFORMER EXPERIENCE LEVEL/BACKGROUND

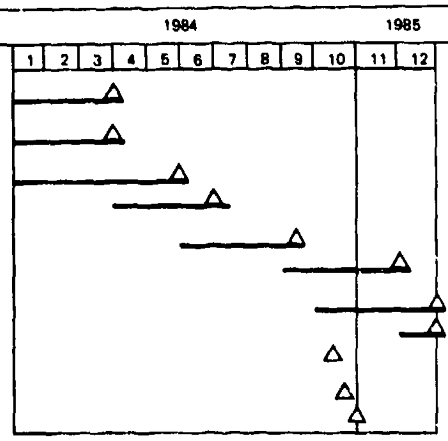
EXPERIENCED ENGINEERS AND COMMUNICATION SYSTEM PROGRAMMERS FAMILIAR WITH SYSTEM INTEGRATION AND TEST. ON-SITE ENGINEER FAMILIAR WITH TEST DESIGN AND APPLICATIONS SOFTWARE

TASK INPUTS/INTERFACES

DETAILED INFORMATION ON ALL INTERFACES, SUBSYSTEMS, AND APPLICATION SUPPORT SOFTWARE TOOLS.

TASK DELIVERABLES/KEY MILESTONES

1. DEVELOP TESTS/TEST PROCEDURES, CI/CPCI
2. DEVELOP LOCAL NETWORK TEST PROCEDURES
3. DEVELOP UNIQUE TEST EQUIPMENT/SOFTWARE
4. PERFORM CI/CPCI INTEGRATION TEST
5. PERFORM EISF NETWORK INTEGRATION/TEST
6. HOST EISF SUPPORT TOOLS
7. TEST AND VALIDATE EISF SUPPORT TOOLS
8. EISF/UTILITY DEMONSTRATION
9. FUNCTIONAL CONFIGURATION AUDIT
10. PHYSICAL CONFIGURATION AUDIT
11. KERNEL QUALIFICATION REVIEW



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Module CI/CPCI Integration/Test

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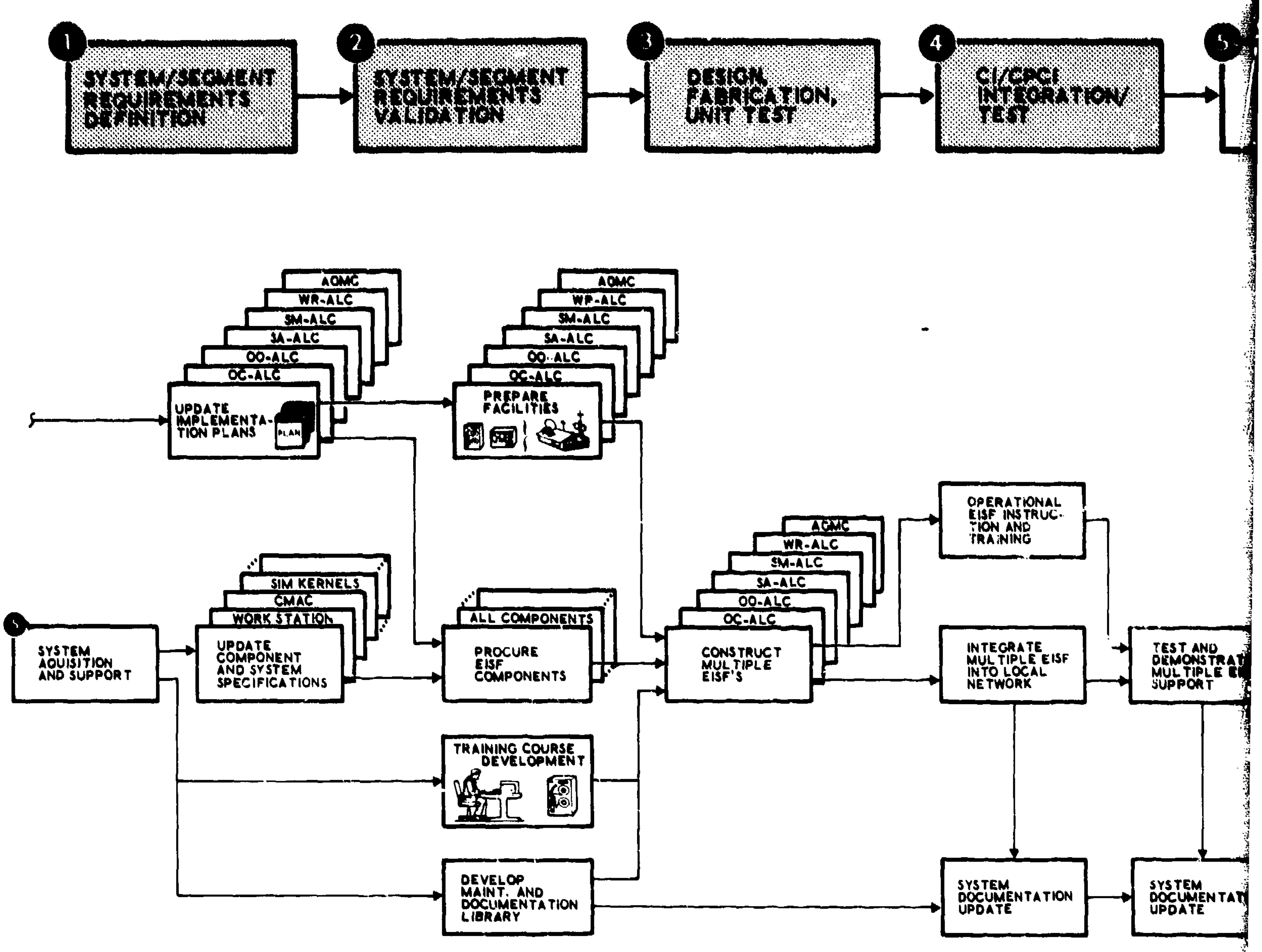
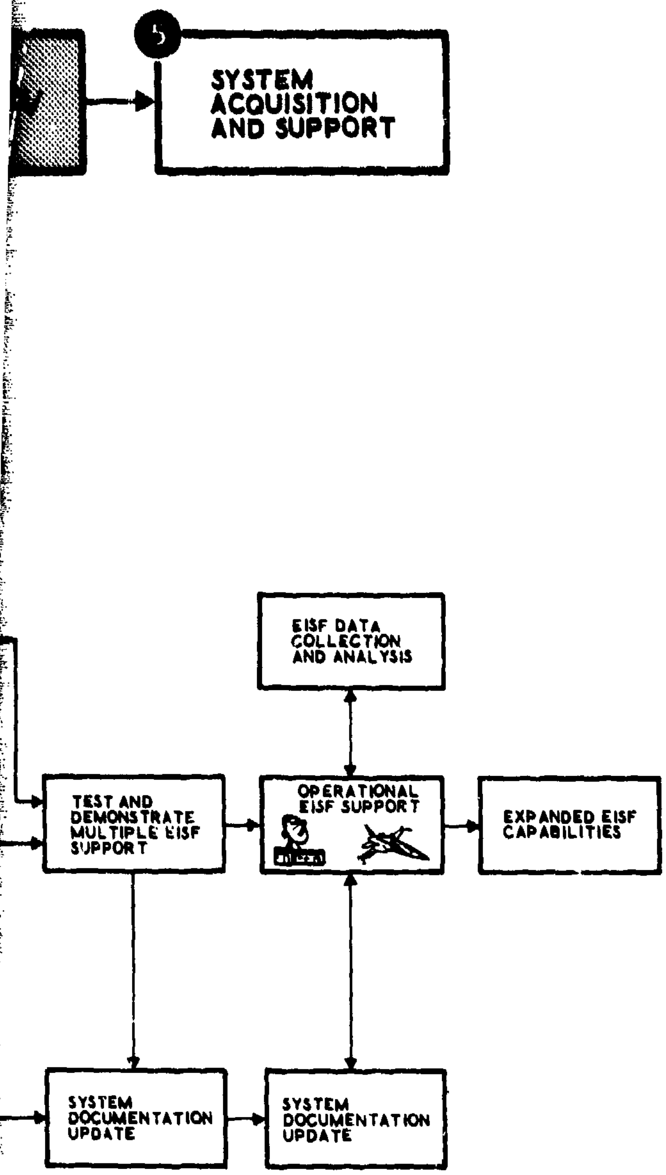


PRODUCTS

- UPDATED IMPLEMENTATION PLANS FROM EACH AL
- REVISE SPECIFICATIONS FOR ALL SYSTEMS TO BE P
- TRAINING COURSE PLANS AND MATERIALS
- ALL COMPONENTS REQUIRED FOR MULTIPLE EISF, ON-HAND COMPONENT FOR EXPANSION, NEW REQUI
- FACILITIES FOR HOUSING EISF'S
- OPERATIONAL EISF'S, WITH OPERATIONS MANUALS, CONFIGURATION DOCUMENTS
- EISF OPERATIONS INSTRUCTION AND OVER-THE-SHO
- TEST REPORTS
- UPDATED DOCUMENTS
- SYSTEM LIBRARY WITH SYSTEM DOCUMENT
- DATA COLLECTION/ANALYSIS SOFTWARE
- OPERATIONAL REPORTS (DEFICIENCIES, FAILURES)
- MAINTENANCE REPORTS (TYPE MAINTENANCE, LO SUPPORT PROBLEMS, ETC.)

Figure 5-17. Modular Extendable
Workstation Module



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VER-THE-SHOULDER TRAINING

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TENANCE, LOGISTICS

Extendable Integration Support Facility:
ion Module System Acquisition and Support

TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION WORKSTATION MODULE SYSTEM ACQUISITION AND SUPPORT (5)

TASK OBJECTIVE(S)

UPDATE WORKSTATION SPECIFICATIONS AND PROCURE SUFFICIENT WORKSTATIONS TO SATISFY CURRENT AND PROJECTED REQUIREMENTS. DEVELOP TRAINING COURSES, SYSTEM DOCUMENTS, UPDATE IMPLEMENTATION PLANS AND PREPARE EISF FACILITIES.

MAJOR ISSUES/PROBLEM AREAS

WORKSTATION, NEAR AND FAR TERM, USE RATE WILL DEPEND ON EXPECTED IMPLEMENTATION AND DEMONSTRATED UTILITY.

TASK APPROACH

1. BASED ON RESULTS OF DEMONSTRATED UTILITY UPDATE COMPONENT AND SYSTEM SPECIFICATIONS.
2. USE ESTABLISHED PROCUREMENT PROCEDURES TO OBTAIN PROVEN COMPONENTS.
3. DEVELOP TRAINING COURSES AND UPDATE DOCUMENTS FOR WORKSTATIONS

LEVEL OF EFFORT

APPROXIMATELY 2 PERSON YEARS OF EFFORT ARE REQUIRED, EXCLUSIVE OF THE NORMAL PROCUREMENT ACTIVITIES, OVER 3 MONTH PERIOD.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

ENGINEERS AND SYSTEM ANALYSTS FAMILIAR WITH THE WORKSTATION PROJECT, PLUS DOCUMENTATION AND TRAINING SPECIALISTS.

TASK INPUTS/INTERFACES

INTERFACES WITH THE NETWORK DESIGN TEAM, TARGET SUBSYSTEM SUPPORT DESIGN TEAMS, AND DATA BASE MANAGEMENT SYSTEM DESIGN TEAM.

TASK DELIVERABLES/KEY MILESTONES

	1985 MONTH 1	2	3
1. REVISED WORKSTATION SPECIFICATIONS	▲ (end)		
2. TRAINING COURSE MATERIALS, PLANS, MANUALS			▲ (end)
3. EISF TRAINING SUPPORT			▲ (end)

1 2

TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION SIMULATION KERNELS SUMMARY TASK SHEET

TASK OBJECTIVE(S)

DEVELOP SIMULATION KERNELS WHICH CAN SUPPORT MULTIPLE HARDWARE SIMULATION TASKS THROUGH THE USE OF FLEXIBLE APPLICATIONS SOFTWARE. LOW UNIT COST WILL ALLOW USE OF MULTIPLE UNITS IN A SINGLE EISF

MAJOR ISSUES/PROBLEM AREAS

SIMULATION KERNELS MUST SUPPORT BOTH COMPLEX AND SIMPLE SIMULATION FOR ALL ECS CATEGORIES. SUFFICIENT FLEXIBILITY MUST BE BUILT IN TO ALLOW INTERFACING WITH MULTIPLE ARCHITECTURES. PROGRAMMABLE INTERFACE UNIT COMPATIBILITY IS ESSENTIAL.

TASK APPROACH

1. SURVEY EISF SIMULATION REQUIREMENT FOR EACH ECS CATEGORY.
2. IDENTIFY CANDIDATE SIMULATION FOR BASELINE DEMONSTRATION
3. DESIGN THE BASELINE SIMULATION KERNEL USING MAXIMUM OFF-THE-SHELF HARDWARE.
4. FABRICATE THE HARDWARE AND CODE CANDIDATE SIMULATION
5. CONDUCT CI/CPCI INTEGRATION AND INTEGRATION WITH EISF NETWORK.
6. PROVIDE SYSTEM DOCUMENTATION AND TRAINING AND PUT INTO OPERATIONAL USE.
7. REFINE DESIGN BASED ON OPERATIONAL EXPERIENCE.

LEVEL OF EFFORT

THIS IS APPROXIMATELY A 12 PERSON YEAR EFFORT TO BUILD THE PROTOTYPE HARDWARE AND DEVELOP REPRESENTATIVE SIMULATIONS FOR INTEGRATION TESTING AND VALIDATION

PERFORMER EXPERIENCE LEVEL/BACKGROUND

SOFTWARE ENGINEERS, SYSTEMS ANALYSTS, TEST ENGINEERS WITH 4 TO 7 YEARS EXPERIENCE IN SIMUTION DESIGN AND A FIRM UNDERSTANDING OF ECS SUPPORT REQUIREMENTS.

TASK INPUTS/INTERFACES

ALL COMPONENTS MUST BE SUPPORTED BY EISF NETWORK AND INTERACT TO MULTIPLE COMPUTER SYSTEM ARCHITECTURES. COORDINATION WITH PROGRAMMABLE INTERFACE UNIT DESIGNER IS VITAL.

TASK DELIVERABLES/KEY MILESTONES

1. REQUIREMENT DEFINITION (SRR)
2. REQUIREMENT VALIDATION (SDR)
3. KERNEL DESIGN, FABRICATION, AND TEST (PDR, CDR)
4. KERNEL AND NETWORK INTEGRATION
5. SYSTEM PROCUREMENT

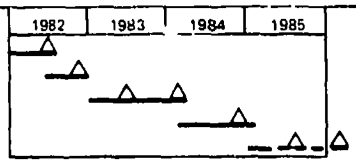


Figure 5-18. Modular Extendable Integration Support Facility: Simulation Kernels Summary Task Sheet

TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION SIMULATION KERNEL SYSTEM/SEGMENT REQUIREMENTS DEFINITION **1**

TASK OBJECTIVE(S)

DEVELOP SIMULATION KERNEL CONCEPT AND FUNCTIONAL BASELINE.

MAJOR ISSUES/PROBLEM AREAS

THE SIMULATION KERNELS MUST SATISFY A WIDE VARIETY OF SIMULATION REQUIREMENTS FOR ECS CATEGORIES ATD, C-E, EW, AND OFP. IN TURN, THE SIMULATORS MUST INTERFACE WITH A BROAD SET OF NON-HOMOGENOUS COMPUTER SYSTEMS.

TASK APPROACH

1. CONDUCT A SURVEY OF EISF SIMULATION REQUIREMENTS BY CATEGORY.
2. CROSS CORRELATE ALL SIMULATION REQUIREMENTS AND IDENTIFY SPECIFIC REQUIRED KERNELS.
3. DEFINE SPECIFIC SIMULATION KERNEL REQUIREMENTS.
4. DEFINE KERNEL INTERFACE REQUIREMENTS.

LEVEL OF EFFORT

APPROXIMATELY 3 PERSON YEARS OF EFFORT ARE REQUIRED OVER A SIX (6) MONTH PERIOD.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

ENGINEER/ANALYST WITH A MINIMUM OF SEVEN (7) YEARS EXPERIENCE IN DIGITAL SIMULATION, DESIGN, AND APPLICATIONS. A FIRM UNDERSTANDING OF ECS INTEGRATED SUPPORT SYSTEM DESIGN AND MICRO-PROCESS WOULD BE VERY DESIRABLE.

TASK INPUTS/INTERFACES

PROGRAMMABLE INTERFACE UNIT REQUIREMENT MUST BE CONSIDERED.

TASK DELIVERABLES/KEY MILESTONES

1. SIMULATION REQUIREMENTS SURVEY BY CATEGORY
2. ANALYSIS OF COMMON SIMULATION NEEDS
3. DEFINITION OF CANDIDATE SIMULATION KERNELS
4. DEFINITION OF SIMULATION KERNEL INTERFACE REQUIREMENTS
5. SIMULATION KERNEL REQUIREMENTS

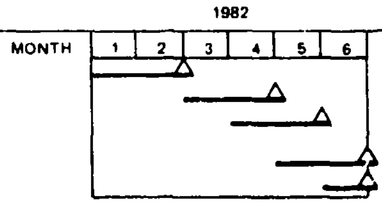


Figure 5-19. Modular Extendable Integration Support Facility: Simulation Kernel System/Segment Requirements Definition

TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION SIMULATION KERNELS SYSTEM/SEGMENT REQUIREMENTS VALIDATION **2**

TASK OBJECTIVE(S)

DEFINE SIMULATION KERNEL SPECIFICATIONS FOR EACH CANDIDATE APPLICATION, TO INCLUDE TYPE-SIMULATION, I/O REQUIREMENTS, COMMON CORE UNITS, SPECIAL INTERFACE NEEDS.

MAJOR ISSUES/PROBLEM AREAS

SIMULATION KERNELS MUST OPERATE IN STAND ALONE MODE OR UNDER THE CONTROL OF A WORK STATION THROUGH COMMAND PROVIDED BY NETWORK COMMUNICATION.

TASK APPROACH

1. DEVELOP A COMMON BASELINE CONFIGURATION FOR EACH SIMULATION APPLICATION AND IDENTIFY UNIQUE REQUIREMENTS, IF ANY.
2. ESTABLISH SYSTEM COMMUNICATIONS REQUIREMENTS FOR EACH APPLICATION
3. DEVELOP HARDWARE SPECIFICATION FOR EACH APPLICATION TO INCLUDE DATA CONVERSION MODULES.
4. DEVELOP APPLICATION SOFTWARE SPECIFICATIONS TO INCLUDE COMMUNICATION AND CONTROL MODULES
5. SURVEY COMMERCIALLY AVAILABLE MICROPROCESSOR BOARDS, COMPONENTS, ETC.
6. CONDUCT A BUILD-OR-BUY ANALYSIS.

LEVEL OF EFFORT

APPROXIMATELY 1.5 PERSON YEARS ARE REQUIRED OVER A 6 MONTH PERIOD.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

SENIOR/ENGINEER ANALYST WITH A MINIMUM OF SIX (6) YEARS EXPERIENCE IN SIMULATION DESIGN AND MICROPROCESSOR APPLICATIONS. A FIRM UNDERSTANDING OF ECS SUPPORT AND EQUIPMENTS AND INTEGRATED SUPPORT SYSTEM DESIGN IS ESSENTIAL.

TASK INPUTS/INTERFACES

INPUTS FROM NETWORK AND WORK STATION DESIGN EFFORTS TO ENSURE COMPATIBLE COMMUNICATION AND CONTROL MODES. PROGRAMMABLE INTERFACE UNIT SPECIFICATIONS.

TASK DELIVERABLES/KEY MILESTONES

1. BASELINE REQUIREMENTS DOCUMENTATION
2. SYSTEM INTERFACE REQUIREMENTS
3. CI DEVELOPMENT SPECIFICATION
4. CPCI DEVELOPMENT SPECIFICATION
5. PERFORM VENDOR SURVEY
6. PERFORM BUILD OR BUY ANALYSIS

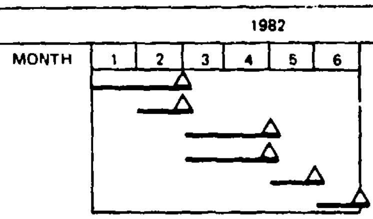


Figure 5-20. Modular Extendable Integration Support Facility: Simulation Kernels System/Segment Requirements Validation

TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION SIMULATION KERNELS DESIGN, FABRICATION, UNIT TEST

3

TASK OBJECTIVE(S)

DETAILED DESIGN AND DEVELOPMENT OF CANDIDATE SIMULATION KERNELS.

MAJOR ISSUES/PROBLEM AREAS

KERNEL DESIGN WILL BE BASED ON COMMERCIALLY AVAILABLE MICROPROCESSOR WITH MATURE DEVELOPMENT SYSTEM AND SUPPORT BASE.

TASK APPROACH

1. PROCUREMENT CYCLE BASED ON OFF-THE-SHELF HARDWARE WITH UNIQUE SOFTWARE
2. SURVEY APPLICABLE MICROPROCESSORS AND SUPPORT SYSTEMS.
3. DESIGN AND DEVELOP ANY UNIQUE HARDWARE, INTERFACES.
4. FABRICATION OF ALL HARDWARE.
5. CODING OF SIMULATION AND COMMUNICATION/CONTROL MODULES.
6. UNIT TEST OF SIMULATION KERNEL HARDWARE AND SOFTWARE.

LEVEL OF EFFORT

THIS IS APPROXIMATELY A 6 PERSON YEAR EFFORT OVER A PERIOD OF 14 MONTHS.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

HARDWARE AND SOFTWARE ENGINEER WITH EXPERIENCE IN SIMULATION DESIGN AND DEVELOPMENT, MICROPROCESSOR PROGRAMMERS SKILLED IN APPROVED DOD HOL'S.

TASK INPUTS/INTERFACES

COMMUNICATION REQUIREMENTS WITH NETWORK AND CONTROL INTERFACES, WITH WORK STATIONS, FILE SEQUENCES, AND PROGRAMMABLE INTERFACE UNITS.

TASK DELIVERABLES/KEY MILESTONES

1. DESIGN IMPLEMENTATION PLANS
2. MICROPROCESSOR UNDER SURVEY
3. PREPARE AND ISSUE RFPS.
4. VENDOR PROPOSAL EVALUATION
5. PDR AND CDR
6. FABRICATION OF UNIQUE HARDWARE
7. SIMULATION DESIGN
8. OFF-THE-SHELF EQUIPMENT PROCUREMENT AND PACKAGING TEST
9. SIMULATION CODING AND TEST

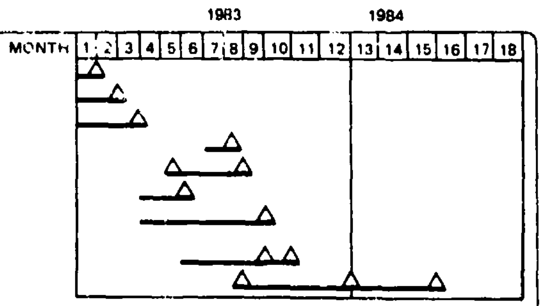


Figure 5-21. Modular Extendable Integration Support Facility: Simulation Kernels Design, Fabrication, Unit Test

TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION SIMULATION KERNELS CI/CPCI INTEGRATION AND TEST **4**

TASK OBJECTIVE(S)

INTEGRATE SIMULATION KERNELS INTO THE EISF NETWORK.

MAJOR ISSUES/PROBLEM AREAS

VALIDATION OF THE SIMULATION SHOULD BE INCLUDED AS PART OF THE INTEGRATION TESTING.

TASK APPROACH

1. DEVELOPMENT CI AND CPCI TEST AND VALIDATION TOOLS AND PROCEDURES
2. CP/CPCI INTEGRATION AND TEST.
3. TOTAL LOCAL NETWORK TESTING TO INCLUDE THE LOADING AND CONTROL OF A SIMULATION FORM WORK STATION
4. VALIDATION OF SIMULATION IN OPERATIONAL ENVIRONMENT.

LEVEL OF EFFORT

APPROXIMATELY 3 PERSON YEARS OF EFFORT OVER AN 8 MONTH PERIOD.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

ENGINEERS, HARDWARE AND SOFTWARE, EXPERIENCED IN SIMULATIONS AND MICROPROCESSORS, COMMUNICATIONS INTERFACES, NETWORK CONTROL, FAMILIAR WITH INTEGRATION AND TESTING.

TASK INPUTS/INTERFACES

DETAILED INFORMATION ON ALL INTERFACES AND SUBSYSTEMS.

TASK DELIVERABLES/KEY MILESTONES

1. DEVELOP TEST PROCEDURES, CI/CPCI
2. DEVELOP EISF NETWORK TESTS
3. DEVELOP UNIQUE TEST EQUIPMENT
4. PERFORM CI/CPCI INTEGRATION AND TEST
5. PERFORM NETWORK INTEGRATION TESTS
6. VALIDATE SIMULATIONS (FUNCTIONAL)
7. FUNCTIONAL CONFIGURATION AUDIT (FCA)
8. PHYSICAL CONFIGURATION AUDIT (PCA)
9. FORMAL QUALIFICATION REVIEW (FQR)

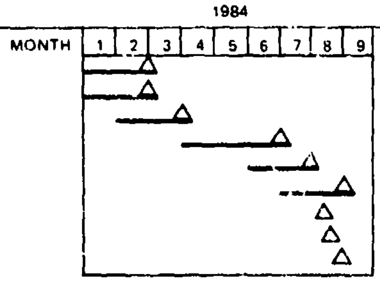


Figure 5-22. Modular Extendable Integration Support Facility: Simulation Kernels CI/CPCI Integration and Test

TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION SIMULATION KERNELS SYSTEM ACQUISITION AND SUPPORT

5

TASK OBJECTIVE(S)

PROCURE BASIC HARDWARE COMPONENTS FOR SIMULATION KERNELS

MAJOR ISSUES/PROBLEM AREAS

SIMULATION KERNEL SOFTWARE WILL BE UNIQUE TO SPECIFIC APPLICATIONS AND WILL BE DEVELOPED DURING THE WEAPON SYSTEM DEVELOPMENT CYCLE.

TASK APPROACH

1. UPDATE SIMULATION KERNEL SYSTEM AND COMPONENT SPECIFICATIONS.
2. USE ESTABLISHED PROCUREMENT PROCEDURES TO OBTAIN REQUIRED COMPONENTS.
3. DEVELOP TRAINING MATERIALS AND UPDATE SYSTEM DOCUMENTATIONS

LEVEL OF EFFORT

APPROXIMATELY 1 PERSON YEAR OF EFFORT IS REQUIRED EXCLUSIVE OF THE NORMAL PROCUREMENT ACTIVITIES.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

ENGINEERS AND SYSTEM ANALYSTS FAMILIAR WITH THE SIMULATION KERNEL PROJECT PLUS DOCUMENTATION AND TRAINING SPECIALISTS

TASK INPUTS/INTERFACES

INPUTS FROM WEAPON SYSTEM DEVELOPERS UPON WHICH TO BASE FUTURE PROCUREMENT ACTION IS VITAL TO ECONOMICAL AND TIMELY PURCHASES OF NECESSARY HARDWARE. SOFTWARE DESIGNERS NEED HARDWARE DOCUMENTATION.

TASK DELIVERABLES/KEY MILESTONES

1. REVISE HARDWARE SPECIFICATIONS
2. TRAINING COURSE MATERIALS AND TRAINING PLAN
3. UPDATE SYSTEM DOCUMENTATION

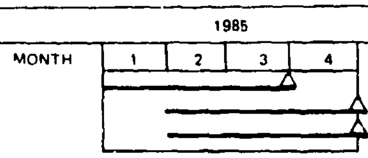


Figure 5-23. Modular Extendable Integration Support Facility: Simulation Kernels System Acquisition and Support

TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION REPROGRAMMABLE CMAC SUMMARY TASK SHEET

TASK OBJECTIVE(S)

DEVELOP REPROGRAMMABLE COMPUTER MONITOR AND CONTROL (CMAC) WHICH CAN BE RETARGETED TO DIFFERENT ECS COMPUTERS AND ISF HOSTS WITH ONLY MINOR CHANGES. LOW UNIT COST OF ADDITIONAL COPIES IS SECONDARY OBJECTIVE.

MAJOR ISSUES/PROBLEM AREAS

INTERFACE SHOULD SUPPORT MULTIPLE COMPUTER ARCHITECTURES DURING INITIAL USE. LATER FOCUS WILL BE ON THE STANDARD ARCHITECTURES.

TASK APPROACH

1. SURVEY TARGET ECS AND ISF HOST INTERFACE REQUIREMENTS.
2. DETERMINE COMPUTER MANAGEMENT AND CONTROL DATA COLLECTION REQUIREMENTS.
3. DESIGN CONCEPTUAL ARCHITECTURE WHICH MAXIMIZES REPROGRAMMABILITY AND MINIMIZES CUSTOM BOARD DESIGN AND RETARGETING DIFFICULTY.
4. PERFORM DETAILED DESIGN, FABRICATE, INTEGRATE, TEST.
5. PROVIDE O&M MANUALS, TRAINING, PLACE IN OPERATIONAL USAGE.
6. REFINE DESIGN BASED ON OPERATIONAL EXPERIENCE.

LEVEL OF EFFORT

10 PERSON YEARS OF EFFORT TO BUILD THE PROTOTYPE EXCLUDING VENDOR FABRICATION. ABOUT $50,000 OF VENDOR-BUILT HARDWARE NEEDED.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

DIGITAL SYSTEMS ENGINEERS, DIGITAL DESIGN ENGINEERS, DIGITAL TEST ENGINEERS WITH ABOUT 7 YEARS APPLICABLE EXPERIENCE AND A FIRM UNDERSTANDING OF ECS HARDWARE.

TASK INPUTS/INTERFACES

TASK INPUTS REQUIRED ARE STUDIES WHICH ALLOCATE FAMILIES OF ECS SYSTEMS TO EISF'S, AND STUDY OF OVERALL EISF ARCHITECTURE.

TASK DELIVERABLES/KEY MILESTONES

1. SURVEY TARGET AND HOST INTERFACE REQUIREMENTS
2. DEFINE CMAC FUNCTIONAL REQUIREMENTS
3. PERFORM REQUIREMENTS VALIDATION AND SDR
4. RFP, DESIGN, PDR, CDR
5. BUILD AND UNIT TEST
6. INTEGRATION AND TEST, FCA, PCA, FQR
7. OPERATIONAL CMAC
8. UPDATE DESIGN SPECIFICATION TO REMOVE OPERATIONAL DEFICIENCIES

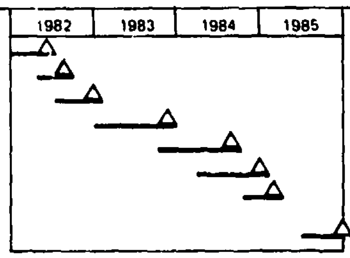


Figure 5-24. Modular Extendable Integration Support Facility: Reprogrammable CMAC Summary Task Sheet

TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION REPROGRAMMABLE CMAC SYSTEM/SEGMENT REQUIREMENTS DEFINITION

1

TASK OBJECTIVE(S)

DEFINE CONCEPTUAL APPROACH AND FUNCTIONAL REQUIREMENTS FOR REPROGRAMMABLE CMAC.

MAJOR ISSUES/PROBLEM AREAS

REPROGRAMMABLE CMAC MUST MONITOR TARGET ECS OF VARYING SPEEDS AND ARCHITECTURE WITH MAXIMUM CMAC STANDARDIZATION.

TASK APPROACH

1. ANALYZE ECS INTERFACE SIGNALS TO SEVERAL REPRESENTATIVE ECS.
2. DEFINE CMAC BREAK POINT DATA COLLECTION CAPABILITIES.
3. DEFINE MEANS OF CAPTURING ECS INTERFACE SIGNALS FROM TARGET ECS.
4. DEFINE OUTPUT INTERFACE REQUIREMENTS TO HOST.
5. DEFINE FUNCTIONAL PROCESSING REQUIREMENTS.

LEVEL OF EFFORT

ABOUT 1.5 PERSON YEARS WITH ABOUT 1 PERSON YEAR OF EFFORT CONCENTRATING ON THE PROBLEMS ASSOCIATED WITH RETARGETING THE COMPUTER MONITOR AND CONTROL UNIT.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

DIGITAL SYSTEMS ENGINEERS WITH 7 YEARS EXPERIENCE IN DESIGN AND INTERFACING OF DIGITAL SYSTEMS. FIRM UNDERSTANDING OF COMPUTER ARCHITECTURE REQUIRED.

TASK INPUTS/INTERFACES

INPUTS REQUIRED FROM STUDIES WHICH ALLOCATE NEW ECS SYSTEMS TO EISF FAMILIES, AND CONCEPTUAL DEFINITION OF THE OVERALL EISF ARCHITECTURE. INTERFACE WITH PROGRAMMABLE INTERFACE UNIT (PIU) DEFINITION.

TASK DELIVERABLES/KEY MILESTONES

1. ANALYZE TARGET INTERFACE REQUIREMENTS FOR SEVERAL SELECTED EMBEDDED COMPUTERS
2. DEFINE CMAC DATA COLLECTION AND ECS CONTROL CAPABILITIES
3. DETERMINE MEANS OF GATHERING TARGET ECS INTERFACE SIGNALS
4. SELECT REPRESENTATIVE HOSTS AND DETERMINE CMAC-TO-HOST INTERFACE
5. DEFINE CMAC FUNCTIONAL PROCESSING REQUIREMENTS
6. SYSTEM REQUIREMENTS REVIEW (SRR)

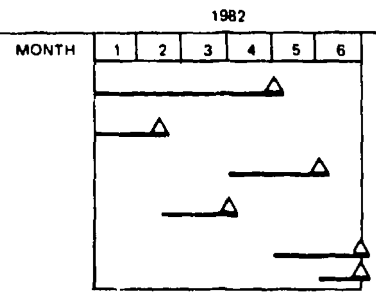


Figure 5-25. Modular Extendable Integration Support Facility: Reprogrammable CMAC System/Segment Requirements Definition

TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION REPROGRAMMABLE CMAC SYSTEM/SEGMENT REQUIREMENTS VALIDATION

2

TASK OBJECTIVE(S)

VALIDATE REPROGRAMMABLE CMAC FUNCTIONAL LEVEL REQUIREMENTS AND WRITE SPECIFICATIONS.

MAJOR ISSUES/PROBLEM AREAS

CMAC'S BUILT OF OFF-THE-SHELF MODULES WHICH ARE SOFTWARE REPROGRAMMABLE MAY NOT KEEP UP WITH TARGET ECS INPUT DATA. THE AMOUNT OF CUSTOM HARDWARE REQUIRED NEEDS TO BE DETERMINED BY TIMING ANALYSIS.

TASK APPROACH

1. PERFORM TIMING ANALYSES OF FUNCTIONAL PROCESSING REQUIREMENTS
   - INPUT DATA CONTROL
   - INPUT DATA PROCESSING
   - DATA COLLECTION AND OUTPUT TO HOST
   - CMAC CONTROL FUNCTIONS
2. DEFINE BOARD LEVEL THROUGHPUT REQUIREMENTS.
3. PERFORM VENDOR SURVEY TO FIND OFF-THE-SHELF BOARDS WHICH MEET REQUIREMENTS.

LEVEL OF EFFORT

APPROXIMATELY ONE PERSON YEAR WITH ABOUT HALF THE EFFORT IN TIMING STUDIES.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

DIGITAL SYSTEMS ENGINEERS WITH 5 YEARS EXPERIENCE IN DIGITAL SYSTEMS DESIGN.

TASK INPUTS/INTERFACES

INTERFACES WITH PROGRAMMABLE INTERFACE UNIT (PIU).

TASK DELIVERABLES/KEY MILESTONES 1982

1. TIMING ANALYSES
2. CMAC BOARD LEVEL THROUGHPUT REQUIREMENTS
3. PERFORM VENDOR SURVEY
4. PUBLISH REQUIREMENTS SPEC AND ICD
5. PERFORM TRADEOFFS, BUILD OR BUY, CUSTOM VS OFF THE-SHELF
6. SYSTEM DESIGN REVIEW SDR

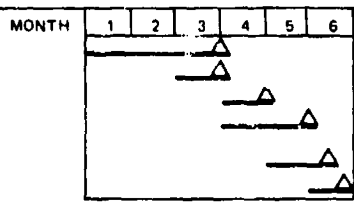


Figure 5-26. Modular Extendable Integration Support Facility: Reprogrammable CMAC System/Segment Requirements Validation

TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION REPROGRAMMABLE CMAC PRELIMINARY AND DETAILED DESIGN **3**

TASK OBJECTIVE(S)

PERFORM PRELIMINARY AND DETAILED DESIGN OF REPROGRAMMABLE CMAC MAKING MAXIMUM USE OF OFF-THE-SHELF MODULES.

MAJOR ISSUES/PROBLEM AREAS

REPROGRAMMABLE BOARD TIMING CANNOT BE ACCURATELY DETERMINED UNTIL THE ACTUAL INSTRUCTION SEQUENCE REQUIRED TO PERFORM THE NECESSARY FUNCTIONS IS SPECIFIED.

TASK APPROACH

1. ORGANIZE DESIGN AND IMPLEMENTATION TEAM FOR PROPOSAL EVALUATION AND CONTRACTOR MANAGEMENT.
2. WRITE DESIGN/IMPLEMENTATION PLAN.
3. SUPPORT PROPOSAL.
4. EVALUATE PROPOSAL, SELECT CONTRACTOR, AWARD TASK.
5. DESIGN TARGET ECS INTERFACE BOARDS
6. SELECT/DESIGN CMAC PROCESSING BOARDS AND PROCESSING SOFTWARE.
7. FINALIZE DESIGN AND PUBLISH DESIGN SPECIFICATIONS.

LEVEL OF EFFORT

ABOUT 2.5 PERSON YEARS OF DESIGN TEAM EFFORT.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

DIGITAL SYSTEMS ENGINEERS, DIGITAL DESIGNERS WITH A BACKGROUND IN MICROPROCESSOR MONITORING AND CONTROL EXPERIENCE WITH DIGITAL INTERFACES DESIGN IS ESSENTIAL.

TASK INPUTS/INTERFACES

IT IS ANTICIPATED THAT RACKS, POWER SUPPLIES, AND PROCESSING BOARDS ARE AVAILABLE OFF-THE-SHELF. THE BACKPLAIN, THE INPUT BOARD, AND POSSIBLY OUTPUT BOARD MAY HAVE TO BE CUSTOM DESIGNED. COORDINATE WITH PIU.

TASK DELIVERABLES/KEY MILESTONES

1. DESIGN IMPLEMENTATION PLAN
2. ISSUE RFP
3. PROPOSAL EVALUATION AND CONTRACT
4. HARDWARE DESIGN
5. SOFTWARE DESIGN
6. PDR
7. CDR

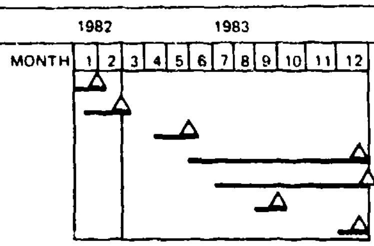


Figure 5-27. Modular Extendable Integration Support Facility: Reprogrammable CMAC Preliminary and Detailed Design

TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION REPROGRAMMABLE CMAC FABRICATION/CODE UNIT TEST

4

TASK OBJECTIVE(S)

PURCHASE AND FABRICATE ALL CMAC COMPONENTS AND BUY OFF-THE-SHELF MODULES. CODE AND UNIT TEST SOFTWARE. UNIT TEST HARDWARE.

MAJOR ISSUES/PROBLEM AREAS

THE DURATION AND DIFFICULTY OF THIS TASK INCREASES AS THE PERCENTAGE OF CUSTOM FABRICATED BOARDS INCREASES.

TASK APPROACH

1. FABRICATE AND TEST CUSTOM MODULES, INCLUDING PIU MODULE.
2. BUY OFF-THE-SHELF COMPONENTS AND MODULES.
3. CODE SOFTWARE INCLUDING SPECIAL UNIT TEST SOFTWARE.
4. WRITE HARDWARE AND SOFTWARE UNIT TEST PLANS.
5. PERFORM HARDWARE AND SOFTWARE UNIT TEST.
6. WRITE UNIT TEST REPORTS.

LEVEL OF EFFORT

1.6 PERSON YEARS WHICH DOES NOT INCLUDE MANUFACTURING/HARDWARE PRODUCTION PERSONNEL. HARDWARE COMPONENT/BOARD/RACK/SUBSYSTEM COST INCLUDING CUSTOM FABRICATION ABOUT $50,000.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

DIGITAL SYSTEMS ENGINEER, HARDWARE TEST ENGINEER, TEST TECHNICIAN, SENIOR SOFTWARE ANALYST, ALL WITH 5 TO 7 YEARS OF APPLICABLE EXPERIENCE.

TASK INPUTS/INTERFACES

PROGRAMMABLE INTERFACE UNIT FABRICATION AND TESTING.

TASK DELIVERABLES/KEY MILESTONES

1. BUY/FABRICATE
2. UNIT TEST
3. SOFTWARE CODE
4. SOFTWARE UNIT TEST
5. UNIT TEST PLAN

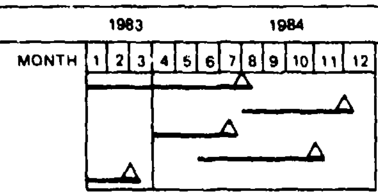


Figure 5-28. Modular Extendable Integration Support Facility: Reprogrammable CMAC Fabrication/Code Unit Test

TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION REPROGRAMMABLE CMAC SYSTEM INTEGRATION AND TEST

5

TASK OBJECTIVE(S)

INTEGRATION AND TEST OF CI/CPCI INTO AN OPERATING REPROGRAMMABLE COMPUTER MONITOR AND CONTROL UNIT.

MAJOR ISSUES/PROBLEM AREAS

INTEGRATION TESTING WILL BE LIMITED TO THE SYSTEMS SELECTED FOR THIS BASELINE DEMONSTRATION.

TASK APPROACH

1. WRITE INTEGRATION PLAN, SYSTEM TEST PLAN, AND PROCEDURES
2. DESIGN/BUILD/OBTAIN SPECIAL TEST HARDWARE AND SOFTWARE
3. PERFORM INTEGRATION TO ACHIEVE OPERATING COMPUTER MONITOR AND CONTROL UNIT
4. PERFORM SYSTEM TEST AND CORRECT DEFICIENCIES.
5. WRITE TEST REPORTS
6. REDLINE DESIGN DOCUMENTS TO "AS-BUILT" CONFIGURATION.

LEVEL OF EFFORT

APPROXIMATELY 2.5 PERSON YEARS, WITH ABOUT 1 PERSON YEAR REQUIRED FOR COMPUTER MONITOR AND CONTROL INTEGRATION.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

DIGITAL SYSTEM INTEGRATION AND TEST ENGINEERS WITH A MINIMUM OF 10 YEARS EXPERIENCE, SUPPORTED BY DIGITAL HARDWARE TECHNICIANS WITH 5 YEARS APPLICABLE EXPERIENCE.

TASK INPUTS/INTERFACES

PROGRAMMABLE INTERFACE UNIT INTEGRATION/TEST COORDINATION.

TASK DELIVERABLES/KEY MILESTONES

1. WRITE INTEGRATION PLAN
2. DEVELOP TESTS/PROCEDURES AND SPECIAL TEST SOFTWARE AND TEST HARDWARE
3. PERFORM CI/CPCI INTEGRATION AND TEST
4. PERFORM CMAC SYSTEM TEST
5. FUNCTIONAL CONFIGURATION AUDIT (FCA)
6. PHYSICAL CONFIGURATION AUDIT (PCA)
7. FORMAL QUALIFICATION REVIEW (FQR)

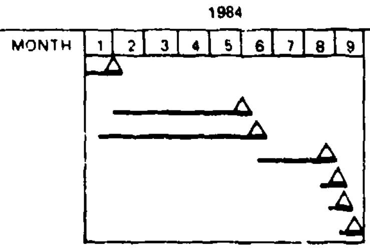


Figure 5-29. Modular Extendable Integration Support Facility: Reprogrammable CMAC System Integration and Test

TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION REPROGRAMMABLE CMAC OPERATION AND SUPPORT **6**

TASK OBJECTIVE(S)

THE CMAC SHOULD BE FULLY OPERATIONAL, AND TRAINING OF OPERATION AND SUPPORT PERSONNEL SHOULD BE UNDERTAKEN. CMAC DESIGN SPECIFICATION SHOULD BE UPDATED TO REFLECT RESOLUTION OF OPERATIONAL PROBLEMS.

MAJOR ISSUES/PROBLEM AREAS

OPERATIONAL EXPERIENCE WILL PROVIDE VALUABLE INSIGHT INTO DESIGN IMPROVEMENTS WHICH SHOULD BE INCORPORATED INTO FUTURE REPROGRAMMABLE CMAC'S.

TASK APPROACH

1. PUBLISH "AS-BUILT" DOCUMENTATION.
2. WRITE OPERATION AND SUPPORT MANUALS.
3. DEVELOP TRAINING COURSE MATERIALS.
4. CREATE FILE OF OPERATIONAL DEFICIENCY REPORTS.
5. REFINE CMAC DESIGN BASED ON OPERATIONAL DEFICIENCIES.

LEVEL OF EFFORT

ONE PERSON YEAR IS REQUIRED, PRIMARILY FOR WRITING OPERATION AND SUPPORT MANUALS AND OPERATOR/MAINTENANCE TRAINING MATERIALS.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

THE ABOVE TASKS REQUIRE DIGITAL HARDWARE AND SOFTWARE ENGINEERS WITH 5 TO 7 YEARS OF EXPERIENCE.

TASK INPUTS/INTERFACES

FEEDBACK ON DESIGN FEATURES AND LIMITATION FOR FUTURE SYSTEM UPDATES.

TASK DELIVERABLES/KEY MILESTONES

1. ESTABLISH DOCUMENTATION LIBRARY
2. WRITE OPERATION AND SUPPORT MANUAL
3. DEVELOP TRAINING COURSE
4. PRESENT TRAINING COURSE
5. UPDATE SYSTEM DESIGN BASED ON OPERATIONAL EXPERIENCE

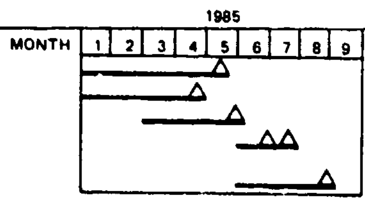


Figure 5-30. Modular Extendable Integration Support Facility: Reprogrammable CMAC Operation and Support

TASK DESCRIPTION MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITY

SUBTASK DESCRIPTION PROGRAMMABLE INTERFACE UNIT SUMMARY TASK SHEET

TASK OBJECTIVE(S)

DESIGN A FLEXIBLE INTERFACE WHICH CAN SUPPORT A MULTITUDE OF NON-HOMOGENOUS ARCHITECTURES THROUGH SOFTWARE CONTROL, CONVERSION, AND DATA MANIPULATION IN REAL TIME. FOCUS WILL BE ON STANDARD BUS AND ARCHITECTURE.

MAJOR ISSUES/PROBLEM AREAS

PROGRAMMABLE INTERFACE UNITS MUST BE COMPATABLE WITH THE SIMULATION KERNELS, PROGRAMMABLE CMACS, HOST COMPUTERS AND THE EISF NETWORK.

TASK APPROACH

1. DEFINE ALL EISF INTERFACE REQUIREMENTS AND CONDUCT TRADEOFF ANALYSIS.
2. DEFINE SPECIFICATIONS FOR INTERFACE UNITS.
3. DESIGN AND FABRICATE CANDIDATE INTERFACE UNITS AND CODE THE SOFTWARE.
4. CONDUCT CI/CPCI INTEGRATION AND TESTING.
5. REVISE SYSTEM SPECIFICATION AND PURCHASE INTERFACE MODULES.

LEVEL OF EFFORT

APPROXIMATELY 15 PERSON YEARS OF EFFORT WILL BE REQUIRED TO BUILD AND TEST, EXCLUSIVE OF THE TIME DEVOTED TO THE SIMULATION KERNEL AND PROGRAMMABLE CMAC INTERFACE DESIGN, FABRICATION, AND TEST.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

SYSTEMS DESIGN, INTEGRATION TEST, OPERATIONAL SUPPORT INVOLVING ELECTRONIC AND SOFTWARE ENGINEERS WITH STRONG MICROPROCESSOR AND SYSTEM INTERFACING BACKGROUNDS.

TASK INPUTS/INTERFACES

INTERFACE REQUIREMENTS AND DESCRIPTIONS FOR ALL EISF SUBSYSTEMS AND ECS HOSTS.

TASK DELIVERABLES/KEY MILESTONES

1. REQUIREMENTS DEFINITION
2. REQUIREMENTS VALIDATION
3. DESIGN, FABRICATION, AND UNIT TEST
4. CI/CPCI INTEGRATION AND TEST
5. PROCUREMENT AND OPERATIONS SUPPORT

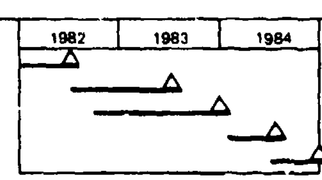


Figure 5-31. Modular Extendable Integration Support Facility: Programmable Interface Unit Summary Task Sheet

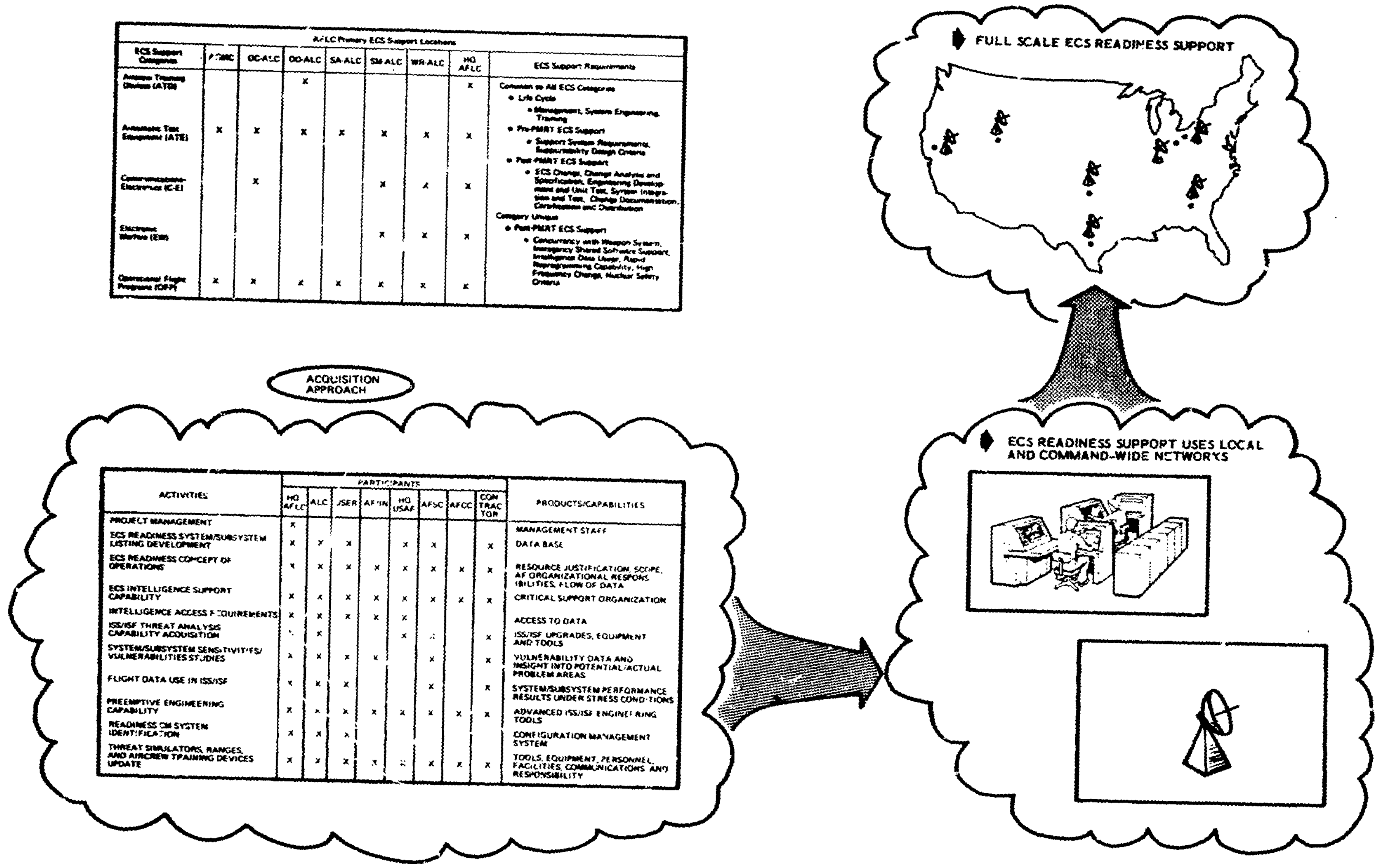


Figure 5-32. ECS Readiness Support Conceptual Evolution

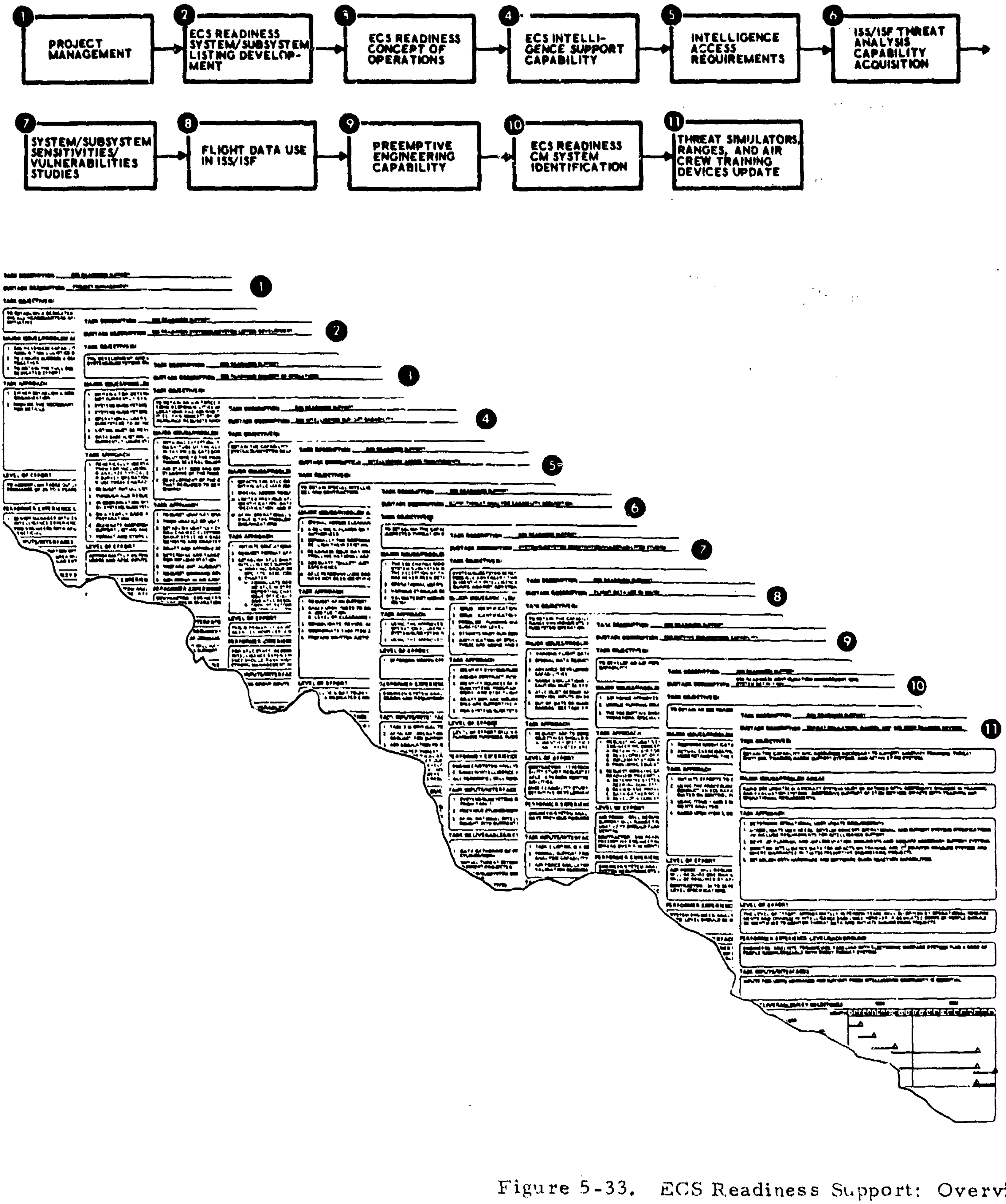
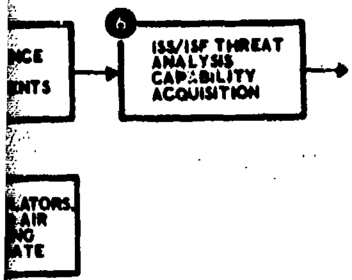


Figure 5-33. ECS Readiness Support: Overvie



TASK DESCRIPTION ECS READINESS SUPPORT

SUBTASK DESCRIPTION SUMMARY TASK SHEET

TASK OBJECTIVE(S)

DEVELOPMENT OF AN AFLC ECS READINESS SUPPORT CAPABILITY TO INCLUDE: 1) THE ESTABLISHMENT OF THE REQUIRED INTELLIGENCE SUPPORT ORGANIZATIONS, 2) THE ACQUISITION OF THE REQUIRED SOFTWARE AND HARDWARE TOOLS, 3) THE DEVELOPMENT AND MAINTENANCE OF THE NECESSARY AUTOMATED SUPPORT DATA BASES, 4) THE ACQUISITION OF THE REQUIRED SUPPORT FROM OTHER AIR FORCE ORGANIZATIONS, 5) THE ESTABLISHMENT OF THE NECESSARY RESOURCES, 6) APPROPRIATE IMPLEMENTATION IN AIR FORCE REGULATIONS, AND 7) THE MODIFICATIONS OF VARIOUS ISS/ISF TO ACCOMMODATE THIS ACTION.

MAJOR ISSUES/PROBLEM AREAS

1. RESOURCES.
2. COMMITMENT TO LONG LEAD TIME ACQUISITION PROCESS.
3. AIR FORCE WIDE SUPPORT.
4. UNDERSTANDING OF PROBLEM BY OTHER AF AGENCIES, DOD, JCS, AND CONGRESS.

TASK APPROACH

1. ESTABLISHMENT OF AN AFLC ECS READINESS CAPABILITIES MANAGEMENT ORGANIZATION.
2. DEVELOPMENT AND MAINTENANCE OF A PRIORITIZED ECS READINESS SYSTEM/SUBSYSTEM LISTING.
3. ECS READINESS CONCEPT OF OPERATIONS DEVELOPMENT AND APPROVAL.
4. ESTABLISHMENT OF AFLC ECS INTELLIGENCE SUPPORT CAPABILITY.
5. IDENTIFICATION OF AFLC INTELLIGENCE ACCESS REQUIREMENTS.
6. DEVELOPMENT OF ISS/ISF THREAT IMPACT ANALYSIS CAPABILITY.
7. DETERMINATION, REPORTING AND STORING OF SELECTED ECS READINESS SYSTEM/SUBSYSTEM SENSITIVITIES/VULNERABILITIES.
8. OBTAIN CAPABILITY TO USE FLIGHT DATA IN ISS/ISF.
9. ESTABLISHMENT OF ECS READINESS ISS/ISF PREEMPTIVE ENGINEERING CAPABILITY.
10. IDENTIFICATION OF ECS READINESS CONFIGURATION MANAGEMENT SYSTEM.
11. ESTABLISHMENT OF A RESPONSIVE TRAINING AND C^3 CM SUPPORT CAPABILITY.

LEVEL OF EFFORT

APPROXIMATELY A 75 PERSON YEAR EFFORT OVER A PERIOD OF 3.5 TO 4 YEARS.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

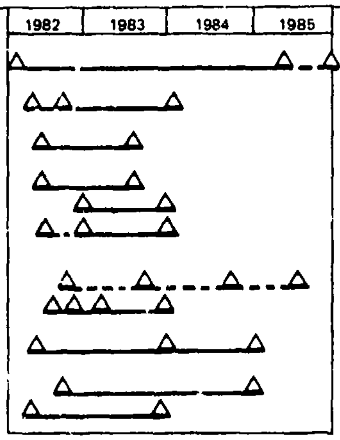
SYSTEM ENGINEERING AND ANALYSIS. ALSO REQUIRES EXTENSIVE OPERATIONAL AND INTELLIGENCE EXPERIENCE.

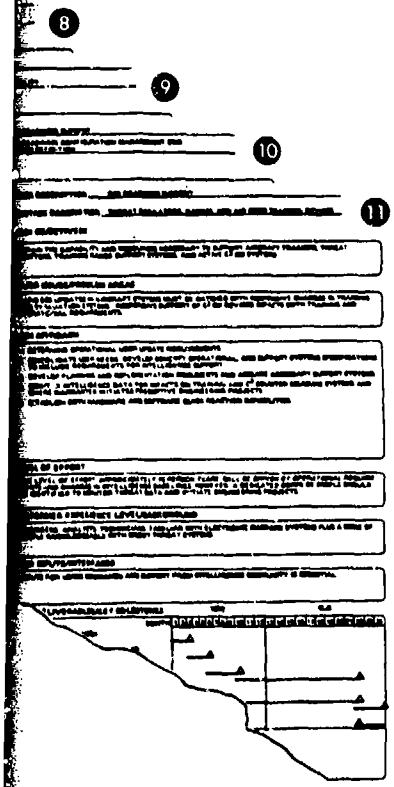
TASK INPUTS/INTERFACES

1. GREAT DEPENDENCY UPON TOTAL AIR FORCE SUPPORT WITH PARTICULAR EMPHASIS IN E/IN AND OPERATIONAL USERS AREA.
2. SUBTASKS, AS DEPICTED IN VARIOUS INDIVIDUAL TASK SHEETS, ARE DEPENDENT UPON EACH OTHER.
3. THIS EFFORT WILL HAVE GREAT IMPACT ON THE AUTOMATION AND STANDARDIZATION OF ECS SUPPORT PROCESSES, MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITIES, AND ECS SUPPORT NETWORKS INITIATIVES.

TASK DELIVERABLES/KEY MILESTONES

1. ESTABLISHMENT OF AFLC ECS READINESS CAPABILITIES MANAGEMENT ORGANIZATIONS
2. DEVELOP AND MAINTAIN A PRIORITIZED ECS READINESS SYSTEM/SUBSYSTEM LISTING
3. ECS READINESS CONCEPT OF OPERATIONS DEVELOPMENT AND APPROVAL
4. ESTABLISHMENT OF AFLC ECS INTELLIGENCE SUPPORT CAPABILITY
5. INITIATE AFLC INTELLIGENCE ACCESS REQUIREMENTS
6. OBTAIN ISS/ISF THREAT IMPACT ANALYSIS CAPABILITY
7. DETERMINE, REPORT, AND STORE SELECTED ECS READINESS SYSTEM/SUBSYSTEM/SENSITIVITIES/VULNERABILITIES
8. OBTAIN CAPABILITY TO USE FLIGHT DATA IN ISS/ISF
9. ECS READINESS ISS/ISF PREEMPTIVE ENGINEERING CAPABILITY
10. ECS READINESS CONFIGURATION MANAGEMENT SYSTEM IDENTIFICATION
11. RESPONSIVE TRAINING AND C^3 CM CAPABILITY





...adiness Support: Overview and Summary Task Sheet

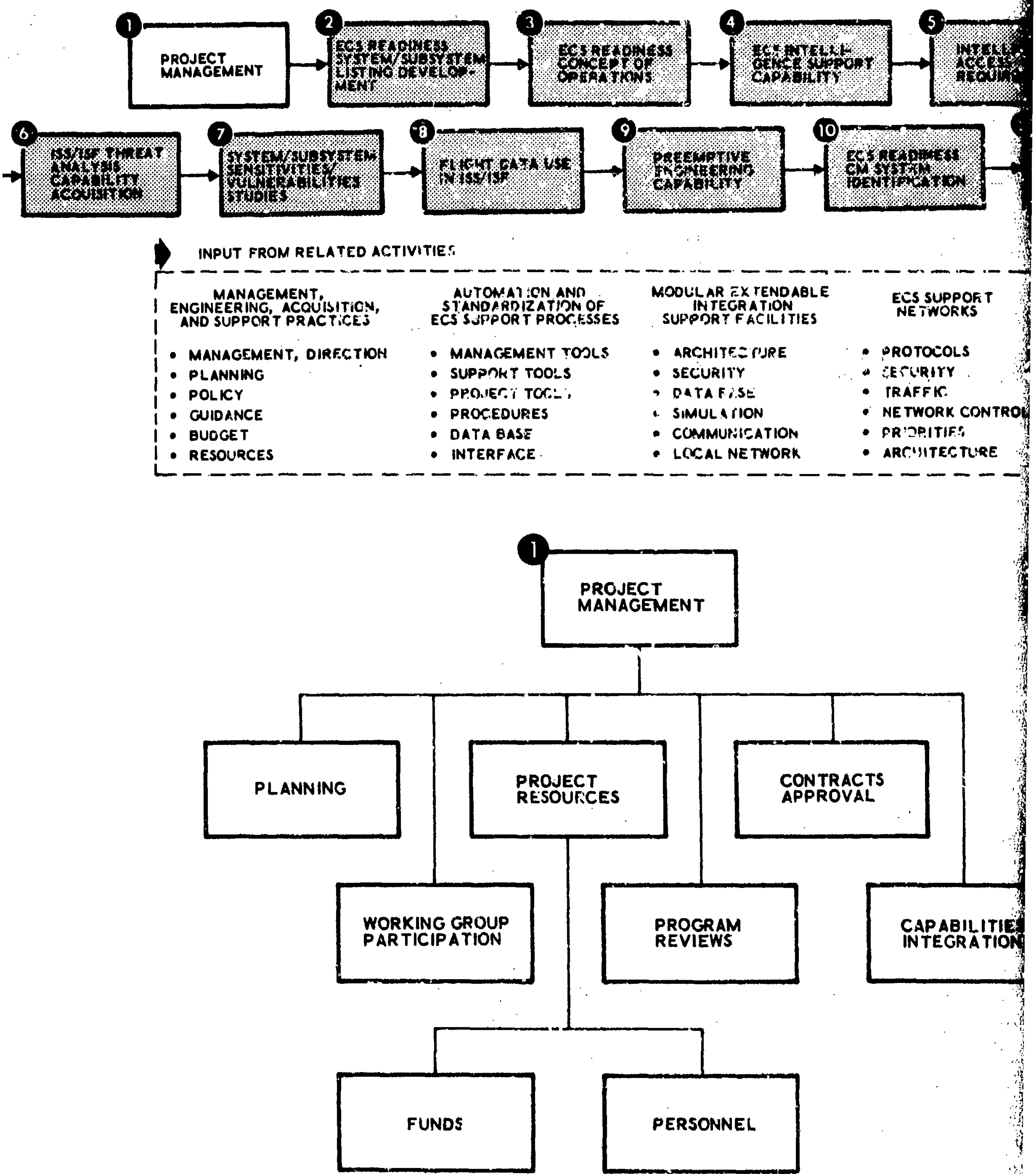
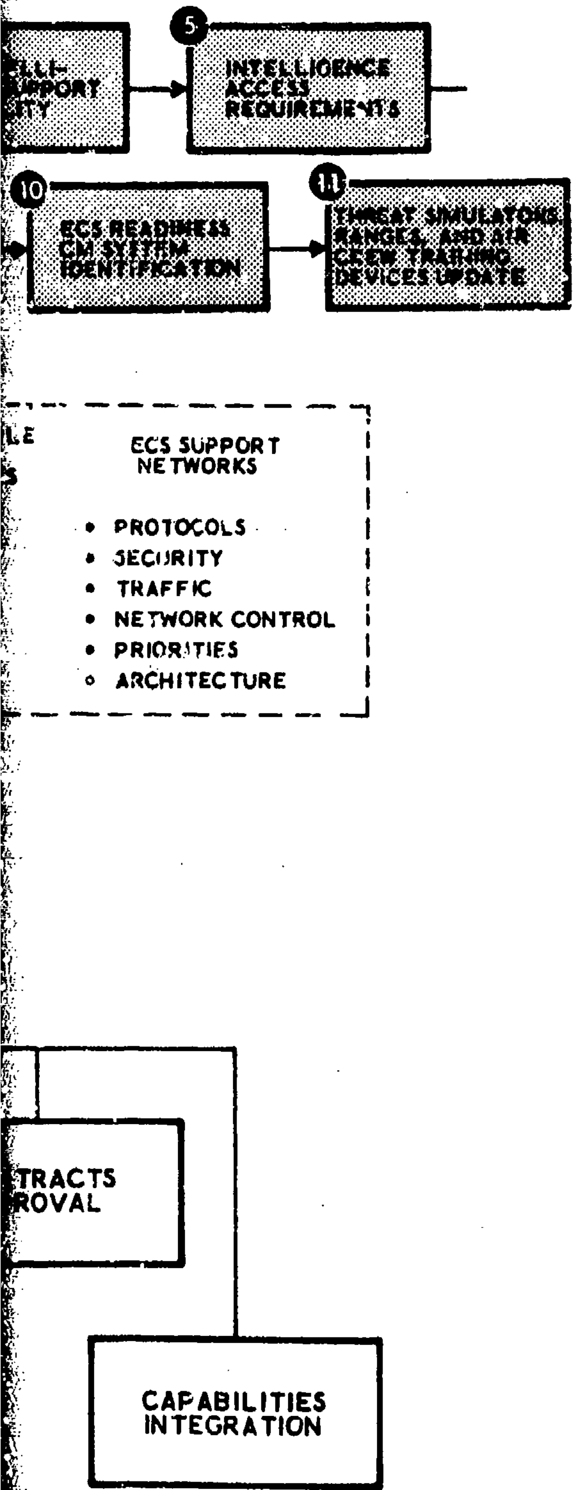


Figure 5-34. ECS Readiness Support: Pro



TASK DESCRIPTION ECS READINESS SUPPORT

SUBTASK DESCRIPTION PROJECT MANAGEMENT

1

TASK OBJECTIVE(S)

TO ESTABLISH A DEDICATED AFLC ECS OVERSIGHT MANAGEMENT FUNCTION FOR THE PURPOSE OF DIRECTING ALL HEADQUARTERS AFLC EFFORTS ASSOCIATED WITH THE ECS READINESS ACQUISITION CAPABILITY INITIATIVE.

MAJOR ISSUES/PROBLEM AREAS

1. ECS READINESS CAPABILITIES ACQUISITION INITIATIVE IMPACTS ON SEVERAL EXISTING AFLC/DCS AND ACQUISITION LOGISTICS DIVISION (ALD) AND ALC FUNCTIONAL RESPONSIBILITIES.
2. TO ENSURE SUCCESS A CENTRAL FOCUS WITHIN HQ AFLC IS REQUIRED TO PULL THE VARIOUS TASKS TOGETHER.
3. TO OBTAIN THE FULL ECS READINESS CAPABILITY WITHIN AFLC WILL REQUIRE SEVERAL YEARS OF DEDICATED EFFORT.

TASK APPROACH

1. EITHER ESTABLISH A NEW OR GIVE MANAGEMENT OVERSIGHT RESPONSIBILITIES TO AN EXISTING AFLC ORGANIZATION.
2. PROVIDE THE NECESSARY MANPOWER/RESOURCES TO ACCOMPLISH THE JOB. (SEE LEVEL OF EFFORT FOR DETAILS.)

LEVEL OF EFFORT

TO ACCOMPLISH TASKS OUTLINED WILL REQUIRE A 3 PERSON AFLC ORGANIZATION WITH PERIOD OF PERFORMANCE OF 3½ TO 4 YEARS.

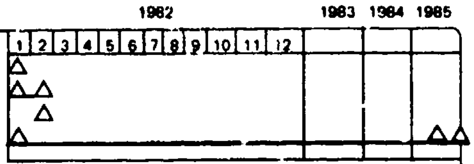
PERFORMER EXPERIENCE LEVEL/BACKGROUND

1. SENIOR MANAGER WITH ENGINEERING EXPERIENCE. PREVIOUS MAJOR COMMAND OR AIR STAFF LEVEL INTELLIGENCE EXPERIENCE IS EXTREMELY DESIRABLE.
2. TWO ENGINEERS WITH AFLC EXPERIENCE. PREVIOUS INTELLIGENCE EXPERIENCE IS EXTREMELY BENEFICIAL.

TASK INPUTS/INTERFACES

1. CLOSE COORDINATION WITH HQ USAF/LEYY AND AF/INYW IS ESSENTIAL.
2. EFFORTS IN THIS AREA WILL IMPACT ON THE AUTOMATION AND STANDARDIZATION OF ECS SUPPORT PROCESSES, MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITIES, AND ECS SUPPORT NETWORKS INITIATIVES.

TASK DELIVERABLES/KEY MILESTONES



1. ESTABLISH AFLC ORGANIZATION
2. REVIEW/REFINE APPROACH
3. INITIATE EFFORTS
4. MONITOR

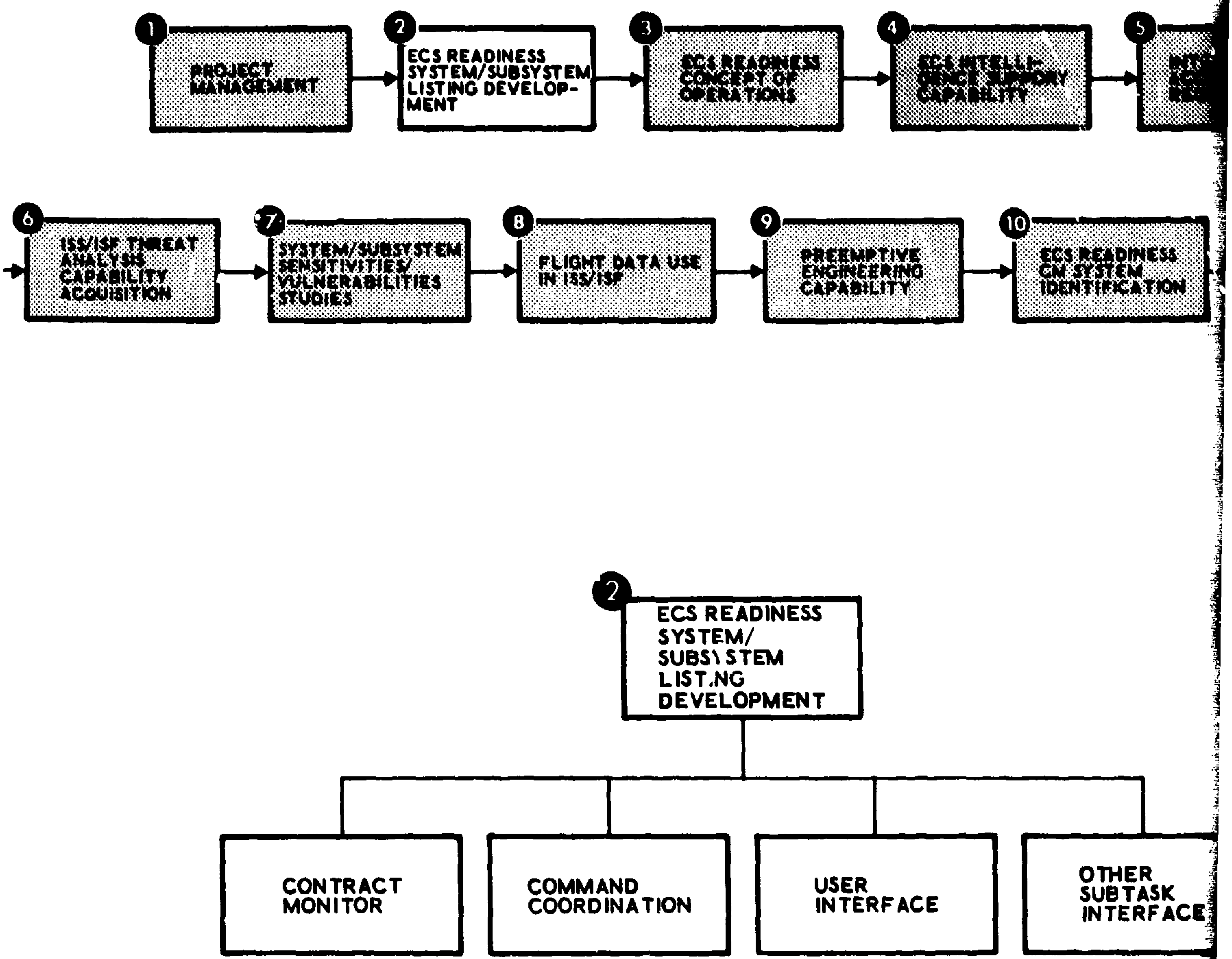
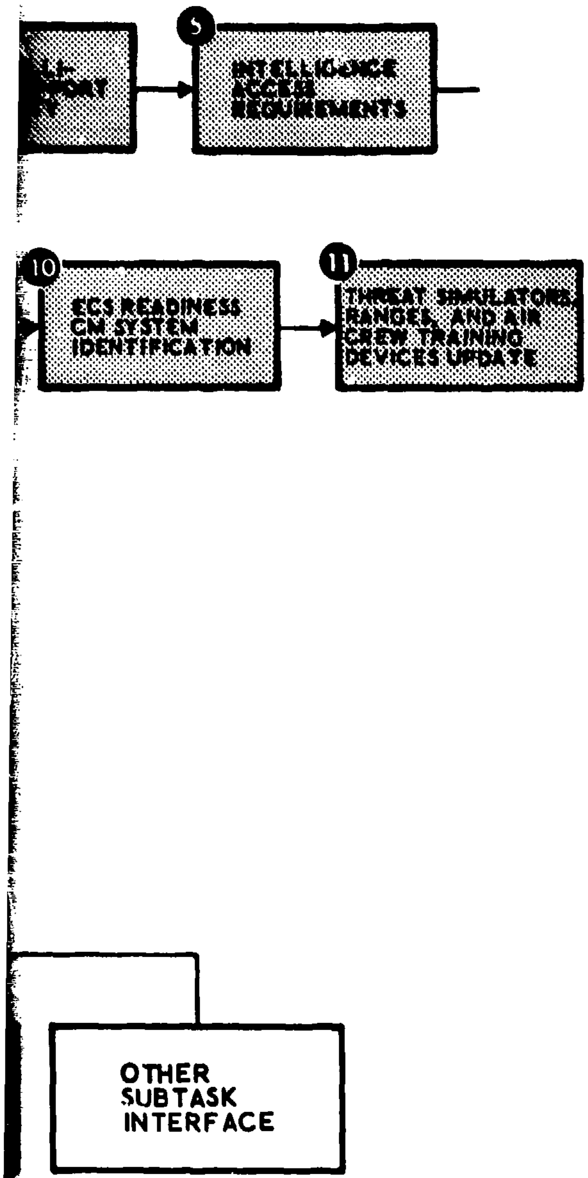


Figure 5-35. ECS Readiness Support: ECS Readiness System/



TASK DESCRIPTION ECS READINESS SUPPORT

SUBTASK DESCRIPTION ECS READINESS SYSTEM/SUBSYSTEM LISTING DEVELOPMENT **2**

TASK OBJECTIVE(S)

THE DEVELOPMENT AND MAINTENANCE OF A COMPREHENSIVE PRIORITIZED LISTING OF THOSE ECS SYSTEMS/SUBSYSTEMS WHICH SHOULD BE INCLUDED UNDER THE READINESS SUPPORT CONCEPT.

MAJOR ISSUES/PROBLEM AREAS

1. CRITERIA FOR DETERMINING ECS SYSTEMS/SUBSYSTEMS TO BE INCLUDED UNDER THIS CONCEPT DOES NOT CURRENTLY EXIST.
2. SYSTEMS/SUBSYSTEMS THAT HAVE NOT HAD PMRT ARE DISPERSED THROUGHOUT AFLC.
3. SYSTEMS/SUBSYSTEMS IN DEVELOPMENT WITHIN AFSC MUST BE INCLUDED.
4. OPERATIONAL USER'S INPUT IS REQUIRED TO: A) DEVELOP CRITERIA FOR DETERMINING ECS SYSTEMS/SUBSYSTEMS TO BE INCLUDED UNDER READINESS CONCEPT; AND B) DEVELOP PRIORITIZED LIST.
5. LISTING MUST BE REVIEWED AND UPDATED YEARLY FOR USE IN POM CYCLE.
6. DATA BASE (LISTING) LOCATION, SOFTWARE, HOST COMPUTER, AND RESPONSIBLE AFLC AGENCY ARE CURRENTLY UNIDENTIFIED.

TASK APPROACH

1. GENERICALLY IDENTIFY THE CHARACTERISTICS OF THE SYSTEM/SUBSYSTEM ECS WHICH QUALIFY THEM FOR INCLUSION UNDER THE READINESS SUPPORT CONCEPT.
   - ANALYZE TYPICAL SYSTEM/SUBSYSTEM FROM EACH ECS CATEGORY.
   - SURVEY OPERATIONAL USER COMMANDS FOR THEIR INPUTS.
   - USE THESE CHARACTERISTICS TO FACILITATE ITEM 2.
2. REQUEST INITIAL LISTING OF ECS SYSTEMS/SUBSYSTEMS FROM EACH ALC.
3. THROUGH ALD REQUEST LISTING OF ECS SYSTEMS UNDER DEVELOPMENT WITHIN AFSC.
4. IN COORDINATION WITH OPERATIONAL USERS, CONSOLIDATE AND APPROVE A PRIORITIZED LISTING OF SYSTEMS/SUBSYSTEMS WHICH SHOULD BE INCLUDED UNDER THE READINESS SUPPORT CONCEPT.
5. ON A YEARLY BASIS, REVIEW, UPDATE, AND REPRIORITIZE THIS LIST FOR USE IN POM CYCLE PREPARATION.
6. DESIGNATE RESPONSIBLE HEADQUARTERS AGENCY FOR CONSOLIDATION/MAINTAINING READINESS SUPPORT LISTING AND PROVIDING YEARLY INPUTS TO POM CYCLE.
7. FORMAT AND STORE LISTING AS PART OF READINESS SUPPORT DATA BASE.

LEVEL OF EFFORT

APPROXIMATELY 4½ PERSON YEARS EFFORT WITH RATHER EXTENSIVE TRAVEL TO OBTAIN OPERATIONAL USERS AND AFSC INPUTS. LENGTH OF EFFORT SHOULD BE A MINIMUM OF 24 MONTHS.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

ENGINEER/SYSTEM ANALYSIS WITH A MINIMUM OF SEVEN (7) YEARS OF EXPERIENCE WITH ECS AND THEIR OPERATIONAL USE. A FIRM UNDERSTANDING OF AFLC PROCEDURES AND AIR FORCE ROLES AND MISSIONS IS ESSENTIAL.

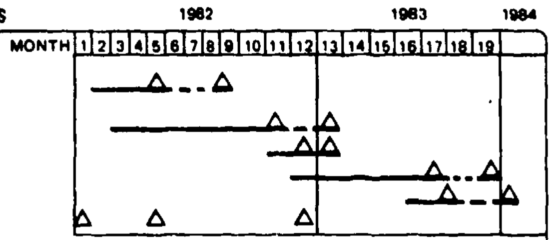
TASK INPUTS/INTERFACES

KEY INPUTS ARE REQUIRED FROM AFSC, ALC, AND OPERATIONAL USERS. INTERFACES WITH OPERATIONAL USERS IS REQUIRED TO DETERMINE CRITERIA (ITEM 1 UNDER MAJOR ISSUES).

TASK DELIVERABLES/KEY MILESTONES

1. ECS READINESS CRITERIA DETERMINATION
2. SURVEY ALC AND AFSC FOR SYSTEMS/SUBSYSTEMS
3. INITIAL LISTING
4. LIST PRIORITIZATION AND APPROVAL
5. DATA BASE FORMATTING

SDR, PDR, CDR



adiness System/Subsystem Listing Development

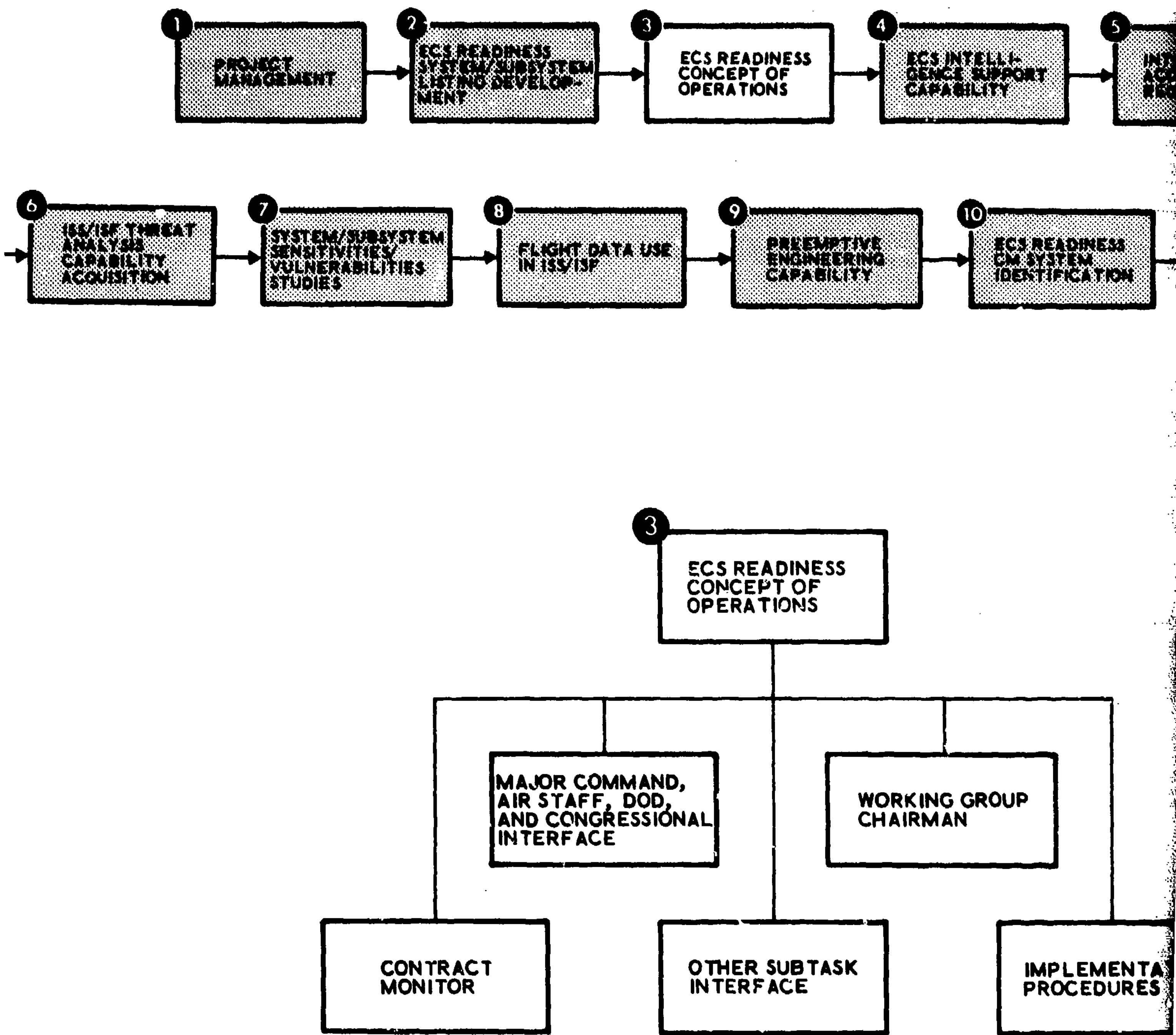
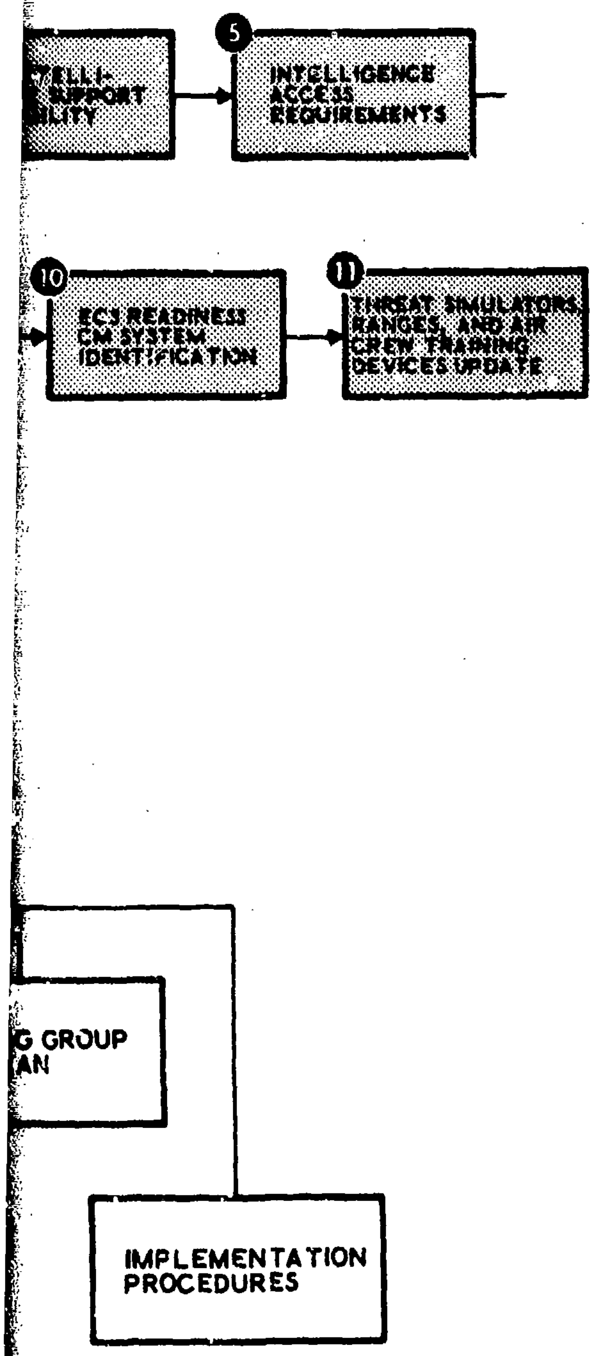


Figure 5-36. ECS Readiness Support: ECS Reaainess



TASK DESCRIPTION ECS READINESS SUPPORT

SUBTASK DESCRIPTION ECS READINESS CONCEPT OF OPERATIONS

3

TASK OBJECTIVE(S)

TO OBTAIN AN AIR FORCE APPROVED ECS READINESS CONCEPT OF OPERATIONS WHICH CLEARLY PARTITIONS RESPONSIBILITIES AMONG THE VARIOUS AIR FORCE MAJOR COMMANDS AND SPECIAL OPERATING LOCATIONS AND ASSIGNS THE ASSOCIATED SPECIFIC TASKS REQUIRED TO PERFORM THESE RESPONSIBILITIES. THIS CONCEPT OF OPERATION WILL SERVE AS THE AIR FORCE AUTHORITATIVE DOCUMENT FOR RESOURCE REQUESTS AMONG THE VARIOUS PARTICIPANTS.

MAJOR ISSUES/PROBLEM AREAS

1. WITH ONE EXCEPTION, THE OPERATIONAL USER IS LARGELY UNAWARE OF THE SIGNIFICANCE AND MAGNITUDE OF THE READINESS SUPPORT ISSUE ON HIS COMBAT CAPABILITY. (THE ONE EXCEPTION IS IN THE EW ECS CATEGORY.)
2. SOLUTIONS TO THE PROBLEM WILL REQUIRE COMMITMENT OF SIGNIFICANT AIR FORCE RESOURCES AMONG SEVERAL MAJOR COMMANDS.
3. AIR STAFF, DOD AND CONGRESSIONAL SUPPORT WILL BE REQUIRED FOR RESOURCES; HOWEVER, UNDERSTANDING OF THE PROBLEM AT THESE LEVELS IS LIMITED.
4. DEVELOPMENT OF THE CONCEPT OF OPERATIONS WILL REQUIRE AIR FORCE WIDE SUPPORT SIMILAR TO THAT REQUIRED TO DEVELOP THE ELECTRONIC WARFARE INTEGRATED REPROGRAMMING CONCEPT (EWIRC).

TASK APPROACH

1. REQUEST USAF/LEY CHAIR CONCEPT OF OPERATIONS WORKING GROUP.
2. FROM USAF/LE OR USAF/CV LEVEL, REQUEST MAJOR COMMAND AND AIR STAFF SUPPORT.
3. ESTABLISH USAF/LEY CHAIRED CONCEPT OF OPERATIONS WORKING GROUP (SUGGEST PREVIOUS USAF/XOA CHAIRED ELECTRONIC WARFARE INTEGRATED REPROGRAMMING CONCEPT (EWIRC) WORKING GROUP SERVE AS A BASELINE APPROACH FOR DETERMINING CONCEPT OF OPERATIONS WORKING GROUP MEMBERS AND CHARTER).
4. DRAFT AND APPROVE SOW FOR CONTRACTOR SUPPORT IN DEVELOPING CONCEPT OF OPERATIONS.
5. DETERMINE AND TARGET CONCEPT OF OPERATIONS TOWARD APPROPRIATE AIR FORCE REGULATION FOR IMPLEMENTATION.
6. PREPARE INITIAL/DRAFT CONCEPT OF OPERATIONS.
7. REQUEST COMMAND REVIEW AND APPROVAL.
8. IMPLEMENT IN AIR FORCE REGULATIONS.

LEVEL OF EFFORT

AIR FORCE: WORKING GROUP RESPONSIBILITIES WILL EXTEND OVER APPROXIMATELY 18 MONTHS. DURING THIS TIME, 3 TO 4 ONE-WEEK MEETINGS WILL BE REQUIRED AND WILL INCLUDE ALL WORKING GROUP MEMBERS. TO PREPARE, REVIEW, AND COORDINATE DATA, EACH PARTICIPATING COMMAND, SERVICE, CENTER, AND/OR OPERATING LOCATION MAY REQUIRE ONE DEDICATED PERSON FOR THE YEAR.
AIR FORCE LEYY PARTICIPATION WILL REQUIRE ONE PERSON FULL TIME FOR THE 18 MONTHS. OTHER AIR STAFF PARTICIPANTS WILL BE DEDICATED FOR ¼ OF THEIR TIME FOR THE 18 MONTHS.

EXTENSIVE TDY WILL BE NECESSARY FOR BOTH THE WORKING GROUP AND THE CONTRACTOR FOR DATA GATHERING AND COORDINATION VISITS. EXACT TDY/VISIT SCHEDULE MUST BE WORKED OUT DURING SOW DRAFTING ACTION.

CONTRACTOR: 38 PERSON MONTHS OF EFFORT WILL BE REQUIRED TO PREPARE CONCEPT OF OPERATIONS OVER AN 18 MONTH PERIOD. THIS IS AN EXTREMELY TIGHT SCHEDULE WITH SEVERAL KEY REVIEWS ESSENTIAL TO A SMOOTH FLOW OF ACTIVITIES.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

CONTRACTOR: ENGINEER/SYSTEM ANALYSIS WITH A MINIMUM OF TEN (10) YEARS OF EXPERIENCE WITH ECS AND THEIR OPERATIONAL USE. A STRONG UNDERSTANDING OF AIR FORCE ROLES AND MISSIONS IS ESSENTIAL.

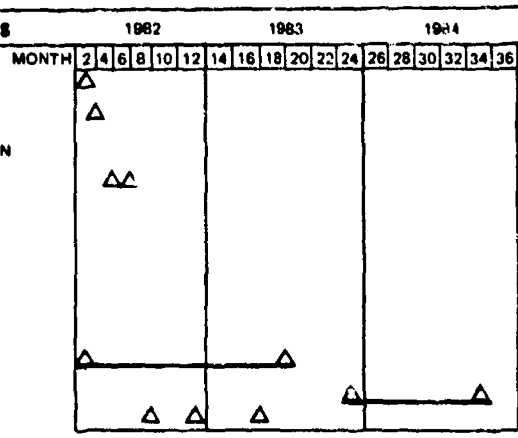
TASK INPUTS/INTERFACES

1. INPUTS ARE REQUIRED FROM AF/IN AND MAJOR COMMANDS.
2. RAPID MAJOR COMMAND REVIEWS ARE ESSENTIAL.
3. THIS EFFORT WILL HAVE AN IMPACT ON THE MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITIES AND ECS SUPPORT NETWORKS INITIATIVES.

TASK DELIVERABLES/KEY MILESTONES

1. REQUEST USAF/LEY SUPPORT (AFLC)
2. USAF/CV DIRECTION FOR SUPPORT (USAF/LE)
3. FORM WORKING GROUP (USAF/LEYY); DRAFT SOW, DEVELOP IMPLEMENTATION APPROACH, LET CONTRACT (USAF/LEYY)
4. DEVELOP CONCEPT OF OPERATIONS; REQUIRE DEFINITION AND DATA GATHERING, FUNCTIONAL PARTITIONING, REVIEW/APPROVAL, IDENTIFICATION OF FUNCTIONAL RESPONSIBILITY BY AF ORGANIZATION, REVIEW/APPROVAL, RESOURCE AND FUNDING PROFILE DEVELOPMENT, REVIEW AND APPROVAL, FINAL REPORT/CONCEPT PREPARATION, AF REVIEW, FINAL PUBLICATION
5. IMPLEMENTATION IN AF REGULATIONS (USAF/LEYY)

SDR, PDR, CDR



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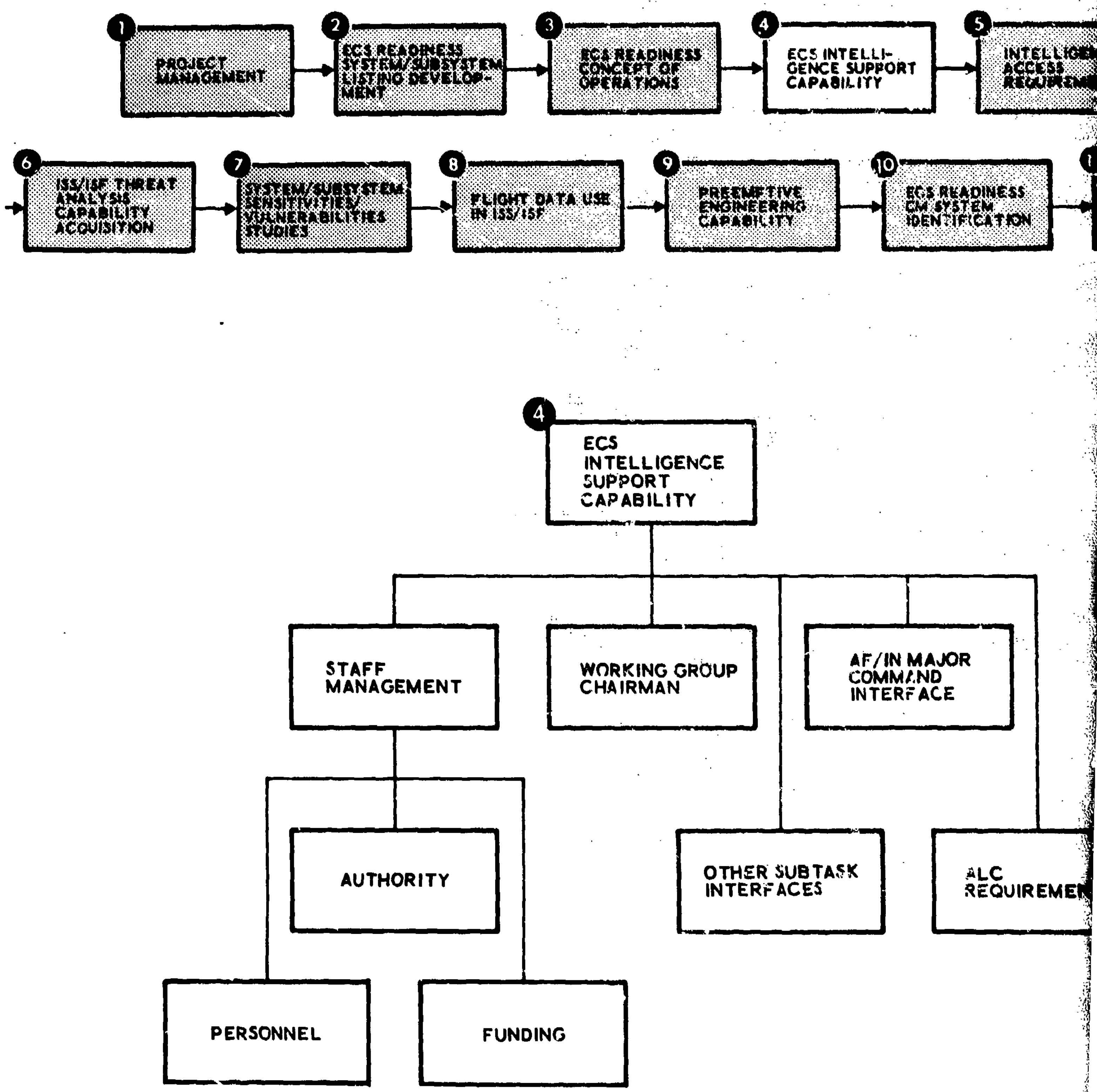
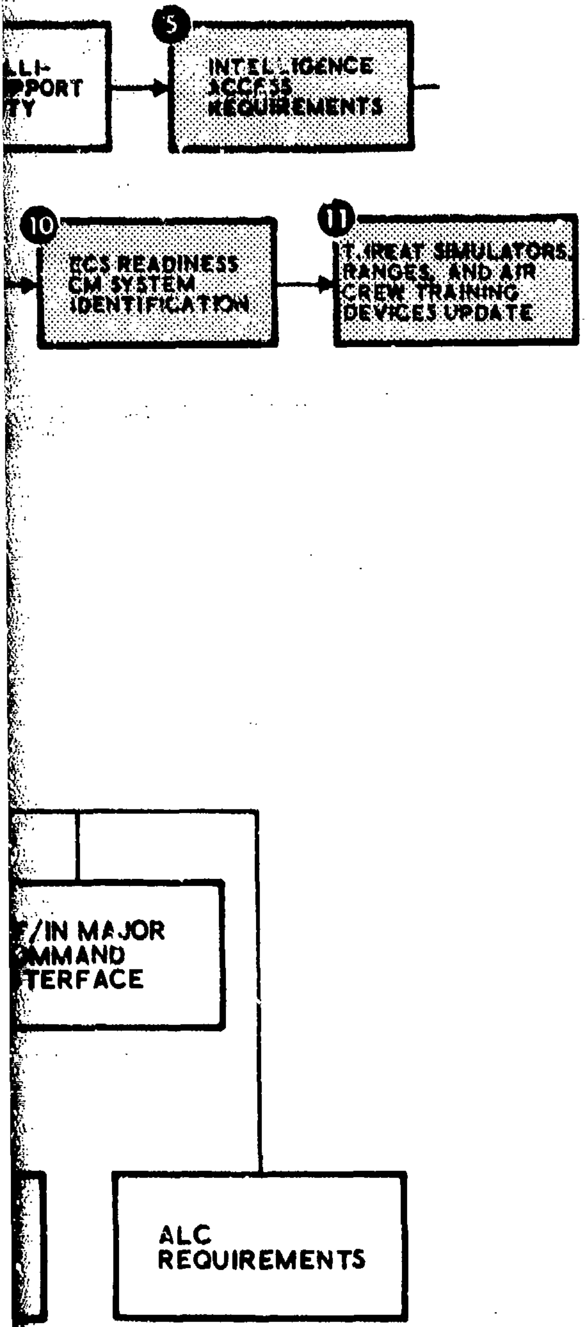


Figure 5-37. ECS Readiness Support: ECS Intellig



TASK DESCRIPTION ECS READINESS SUPPORT

SUBTASK DESCRIPTION ECS INTELLIGENCE SUPPORT CABABILITY

4

TASK OBJECTIVE(S)

OBTAIN THE CAPABILITY AND RESOURCES NECESSARY TO RECEIVE, STORE, PRODUCE AND ANALYZE SYSTEM/SUBSYSTEM RELATED CLASSIFIED INTELLIGENCE DATA.

MAJOR ISSUES/PROBLEM AREAS

1. IMPACTS THE AFLC ORGANIZATION IN THAT MANPOWER TO SUPPORT THIS FUNCTION MUST COME FROM WITHIN AFLC (AFR 200-1).
2. SPECIAL ACCESS REQUIREMENTS WILL REQUIRE AF/IN SUPPORT.
3. LIMITED PREVIOUS AFLC EXPERIENCE IN THIS AREA WITH IMPLICATIONS IN: TRAINING, PERSONNEL IDENTIFICATION, DATA IDENTIFICATION/ACQUISITION, COMMUNICATION REQUIREMENTS, FACILITY SPECIFICATION, AND INTELLIGENCE PROCESS.
4. AF/IN, OPERATIONAL USER, AND AIR STAFF SUPPORT ESSENTIAL FOR SUCCESS. COMPLICATING THE ISSUE IS THE PROBLEM OF LIMITED UNDERSTANDING OF THE AFLC ECS READINESS ISSUE BY THESE ORGANIZATIONS

TASK APPROACH

1. INITIATE EDUCATIONAL DIALOGUE WITH AF/IN, OPERATIONAL USER, AND AIR STAFF.
2. REQUEST FORMAT AF/IN SUPPORT IN ESTABLISHING AFLC INTELLIGENCE CAPABILITY.
3. ESTABLISH AFLC CHAIRED WORKING GROUP TO PREPARE DETAILED ROAD MAP FOR OBTAINING AFLC INTELLIGENCE SUPPORT ORGANIZATION
   - A. WORKING GROUP MEMBERS SHOULD INCLUDE: HQ/AFLC (CHAIRMAN), ALC, HQ USAF/IN/LE, ALD, MPC, FTD, AFSC, COMMUNICATIONS COMMAND, AND USER.
   - B. CHARTER
     - FORMULATE RECOMMENDED AFLC INTELLIGENCE ORGANIZATIONAL STRUCTURE TO INCLUDE: HQ AFLC/IN STRENGTH, FUNCTIONAL REPORTING CHAIN AND MISSION; ALC/IN STAFF, LOCATION, REPORTING CHAIN AND MISSION; INITIATE AFLC SPECIAL ACCESS CLEARANCE REQUIREMENTS; ISSUE OFFICIAL ALC TASKING FOR SUPPORT IN SELECTED AREA; FACILITY DEVELOPMENT PLAN, AND AFLC RESOURCE IMPACT, FUNDING PROFILE, AND MANPOWER REQUISITION REQUIREMENTS.
     - PROVIDE RECOMMENDATIONS TO APPROPRIATE HQ AFLC ORGANIZATION FOR IMPLEMENTATION. RECOMMEND "TWO" LETTER SYMBOL. ALSO RECOMMENDATIONS SHOULD BE BRIEFED TO AF/IN, HQ USAF/LE/XO/RD/MP, AND USERS.

LEVEL OF EFFORT

THIS IS PRIMARILY AN INTERNAL AFLC ADMINISTRATIVE ACTION WITH SUPPORT FROM OTHER AIR FORCE AGENCIES; HOWEVER, A DEDICATED AFLC STAFF WILL BE REQUIRED TO PERFORM THE NECESSARY FUNCTIONS. RECOMMEND A DEDICATED TWO PERSON EFFORT WITH APPROPRIATE ADMINISTRATIVE SUPPORT FOR APPROXIMATELY 1 YEAR TO 18 MONTHS. FURTHER RECOMMEND THIS TWO PERSON EFFORT BE HEADED BY AN 05 OR GS-13. TO SUPPORT THIS EFFORT, AFLC SHOULD CONSIDER THE SERVICES OF A "QUALIFIED" CONSULTANT FOR THE DURATION OF THE EFFORT. AS TDY WILL BE NECESSARY, AN APPROPRIATE BUDGET SHOULD BE ESTABLISHED.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

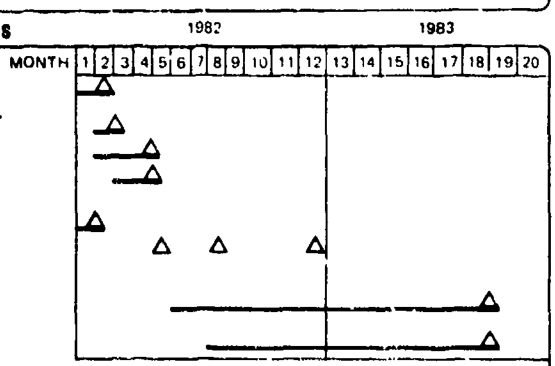
FOR AFLC STAFF, RECOMMEND SELECTION OF PERSONNEL WITH PREVIOUS EW AND MAJOR COMMAND INTELLIGENCE EXPERIENCE. PERSONNEL WITH PREVIOUS AF/INYW, AFIS OL-N/OL-F, AND AFEWC EXPERIENCE SHOULD RANK HIGH IN THE SELECTION GROUP. IN ADDITION, LEAD PERSONNEL SHOULD HAVE STRONG MANAGEMENT AND ORGANIZATIONAL EXPERIENCE.

TASK INPUTS/INTERFACES

WORKING GROUP INPUTS ARE ESSENTIAL. AF/IN SUPPORT NECESSARY TO ESTABLISH CAPABILITY.

TASK DELIVERABLES/KEY MILESTONES

1. ESTABLISH AFLC STAFF
2. PREPARE BRIEFINGS FOR AF/IN, USERS, AIR STAFF
3. FORMULATE WORKING
4. GROUP CHARTER
5. BRIEF AND REQUEST SUPPORT
6. CONTRACT FOR CONSULTANT
7. WORKING GROUP MEETINGS
8. INITIATE ACTIONS REQUESTING FORMATION OF HQ/AFLC AND ALC STAFFS
9. INITIATE REQUESTS FOR CLEARANCES, FACILITIES, AND COMMUNICATIONS



ort: ECS Intelligence Support Capability

12

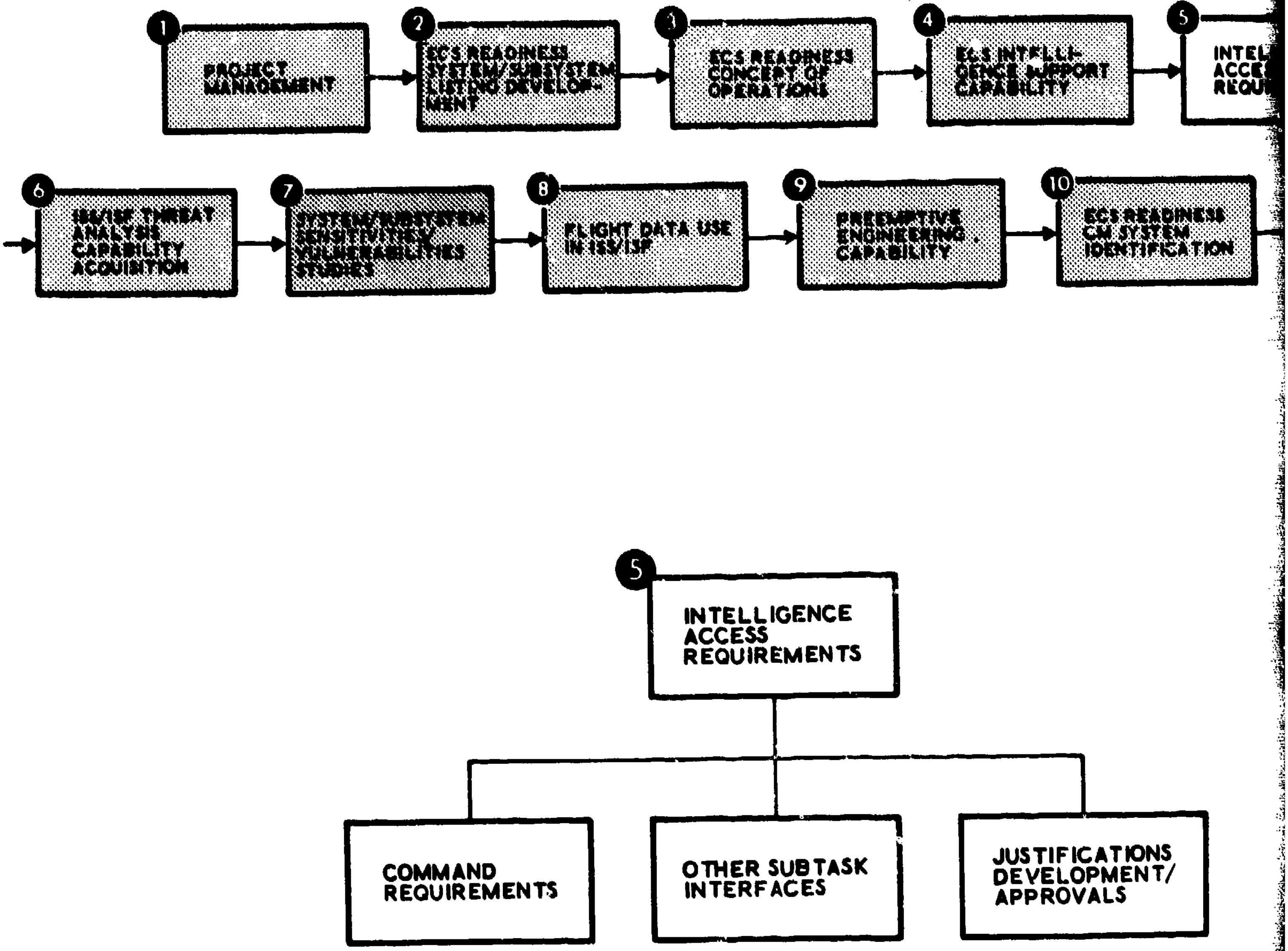
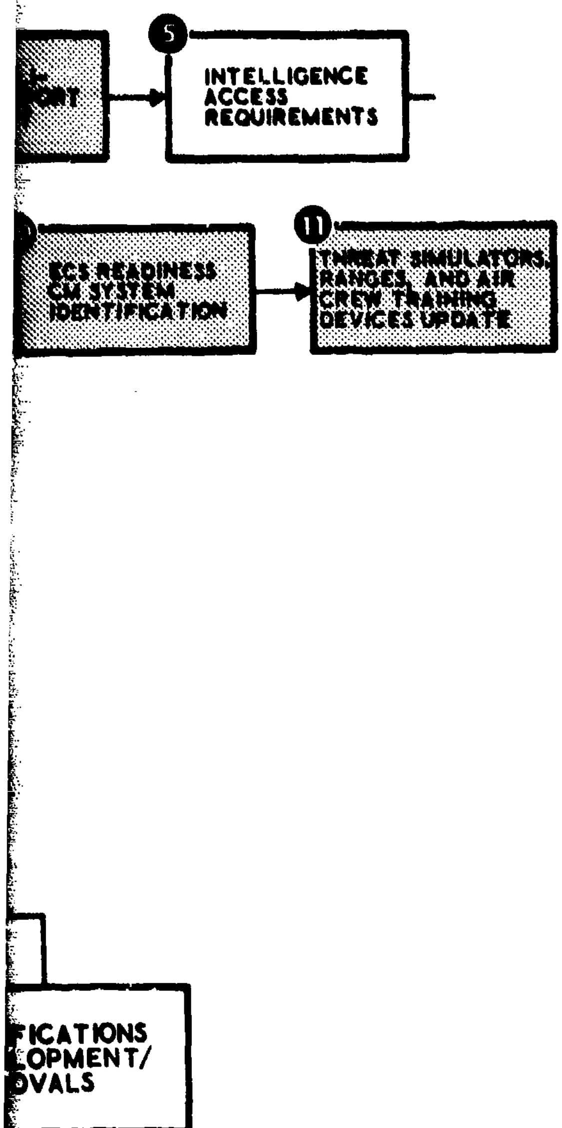


Figure 5-38. ECS Readiness Support: Intelli



TASK DESCRIPTION ECS READINESS SUPPORT

SUBTASK DESCRIPTION INTELLIGENCE ACCESS REQUIREMENTS (5)

TASK OBJECTIVE(S)

TO OBTAIN SPECIAL INTELLIGENCE BILLETS, CLEARANCES, AND ACCESS FOR THE REQUIRED AFLC PERSONNEL AND CONTRACTORS.

MAJOR ISSUES/PROBLEM AREAS

1. SPECIAL ACCESS CLEARANCES ARE CONTROLLED BY AF/IN.
2. A CEILING IS PLACED ON THE AIR FORCE AS TO THE TOTAL NUMBER OF SPECIAL ACCESS BILLETS AUTHORIZED.
3. NORMALLY THE RESPONSE FOR ADDITIONAL "BILLETS" IS TO DIRECT THE REQUESTING COMMAND TO REALIGN THEIR EXISTING BILLET STRUCTURE.
4. READINESS ISSUE MAY NECESSITATE AIR FORCE REQUEST FOR ADDITIONAL "BILLETS" FROM THE CONTROLLING NATIONAL AGENCY.
5. ADEQUATE "BILLET" JUSTIFICATIONS ARE VERY DIFFICULT TO PREPARE WITHOUT PREVIOUS EXPERIENCE.
6. AFLC PERSONNEL/JOB DESCRIPTION REQUIRING SPECIAL ACCESS, UNDER THE READINESS PROGRAM, HAVE NOT BEEN IDENTIFIED.

TASK APPROACH

1. REQUEST AF/IN SUPPORT.
2. BASED UPON "NEED TO KNOW," IDENTIFY AFLC ACCESS REQUIREMENTS BY:
   A. JOB POSITION.
   - LEVEL OF CLEARANCE REQUIRED.
3. CONSOLIDATE, REVIEW, AND OBTAIN AFLC APPROVAL OF TASK ITEM 2. ABOVE
4. COORDINATE TASK ITEM 2. AND OBTAIN GUIDANCE FROM AF/IN.
5. PREPARE WRITTEN JUSTIFICATION AND FORWARD TO AF/IN FOR ACTION.

LEVEL OF EFFORT

THIS WILL BE A DAY-TO-DAY JOB FOR THE AFLC INTELLIGENCE STAFF; HOWEVER, INITIALLY IT WILL REQUIRE A DEDICATED 6 MONTHS TO 1 YEAR.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

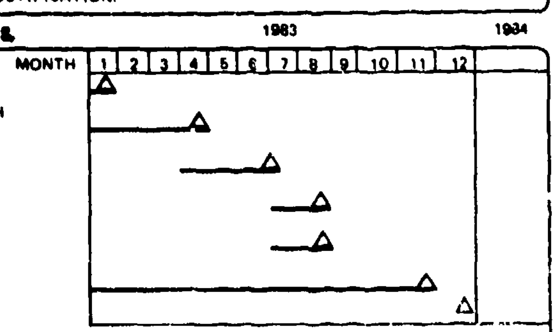
CLASSIC INTELLIGENCE AIR FORCE SPECIALTY CODES (AFSC).

TASK INPUTS/INTERFACES

1. AF/IN SUPPORT IS ESSENTIAL.
2. ALC MUST DEVELOP RECOMMENDED PERSONNEL/JOB TITLE LIST.
3. ALC MUST PREPARE WRITTEN BILLET JUSTIFICATION.

TASK DELIVERABLES/KEY MILESTONES

1. REQUEST AF/IN SUPPORT
2. REQUEST ALC BILLET LIST ALONG WITH JUSTIFICATION
3. REVIEW, CONSOLIDATE AFLC ACCESS LIST
4. OBTAIN AFLC COMMENTS ON REVISED ACCESS LIST
5. REQUEST AF/IN REVIEW AND COMMENTS
6. PREPARE, COORDINATE LIST AND JUSTIFICATION
7. SUBMIT FOR AF/IN ACTION



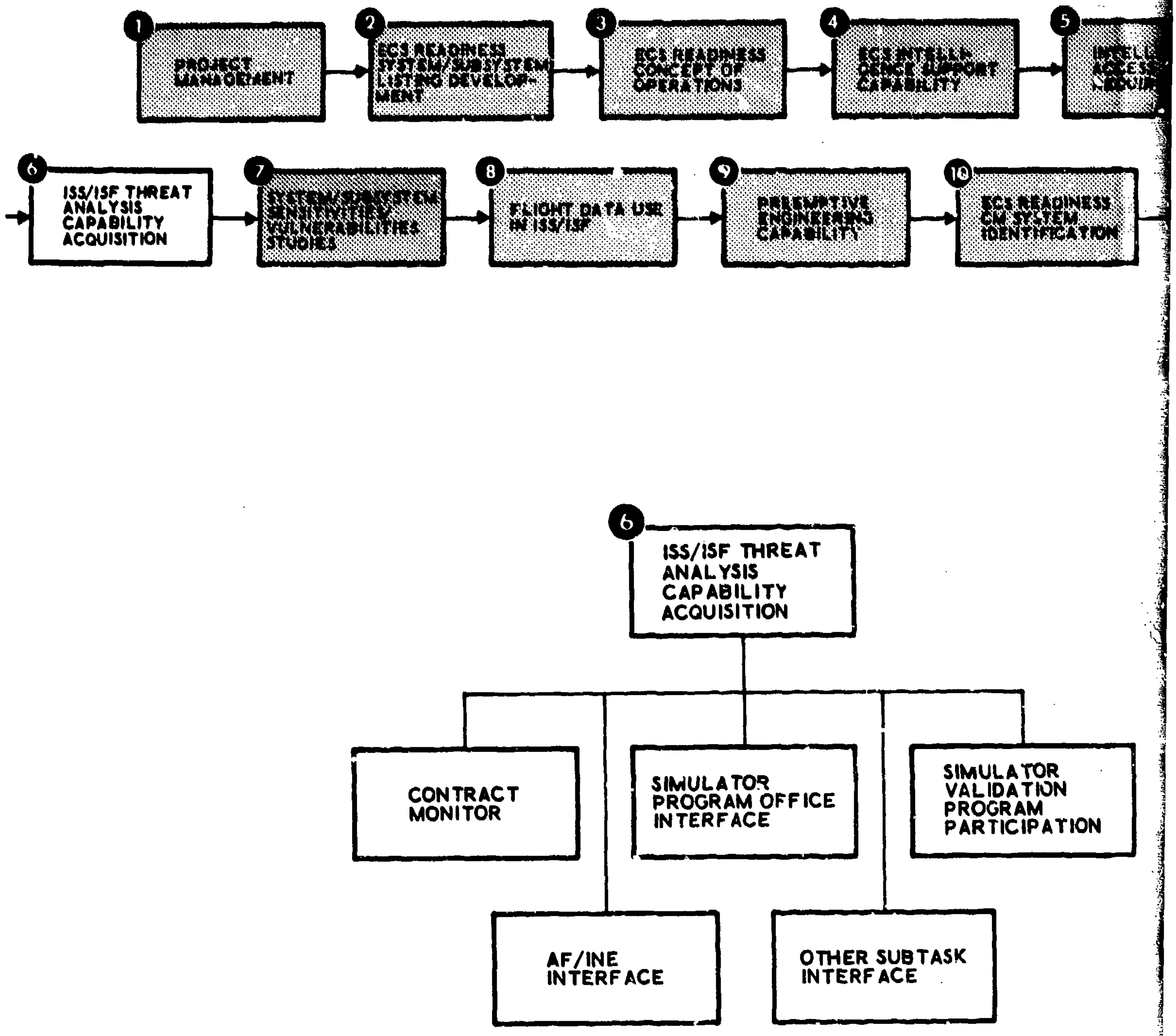
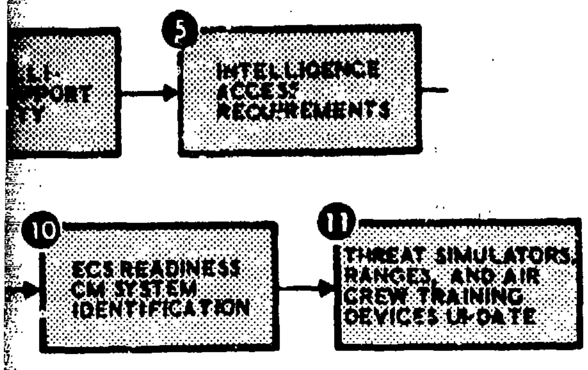


Figure 5-39. ECS Readiness Support: ISS/ISF Threat An



TASK DESCRIPTION ECS READINESS SUPPORT

SUBTASK DESCRIPTION ISS/ISF THREAT ANALYSIS CABABILITY ACQUISITION

6

TASK OBJECTIVE(S)

TO ESTABLISH THE CAPABILITY, WITHIN EACH ISS/ISF, TO DETERMINE THE IMPACT OF THE ACTUAL OR SUSPECTED THREAT ON SELECTED SYSTEM/SUBSYSTEM ECS SOFTWARE.

MAJOR ISSUES/PROBLEM AREAS

1. THE ECS CHANGE/MODIFICATION RESPONSE TIME IS A KEY FACTOR IN DETERMINING THE VARIOUS SYSTEM/SUBSYSTEM ISS/ISF READINESS SUPPORT CAPABILITY AND THE MODIFICATION REQUIRED. WITH THE EXCEPTION OF THE EW CATEGORY, THIS CHANGE/MODIFICATION RESPONSE TIME REQUIREMENT HAS NEVER BEEN DETERMINED.
2. OPERATIONAL USER'S SUPPORT IS REQUIRED TO DETERMINE CHANGE/MODIFICATION RESPONSE TIME.
3. VARIOUS STIMULUS DEVICES/APPROACHES ARE CURRENTLY AVAILABLE WITHIN THE AIR FORCE.
4. VALIDATED/STANDARD THREAT DATA IS REQUIRED TO SUPPORT THE STIMULUS DEVICES USED IN THESE ISS/ISF

TASK APPROACH

1. USING THE APPROVED SYSTEM/SUBSYSTEM ECS READINESS LIST DEVELOPED UNDER TASK 2, OBTAIN OPERATIONAL USERS RESPONSE/MODIFICATION TIME REQUIREMENTS. USE THIS DATA TO DEVELOP SYSTEM/SUBSYSTEM RESPONSE/MODIFICATION TIME REQUIREMENT.
2. USING THE APPROVED SYSTEM/SUBSYSTEM ECS READINESS LIST FROM TASK 2, AND IN CONJUNCTION WITH OPERATIONAL USER AND AF/IN, DETERMINE THREAT STIMULUS REQUIREMENTS FOR THE VARIOUS SYSTEM/SUBSYSTEMS.
3. SURVEY EXISTING AIR FORCE STIMULUS DEVICES, WITH PARTICULAR ATTENTION GIVEN TO DLQ-38 AND EWOLS, TO DETERMINE THEIR CAPABILITY TO SUPPORT THE REQUIREMENTS IN ITEM 2.
4. USING 2 AND 3 DEVELOP THE SPECIFICATIONS FOR DEVELOPMENT/MODIFICATION REQUIRED TO OBTAIN THE STIMULUS DEVICE(S).
5. REQUEST AF/INE SUPPORT IN PROVIDING VALIDATED THREAT ENVIRONMENTAL DATA REQUIRED TO SUPPORT 4.
6. CONCURRENT WITH 3 AND 4, DEVELOP SPECIFICATIONS FOR ISS/ISF MODIFICATIONS NECESSARY TO ACCOMMODATE THE PROPOSED STIMULUS INPUT (THESE SPECIFICATIONS SHOULD INCLUDE CONSIDERATION OF TASK 8 EFFORT ALSO AND SHOULD BE DEVELOPED TO ACCOMMODATE BOTH SETS OF REQUIREMENTS.)
7. REQUEST AFSC TO INCLUDE STIMULUS DEVICES DEVELOPED/MODIFIED IN 4 IN THE AIR FORCE SIMULATOR VALIDATION EFFORTS.

LEVEL OF EFFORT

1. 32 PERSON MONTH EFFORT OVER A 12 MONTH PERIOD.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

ENGINEER/SYSTEM ANALYSIS WITH A MINIMUM OF TEN (10) YEARS EXPERIENCE WORKING WITH SYSTEM DESIGN AND REQUIREMENT DEFINITIONS.

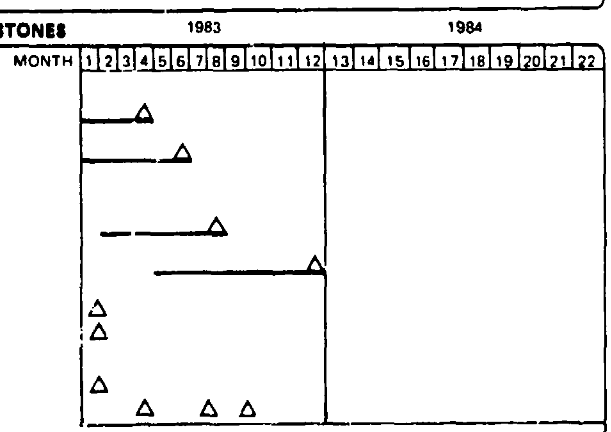
TASK INPUTS/INTERFACES

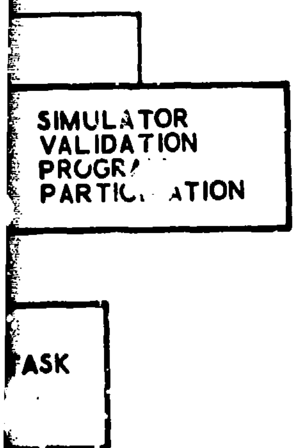
1. TASK 2 IS CRITICAL TO THIS EFFORT.
2. AF/IN AND OPERATIONAL USER SUPPORT IS ESSENTIAL. RECOMMEND AFLC "TWO LETTER" MESSAGE REQUEST FOR SUPPORT.
3. ASD SIMULATION PO IS A KEY PLAYER IN BOTH POM SUPPORT AND DEVELOPMENT AREAS.
4. VALIDATED THREAT DATA FOR USE IN THIS EFFORT (BOTH DEVELOPMENT AND DURING OPERATIONAL USE) IS A CRITICAL AREA THAT SHOULD BE UNDERSTOOD "UP-FRONT." THE ANSWERS IN THIS AREA COULD HAVE SERIOUS IMPACTS ON TASK 4. SPECIFIC QUESTIONS WHICH MUST BE ANSWERED ARE: WHAT AGENCY WILL DEVELOP THE DATA? WHAT PROCEDURE WILL BE USED TO OBTAIN AF/IN APPROVAL/REVIEW OF DATA? HOW MUCH LEAD TIME IS REQUIRED FOR AF/IN APPROVAL/REVIEW? ASSUMING AFLC ACCOMPLISHES DEVELOPMENT OF THE DATA, WHAT IS THE IMPACT IN LIGHT OF TASK 4 AND WHAT ARE THE RESOURCES REQUIRED?

TASK DELIVERABLES/KEY MILESTONES

1. DEVELOP SYSTEM/SUBSYSTEM RESPONSE/MODIFICATION TIME REQUIREMENT LISTING
2. DEVELOP THREAT STIMULUS REQUIREMENTS
3. SURVEY EXISTING AIR FORCE STIMULUS DEVICES AND DOCUMENT CAPABILITIES/LIMITATIONS
4. DEVELOP STIMULUS SPECIFICATIONS
5. REQUEST SIMULATOR PO SUPPORT
6. REQUEST AF/IN SUPPORT
7. REQUEST INCLUSION UNDER SIMULATION VALIDATION PROGRAM

SDR, PDR, CDR





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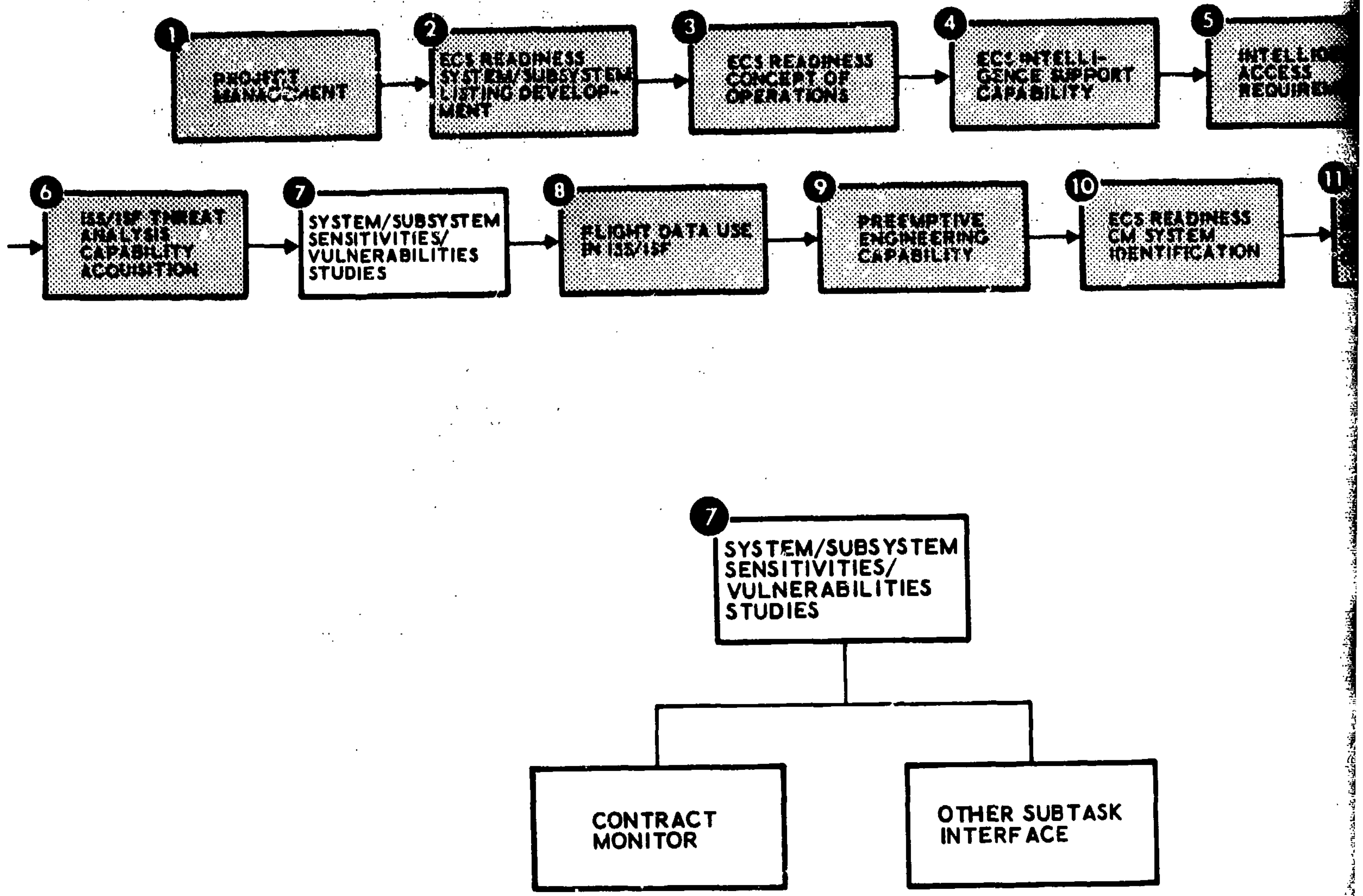
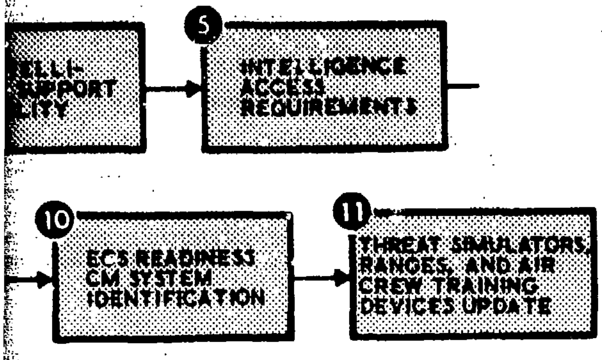


Figure 5-40. ECS Readiness Support: System/Subsystem Sensitivities/



TASK DESCRIPTION ECS READINESS SUPPORT

SUBTASK DESCRIPTION SYSTEM/SUBSYSTEM SENSITIVITIES/VULNERABILITIES STUDIES 7

TASK OBJECTIVE(S)

SYSTEM/SUBSYSTEM SENSITIVITIES STUDIES TO: 1) DETERMINE VULNERABILITIES TO ACTUAL/EXPECTED/POSSIBLE ADVERSARY THREAT; 2) IDENTIFY GENERIC ECS SOFTWARE MODIFICATIONS TO COUNTER 1), AND 3) IDENTIFY INTELLIGENCE COLLECTION AND ANALYSIS REQUIRED TO SUPPORT CONTINUING EFFORT AND GUARD AGAINST ADVERSARY TECHNOLOGY

MAJOR ISSUES/PROBLEM AREAS

1. **ISSUE**: IDENTIFICATION OF SYSTEMS/SUBSYSTEMS TO BE SUBJECTED TO SENSITIVITY STUDIES.
2. **ISSUE**: IDENTIFICATION OF RELATED/PREVIOUS EFFORTS IN THIS AREA.
3. **PROBLEM**: FUNDING AND PROGRAM MONITOR. PROGRAM MONITOR IS PROBABLY AT THE SYSTEM/SUBSYSTEM LEVEL.
4. EFFORTS MUST RUN CONCURRENT WITH OTHER ECS READINESS ACQUISITION TASKS.
5. JUSTIFICATION OF SPECIAL INTELLIGENCE CLEARANCES FOR CONTRACTOR AND AIR FORCE PERSONNEL. THESE ARE ABOVE AND BEYOND THOSE DESCRIBED IN TASK 5.

TASK APPROACH

1. IDENTIFY SYSTEMS/SUBSYSTEMS TO BE SUBJECTED TO STUDIES. TASK 2 IS KEY INPUT.
2. ASSIGN CONTRACT MONITORS AT SYSTEM/SUBSYSTEM MANAGER LEVEL.
3. IDENTIFY SOURCES OF RELATED/PREVIOUS WORK SUCH AS: AF/IN THREAT ESTIMATES FOR SYSTEMS/SUBSYSTEMS, PROGRAM OFFICE WORK, AFTEC TESTING, AIR FORCE ELECTRONIC WARFARE CENTER WORK, AND DT&E FLIGHT TEST REPORTS.
4. DRAFT SOW AND INSURE HEADQUARTERS OVERSIGHT TO MINIMIZE DUPLICATIONS AND INSURE STUDIES ARE SUPPORTIVE AND REQUEST SIMILAR ACTIONS/DELIVERABLES.
5. FOR SYSTEMS/SUBSYSTEMS IN DEVELOPMENT CYCLE, REQUEST PO TO PROVIDE SENSITIVITY/VULNERABILITY ASSESSMENT AT PMRT.
6. AT HQ USAF/LE LEVEL, INITIATE ACTIONS TO INSURE THAT FUTURE PMD'S REQUIRE SENSITIVITY ANALYSIS AS PART OF DEVELOPMENT PROCESS.
7. REVIEW AND MODIFY AS APPROPRIATE 800 SERIES AF REGULATIONS. IDENTIFY ISSUE WITHIN CRWG STRUCTURE AND REQUEST APPROPRIATE SUPPORT.
8. REVIEW AF IMPLEMENTATION OF DOD DIRECTIVES 5000.1, 5000.2, C-4600.3, 4600-4, AND 3100.9 FOR APPLICABILITY AND REQUECT MODIFICATIONS AS REQUIRED.
9. REQUEST AF/IN APPROVAL OF APPROPRIATE INTELLIGENCE ACCESS FOR CONTRACTOR PERSONNEL OR REQUIRE ACCESS AS PART OF SOW.

LEVEL OF EFFORT

LEVEL OF EFFORT WILL VARY FROM SYSTEM/SUBSYSTEM TO SYSTEM/SUBSYSTEM. FOR INITIAL FUNDING PLANNING PURPOSES, SUGGEST AN AVERAGE OF 2 PERSON YEARS PER SYSTEM/SUBSYSTEM SELECTED.

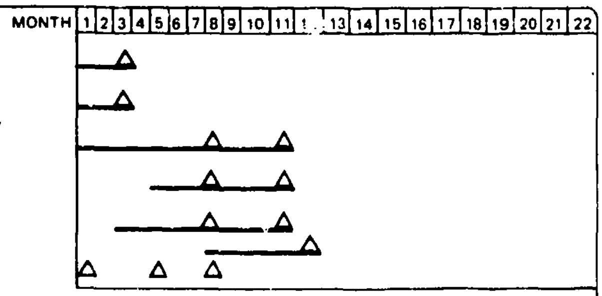
PERFORMER EXPERIENCE LEVEL/BACKGROUND

ENGINEER/SYSTEM ANALYSIS WITH A MINIMUM OF 10 YEARS IN SYSTEM/SUBSYSTEM RELEATED AREA.
ENGINEER/INTELLIGENCE ANALYSIS WITH A MINIMUM OF 5 YEARS IN TECHNICAL THREAT ANALYSIS.
ALL PERSONNEL WILL REQUIRE SPECIAL INTELLIGENCE CLEARANCES.

TASK INPUTS/INTERFACES

1. SYSTEMS/SUBSYSTEMS SELECTED WILL BE DETERMINED USING ECS READINESS PRIORITIZED LIST FROM FROM TASK 1.
2. PREVIOUS STUDIES/WORK IS VERY IMPORTANT INPUT TO THIS EFFORT. SEE TASK APPROACH ITEM 3.
3. AF/IN, NATIONAL INTELLIGENCE AGENCIES, AND OPERATIONAL USERS COULD PROVIDE VALUABLE INSIGHT INTO CURRENT/PROJECTED THREAT DATA.

TASK DELIVERABLES/KEY MILESTONES 1982 – 1984



*THESE ARE REPRESENTATIVE DELIVERABLES/MILESTONES. ACTUAL DATA WILL VARY FROM SYSTEM/SUBSYSTEM TO SYSTEM/SUBSYSTEM.

bsystem Sensitivities/Vulnerabilities Studies

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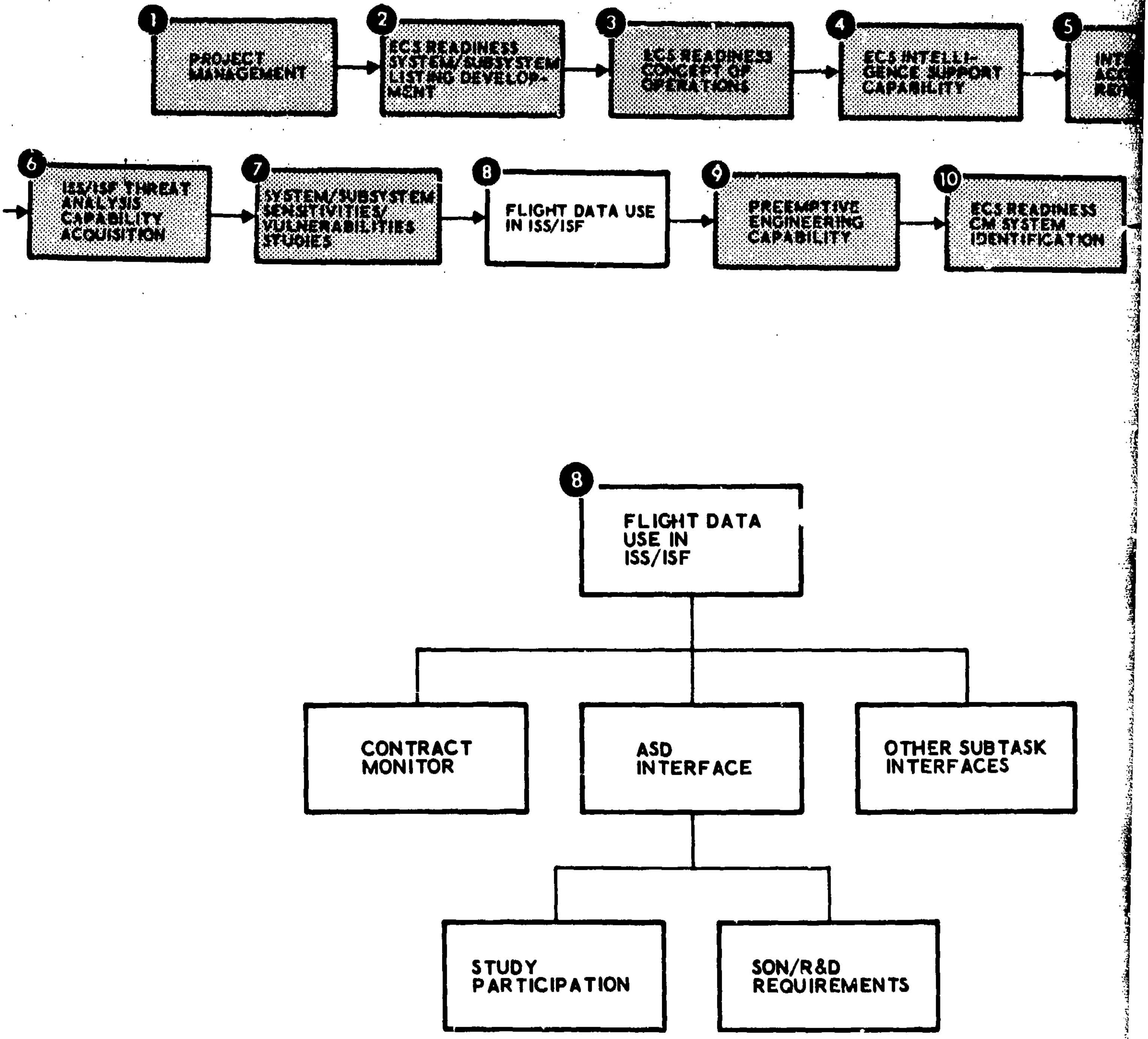
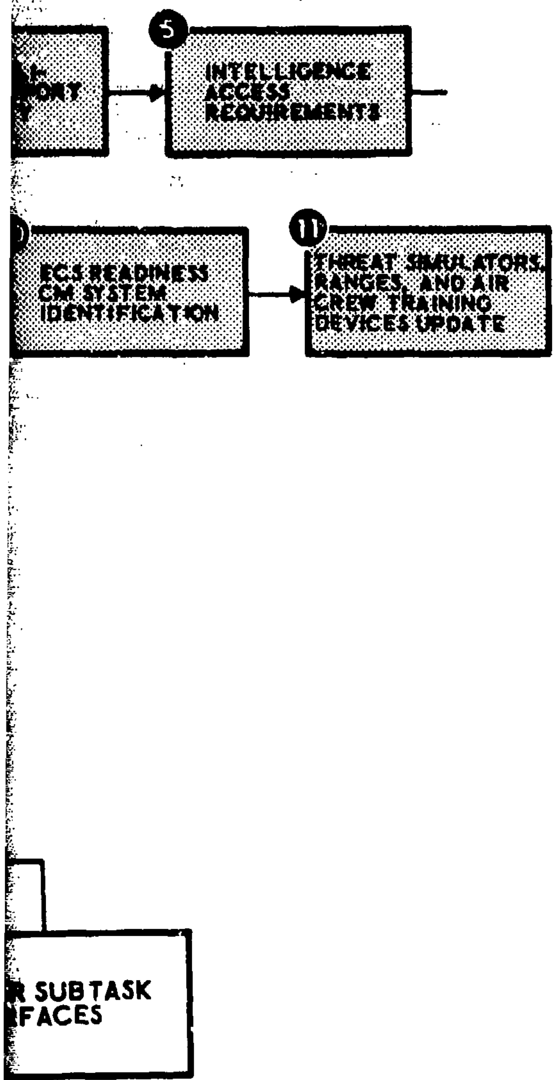


Figure 5-41. ECS Readiness Support: Flight Data Us



TASK DESCRIPTION ECS READINESS SUPPORT

SUBTASK DESCRIPTION FLIGHT DATA USE IN ISS/ISF

8

TASK OBJECTIVE(S)

TO OBTAIN THE CAPABILITY TO RECORD ECS FLIGHT PERFORMANCE DATA UNDER ACTUAL THREAT RANGE ENVIRONMENTS, AND TO USE THIS DATA WITHIN AN ISS/ISF TO ASSIST IN DETERMINING SYSTEM/SUBSYSTEM OPERATION.

MAJOR ISSUES/PROBLEM AREAS

1. VARIOUS FLIGHT DATA RECORDING CAPABILITIES ARE AVAILABLE.
2. SPECIAL DATA REDUCTION CAPABILITIES MUST BE OBTAINED IN ORDER TO USE DATA IN THE ISS/ISF.
3. ADVANCE DEVELOPMENT EFFORTS MAY BE NECESSARY IN ORDER TO OBTAIN THE NECESSARY CAPABILITIES.
4. RANGE SIMULATIONS VARY FROM RANGE TO RANGE AND FROM SYSTEM TO SYSTEM. AS A RESULT, CAUTION MUST BE EXERCISED WHEN THIS DATA IS TO BE USED. TASK 2 AMPLIFIES IN THIS AREA.
5. AFLC MUST BECOME AN ACTIVE MEMBER OF THE AIR FORCE SIMULATOR VALIDATION PROGRAM AND PROVIDE INPUTS ON SIMULATOR VALIDATION PRIORITIES.
6. OUT OF DATE OR INACCURATE SIMULATORS ARE CURRENTLY IN USE ON MANY OF THE AIR FORCE RANGES. SEE TASK 2 FOR ADDITIONAL INFORMATION.

TASK APPROACH

1. REQUEST ASD TO CONDUCT ECS DATA RECORDING AND DATA REDUCTION FEASIBILITY STUDY. STUDY OBJECTIVES SHOULD BE TO:
   A. IDENTIFY SPECIFIC ECS DATA WHICH SHOULD BE RECORDED TO SUPPORT THIS ACTIVITY. (MEMORY AND REGISTER ARE PRIME EXAMPLES).
   B. EQUIPMENT DEFINITION AND COST ESTIMATES.
   C. RECOMMEND ACQUISITION APPROACH.
   D. COMPLEXITY OF RETROFITTING SUCH A CAPABILITY TO TASK 2 SYSTEMS/SUBSYSTEMS – LIST HOST AIRCRAFT.
   E. RECOMMEND DATA REDUCTION CAPABILITIES TO SUPPORT ISS/ISF USAGE OF INFORMATION.
2. IN THE INTERIM, INITIATE ACTIONS AT THE SYSTEM/SUBSYSTEM MANAGER LEVEL TO INSTALL CURRENTLY AVAILABLE FLIGHT DATA RECORDING AND DATA REDUCTION EQUIPMENT ABOARD KEY AIRCRAFT.
3. INITIATE ACTIONS TO MODIFY EXISTING ISS/ISF IN RESPONSE TO 2.

LEVEL OF EFFORT

CONTRACTOR: 17 PERSON MONTHS OF EFFORT OVER 9 MONTH PERIOD. THIS DOES NOT INCLUDE FEASIBILITY STUDY REQUESTED FROM ASD. ESTIMATE 24 PERSON MONTHS IN THAT AREA.

AFLC: 6 PERSON MONTHS OF DEDICATED EFFORT. THIS DOES NOT INCLUDE CONTRACT MONITOR RESPONSIBILITIES.

ONCE FEASIBILITY STUDY IS COMPLETED, ESTIMATE 3 PERSON MONTHS EFFORT TO CONVERT THIS INTO DEFINITIVE DEVELOPMENT REQUIREMENTS.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

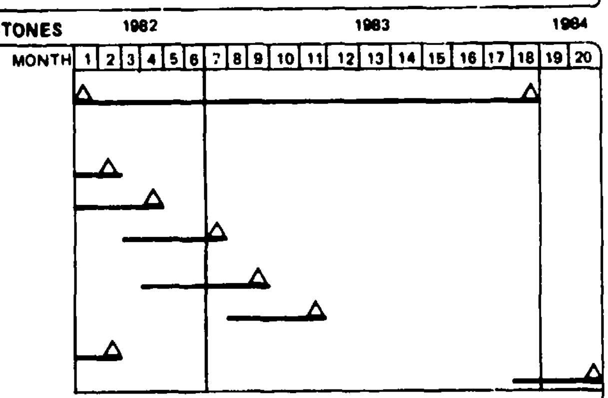
ENGINEER/SYSTEM ANALYSIS WITH MINIMUM OF 7 YEARS OF EXPERIENCE. PERSONNEL SELECTED SHOULD HAVE PREVIOUS REQUIREMENTS AND SYSTEM DESIGN EXPERIENCE WITH DT&E/OT&E BACKGROUND.

TASK INPUTS/INTERFACES

1. TASK 2 LISTING IS A KEY INPUT.
2. FORMAL SUPPORT FROM ASD IS REQUIRED IN AREA OF ECS DATA RECORDING AND DATA REDUCTION ANALYSIS CAPABILITY DEVELOPMENT.
3. AIR FORCE SIMULATOR VALIDATION PROGRAM PRIORITIES GIVEN TO THE VARIOUS SIMULATORS FOR VALIDATION BECOMES VERY IMPORTANT TO THE SUCCESS OF THIS EFFORT.

TASK DELIVERABLES/KEY MILESTONES

1. REQUEST ASD SUPPORT FOR FEASIBILITY STUDY (AFLC)
2. DEFINE DATA RECORDING AND DATA REDUCTION ANALYSIS CAPABILITY ON KEY AIRCRAFT
   - KEY IDENTIFICATION
   - DATA RECORDING REQUIREMENTS DEFINITION
   - DATA REDUCTION ANALYSIS DEFINITION
   - A/C RETROFIT REQUIREMENTS DEFINITION AND SCHEDULE
   - FUNDING PROFILE AND SOURCE (AFLC)
3. SIMULATION VALIDATION INPUTS
4. R&D REQUIREMENTS



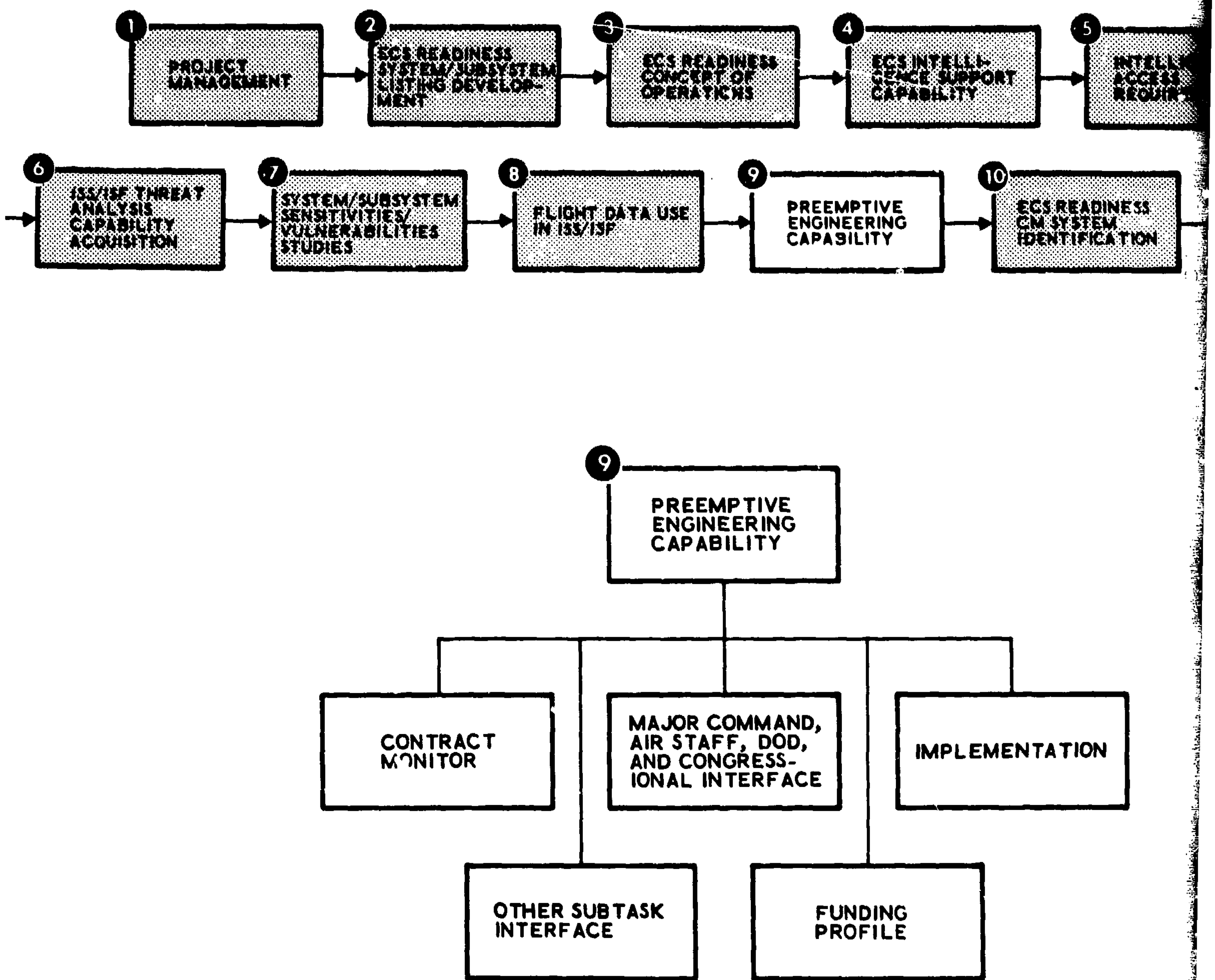
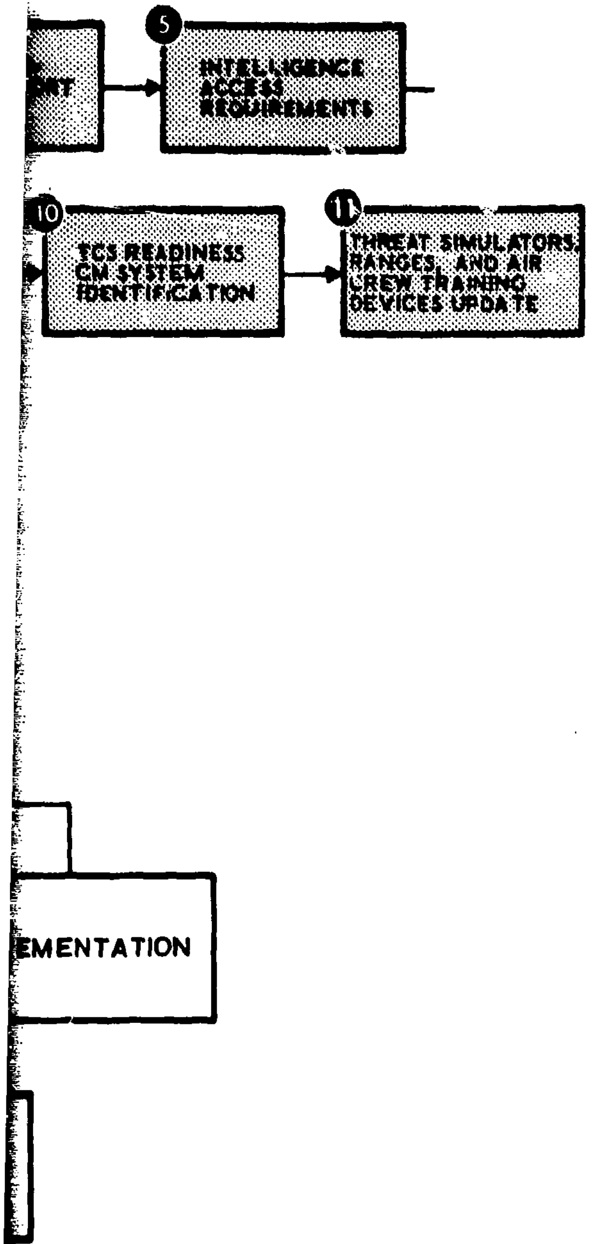


Figure 5-42. ECS Readiness Support: Preemptive



TASK DESCRIPTION ECS READINESS SUPPORT

SUBTASK DESCRIPTION PREEMPTIVE ENGINEERING CAPABILITY (9)

TASK OBJECTIVE(S)

TO DEVELOP AN AIR FORCE APPROVED AND FUNDED ECS READINESS ISS/ISF PREEMPTIVE ENGINEERING CAPABILITY.

MAJOR ISSUES/PROBLEM AREAS

1. AIR FORCE APPROVED PREEMPTIVE ENGINEERING CONCEPT OF OPERATIONS DOES NOT EXIST.
2. UNIQUE FUNDING SOURCES AND JUSTIFICATION WILL BE REQUIRED TO SUPPORT THIS ACTIVITY.
3. THE PREEMPTIVE ENGINEERING APPROACH IS NOT WELL UNDERSTOOD WITHIN DOD OR CONGRESS; THEREFORE, SPECIAL ATTENTION MUST BE GIVEN TO EDUCATION IN THIS AREA.

TASK APPROACH

1. REQUEST HQ USAF/LEYY SUPPORT IN DEVELOPMENT OF AN APPROVED ECS READINESS PREEMPTIVE ENGINEERING CONCEPT OF OPERATIONS. SPECIFIC SUPPORT WILL BE REQUIRED IN AREAS OF:
   A. OBTAINING AIR FORCE APPROVAL OF CONCEPT OF OPERATIONS.
   B. DEVELOPMENT OF FUNDING SOURCES AND THE ASSOCIATED JUSTIFICATION.
   C. IMPLEMENTATION IN AIR FORCE REGULATIONS.
   D. PROVIDING EDUCATIONAL BRIEFINGS AND DISCUSSIONS WITH DOD, JSC, AND CONGRESS.
2. REQUEST WORKING GROUP DEVELOPED UNDER TASK 4 TO ASSIST IN DEFINING SOW FOR AN ECS READINESS PREEMPTIVE ENGINEERING FEASIBILITY STUDY. PURPOSE OF STUDY WOULD BE TO:
   A. DETERMINE SYSTEMS/SUBSYSTEMS/ECS CATEGORIES TO BE INCLUDED UNDER PREEMPTIVE ENGINEERING CONCEPT.
   B. REVIEW AND PROVIDE INPUTS INTO TASK 7 SENSITIVITY STUDIES OBJECTIVES.
   C. DATA GATHERING AND REQUIREMENTS DEFINITION.
   D. DEVELOP A CONCEPT OF OPERATIONS FOR ACCOMPLISHING PREEMPTIVE ENGINEERING FOCUSED AROUND THE AFLC ISS/ISF CONCEPT.
   E. PROVIDE SPECIFIC LISTING OF ISS/ISF STRENGTHS AND WEAKNESSES IN CONDUCTING PREEMPTIVE ENGINEERING AND A ROADMAP FOR UPGRADING THESE ISS/ISF TO ACCOMPLISH THE TASK. COST ESTIMATES SHOULD BE INCLUDED IN THIS SUBTASK.
3. UPON COMPLETION OF THE STUDY, THE CONCEPT OF OPERATIONS SHOULD BE CIRCULATED WITHIN THE AIR FORCE FOR COORDINATION AND APPROVAL.
4. CONCURRENT WITH ITEM 2, AIR STAFF ACTION SHOULD BE INITIATED TO DEVELOP FUNDING PROFILE AND JUSTIFICATIONS.
5. ONCE APPROVED, THE CONCEPT OF OPERATIONS SHOULD BE IMPLEMENTED IN APPROPRIATE AIR FORCE REGULATIONS.

LEVEL OF EFFORT

AIR FORCE: WILL REQUIRE AFLC AND HQ USAF/LEYY SUPPORT FOR APPROXIMATELY 36 MONTHS. AFLC SUPPORT WILL RANGE FROM 1 PERSON FULL TIME TO ONE PERSON HALF TIME OVER THIS PERIOD. HQ USAF/LEYY SHOULD PLAN FOR ONE PERSON TO DEDICATE ¼ OF THIS TIME TO THIS EFFORT FOR THE 36 MONTHS.

CONTRACTOR: ECS READINESS FEASIBILITY STUDY TO INCLUDE THE DEVELOPMENT OF AN ECS READINESS PREEMPTIVE ENGINEERING CONCEPT OF OPERATIONS WILL REQUIRE A MINIMUM OF 48 PERSON MONTHS SPREAD OVER AN 18 MONTH PERIOD.

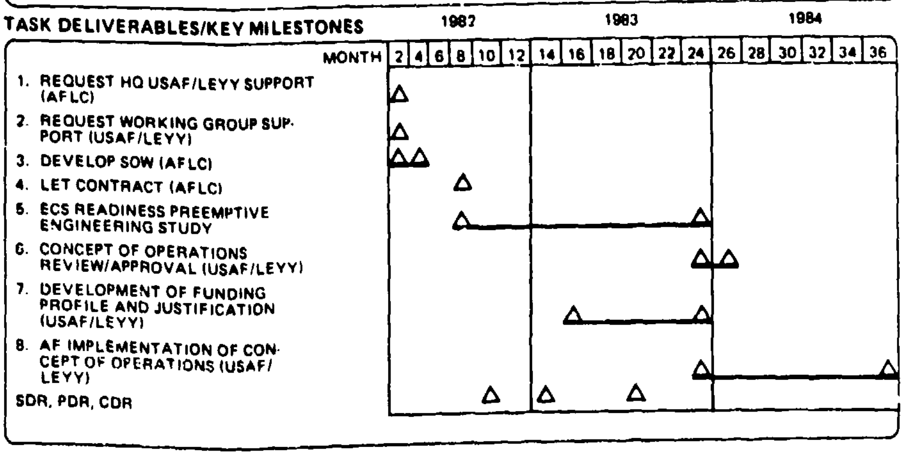
PERFORMER EXPERIENCE LEVEL/BACKGROUND

ENGINEER/SYSTEM ANALYSIS WITH A MINIMUM OF TEN (10) YEARS EXPERIENCE. STRONG BACKGROUND IN SYSTEM REQUIREMENTS ANALYSIS AND SYSTEM DESIGN IS ESSENTIAL.

TASK INPUTS/INTERFACES

1. TASK 7 PROVIDES ESSENTIAL INFORMATION FOR THIS EFFORT.
2. THE RESULTS OF THIS EFFORT WILL IMPACT THE AUTOMATION AND STANDARDIZATION OF ECS SUPPORT PROCESSES, MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITIES, AND ECS SUPPORT NETWORKS INITIATIVES.

TASK DELIVERABLES/KEY MILESTONES



ort: Preemptive Engineering Capability

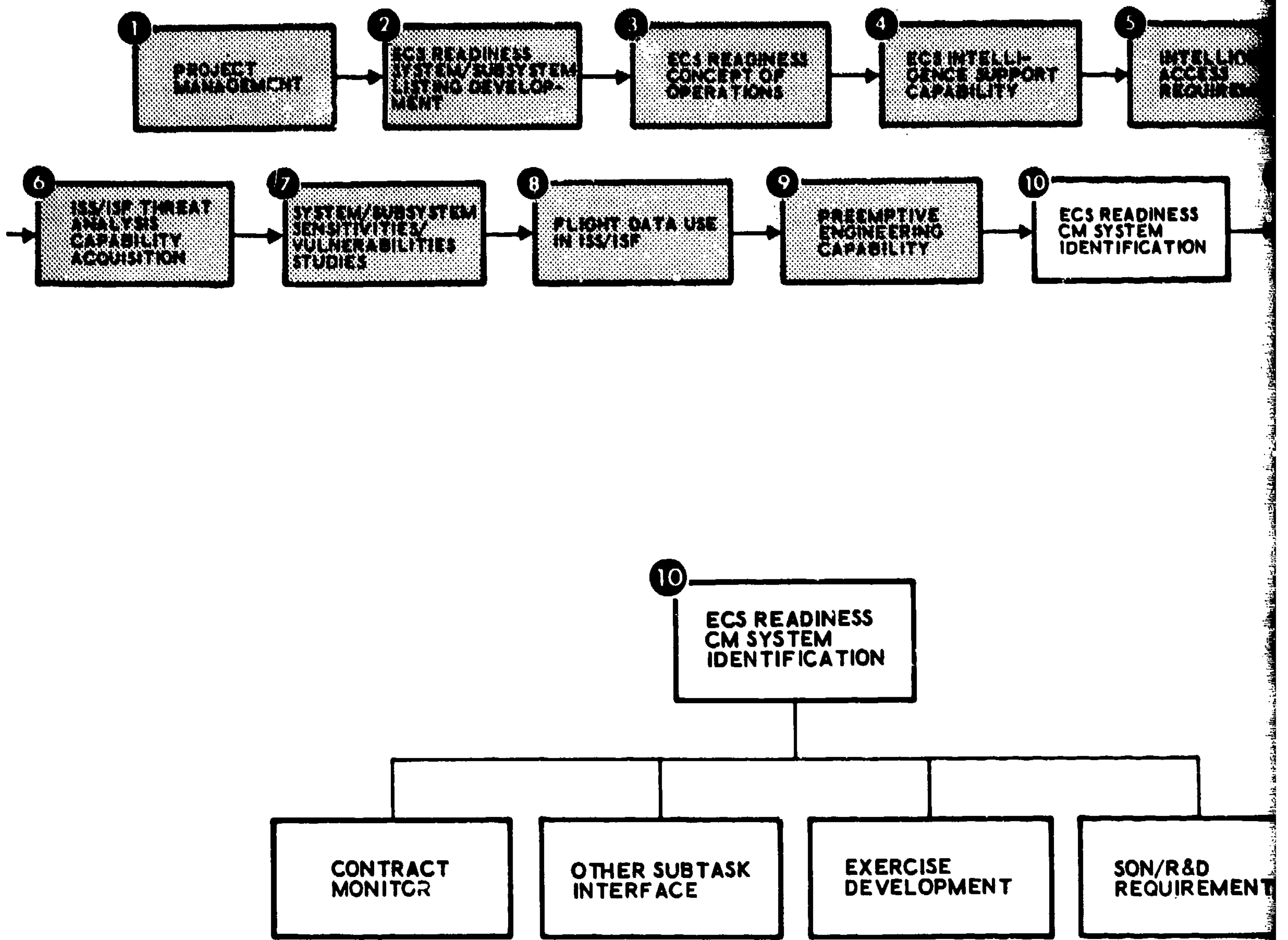
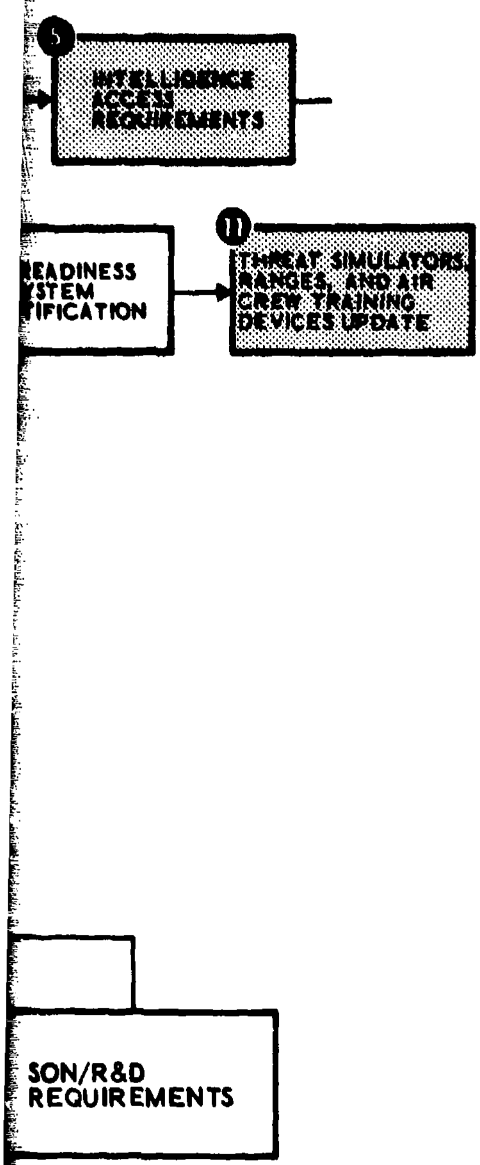


Figure 5-43. ECS Readiness Support: ECS Readi
System Identification



10

TASK DESCRIPTION ECS READINESS SUPPORT

SUBTASK DESCRIPTION ECS READINESS CONFIGURATION MANAGEMENT (CM) SYSTEM IDENTIFICATION

TASK OBJECTIVE(S)

TO OBTAIN AN ECS READINESS CONFIGURATION MANAGEMENT SYSTEM.

MAJOR ISSUES/PROBLEM AREAS

1. RESPONSE/MODIFICATION TIME (TASK 6) IMPOSES UNIQUE CM PROBLEMS.
2. ACTUAL EXERCISES/TRAINING UNDER STRESS CONDITIONS IS ESSENTIAL TO DOCUMENTING/UNDERSTANDING THE CM REQUIREMENTS IN THIS AREA.

TASK APPROACH

1. INITIATE EFFORTS TO CONDUCT A "LOUD BYTE" EXERCISE TO DOCUMENT EW CM CONTROL PROBLEMS.
2. USING THE PROCEDURES DEVELOPED FROM THE "LOUD BYTE" CM CONTROL EXERCISE, DEVELOP AND CONDUCT AN ECS RAPID CHANGE EXERCISE FOR A FIRE CONTROL RADAR OFP. DOCUMENT THE ASSOCIATED CM CONTROL PROBLEMS.
3. USING ITEMS 1 AND 2 RESULTS AS INPUTS, CONDUCT A COMPLETE ECS READINESS CM SYSTEMS REQUIREMENTS ANALYSIS.
4. BASED UPON ITEM 3, DEVELOP TOP LEVEL SPECIFICATIONS FOR AN AFLC ECS READINESS CM SYSTEM.

LEVEL OF EFFORT

AIR FORCE: WILL REQUIRE AFLC PARTICIPATION FOR THE ENTIRE 28 MONTHS. THE FIRST 16 MONTHS WILL REQUIRE ONE MAN ½ TIME. DURING CONTRACT EFFORT, NORMAL CONTRACTOR MONITORING TIME WILL BE REQUIRED BY AFLC.

CONTRACTOR: 24 TO 36 PERSON MONTHS EFFORT OVER 12 MONTHS WILL BE REQUIRED TO DEVELOP TOP LEVEL SPECIFICATIONS.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

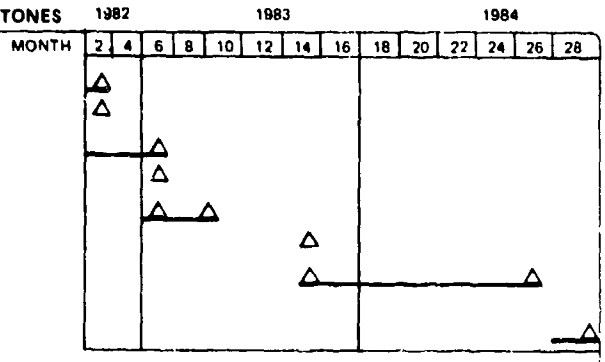
SYSTEM ENGINEER/ANALYSIS WITH PREVIOUS CM AND DATA BASE MANAGEMENT EXPERIENCE. EXPERIENCE LEVEL SHOULD BE ON THE ORDER OF SEVEN TO TEN (7-10) YEARS.

TASK INPUTS/INTERFACES

1. CM LESSONS LEARNED FROM PREVIOUS LOUD BYTE EXERCISES SHOULD BE REVIEWED.
2. THIS EFFORT WILL IMPACT ON THE AUTOMATION AND STANDARDIZATION OF ECS SUPPORT PROCESSES, MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITIES, AND ECS SUPPORT NETWORKS INITIATIVES

TASK DELIVERABLES/KEY MILESTONES

1. PLAN AND CONDUCT EW LOUD BYTE EXERCISE
2. DOCUMENT CM REQUIREMENTS
3. PLAN AND CONDUCT FIRE CONTROL RADAR EXERCISE
4. DOCUMENT CM REQUIREMENTS
5. DRAFT CM SYSTEM SPECIFICATIONS STUDY SOW (AFLC)
6. LET CONTRACT (AFLC)
7. CONDUCT CM SYSTEM SPECIFICATIONS STUDY
8. SUBMIT ITEM 7 RESULTS FOR DEVELOPMENT/PROCUREMENT ACTIONS (AFLC)



: ECS Readiness Configuration Management (CM)

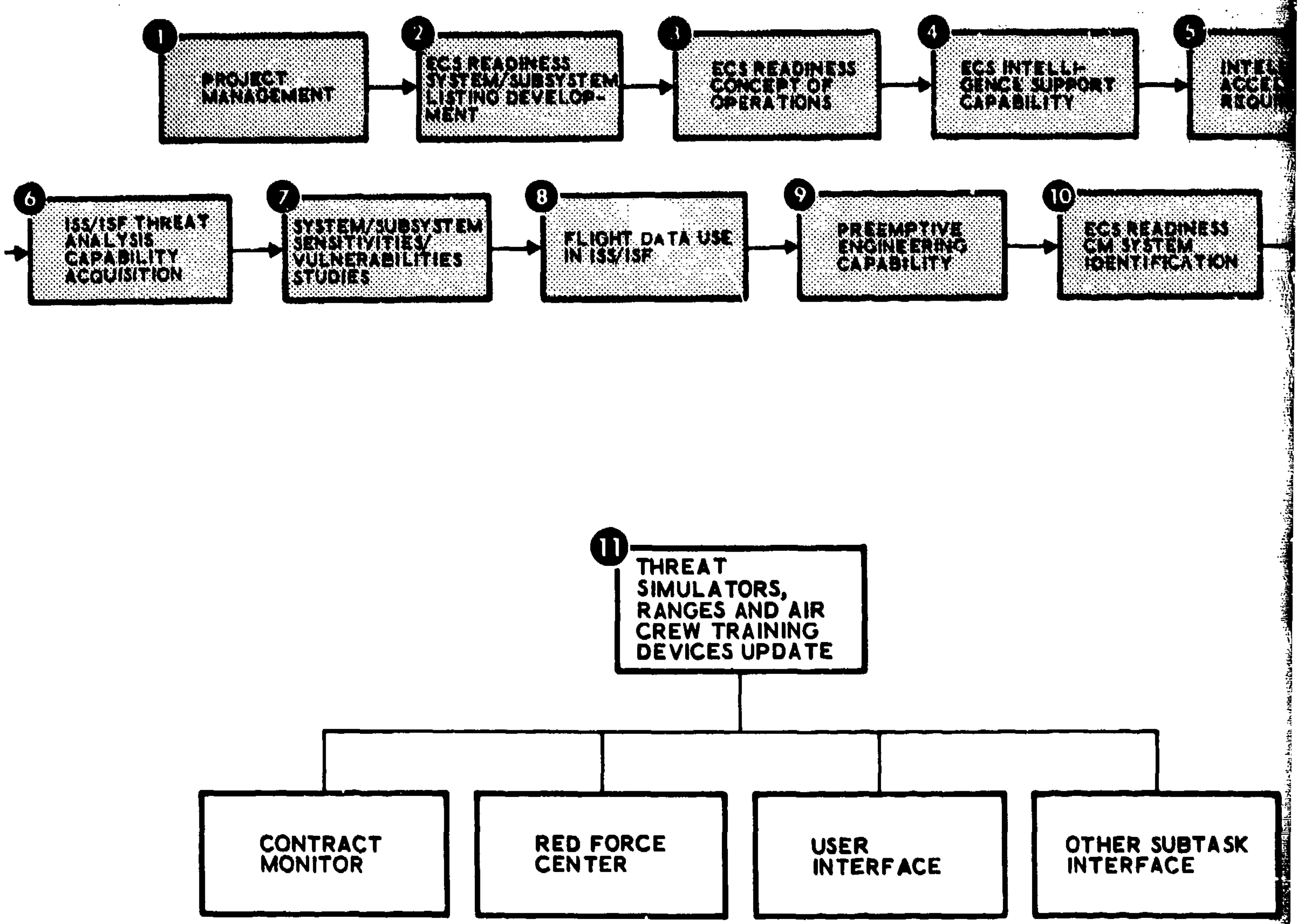
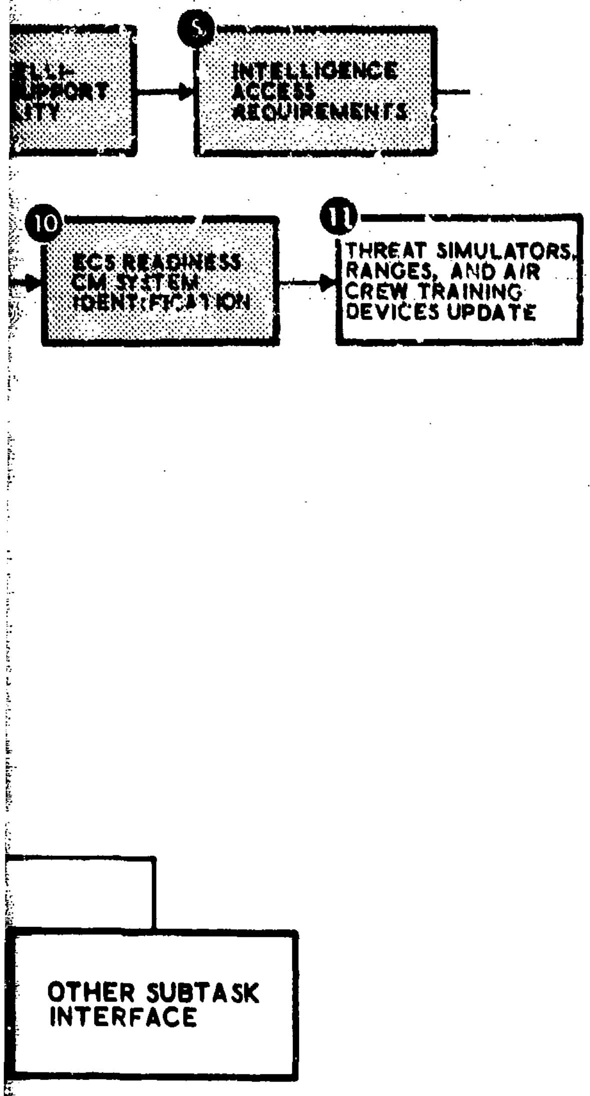


Figure 5-44. ECS Readiness Support: Threat Sim
Devices Update



TASK DESCRIPTION ECS READINESS SUPPORT

SUBTASK DESCRIPTION THREAT SIMULATORS, RANGES, AND AIR CREW TRAINING DEVICES UPDATE

11

TASK OBJECTIVE(S)

OBTAIN THE CAPABILITY AND RESOURCES NECESSARY TO SUPPORT AIRCRAFT TRAINERS, THREAT EMITTERS, TRAINING RANGE SUPPORT SYSTEMS, AND ACTIVE C^3 CM SYSTEMS.

MAJOR ISSUES/PROBLEM AREAS

RAPID ECS UPDATES IN AIRCRAFT SYSTEMS MUST BE MATCHED WITH RESPONSIVE CHANGES IN TRAINING AND EVALUATION SYSTEMS. RESPONSIVE SUPPORT OF C^3 CM DEVICES IMPACTS BOTH TRAINING AND OPERATIONAL REQUIREMENTS.

TASK APPROACH

1. DETERMINE OPERATIONAL USER UPDATE REQUIREMENTS.
2. CONSOLIDATE USER NEEDS, DEVELOP CONCEPT OPERATIONAL, AND SUPPORT SYSTEMS SPECIFICATIONS, TO INCLUDE REQUIREMENTS FOR INTELLIGENCE SUPPORT.
3. DEVELOP PLANNING AND IMPLEMENTATION DOCUMENTS AND ACQUIRE NECESSARY SUPPORT SYSTEMS.
4. MONITOR INTELLIGENCE DATA FOR IMPACTS ON TRAINING AND C^3 COUNTER MEASURE SYSTEMS AND WHERE WARRANTED INITIATES PREEMPTIVE ENGINEERING PROJECTS.
5. ESTABLISH BOTH HARDWARE AND SOFTWARE QUICK REACTION CAPABILITIES.

LEVEL OF EFFORT

THE LEVEL OF EFFORT, APPROXIMATELY 15 PERSON YEARS, WILL BE DRIVEN BY OPERATIONAL REQUIREMENTS AND CHANGES IN INTELLIGENCE BASELINES; HOWEVER, A DEDICATED CORPS OF PEOPLE SHOULD BE IDENTIFIED TO MONITOR THREAT DATA AND INITIATE ENGINEERING PROJECTS.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

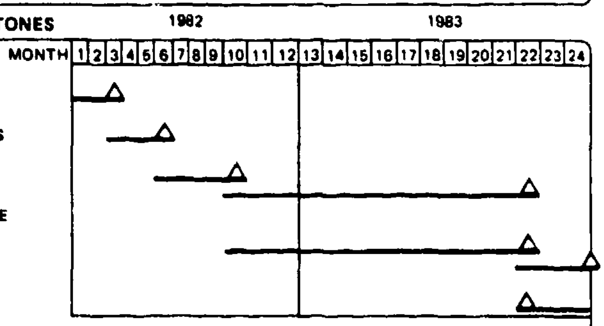
ENGINEERS, ANALYSTS, TECHNICIANS, FAMILIAR WITH ELECTRONIC WARFARE SYSTEMS PLUS A CORE OF PEOPLE KNOWLEDGEABLE WITH ENEMY THREAT SYSTEMS.

TASK INPUTS/INTERFACES

INPUTS FOR USING COMMANDS AND SUPPORT FROM INTELLIGENCE COMMUNITY IS ESSENTIAL.

TASK DELIVERABLES/KEY MILESTONES

1. OPERATIONAL USER REQUIREMENTS
2. CONCEPT OF OPERATIONAL AND SUPPORT SYSTEM SPECIFICATIONS
3. ACQUIRE SUPPORT SYSTEMS
   - INTERIM
   - ADVANCED
4. OPERATIONAL AND MAINTENANCE OF SYSTEM
   - INTERIM
   - ADVANCED
5. QUICK REACTION CAPABILITY (QRC)



pport: Threat Simulators, Ranges, and Air Crew Training

12

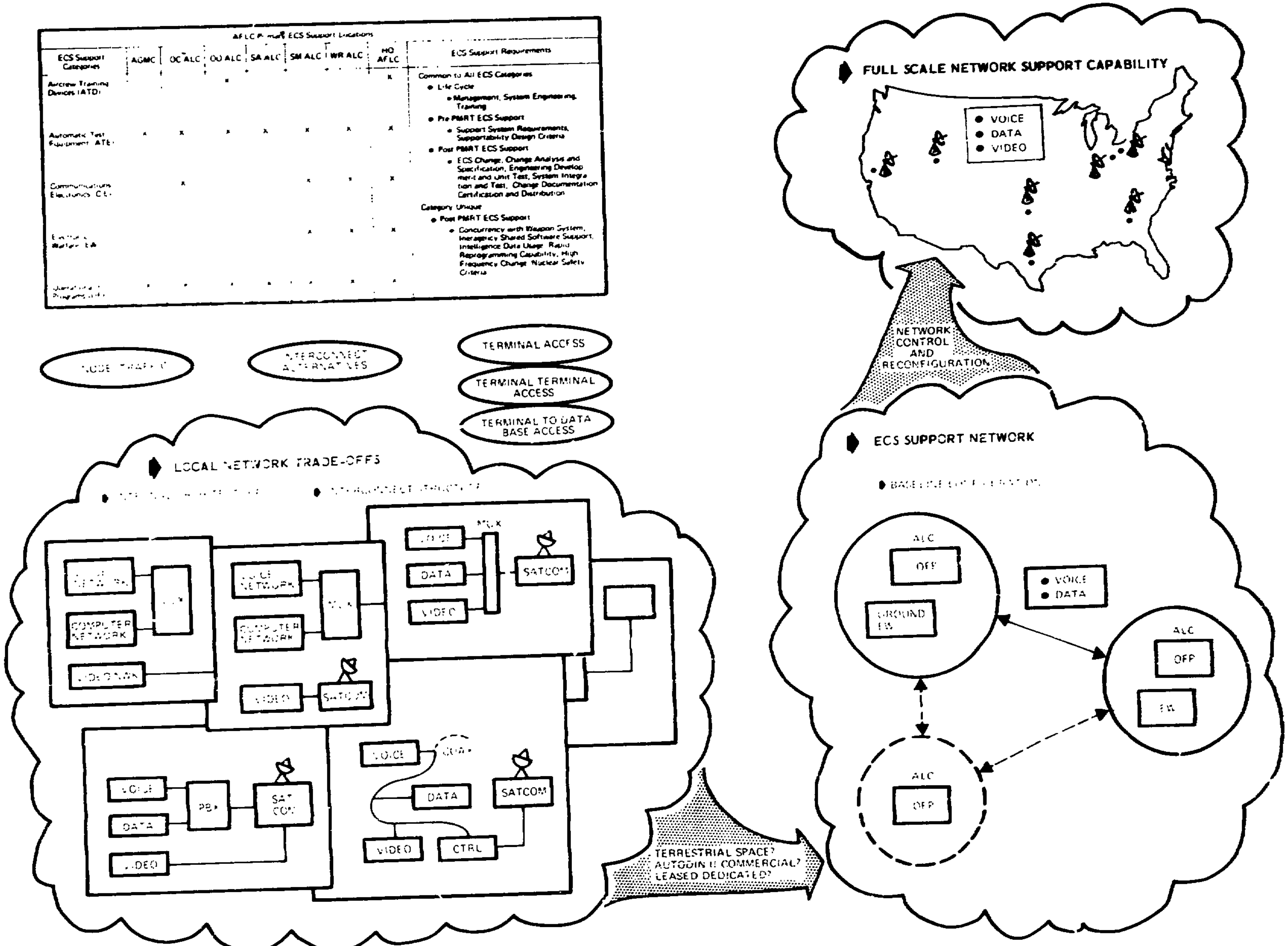


Figure 5-45. ECS Support Network Conceptual Evolution

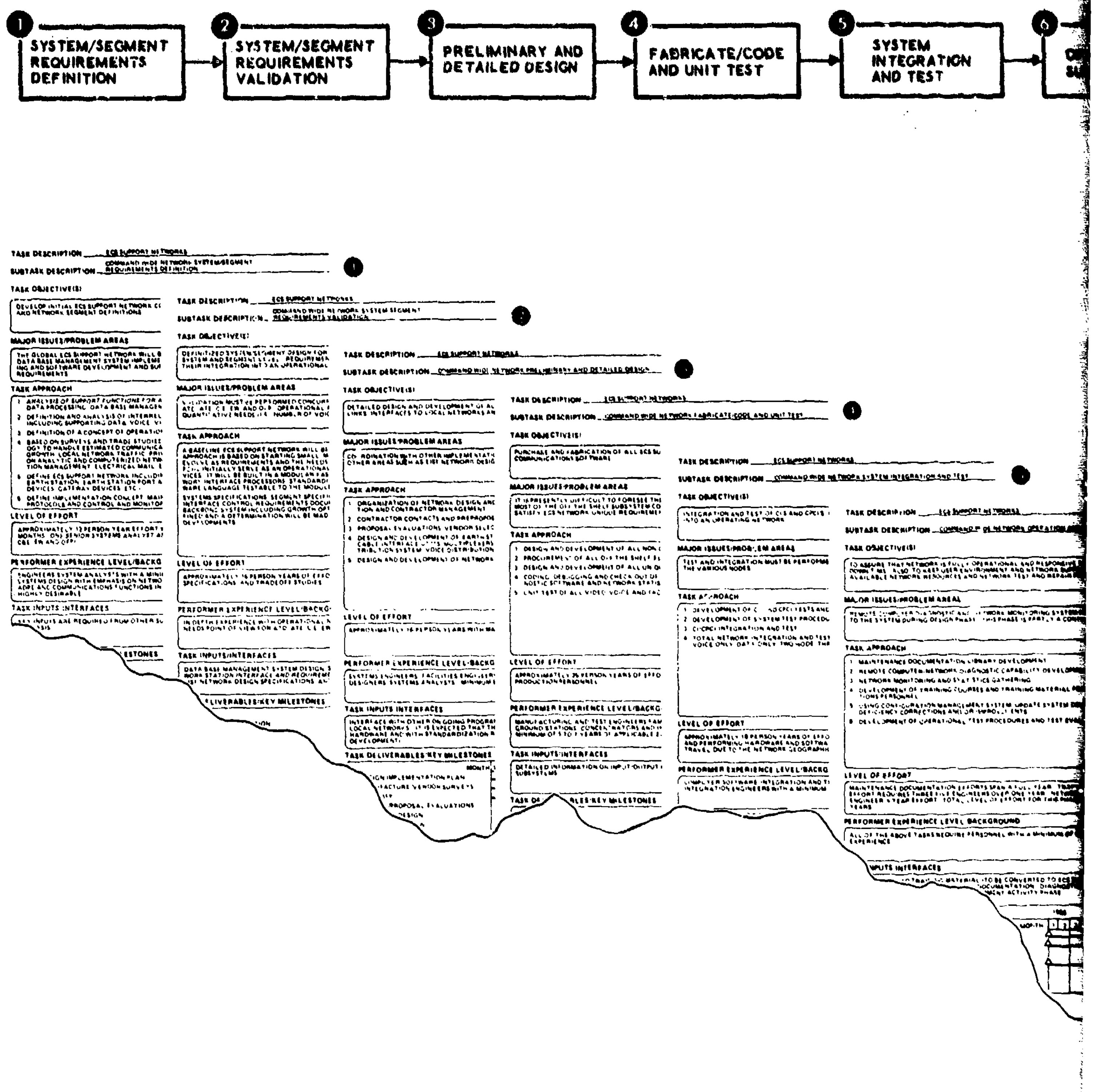


Figure 5-46. ECS Support Networks: Command-Wide Overview and Summary Task Sheet

SYSTEM INTEGRATION AND TEST → ⑥ OPERATION AND SUPPORT

TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION COMMAND-WIDE NETWORK SUMMARY TASK SHEET ⓪

TASK OBJECTIVE(S)

DEVELOPMENT OF A COMMAND-WIDE ECS SUPPORT NETWORK FOR INFORMATION EXCHANGE BETWEEN VARIOUS AFLC ECS SUPPORT LOCATIONS. THE NETWORK WILL SUPPORT DATA, VOICE, VIDEO, AND FACSIMILE TRANSMISSION. OVERALL TASK INCLUDES DEVELOPMENT OF EISF/LOCAL ECS SUPPORT NETWORKS AND A DATA BASE MACHINE.

MAJOR ISSUES/PROBLEM AREAS

NETWORK WILL BE DESIGNED AND IMPLEMENTED BY SEVERAL ORGANIZATIONS, REQUIRING CLOSE COORDINATION. NETWORK MUST HANDLE MULTI-LEVEL SECURITY INFORMATION.

TASK APPROACH

1. CONCEPTS DEFINITION WITH NETWORK STRUCTURE AND CONCEPT OF OPERATION.
2. BASELINE SYSTEM DEVELOPMENT WITH SYSTEM AND SEGMENT SPECIFICATIONS.
3. DETAILED DESIGN OF EQUIPMENT, INTERFACES, SOFTWARE AND FACILITIES.
4. SYSTEM INTEGRATION AND TEST (TOTAL NETWORK).
5. SYSTEM OPERATION AND SUPPORT INCLUDING NETWORK MONITORING AND MAINTENANCE, OPERATOR TRAINING AND DEVELOPMENT AND MAINTENANCE OF NETWORK LIBRARY FUNCTION.

LEVEL OF EFFORT

APPROXIMATELY A SIX YEAR EFFORT WHERE LAST SIX MONTHS ARE MAINLY OPERATIONAL SUPPORT. TOTAL NETWORK DEVELOPMENT IS APPROXIMATELY 100 PERSON YEARS DEPENDING ON MAGNITUDE OF NEW DESIGN. DEVELOPMENT OF EISF/LOCAL NETWORKS REQUIRES AN ADDITIONAL 100 PERSON YEARS. DATA BASE MACHINE DEVELOPMENT ESTIMATED AT 12 PERSON YEARS FOR AN OVERALL LEVEL OF EFFORT OF 212 PERSON YEARS.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

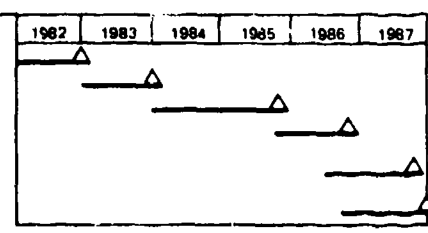
FULL SYSTEM DESIGN, INTEGRATION, TEST AND OPS SUPPORT CAPABILITY INVOLVING MECHANICAL, ELECTRICAL, ELECTRONICS, FACILITIES/ENVIRONMENTAL, HUMAN FACTORS AND MANUFACTURING ENGINEERS PLUS "TOTAL" SOFTWARE CAPABILITY.

TASK INPUTS/INTERFACES

HEAVY RELIANCE ON INPUTS FROM THE FIVE ECS SUPPORT CATEGORIES AND THE EISF LOCAL NETWORK DEVELOPMENT EFFORT.

TASK DELIVERABLES/KEY MILESTONES

1. REQUIREMENTS DEFINITION (SRR)
2. REQUIREMENTS VALIDATION (SDR)
3. NETWORK DESIGN (PDR, CDR)
4. FABRICATION, INTEGRATION, UNIT TEST
5. NETWORK INTEGRATION AND TEST (FCA, PCA, FQR)
6. OPERATIONAL AND SUPPORT (DEMONSTRATION)



SYSTEM INTEGRATION AND TEST ●

DESCRIPTION ECS SUPPORT NETWORKS

DESCRIPTION COMMAND-WIDE NETWORK OPERATION AND SUPPORT ⑥

OBJECTIVE(S)

ISSUES/PROBLEM AREAS

APPROACH

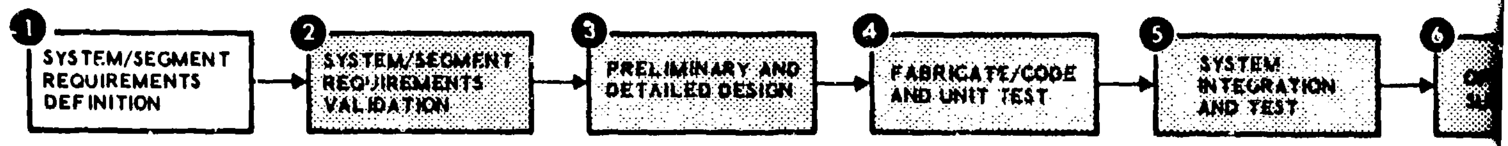
OF EFFORT

PERFORMER EXPERIENCE LEVEL BACKGROUND

INPUTS/INTERFACES

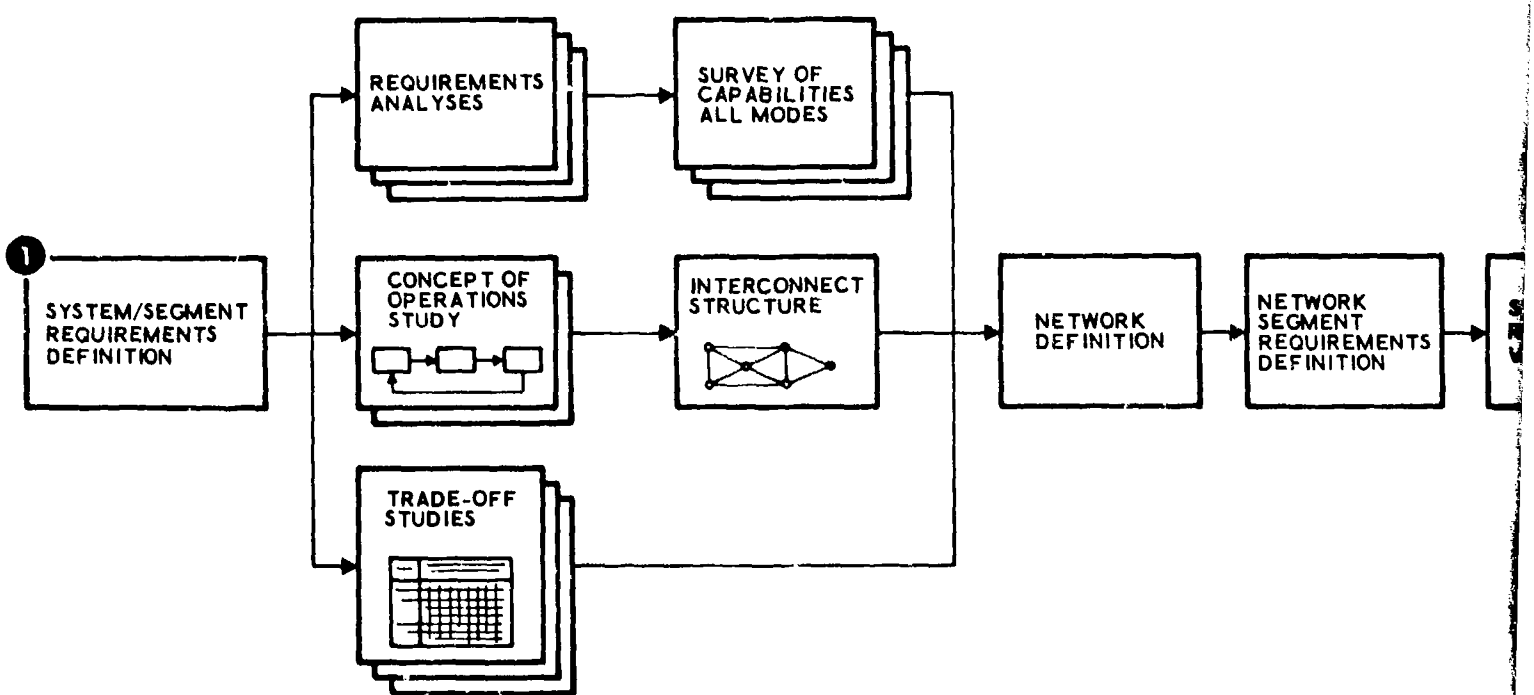
: Command-Wide Network
y Task Sheet

1 2



INPUT FROM RELATED ACTIVITIES

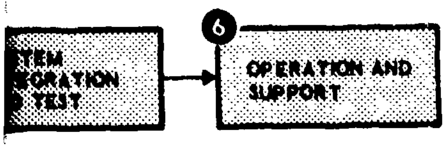
MANAGEMENT, ENGINEERING, ACQUISITION, AND SUPPORT PRACTICES	AUTOMATION AND STANDARDIZATION OF ECS SUPPORT PROCESSES	MODULAR EXTENDABLE INTEGRATION SUPPORT FACILITIES	ECS READINESS SUPPORT
• MANAGEMENT, DIRECTION	• MANAGEMENT TOOLS	• ARCHITECTURE	• INTELLIGENCE
• PLANNING	• SUPPORT TOOLS	• SECURITY	• SECURITY
• POLICY	• PROJECT TOOLS	• DATA BASE	• DATA BASE
• GUIDANCE	• PROCEDURES	• SIMULATION	• PRIORITIES
• BUDGET	• DATA BASE	• COMMUNICATION	• THREATS
• RESOURCES	• INTERFACE	• LOCAL NETWORK	• TRAINING

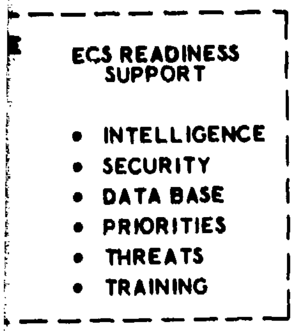


PRODUCTS

- TRADE-OFF STUDIES
- ANALYSES REPORTS
- SURVEY REPORT
- CONCEPT OF OPERATIONS STUDY
- NETWORK AND NETWORK SEGMENTS REQUIREMENTS DEFINITION REPORT

Figure 5-47. ECS Support Networks: Requirements Definition





TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION COMMAND-WIDE NETWORK SYSTEM/SEGMENT REQUIREMENTS DEFINITION

1

TASK OBJECTIVE(S)

DEVELOP INITIAL ECS SUPPORT NETWORK CONCEPT AN' ·UNCTIONAL BASELINE INCLUDING NETWORK AND NETWORK SEGMENT DEFINITIONS.

MAJOR ISSUES/PROBLEM AREAS

THE COMMAND-WIDE ECS SUPPORT NETWORK WILL BE DEVELOPED CONCURRENTLY WITH EISF LOCAL NETWORKS, DATA BASE MANAGEMENT SYSTEM IMPLEMENTATION, INTEGRATION OF WORK STATION MODULES, TRAINING AND SOFTWARE DEVELOPMENT AND SUPPORT TOOLS, EACH IMPACTING TOTAL NETWORK DESIGN REQUIREMENTS.

TASK APPROACH

1. ANALYSIS OF SUPPORT FUNCTIONS FOR ATD, ATE C-E, EW AND OFP ON PER-NODE BASIS INCLUDING DATA PROCESSING, DATA BASE MANAGEMENT AND COMMUNICATIONS.
2. DEFINITION AND ANALYSIS OF INTERRELATIONSHIPS BETWEEN THE ABOVE SUPPORT FUNCTIONS INCLUDING SUPPORTING DATA, VOICE, VIDEO AND FACSIMILE COMMUNICATIONS (FUNCTIONAL FLOW).
3. DEFINITION OF A CONCEPT OF OPERATION FOR NETWORK (INITIAL SYSTEM CONCEPT).
4. BASED ON SURVEYS AND TRADE STUDIES DEFINE INTERCONNECT STRUCTURE AND NETWORK TOPOLOGY TO HANDLE ESTIMATED COMMUNICATIONS NEEDS (I.E., DATA RATES, RESPONSE TIMES, PHASED GROWTH, LOCAL NETWORK TRAFFIC, PRIVACY, PRECEDENCE HANDLING, ETC.) THE LATTER IS BASED ON ANALYTIC AND COMPUTERIZED NETWORK SIMULATIONS OF DOCUMENTATION SYSTEM, CONFIGURATION MANAGEMENT, ELECTRICAL MAIL, ELECTRONICS, AND OTHER TRAFFIC REQUIREMENTS
5. DEFINE ECS SUPPORT NETWORK INCLUDING NETWORK SEGMENTS (I.E., NETWORK CONTROL CENTER, EARTH STATION, EARTH STATION PORT ADAPTER SYSTEM, SYSTEM TEST FACILITY, HOST INTERFACE DEVICES, GATEWAY DEVICES, ETC.).
6. DEFINE IMPLEMENTATION CONCEPT, MAINTENANCE AND RECOVERY PROCEDURES, ARCHITECTURE, PROTOCOLS AND CONTROL AND MONITORING PROCEDURES.

LEVEL OF EFFORT

APPROXIMATELY 12 PERSON YEAR EFFORT WITH MOST OF LOADING CONCENTRATED ON INITIAL 4 TO 5 MONTHS. ONE SENIOR SYSTEMS ANALYST ASSIGNED TO EACH ECS SUPPORT CATEGORY (I.E., ATD, ATE, C&E, EW AND OFP).

PERFORMER EXPERIENCE LEVEL/BACKGROUND

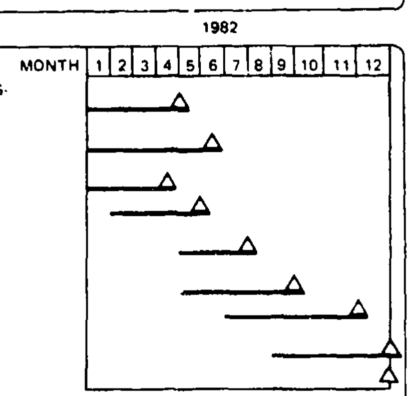
ENGINEERS/SYSTEM ANALYSTS WITH A MINIMUM OF SEVEN (7) YEARS OF EXPERIENCE IN LARGE SCALE SYSTEMS DESIGN WITH EMPHASIS ON NETWORKING AND COMMUNICATIONS, A FIRM UNDERSTANDING OF ADPE AND COMMUNICATIONS FUNCTIONS IN ATD, ATE, C-E, EW AND OFP DEVELOPMENT AND TEST IS HIGHLY DESIRABLE.

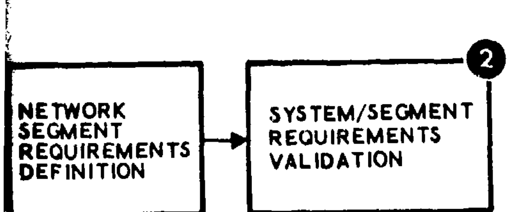
TASK INPUTS/INTERFACES

KEY INPUTS ARE REQUIRED FROM OTHER SUBTASKS SUCH AS DATA BASE MANAGEMENT SYSTEM TRAFFIC ANALYSIS.

TASK DELIVERABLES/KEY MILESTONES

1. TRADEOFF STUDY, TERRESTRIAL AND SATELLITE, LONG-HAUL NETWORK ALTERNATIVES (GOV'T & COMM'L)
2. SURVEY, EXISTING AND PLANNED COMMUNICATIONS FACILITIES AT ALL PERTINENT NODES
3. NODE COMMUNICATION SUPPORT FUNCTION REQUIREMENTS ANALYSIS (ALL NODES)
4. SUPPORT FUNCTION INTERRELATIONSHIP DEFINITION
5. OPERATIONAL SCENARIOS, CONCEPT OF OPERATIONS, ECS SUPPORT NETWORK
6. DEFINITION OF INTERCONNECT STRUCTURE AND NETWORK TOPOLOGY
7. ECS SUPPORT NETWORK DEFINITION
8. ECS SUPPORT NETWORK SEGMENT REQUIREMENTS DEFINITION
9. SYSTEM REQUIREMENTS REVIEW (SRR)

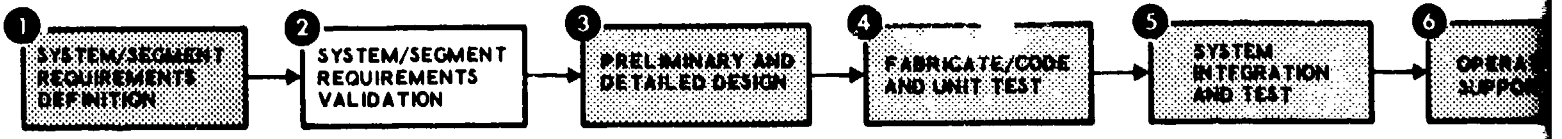


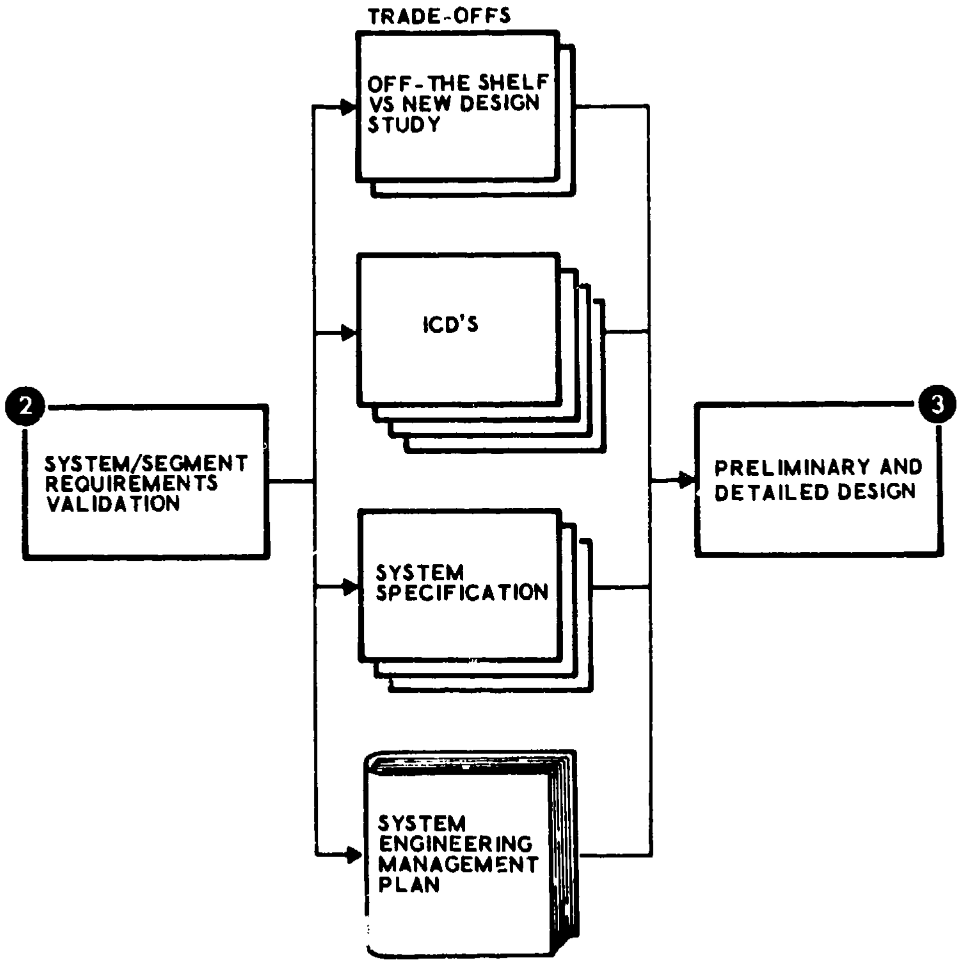


REMENTS

pport Networks: Command-Wide Network System/Segment
ments Definition

1 2

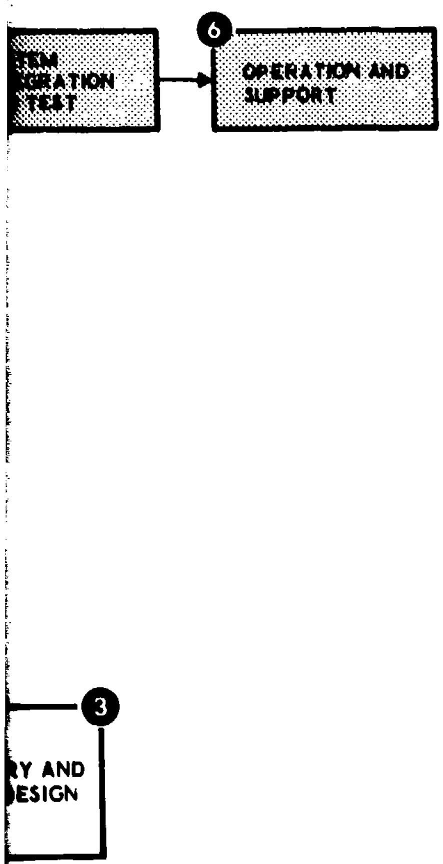




PRODUCTS

- BUILD OR BUY TRADE-OFF
- SPECIFICATIONS
- INTERFACE CONTROL DOCUMENTS (ICD)
- SYSTEM ENGINEERING MANAGEMENT PLAN

Figure 5-48. ECS Support Networks: Comm
Requirements Validation



TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION COMMAND-WIDE NETWORK SYSTEM/SEGMENT REQUIREMENTS VALIDATION

2

TASK OBJECTIVE(S)

DEFINITIZED SYSTEM/SEGMENT DESIGN FOR ECS SUPPORT NETWORK INCLUDING SPECIFICATIONS AT BOTH SYSTEM AND SEGMENT LEVEL. REQUIREMENTS VALIDATION OF THE VARIOUS NETWORK ELEMENTS AND THEIR INTEGRATION INTO AN OPERATIONAL SYSTEM

MAJOR ISSUES/PROBLEM AREAS

VALIDATION MUST BE PERFORMED CONCURRENTLY FOR ALL FIVE ECS CATEGORIES/USER COMMUNITIES ATD, ATE, C-E, EW, AND OFP. OPERATIONAL ASPECTS MUST BE UNDERSTOOD IN ORDER TO VALIDATE QUANTITATIVE NEEDS (I.E., NUMBER OF VOICE LINKS, VIDEO CHANNELS, DATA LINKS, ETC.).

TASK APPROACH

A BASELINE ECS SUPPORT NETWORK WILL BE DEVELOPED WHICH CAN READILY BE EXPANDED. THE APPROACH IS BASED ON STARTING SMALL, MEET THE KNOWN VALIDATED REQUIREMENTS, AND GROW/EVOLVE AS REQUIREMENTS AND THE NEEDS FOR SERVICE INCREASE. THE BASELINE SYSTEM WILL THEREFORE INITIALLY SERVE AS AN OPERATIONAL TESTBED FOR INTERFACING OTHER NETWORKS AND DEVICES. IT WILL BE BUILT IN A MODULAR FASHION USING STANDARD BUILDING BLOCKS SUCH AS EISF NETWORK INTERFACE PROCESSORS, STANDARDIZED INTERFACES AND PROTOCOLS, AND STANDARD SOFTWARE LANGUAGE TESTABLE TO THE MODULE LEVEL.

SYSTEMS SPECIFICATIONS, SEGMENT SPECIFICATIONS, CI AND CPCI DEVELOPMENT SPECIFICATIONS, AND INTERFACE CONTROL REQUIREMENTS DOCUMENTS WILL BE DEVELOPED WHICH DESCRIBE THE INITIAL BACKBONE SYSTEM INCLUDING GROWTH OPTIONS. SEGMENT PERFORMANCE ALLOCATIONS WILL BE DEFINED AND A DETERMINATION WILL BE MADE OF USE OF OFF-THE-SHELF SYSTEMS VERSUS NEW DEVELOPMENTS

LEVEL OF EFFORT

APPROXIMATELY 16 PERSON YEARS OF EFFORT WITH SEPARATE TEAM EFFORTS FOR REQUIREMENTS, SPECIFICATIONS, AND TRADEOFF STUDIES

PERFORMER EXPERIENCE LEVEL/BACKGROUND

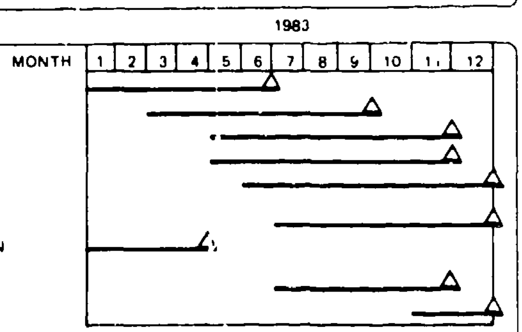
IN-DEPTH EXPERIENCE WITH OPERATIONAL NEEDS AND GROWTH REQUIREMENTS FROM INFORMATION NEEDS POINT OF VIEW FOR ATD, ATE, C-E, EW AND OFP.

TASK INPUTS/INTERFACES

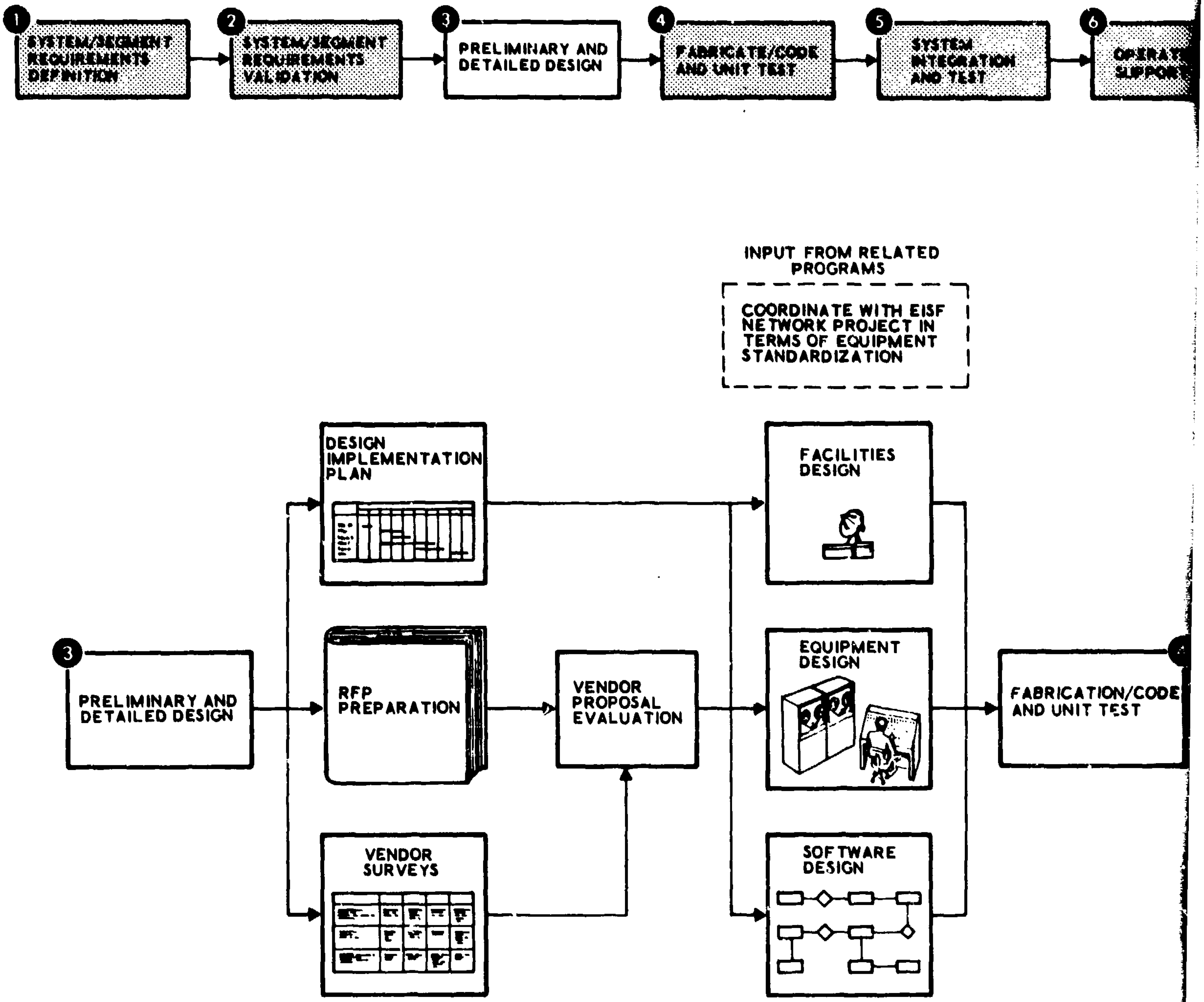
DATA BASE MANAGEMENT SYSTEM DESIGN, SOFTWARE TOOLS DEVELOPMENT SYSTEM SPECIFICATIONS WORK STATION INTERFACE AND REQUIREMENTS SPECIFICATIONS, DATA BASE MACHINE SPECIFICATIONS, EISF NETWORK DESIGN SPECIFICATIONS, AND FACILITY SECURITY REQUIREMENTS

TASK DELIVERABLES/KEY MILESTONES

1. SYSTEM SPECIFICATION
2. SEGMENT SPECIFICATIONS
3. CI DEVELOPMENT SPECIFICATIONS
4. CPCI DEVELOPMENT SPECIFICATIONS
5. EQUIPMENT REQUIREMENTS
6. INTERFACE CONTROL REQUIREMENTS DOCUMENTATION
7. SYSTEM ENGINEERING MANAGEMENT PLAN
8. OFF-THE-SHELF VERSUS NEW DEVELOPMENT ASSESSMENT
9. SYSTEM DESIGN REVIEW (SDR)



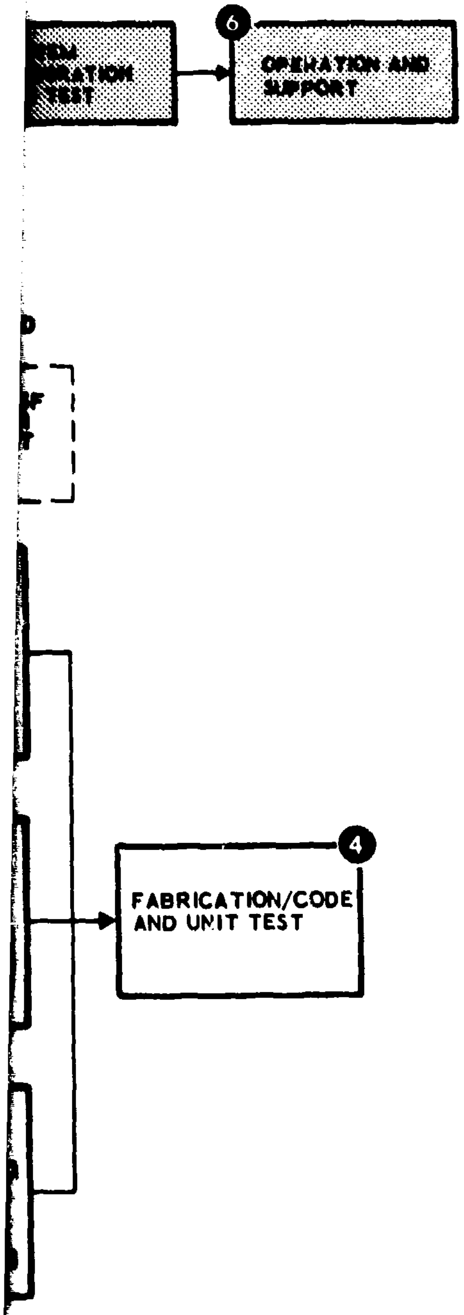
t Networks: Command-Wide Network System/Segment
ts Validation



PRODUCTS

- DESIGN IMPLEMENTATION PLAN
- RFP PACKAGE
- VENDOR SURVEY REPORT
- DESIGN DOCUMENTS
  - FACILITIES
  - EQUIPMENT
  - SOFTWARE

Figure 5-49. ECS Support Networks: Command-Wide N
Detailed Design



TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION COMMAND-WIDE NETWORK PRELIMINARY AND DETAILED DESIGN

3

TASK OBJECTIVE(S)

DETAILED DESIGN AND DEVELOPMENT OF ALL NETWORK ELEMENTS SUCH AS SATELLITE AND GROUND LINKS, INTERFACES TO LOCAL NETWORKS AND NETWORK CONTROL FACILITY

MAJOR ISSUES/PROBLEM AREAS

COORDINATION WITH OTHER IMPLEMENTATION ACTIVITIES TO AVOID DELAYS DUE TO PROBLEMS IN OTHER AREAS SUCH AS EISF NETWORK DESIGN AND DATA BASE MACHINE DEVELOPMENT

TASK APPROACH

1. ORGANIZATION OF NETWORK DESIGN AND IMPLEMENTATION SUPPORT TEAM FOR PROPOSAL EVALUATION AND CONTRACTOR MANAGEMENT.
2. CONTRACTOR CONTACTS AND PREPROPOSAL SUPPORT
3. PROPOSAL EVALUATIONS, VENDOR SELECTIONS AND CONTRACT AWARDS.
4. DESIGN AND DEVELOPMENT OF EARTH STATIONS, CONTROLLERS AND INTERFACE DEVICES, CABLES, CABLE INTERFACE UNITS, MULTIPLEXERS, MODEMS, SWITCHES, FRONT-END PROCESSORS, VIDEO DISTRIBUTION SYSTEM, VOICE DISTRIBUTION SYSTEM AND OTHER NETWORK ELEMENTS
5. DESIGN AND DEVELOPMENT OF NETWORK CONTROL AND MONITORING SYSTEM

LEVEL OF EFFORT

APPROXIMATELY 16 PERSON YEARS WITH MAJOR EMPHASIS ON NETWORK DESIGN EXPERIENCE

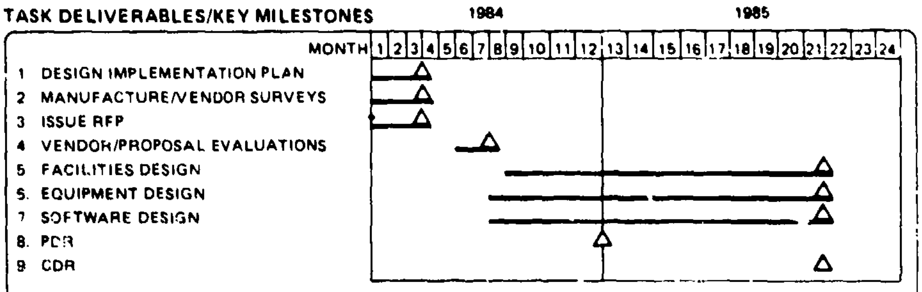
PERFORMER EXPERIENCE LEVEL/BACKGROUND

SYSTEMS ENGINEERS, FACILITIES ENGINEERS, NETWORK (COMMUNICATIONS) ENGINEERS, SOFTWARE DESIGNERS, SYSTEMS ANALYSTS. MINIMUM EXPERIENCE 7 10 YEARS IN RELATED SYSTEM DESIGN

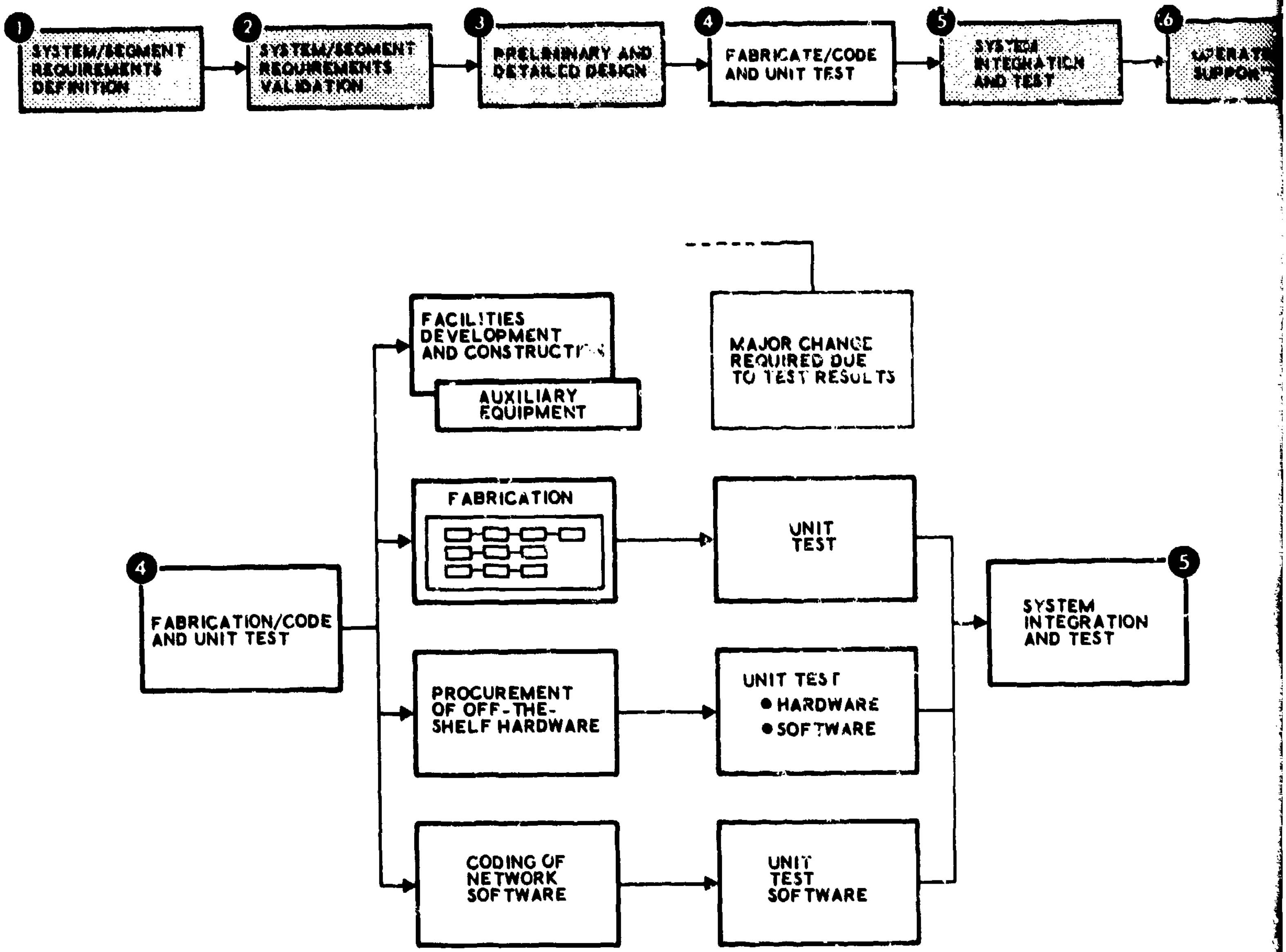
TASK INPUTS/INTERFACES

INTERFACE WITH OTHER ON-GOING PROGRAMMATIC IMPLEMENTATION ACTIVITIES, IN PARTICULAR EISF LOCAL NETWORKS. IT IS EXPECTED THAT THE MAJORITY OF EQUIPMENT CONSISTS OF OFF THE-SHELF HARDWARE AND WITH STANDARDIZATION RULES TO BE APPLIED ACROSS THE BOARD (I.E., EISF NETWORK DEVELOPMENT).

TASK DELIVERABLES/KEY MILESTONES



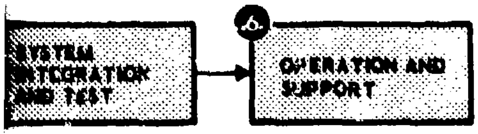
...s: Command-Wide Network Preliminary and



PRODUCTS

- FACILITIES TO HOUSE ALL ECS SUPPORT NETWORK ELEMENTS
- FABRICATED BOARDS, RACKS, STANDS, ENCLOSURES, CONSOLES AND OTHER SUBSYSTEMS
- PROCURED OFF-THE-SHELF EQUIPMENT (SATELLITES, GROUND STATIONS INCLUDING ANTENNAE, MODEMS, MULTIPLEXORS, ETC.)
- CODED SOFTWARE INCLUDING LISTINGS
- TEST REPORTS ON UNIT TESTS (HARDWARE, SOFTWARE)
- AUXILIARY EQUIPMENT INCLUDING CABLING, ETC.)

Figure 5-50. ECS Support Networks: Comman



TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION COMMAND-WIDE NETWORK FABRICATE/CODE AND UNIT TEST

4

TASK OBJECTIVE(S)

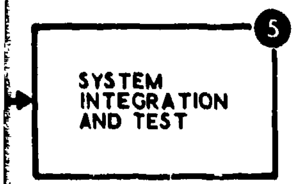
PURCHASE AND FABRICATION OF ALL ECS SUPPORT NETWORK ELEMENTS AND CODING OF ALL NETWORK/COMMUNICATIONS SOFTWARE

MAJOR ISSUES/PROBLEM AREAS

IT IS PRESENTLY DIFFICULT TO FORESEE THE MAGNITUDE AND TIME-SCALE OF THIS TASK AS SOME OR MOST OF THE OFF-THE-SHELF SUBSYSTEM COMPONENTS MAY HAVE TO BE MODIFIED OR REDESIGNED TO SATISFY ECS NETWORK UNIQUE REQUIREMENTS.

TASK APPROACH

1. DESIGN AND DEVELOPMENT OF ALL NON-OFF-THE-SHELF COMPONENTS OF THE NETWORK.
2. PROCUREMENT OF ALL OFF-THE-SHELF ELEMENT.
3. DESIGN AND DEVELOPMENT OF ALL UNIQUE INTERFACES.
4. CODING, DEBUGGING AND CHECK-OUT OF ALL NETWORK PROCESSOR SOFTWARE, NETWORK DIAGNOSTIC SOFTWARE AND NETWORK STATISTICS AND DATA COLLECTION SOFTWARE.
5. UNIT TEST OF ALL VIDEO, VOICE AND FACSIMILE SUBSYSTEMS



LEVEL OF EFFORT

APPROXIMATELY 25 PERSON YEARS OF EFFORT WHICH DOES NOT INCLUDE ACTUAL MANUFACTURING/PRODUCTION PERSONNEL.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

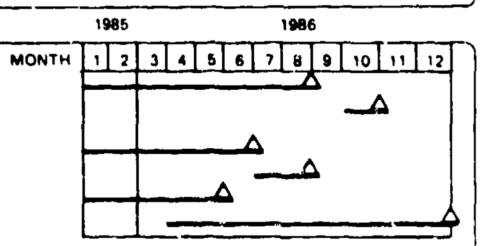
MANUFACTURING AND TEST ENGINEERS FAMILIAR WITH COMMUNICATIONS SYSTEMS SUCH AS SATELLITE GROUND STATIONS, CONCENTRATORS AND INTERFACE DEVICES. PROGRAMMERS AND CODERS WITH A MINIMUM OF 5 TO 7 YEARS OF APPLICABLE EXPERIENCE

TASK INPUTS/INTERFACES

DETAILED INFORMATION ON INPUT/OUTPUT CHARACTERISTICS/REQUIREMENTS ON ALL NETWORK SUBSYSTEMS.

TASK DELIVERABLES/KEY MILESTONES

1. FABRICATION
2. UNIT TEST
3. PROCUREMENT OF OFF-THE-SHELF EQUIPMENT
4. UNIT TEST OF OFF-THE-SHELF EQUIPMENT
5. CODING OF NETWORK SOFTWARE
6. UNIT TEST OF NETWORK SOFTWARE



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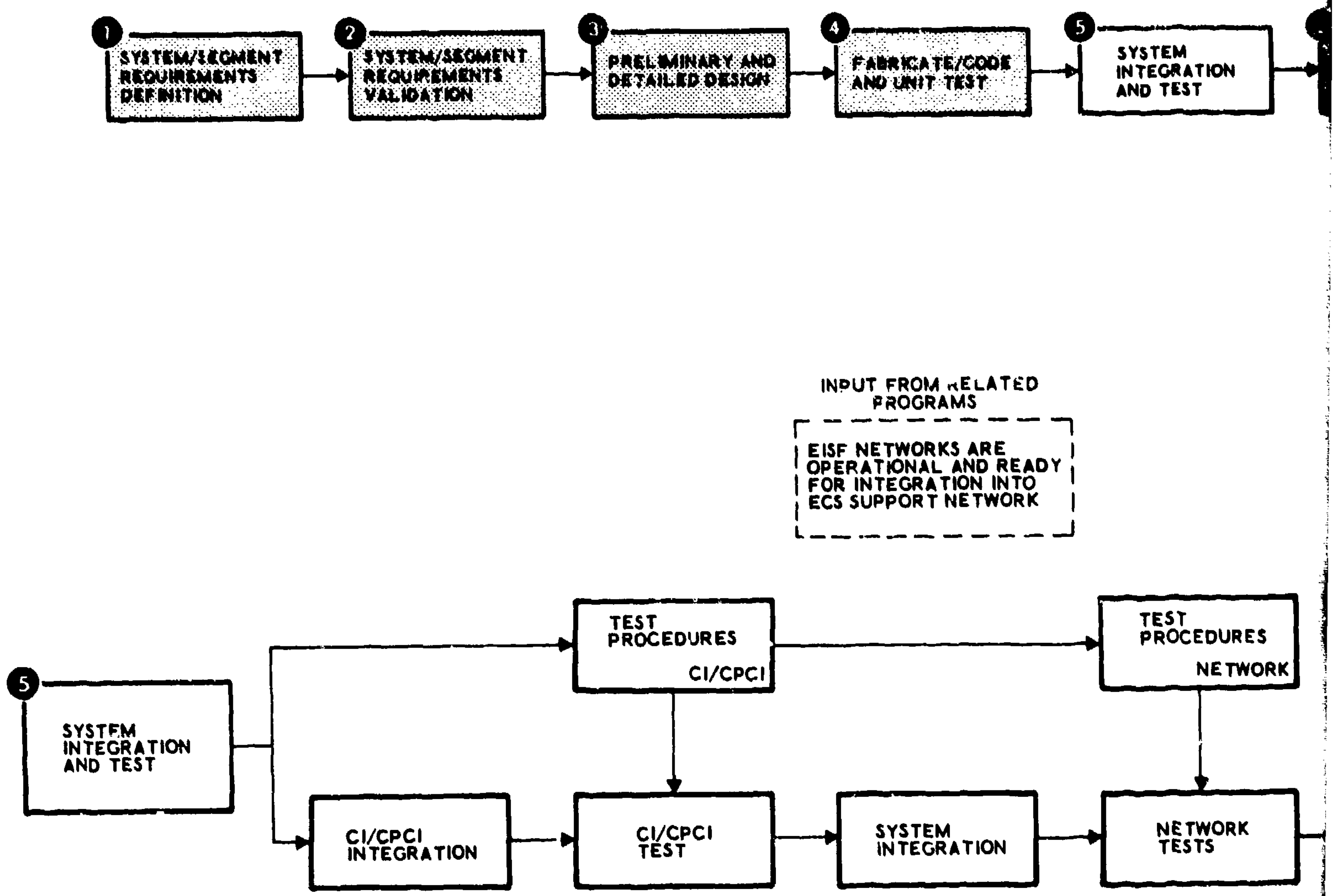
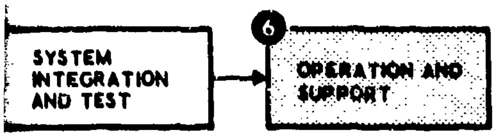
rt Networks: Command-Wide Network Fabricate/Code and Unit Test



PRODUCTS

- TEST PROCEDURES, UNIQUE TEST EQUIPMENT, TEST PLANS
- TEST REPORTS, CI/CPCI AND NETWORK TEST RESULTS INCLUDING ANALYSIS OF TEST RESULTS WITH RECOMMENDED SYSTEM AMENDMENTS, IF ANY
- OPERATIONAL ECS SUPPORT NETWORK WITH ALL INTERFACES AND NETWORK ELEMENTS

Figure 5-51. ECS Support Networks:



TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION COMMAND-WIDE NETWORK SYSTEM INTEGRATION AND TEST

5

TASK OBJECTIVE(S)

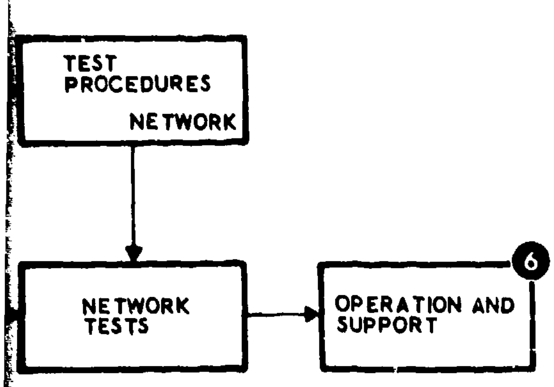
INTEGRATION AND TEST OF CI'S AND CPCI'S, INTEGRATION OF ALL HARDWARE/SOFTWARE SUBSYSTEMS INTO AN OPERATING NETWORK

MAJOR ISSUES/PROBLEM AREAS

TEST AND INTEGRATION MUST BE PERFORMED WITHOUT INTERFERENCE WITH ON-GOING OPERATIONS AT THE VARIOUS NODES

TASK APPROACH

1. DEVELOPMENT OF CI AND CPCI TESTS AND TEST PROCEDURES.
2. DEVELOPMENT OF SYSTEM TEST PROCEDURES AND TEST TOOLS.
3. CI/CPCI INTEGRATION AND TEST
4. TOTAL NETWORK INTEGRATION AND TESTS – PERFORMED ON INCREMENTAL BASIS (I.E., VIDEO ONLY, VOICE ONLY, DATA ONLY, TWO-NODE, THREE-NODE, NETWORK SECURITY LEVELS, ETC.).



LEVEL OF EFFORT

APPROXIMATELY 18 PERSON YEARS OF EFFORT, MAINLY IN DEVELOPING TEST PROCEDURES/EQUIPMENT AND PERFORMING HARDWARE AND SOFTWARE INTEGRATION AND TEST. THIS WILL REQUIRE EXTENSIVE TRAVEL DUE TO THE NETWORK GEOGRAPHIC DISTRIBUTION.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

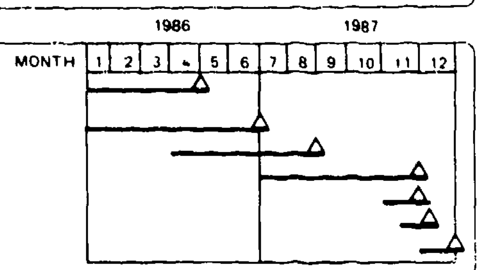
COMPUTER/SOFTWARE INTEGRATION AND TEST ENGINEERS, FACILITIES DESIGN ENGINEERS, SYSTEM INTEGRATION ENGINEERS WITH A MINIMUM OF TEN YEARS OF EXPERIENCE

TASK INPUTS/INTERFACES

AUTODIN II TEST SPECIFICATIONS, EISF LOCAL NETWORK TEST PROCEDURES.

TASK DELIVERABLES/KEY MILESTONES

1. DEVELOP CI/CPCI TESTS/TEST PROCEDURES
2. DEVELOP TESTS/TEST PROCEDURES FOR ECS SUPPORT NETWORK
3. PERFORM CI/CPCI INTEGRATION AND TEST
4. PERFORM NETWORK INTEGRATION AND TEST
5. FUNCTIONAL CONFIGURATION AUDIT (FCA)
6. PHYSICAL CONFIGURATION AUDIT (PCA)
7. FORMAL QUALIFICATION REVIEW (FQR)



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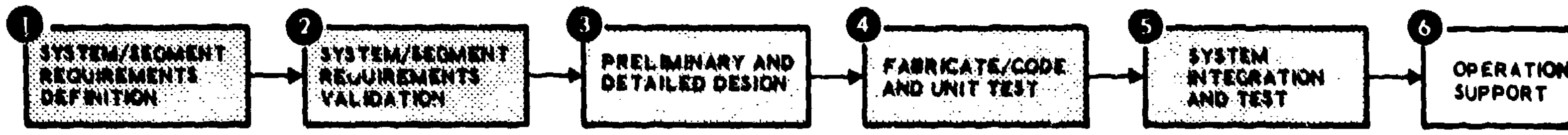
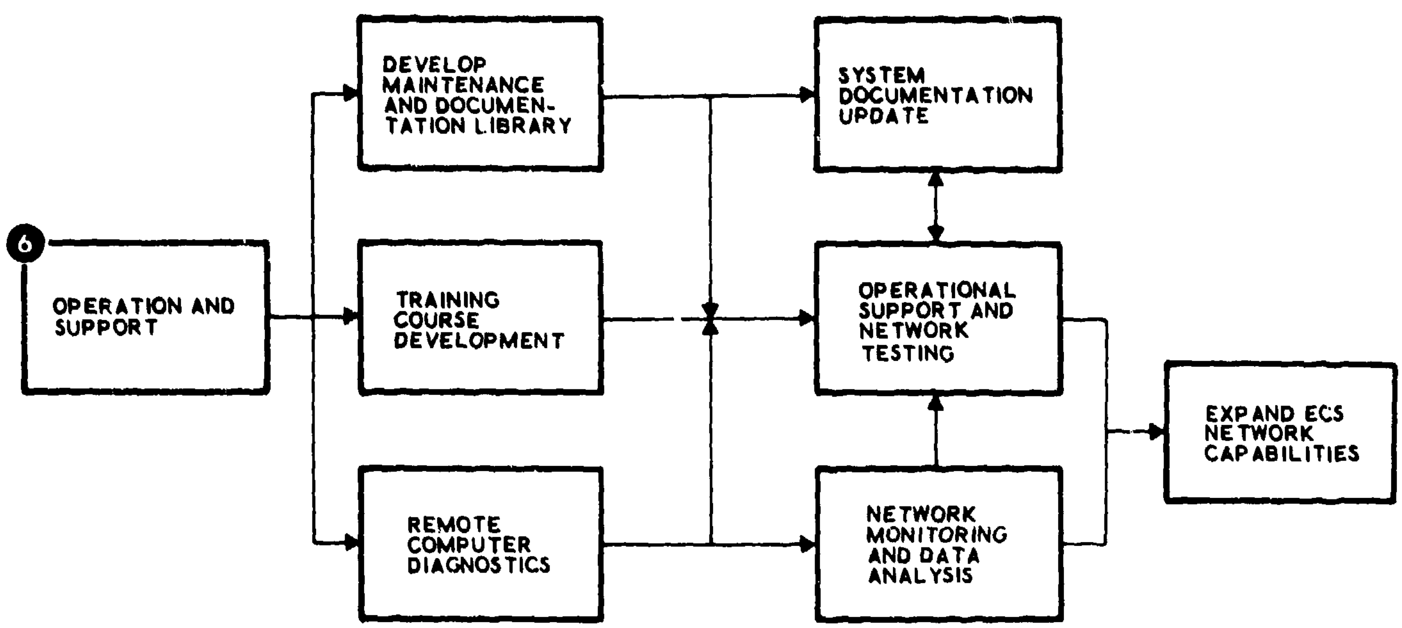
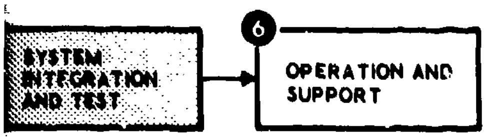




PRODUCTS

- SYSTEMS LIBRARY WITH DOCUMENTATION ON SYSTEM
- REMOTE COMPUTER DIAGNOSTICS FACILITY
- TRAINING COURSE MATERIALS AND MANUALS, TRAINING PLANS
- NETWORK MONITORING HARDWARE AND SOFTWARE
- OPERATIONAL REPORTS (INCLUDING NETWORK FAILURES, CONGESTION (CHOKE) POINTS, UNUSED CAPACITY, ANOMALIES, ETC., BASED ON STATISTICS
- MAINTENANCE REPORTS (TYPES OF MAINTENANCE PROBLEMS, LOGISTICS SUPPORT DEFICIENCIES, ETC.)

Figure 5-52. ECS Support Networks: Command-



TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION COMMAND-WIDE NETWORK OPERATION AND SUPPORT (6)

TASK OBJECTIVE(S)

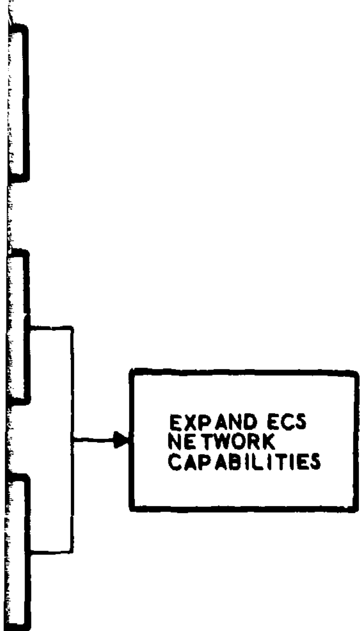
TO ASSURE THAT NETWORK IS FULLY OPERATIONAL AND RESPONSIVE TO USER NEEDS WITH MINIMAL DOWN TIME. ALSO, TO KEEP USER-ENVIRONMENT AND NETWORK SUPPORT PERSONNEL ABREAST OF ALL AVAILABLE NETWORK RESOURCES AND NETWORK TEST AND REPAIR PROCEDURES, RESPECTIVELY

MAJOR ISSUES/PROBLEM AREAS

REMOTE COMPUTER DIAGNOSTIC AND NETWORK MONITORING SYSTEM PROVISIONS SHOULD BE "BUILT-IN" TO THE SYSTEM DURING DESIGN PHASE. THIS PHASE IS PARTLY A CONTINUATION OF THAT WORK.

TASK APPROACH

1. MAINTENANCE DOCUMENTATION LIBRARY DEVELOPMENT.
2. REMOTE COMPUTER/NETWORK DIAGNOSTIC CAPABILITY DEVELOPMENT.
3. NETWORK MONITORING AND STATISTICS GATHERING.
4. DEVELOPMENT OF TRAINING COURSES AND TRAINING MATERIAL FOR NETWORK USERS AND OPERATIONS PERSONNEL
5. USING CONFIGURATION MANAGEMENT SYSTEM, UPDATE SYSTEM DOCUMENTATION IN TERMS OF DEFICIENCY CORRECTIONS AND/OR IMPROVEMENTS
6. DEVELOPMENT OF OPERATIONAL TEST PROCEDURES AND TEST EVALUATION TOOLS.



LEVEL OF EFFORT

MAINTENANCE DOCUMENTATION EFFORTS SPAN A FULL YEAR. TRAINING COURSE DEVELOPMENT EFFORT REQUIRES THREE-FIVE ENGINEERS OVER ONE YEAR. NETWORK MONITORING IS A FOUR-ENGINEER ½ YEAR EFFORT. TOTAL LEVEL OF EFFORT FOR THIS PHASE IS APPROXIMATELY 13 PERSON YEARS.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

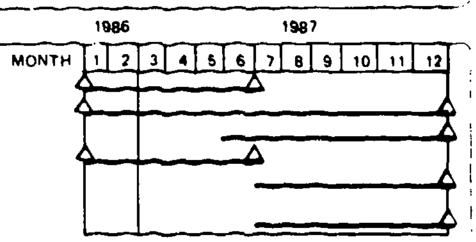
ALL OF THE ABOVE TASKS REQUIRE PERSONNEL WITH A MINIMUM OF 6 TO 8 YEARS OF RELATED EXPERIENCE

TASK INPUTS/INTERFACES

VENDOR SUPPLIED TRAINING MATERIAL (TO BE CONVERTED TO ECS SUPPORT NETWORK-UNIQUE NEEDS). THIS IS ALSO TRUE FOR MAINTENANCE DOCUMENTATION. DIAGNOSTIC SUPPORT DEVELOPMENT CAPABILITY IS OBTAINED IN DESIGN AND DEVELOPMENT ACTIVITY PHASE

TASK DELIVERABLES/KEY MILESTONES

1. MAINTENANCE AND DOCUMENTATION LIBRARY
2. REMOTE COMPUTER DIAGNOSTICS
3. NETWORK MONITORING AND DATA ANALYSIS
4. TRAINING COURSE DEVELOPMENT
5. SYSTEM DOCUMENTATION UPDATE
6. NETWORK OPERATIONAL SUPPORT INCLUDING OPERATIONAL TESTING



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Networks: Command-Wide Network Operation and Support

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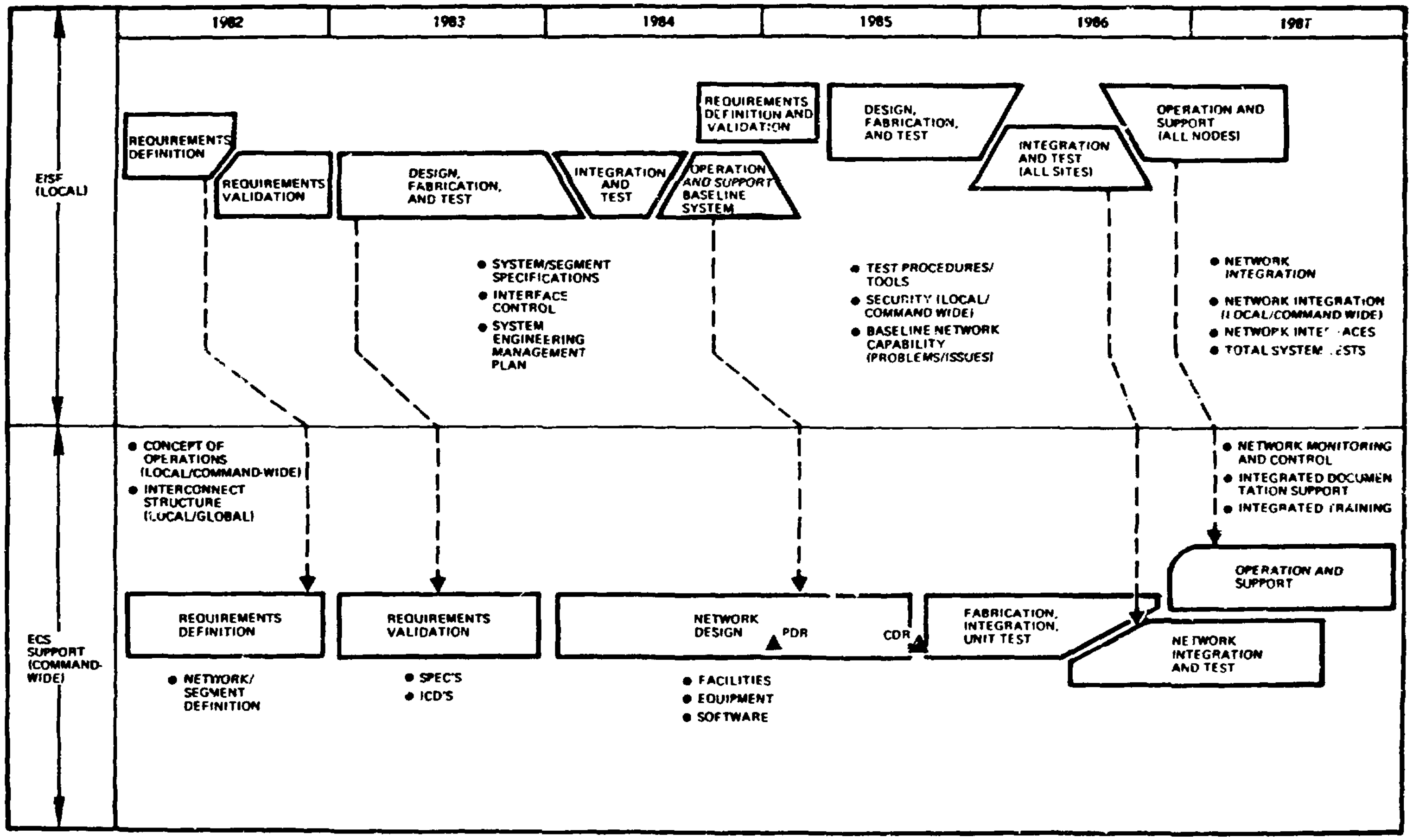

Figure 5-53. Task Interrelationships, Command-Wide and Local Networks

TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION EISF/LOCAL NETWORK SUMMARY TASK SHEET

TASK OBJECTIVE(S)

A MULTIPHASED DEVELOPMENT OF EISF/LOCAL NETWORK TO BUILD A MATURE AND ROBUST SUPPORT SYSTEM BY THE END OF THE 1980'S. THE FOCUS WILL BE ON RELIABILITY, MAINTAINABILITY, COST, AND FLEXIBILITY USING PROVEN, OFF-THE-SHELF HARDWARE AND SOFTWARE, WHEN FEASIBLE, TO MINIMIZE DEVELOPMENT RISK.

MAJOR ISSUES/PROBLEM AREAS

SUPPORT OF MULTIPLE SYSTEMS WITH MULTIPLE FUNCTIONS (DIFFERENT), COMPUTERS WITH DISSIMILAR ARCHITECTURES, LANGUAGES, PROGRAM STRUCTURES, AND INPUT/OUTPUT REQUIREMENTS USING COMMON HARDWARE AND SOFTWARE MODULAR BUILDING BLOCKS.

TASK APPROACH

THE APPROACH IS BASED ON A MULTI-PHASED DEVELOPMENT WITH EXTENSIVE TESTING BETWEEN THE PHASES, TO ASSURE MAXIMUM RELIABILITY, MAINTAINABILITY, AND FLEXIBILITY FOR MINIMUM COST. INITIALLY, A BASELINE SYSTEM WILL BE DEVELOPED AND INSTALLED IN ONE OR TWO FACILITIES, TO ASSESS CAPABILITIES AND LIMITATIONS. THIS DESIGN WILL SUBSEQUENTLY BE REVISED OR UPGRADED BASED ON OPERATIONAL EXPERIENCE AND REMAINING FACILITIES WILL BE INTERCONNECTED INTERNALLY. ALL LOCAL NETWORKS WILL THEN BE INTERCONNECTED TO FORM A COMMAND-WIDE NETWORK

LEVEL OF EFFORT

86 PERSON YEARS OF EFFORT (EXCLUDING OVERALL MANAGEMENT). TOTAL LEVEL OF EFFORT ESTIMATED AT APPROXIMATELY 100 PERSON YEARS ASSUMING A 3-PERSON MANAGEMENT TEAM.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

SYSTEM DESIGN, INTEGRATION, TEST, AND OPERATIONAL SUPPORT CAPABILITY INVOLVING ELECTRONIC, ELECTRICAL, MECHANICAL, AND ENVIRONMENTAL ENGINEERING DISCIPLINES WITH EMPHASIS ON COMMUNICATIONS TECHNOLOGY.

TASK INPUTS/INTERFACES

DOD NETWORK STUDIES, IEEE STANDARDS, EISF REQUIREMENTS, DOCUMENTS, RELATED STUDIES, AND ECS SUPPORT NETWORK DEVELOPMENT TASK.

TASK DELIVERABLES/KEY MILESTONES

BASELINE SYSTEM

1. REQUIREMENTS DEFINITION
2. REQUIREMENTS VALIDATION
3. DESIGN, FABRICATION, AND UNIT TEST
4. CI/CPCI INTEGRATION AND TEST, NETWORK INTEGRATION AND TEST
5. OPERATION AND SUPPORT ALL 7 NODES
6. REQUIREMENTS REDEFINITION
7. REQUIREMENTS REVALIDATION
8. DESIGN, FABRICATION AND UNIT TEST
9. CI/CPCI INTEGRATION AND TEST; NETWORK INTEGRATION AND TEST
10. OPERATION AND SUPPORT

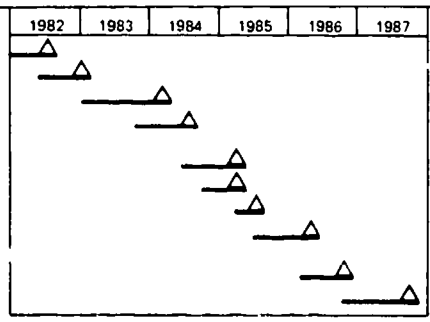

Figure 5-54. ECS Support Networks: EISF/Local Network Summary Task Sheet

TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION EISF/LOCAL NETWORK SYSTEM/SEGMENT REQUIREMENTS DEFINITION (BASELINE SYSTEM) **1**

TASK OBJECTIVE(S)

DEVELOP INITIAL EISF NETWORK CONCEPT FOR DATA, VOICE, AND VIDEO COMMUNICATIONS SUPPORTING INFORMATION EXCHANGE BETWEEN ATD, ATE, C-E, EW, AND OFP, IF APPLICABLE WITHIN A NODE

MAJOR ISSUES/PROBLEM AREAS

DEFINE EISF LOCAL NETWORK WHICH (1) IS BASED ON ARCHITECTURE INDEPENDENT OF TERMINAL EQUIPMENT AND SYSTEMS, (2) IS HIGHLY RELIABLE DUE TO DECENTRALIZED CONTROL, AND (3) CAN BE EXPANDED INTERNALLY AND COMMAND-WIDE INTO AN ECS SUPPORT NETWORK WITHOUT ANY MODIFICATIONS OR HARDWARE CHANGES

TASK APPROACH

1. JOINT NODE COMMUNICATIONS SUPPORT FUNCTION REQUIREMENTS ANALYSIS AND DEFINITION PHASE. ECS SUPPORT NETWORK DEFINITION. EMPHASIS IS ON LOCAL, RATHER THAN COMMAND-WIDE INFORMATION EXCHANGE.
2. TRADEOFF STUDY OF OFF-THE-SHELF LOCAL NETWORKING SYSTEMS AND THEIR APPLICABILITY TO EISF
3. BASED ON REQUIREMENTS ANALYSIS AND TRADEOFF STUDY, DEFINE INTERCONNECT STRUCTURE. THIS WILL TAKE INTO ACCOUNT CONCEPT OF OPERATIONS AND QUANTITATIVE REQUIREMENTS OF NUMBER OF HANDSETS, VOICE CHANNELS, VIDEO CHANNELS, NOMINAL AND PEAK DATA RATES, NUMBER OF INTERFACES, ETC
4. DEFINITION OF TWO INITIAL DEVELOPMENT NODES, INCLUDING SEGMENT REQUIREMENTS (VOICE, VIDEO, FAX AND DATA SEGMENT).

LEVEL OF EFFORT

APPROXIMATELY 4 PERSON YEAR EFFORT

PERFORMER EXPERIENCE LEVEL/BACKGROUND

ENGINEERS/SYSTEM ANALYSTS FAMILIAR WITH LOCAL AREA NETWORKS, LOCAL VIDEO AND VOICE COMMUNICATION TECHNOLOGY, AND OFP, EW AND COMMUNICATION AND ELECTRONICS DATA EXCHANGE NEEDS ASSESSMENT

TASK INPUTS/INTERFACES

KEY INPUTS ARE REQUIRED FROM OTHER TRADEOFF OR STUDY TEAM EFFORTS SUCH AS DATA BASE MANAGEMENT SYSTEM, TRAFFIC ANALYSIS, AND ECS SUPPORT NETWORK REQUIREMENTS DEFINITION SUBTASKS.

TASK DELIVERABLES/KEY MILESTONES

1. TRADEOFF STUDY, LOCAL AREA NETWORK IMPLEMENTATION ALTERNATIVES
2. DETAILED OPERATIONS ANALYSIS, COHOST, TWO ORIGINALLY NETTED NODES
3. LINK ALTERNATIVES, LOCAL NETWORK TRAFFIC ANALYSIS, COMMAND-WIDE NET EXPANSION, GATEWAY ANALYSIS
4. EISF NETWORK DEFINITION
5. EISF NETWORK SEGMENT REQUIREMENTS DEFINITION
6. SYSTEM REQUIREMENTS REVIEW

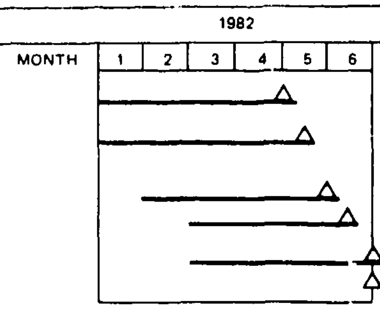

Figure 5-55. ECS Support Networks: EISF/Local Network System/Segment Requirements Definition (Baseline System)

TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION EISF/LOCAL NETWORK SYSTEM/SEGMENT REQUIREMENTS VALIDATION (BASELINE SYSTEM)

2

TASK OBJECTIVE(S)

TO DEFINITIZE THE LOCAL AREA NETWORK (EISF) DESIGN INCLUDING SPECIFICATIONS FOR FIRST TWO NODES TO BE NETWORKED WITH PRELIMINARY INTERFACE CONTROL DOCUMENTATION (ICD'S) FOR COMMAND-WIDE NETWORK INTERCONNECTION.

MAJOR ISSUES/PROBLEM AREAS

NETWORKING REQUIREMENTS AT EACH NODE MAY BE UNIQUE IN NATURE. THE DESIGN MUST BE GENERAL ENOUGH TO SATISFY NETWORKING REQUIREMENTS FOR EACH INDIVIDUAL NODE WITHOUT SACRIFICE TO OVERALL PERFORMANCE.

TASK APPROACH

A BASELINE LOCAL AREA NETWORK WILL BE DEVELOPED AND INTEGRATED AT A MAXIMUM OF TWO FACILITIES (POSSIBLY SACRAMENTO AND WARNER ROBINS). THESE TWO FACILITIES WILL BE USED TO GAIN EXPERIENCE IN NETWORKING AND PROVIDE GUIDANCE IN TERMS OF EXPANSION TO FULL NETWORK CAPABILITY. OUTPUTS FROM THIS TASK WILL ALSO BE USED TO FINALIZE THE COMMAND-WIDE (ECS SUPPORT) NETWORK DESIGN. THE REMAINING NODES WILL BE INTEGRATED IN A SECOND PHASE AND FOLLOWING OPERATIONAL TESTS, INTERCONNECTED INTO A FULL-BLOWN COMMAND-WIDE ECS SUPPORT NETWORK.

LEVEL OF EFFORT

APPROXIMATELY A 6 PERSON YEAR EFFORT IN A 6 MONTH PERIOD.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

SENIOR NETWORK DESIGN ENGINEERS FAMILIAR WITH DEVELOPING REQUIREMENTS DOCUMENTATION AND VARIOUS HARDWARE AND SOFTWARE SPECIFICATIONS

TASK INPUTS/INTERFACES

DETAILED DOCUMENTATION ON ATD, ATE, C-E, EW, AND OFP SYSTEMS INCLUDING DATA REQUIREMENTS, VOICE AND VIDEO COMMUNICATIONS NEEDS

TASK DELIVERABLES/KEY MILESTONES

1982

MONTH

1. SYSTEM SPECIFICATION, EISF SYSTEM, SM, WR
2. SEGMENT SPECIFICATIONS, VOICE, VIDEO, DIGITAL, FAX
3. CI DEVELOPMENT SPECIFICATIONS
4. CPCI DEVELOPMENT SPECIFICATIONS
5. EQUIPMENT REQUIREMENTS
6. FACILITIES MODIFICATION PLAN
7. ICD'S
8. SYSTEM ENGINEERING MANAGEMENT PLAN
9. BUILD OR BUY ASSESSMENT
10. SDR

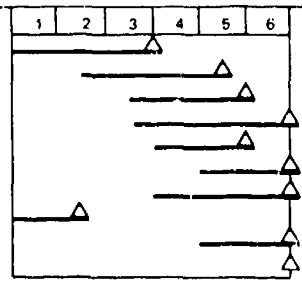

Figure 5-56. ECS Support Networks: EISF/Local Network System/Segment Requirements Validation (Baseline System)

TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION EISF/LOCAL NETWORK PRELIMINARY AND DETAILED DESIGN (BASELINE SYSTEM)

3

TASK OBJECTIVE(S)

DETAILED DESIGN AND DEVELOPMENT OF ALL NETWORK ELEMENTS SUCH AS COMPUTER AND TERMINAL INTERFACES, VOICE COMMUNICATIONS INTERFACES, VIDEO AND FACSIMILE CHANNELS, AND INTER AND INTRABUILDING COMMUNICATIONS LINKS

MAJOR ISSUES/PROBLEM AREAS

IN ORDER TO MEET THE OVERALL ECS SUPPORT NETWORK SCHEDULE, THIS PHASE MUST BE COMPRESSED TO 14 MONTHS. IN ORDER TO REDUCE RISK OF SCHEDULE OVERRUN, THE SYSTEM MUST BE BASED ON "OFF THE-SHELF" HARDWARE AND SOFTWARE WITH A MINIMUM OF NEW DESIGN

TASK APPROACH

1. PROCUREMENT CYCLE BASED ON USE OF OPTIMAL OFF-THE-SHELF HARDWARE AND SOFTWARE. DESIGN MUST BE COMPATIBLE WITH ECS SUPPORT COMMAND-WIDE NETWORK REQUIREMENTS
2. DESIGN AND DEVELOPMENT OF UNIQUE INTERFACES, SOFTWARE DRIVERS, CABLING, ETC
3. FABRICATION OF ALL HARDWARE (STANDARD OFF-THE-SHELF, AND SPECIAL DESIGN)
4. CODING OF ALL NON-STANDARD SOFTWARE.
5. UNIT TEST OF EISF NETWORK HARDWARE AND SOFTWARE

LEVEL OF EFFORT

THIS IS A 16 PERSON YEAR EFFORT OVER A PERIOD OF 14 MONTHS

PERFORMER EXPERIENCE LEVEL/BACKGROUND

HARDWARE AND SOFTWARE ENGINEERS EXPERIENCED IN COMMUNICATIONS EQUIPMENT AND INTERFACE DESIGN, DEVELOPMENT, MANUFACTURING, AND TESTING.

TASK INPUTS/INTERFACES

FACILITIES REQUIREMENTS, SECURITY REQUIREMENTS, ECS COMMAND-WIDE SUPPORT NETWORK REQUIREMENTS.

TASK DELIVERABLES/KEY MILESTONES

1. DESIGN IMPLEMENTATION PLAN
2. MANUFACTURER/VENDOR SURVEY
3. PREPARE AND ISSUE RFP'S
4. VENDOR PROPOSAL EVALUATIONS
5. UNIQUE INTERFACE DESIGN
6. PDR AND CDR
7. UNIQUE EISF NETWORK INTERFACE TEST
8. FACILITIES DESIGN
9. EISF NETWORK SOFTWARE DESIGN
10. FABRICATION OF HARDWARE AND TEST OF HARDWARE
11. OFF-THE-SHELF EQUIPMENT PROCUREMENT AND TEST
12. EISF NETWORK SOFTWARE CODE AND TEST

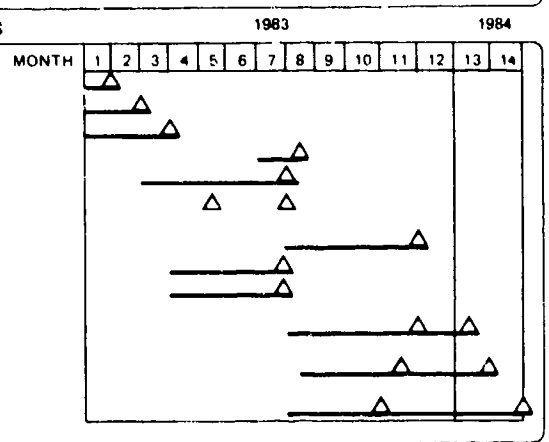

Figure 5-57. ECS Support Networks: EISF/Local Network Preliminary and Detailed Design (Baseline System)

TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION EISF/LOCAL NETWORK SYSTEM INTEGRATION AND TEST (BASELINE SYSTEM)

4

TASK OBJECTIVE(S)

INTEGRATION AND TEST OF CI'S (OFF THE SHELF AND SPECIAL DESIGN INTERFACES) AND CPCI'S (OFF THE SHELF SOFTWARE AND UNIQUE EISF SOFTWARE). INTEGRATION OF ALL HARDWARE AND SOFTWARE ELEMENTS AT EACH NODE INTO A LOCAL STAND-ALONE OPERATIONAL NETWORK

MAJOR ISSUES/PROBLEM AREAS

IN ORDER TO FIT INTO THE ECS SUPPORT COMMAND-WIDE NETWORK SCHEDULE, BOTH BASELINE NODES HAVE TO BE INTEGRATED AND TESTED CONCURRENTLY. SINCE BOTH HAVE SLIGHTLY DIFFERENT REQUIREMENTS, THIS WILL PROVIDE A VERIFICATION OF THE "UNIVERSALITY" OF THE DESIGN

TASK APPROACH

1. DEVELOPMENT OF CI AND CPCI TEST TOOLS AND TEST PROCEDURES
2. CI/CPCI INTEGRATION AND TEST
3. TOTAL LOCAL NETWORK TESTING INCLUDING DIGITAL DATA TRANSMISSION, FILE TRANSFER, ACCESS FROM TERMINALS TO FILES, VIDEO CONFERENCING, VOICE COMMUNICATIONS, AND LOCAL FACSIMILE TRANSMISSION

LEVEL OF EFFORT

APPROXIMATELY 8 PERSON YEARS OF EFFORT EXPENDED OVER AN EIGHT MONTH PERIOD

PERFORMER EXPERIENCE LEVEL/BACKGROUND

EXPERIENCED ENGINEERS AND COMMUNICATION SYSTEM PROGRAMMERS, FAMILIAR WITH SYSTEM INTEGRATION AND TEST. ON SITE ENGINEERS FAMILIAR WITH TEST EQUIPMENT DESIGN

TASK INPUTS/INTERFACES

DETAILED INFORMATION ON ALL INTERFACES AND SUBSYSTEM FACILITIES.

TASK DELIVERABLES/KEY MILESTONES

1. DEVELOP TESTS/TEST PROCEDURES, CI/CPCI
2. DEVELOP TEST PROCEDURES FOR LOCAL NETWORK FUNCTIONS
3. DEVELOP UNIQUE TEST EQUIPMENT
4. PERFORM CI/CPCI INTEGRATION AND TEST
5. PERFORM EISF NETWORK INTEGRATION AND TEST
6. FUNCTIONAL CONFIGURATION AUDIT (FCA)
7. PHYSICAL CONFIGURATION AUDIT (PCA)
8. FORMAL QUALIFICATION REVIEW (FQR)

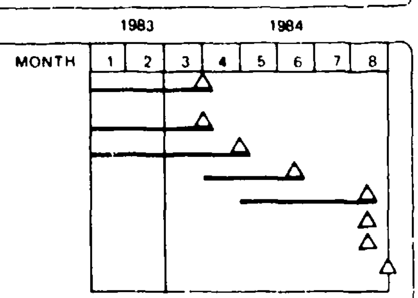

Figure 5-58. ECS Support Networks: EISF/Local Network System Integration and Test (Baseline System)

TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION EISF/LOCAL NETWORKS OPERATION AND SUPPORT (BASELINE SYSTEM) **5**

TASK OBJECTIVE(S)

TO ASSURE THAT EISF BASELINE NETWORK IS FULLY OPERATIONAL AND RESPONSIVE TO USER NEEDS, WITH MINIMAL IMPACT ON OPERATIONS. THE SYSTEM WILL FUNCTION IN A NORMAL, DAY TO-DAY OPERATIONAL ENVIRONMENT AND WILL ALSO BE USED TO VALIDATE THE DESIGN BEFORE FULL LOCAL NETWORK CAPABILITY IS DEVELOPED IN ALL OF THE NODES

MAJOR ISSUES/PROBLEM AREAS

TO OBTAIN SUFFICIENT INFORMATION WITHIN LESS THAN 8 MONTHS TO ASSESS DEFICIENCIES OF NETWORK DESIGN, IN ORDER TO INFLUENCE CHANGES IN UPGRADE

TASK APPROACH

1. DEVELOPMENT OF LOCAL ECS SUPPORT LIBRARIES.
2. DEVELOPMENT OF EISF NETWORK DIAGNOSTIC AND MONITORING CAPABILITY.
3. DEVELOPMENT TRAINING COURSES AND MATERIAL
4. UPDATE DOCUMENTATION IN TERMS OF DEFICIENCY CORRECTIONS AND/OR IMPROVEMENTS.
5. DEVELOPMENT OF OPERATIONAL TEST PROCEDURES AND TEST EVALUATION TOOLS.

LEVEL OF EFFORT

APPROXIMATELY 7 PERSON YEAR EFFORT OVER AN 8 MONTH PERIOD.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

ENGINEERS THOROUGHLY FAMILIAR WITH DEBUGGING COMPLEX HARDWARE/SOFTWARE SYSTEMS. TRAINING EXPERTS FAMILIAR WITH NETWORK MAINTENANCE AND OPERATION.

TASK INPUTS/INTERFACES

INPUT OF TEST RESULTS AND OPERATIONAL EXPERIENCES INTO ECS SUPPORT NETWORK DESIGN ACTIVITY. INPUT OF INTERFACE REQUIREMENTS INTO ABOVE ACTIVITY

TASK DELIVERABLES/KEY MILESTONES

1. MAINTENANCE AND DOCUMENTATION LIBRARY
2. REMOTE COMPUTER DIAGNOSTICS
3. TRAINING COURSE DEVELOPMENT
4. DOCUMENTATION UPDATE
5. OPERATIONAL SUPPORT WITH INPUTS TO ECS DESIGN ACTIVITY (SM AND WR)

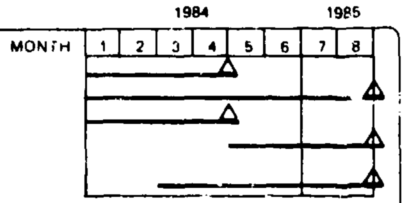

Figure 5-59. ECS Support Networks: EISF/Local Networks Operation and Support (Baseline System)

TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION EISF/LOCAL NETWORK SYSTEM/SEGMENT REQUIREMENTS REDEFINITION (ALL NODES)

6

TASK OBJECTIVE(S)

BASED ON OPERATIONAL EXPERIENCE WITH BASELINE EISF NETWORKS, THE ORIGINAL REQUIREMENTS DEFINITIONS WILL BE UPGRADED AND/OR REDEFINED

MAJOR ISSUES/PROBLEM AREAS

THE MAJOR RISK DUE TO SCHEDULE SLIP MAY BE THE LACK OF INSIGHT INTO OPERATIONAL PROBLEMS, RESULTING IN ADDITIONAL NODES BEING DESIGNED WITH NO IMPROVEMENTS, THEREBY POSTPONING THE IMPROVEMENT CYCLE WITH RESULTING MORE EXPENSIVE MODIFICATIONS.

TASK APPROACH

1. REVISE DEFINITION OF CONCEPTS OF OPERATION
2. EXPAND/REVISE INTERCONNECT STRUCTURE.
3. DEFINE REMAINING DEVELOPMENT NODES, INCLUDING SEGMENT REQUIREMENTS.

LEVEL OF EFFORT

APPROXIMATELY 6.5 PERSON YEARS OF EFFORT OVER A 4 MONTH PERIOD WITH TWO OPERATION ANALYST ASSIGNED TO EACH FACILITY.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

ENGINEERS AND SYSTEMS ANALYSTS FAMILIAR WITH LOCAL AREA NETWORKING, VIDEO CONFERENCING, VOICE COMMUNICATIONS, AND ELECTRONIC MAIL. PERSONNEL SHOULD BE FAMILIAR WITH PREVIOUS EFFORTS IN THIS TASK (I.E., BASELINE SYSTEM).

TASK INPUTS/INTERFACES

INTERFACES WITH ECS SUPPORT COMMAND-WIDE NETWORK DESIGN TEAM.

TASK DELIVERABLES/KEY MILESTONES

1. EXPANDED OPERATIONS ANALYSIS FOR ALL NODES
2. TRAFFIC ANALYSIS UPGRADE, INCLUDING EXPANDED TRAFFIC REQUIREMENTS
3. EISF NETWORK DEFINITION REVISION
4. REVISED EISF NETWORK SEGMENT REQUIREMENTS
5. SYSTEM REQUIREMENTS REVIEW

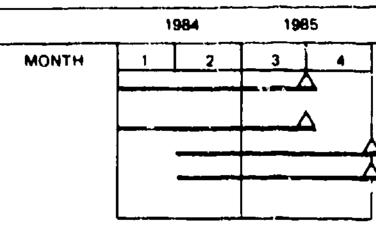

Figure 5-60. ECS Support Networks: EISF/Local Network System/Segment Requirements Redefinition (All Nodes)

TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION EISF/LOCAL NETWORK SYSTEM/SEGMENT REQUIREMENTS REVALIDATION (ALL NODES)

7

TASK OBJECTIVE(S)

REDEFINITIZED LOCAL AREA NETWORK (EISF) DESIGN INCLUDING CHANGES/ADDITIONS/DELETIONS TO EXISTING DESIGNS BASED ON OPERATIONAL EXPERIENCES WITH THE BASELINE SYSTEM(S)

MAJOR ISSUES/PROBLEM AREAS

THE VALIDATION SHOULD ALSO ENCOMPASS EXISTING BASELINE FACILITIES DESIGN UPGRADES (IF ANY) INCLUDING VALIDATED REQUIREMENTS FROM ECS SUPPORT NETWORK VALIDATION AND DESIGN TASKS

TASK APPROACH

THIS TASK CONSISTS MAINLY OF REVISING EXISTING SPECIFICATIONS AND PLANS FROM BASELINE VALIDATION PHASE. HOWEVER, SOME OF THE TASKS WILL REQUIRE THE GENERATION OF NEW DOCUMENTATION SUCH AS FACILITIES MODIFICATION PLANS FOR NETWORKING THE REMAINING NODES

LEVEL OF EFFORT

APPROXIMATELY 3 PERSON YEARS OF EFFORT OVER A 3 MONTH PERIOD.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

SENIOR NETWORK DESIGN ENGINEERS FAMILIAR WITH DEVELOPING REQUIREMENT DOCUMENTATION AND VARIOUS HARDWARE AND SOFTWARE SPECIFICATIONS

TASK INPUTS/INTERFACES

TASK INPUTS FROM EIS BASELINE VALIDATION PHASE AND OPERATIONS AND SUPPORT PHASE. KEY INPUTS ARE ALSO REQUIRED FROM ECS SUPPORT COMMAND-WIDE NETWORK VALIDATION AND DESIGN TASKS.

TASK DELIVERABLES/KEY MILESTONES

1. SYSTEM SPECIFICATION REVISION
2. SEGMENT SPECIFICATION REVISION
3. CI DEVELOPMENT SPECIFICATION REVISIONS
4. CPCI DEVELOPMENT SPECIFICATION REVISIONS
5. EQUIPMENT REQUIREMENTS UPGRADE
6. FACILITIES MODIFICATION PLANS
7. UPDATED ICD'S
8. UPDATED SYSTEM ENGINEERING MANAGEMENT PLAN
9. BUILD OR BUY ASSESSMENT
10. SDR

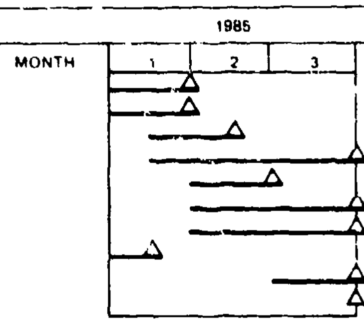

Figure 5-61. ECS Support Networks: EISF/Local Network System/Segment Requirements Revalidation (All Nodes)

TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION EISF/LOCAL NETWORK FABRICATION/CODE AND UNIT TEST (ALL NODES)

8

TASK OBJECTIVE(S)

DETAILED DESIGN AND DEVELOPMENT OF ALL NETWORK ELEMENTS FOR ALL NON-NETTED EISF NODES AS WELL AS POSSIBLE CHANGES/UPGRADES TO THE BASELINE SYSTEM

MAJOR ISSUES/PROBLEM AREAS

TO MAINTAIN FULL COMPATIBILITY BETWEEN ALL NODES AND TO MINIMIZE CHANGES TO EXISTING BASE LINE NODES IN ORDER NOT TO DISRUPT DAY-TO-DAY OPERATIONS

TASK APPROACH

THE DESIGN PHASE OF THIS TASK IS REDUCED AS MOST ELEMENTS IN THE SYSTEM HAVE BEEN DEVELOPED DURING THE BASELINE SYSTEM DESIGN PHASE. THE EMPHASIS WILL THEREFORE BE ON DESIGN REVISION AND, POSSIBLY, SOME NEW INTERFACES BOTH IN THE HARDWARE AND SOFTWARE AREAS. HARDWARE WILL, HOWEVER, HAVE TO BE FABRICATED FOR THE REMAINING NODES AND ALL REVISED HARDWARE FOR THE BASELINE SYSTEM MUST BE MANUFACTURED AND TESTED

LEVEL OF EFFORT

APPROXIMATELY 11 PERSON YEARS OF EFFORT OVER A ONE YEAR PERIOD.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

HARDWARE AND SOFTWARE ENGINEERS EXPERIENCED WITH COMMUNICATIONS EQUIPMENT AND SOFTWARE DESIGN, AND INTERFACE DESIGN, DEVELOPMENT, MANUFACTURING, AND TEST

TASK INPUTS/INTERFACES

FACILITIES REQUIREMENTS, SECURITY REQUIREMENTS, ECS SUPPORT NETWORK REQUIREMENTS.

TASK DELIVERABLES/KEY MILESTONES

1. DESIGN IMPLEMENTATION PLAN
2. REVISE AND ISSUE RFP
3. UNIQUE, NEW INTERFACE DESIGNS
4. PDR AND CDR
5. FACILITIES DESIGN
6. EISF NETWORK SOFTWARE ADDITIONS DESIGN
7. FABRICATION OF HARDWARE
8. HARDWARE UNIT TEST
9. SOFTWARE CODE AND TEST
10. OFF-THE-SHELF EQUIPMENT ACQUISITION AND TEST

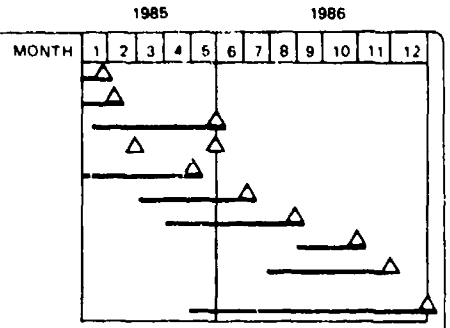

Figure 5-62. ECS Support Networks: EISF/Local Network Fabrication/Code and Unit Test (All Nodes)

TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION EISF/LOCAL NETWORK SYSTEM INTEGRATION AND TEST (ALL NODES) **9**

TASK OBJECTIVE(S)

INTEGRATION AND TEST OF CI'S AND CPCI'S (ALL NEW HARDWARE AND SOFTWARE ELEMENTS OR SUBSYSTEMS WHICH HAVE BEEN REDESIGNED OR UPGRADED). INTEGRATION AND TEST OF ALL HARDWARE AND SOFTWARE AT REMAINING NODES

MAJOR ISSUES/PROBLEM AREAS

THE LOCAL NETWORK INTEGRATION AND TEST WILL BE FOLLOWED BY THE ECS SUPPORT NETWORK INTEGRATION AND TEST. FOR COMMAND-WIDE NETWORK CHECKOUT WORK MUST BE PERFORMED CONCURRENTLY AT ALL NODES REQUIRING OVERLAPPING RATHER THAN STAGGERED EFFORTS

TASK APPROACH

1. REVISION OF ALL DOCUMENTS AND EQUIPMENT PERTAINING TO INTEGRATION AND TESTING OF BASELINE CONFIGURATION
2. CI/CPCI INTEGRATION AND TEST WITH EMPHASIS ON CHECKOUT OF UPGRADED CAPABILITIES
3. TOTAL LOCAL NETWORK TESTING AT ALL SITES.

LEVEL OF EFFORT

APPROXIMATELY 9 PERSON YEARS OVER A 7 MONTH PERIOD

PERFORMER EXPERIENCE LEVEL/BACKGROUND

ENGINEERS EXPERIENCED IN TEST EQUIPMENT DESIGN, TEST PROCEDURES, HARDWARE/SOFTWARE INTEGRATION AND TEST AND SYSTEM INSTALLATION AND TEST, ON SITE.

TASK INPUTS/INTERFACES

INTEGRATION WITH ECS NETWORK INTEGRATION AND TEST ACTIVITY.

TASK DELIVERABLES/KEY MILESTONES

1. REVISE TEST PROCEDURES, CI/CPCI
2. REVISE TEST PROCEDURES FOR LOCAL NETWORK FUNCTIONS
3. MODIFY UNIQUE TEST EQUIPMENT
4. PERFORM CI/CPCI INTEGRATION AND TEST
5. PERFORM EISF NETWORK INTEGRATION AND TEST FOR EACH NODE
6. FUNCTIONAL CONFIGURATION AUDIT (FCA)
7. PHYSICAL CONFIGURATION AUDIT (PCA)
8. FORMAL QUALIFICATION REVIEW (FQR)

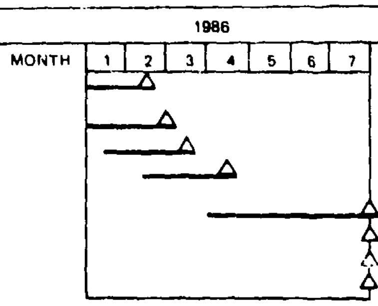

Figure 5-63. ECS Support Networks: EISF/Local Network System Integration and Test (All Nodes)

TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION EISF/LOCAL NETWORK OPERATION AND SUPPORT (ALL NODES) **10**

TASK OBJECTIVE(S)

TO ENSURE THAT EACH NODE IS FULLY OPERATIONAL AND RESPONSIVE TO USER NEEDS WITH MINIMAL DOWN TIME AND TO SUPPORT INTEGRATION AND TEST, AND OPERATIONAL SUPPORT ACTIVITIES RELATED TO THE ECS SUPPORT NETWORK DEVELOPMENT

MAJOR ISSUES/PROBLEM AREAS

ONE OF THE MORE DIFFICULT PROBLEMS WILL BE THE GRADUAL CAPABILITIES EXPANSION FROM LOCAL TO COMMAND-WIDE NETWORK SUPPORT.

TASK APPROACH

THIS TASK WILL SERVE A DUAL PURPOSE TO SUPPORT BOTH THE INTER AND INTRA NODE COMMUNICATIONS. SEVERAL ACTIVITIES THEREFORE OVERLAP, SUCH AS THE SUPPORT OF THE MAINTENANCE AND DOCUMENTATION LIBRARY, TRAINING COURSE DEVELOPMENT, NETWORK MONITORING AND STATISTICAL DATA TRAFFIC ANALYSIS, AND OPERATIONAL TESTING. SINCE THE EISF SUPPORT FUNCTION PRECEDES THE ECS SUPPORT NETWORK SUPPORT FUNCTION, OVERLAP WILL EXIST BETWEEN IT AND THE ECS NETWORK INTEGRATION AND TEST TASK

LEVEL OF EFFORT

APPROXIMATELY 16 PERSON YEARS OF EFFORT OVER A NINE MONTH PERIOD

PERFORMER EXPERIENCE LEVEL/BACKGROUND

ENGINEERS AND PROGRAMMERS THOROUGHLY FAMILIAR WITH HANDS-ON DEBUGGING OF COMPLEX HARDWARE/SOFTWARE SYSTEMS. WORK REQUIRES CLOSE COORDINATION BETWEEN ALL OF THE REMOTE SITES. TRAINING AND DOCUMENTATION ANALYSTS WITH PREVIOUS NETWORKING EXPERIENCE

TASK INPUTS/INTERFACES

INPUTS AND INTERFACES WITH EACH NODE AND THE ECS SUPPORT SERVICES FOR ALL ECS CATEGORIES.

TASK DELIVERABLES/KEY MILESTONES

1. UPDATE MAINTENANCE AND DOCUMENTATION LIBRARY AND COORDINATE WITH ECS SUPPORT NETWORK LIBRARY
2. PHASE OVER COMPUTER DIAGNOSTICS FROM LOCAL TO COMMAND-WIDE CAPABILITY
3. LOCAL NETWORK MONITORING AND DATA ANALYSIS
4. REVISION OF TRAINING COURSES
5. DOCUMENTATION UPDATE
6. OPERATIONAL SUPPORT WITH CLOSE COORDINATION WITH ECS SUPPORT NETWORK TEST AND SUPPORT

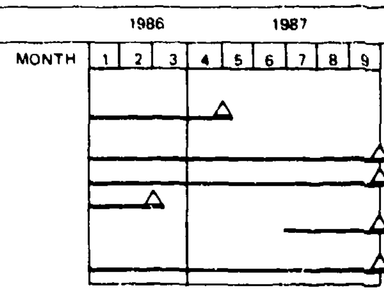

Figure 5-64. ECS Support Networks: EISF/Local Network Operation and Support (All Nodes)

TASK DESCRIPTION ECS SUPPORT NETWORKS

SUBTASK DESCRIPTION DATA BASE MACHINE SUMMARY TASK SHEET

TASK OBJECTIVE(S)

TO PROVIDE EASY AND FAST ACCESS TO A WIDE VARIETY OF DATA ASSOCIATED WITH ATD, ATE, C-E, EW, AND OFP WHILE ENSURING THAT THIS DATA IS CURRENT.

MAJOR ISSUES/PROBLEM AREAS

IT IS POSSIBLE THAT NO ONE TYPE OF DATA BASE MACHINE CAN SATISFY THE DIVERSE REQUIREMENTS OF AFLC THEREBY NECESSITATING THE COMBINATION OF DISTRIBUTED DATA BASES TOGETHER WITH DATA BASE MACHINES AT ALL LOCAL NODES.

TASK APPROACH

1. SURVEY DATA BASE NEEDS AT ALL ECS SUPPORT FACILITIES USING FORMAL SURVEY FORMS AS WELL AS USER INTERVIEWS.
2. DEVELOP SPECIFICATIONS FOR THE DATA BASE MACHINE.
3. DESIGN, FABRICATE AND TEST THE DATA BASE MACHINE (THIS COULD BE AN OFF-THE-SHELF SYSTEM OR A MINICOMPUTER-BASED SYSTEM WITH A STANDARD DATA BASE MANAGEMENT SYSTEM.)
4. INTEGRATE THE DATA BASE MACHINE INTO EACH EISF NETWORK.
5. CHECK OUT REMOTE ACCESS IN OPERATIONAL ENVIRONMENT USING ECS SUPPORT NETWORK.

LEVEL OF EFFORT

A TOTAL OF 12 PERSON YEARS OVER A 5 YEAR PERIOD. LEVEL OF EFFORT IS EXPANDED WHEN DATA BASE MACHINES ARE INSTALLED IN ALL EISF NETWORK NODES IN 1986.

PERFORMER EXPERIENCE LEVEL/BACKGROUND

BROAD EXPERIENCE IN DATA BASE MANAGEMENT SYSTEM DESIGN INCLUDING DISTRIBUTION OF DATA BASES AND REMOTE ACCESS

TASK INPUTS/INTERFACES

INPUTS FROM THE EISF LOCAL NETWORK DESIGN TASK AND ECS SUPPORT COMMAND-WIDE NETWORK DESIGN TASK. A KEY INPUT IS FROM THE SECURITY REQUIREMENTS IN ECS SUPPORT NETWORK REQUIREMENTS DEFINITION PHASE.

TASK DELIVERABLES/KEY MILESTONES

1. REQUIREMENTS DEFINITION (SRR)
2. DATA BASE MANAGEMENT SPECIFICATION (SDR)
3. INTERFACE CONTROL DOCUMENTS
4. DESIGN AND FABRICATION PROCUREMENT PDR, CDR)
5. INTEGRATION AND TEST
6. OPERATION AND SUPPORT

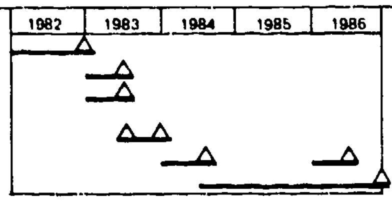

Figure 5-65. ECS Support Networks: Data Base Machine Summary Task Sheet

APPENDIX A

EMBEDDED COMPUTER SYSTEM SUPPORT OBJECTIVES

The following embedded computer system (ECS) support objectives were distilled from a longer list of specific problem or definiency related objectives. They encompass known and projected ECS support requirements. They are an extension of the current Statement of Need/Mission Element Need Analysis and serve as statements of Air Force Logistic Commands intentions for support of the five category of ECS. The initiatives presented in the long range ECS support plan are intended to achieve these objectives.

A. 1 ACQUIRE AND MAINTAIN A FLEXIBLE TECHNICAL SUPPORT BASE AND ESTABLISH DATA FLOW TO RAPIDLY RESPOND TO ECS COMBAT NEEDS

Enhanced performance and flexibility of weapon systems is being achieved by incorporating integral embedded computer systems. These capabilities, however, can only be realized or sustained by acquiring and maintaining an equally flexible technical support base and associated data flow. The technical support base provides the capability to stay ready for the known operational environment as well as the capability to react quickly to combat requirements. Readiness prior to hostilities involves the exploitation of technology and intelligence. In this context, ECS support needs are closely coupled to weapon system readiness.

The ECS change process is a continuing activity that begins early in the ECS life cycle but commences officially for AFLC at PMRT. It encompasses all ECS categories and frequently includes multiple versions of operational software for a single ECS. The ECS change process is engineering intensive, requires close interaction with the user, and is performed primarily in a laboratory environment. It involves software error correction, ECS enhancement, and the addition of new capabilities. The responsiveness of ECS change support is a function of the system design and complexity and the tools and expertise committed to it. The capability for ECS change support is fundamental to ECS readiness.

A.2 PROVIDE EFFICIENT AND EFFECTIVE LIFE CYCLE ECS MANAGEMENT AND SYSTEM ENGINEERING SUPPORT

The technical management and system engineering functions are closely related because ECS and support system acquisition and operation are predominantly engineering and scientifically oriented activities throughout the life cycle. While the technical management function typically relies primarily on management oriented plans and controls, it encompasses the system engineering function particularly in the initial or early stages of the ECS life cycle. The system engineering function, which varies in magnitude with ECS complexity, primarily supports the management function and is dependent upon tools like those in a typical ECS support facility. The system engineering function is significant for continuous ECS change support as well as for ECS support system acquisition and major ECS and associated support system modification and retrofit programs.

A.3 PROMOTE EFFICIENT, EFFECTIVE, AND TIMELY USE OF INTERSERVICE AS WELL AS INTER AND INTRA COMMAND ECS SUPPORT RESOURCES

Several Department of Defense initiatives have been aimed at unifying the various services approach to the support of embedded computer systems. While these initiatives primarily address standardization on a broad range of topics, the advent of joint service weapon system programs raises the potential for complex interservice ECS support arrangements. When viewed in a "western world" context the sharing of available DOD ECS support resources looms as an important, if not overriding, factor in the future support of multiservice ECS acquisitions. In addition, interoperability of the ECS in service and DOD weapon system should benefit from standardization of instruction set architecture, languages, and interfaces along with modular design of ECS and ECS support systems.

A.4 ACQUIRE AND MAINTAIN QUALITY ECS AND ECS SUPPORT SYSTEMS

The quality and supportability of ECS and associated support systems have a direct relationship to the AFSC/AFLC/USER management attention, and the engineering discipline imposed during the planning and acquisition process. Quality and supportability considerations start with clearly stated requirements by AFLC/USER and coordination with AFSC for the initial ECS and support system design. Product quality assurance at or prior to PMRT will be enhanced by application of independent verification and validation techniques. ECS and support systems quality after PMRT is dependent upon adequate documentation which must be acquired with the product and rigorously controlled through automated processes to maintain product baselines.

A.5 ENSURE CURRENCY AND SURVIVABILITY OF ECS SUPPORT SYSTEMS

The currency of ECS support systems is an ongoing activity that affects each category, and encompasses all related or associated support systems for any given weapon system. Changes to the operational ECS or the weapon system initiates a rippling affect throughout the various ECS support systems. While currency of ECS support systems is directly related to ECS mission readiness on a day to day basis, survivability is a concern in the event of hostilities or natrual disaster. Mission essential ECS and support systems should be identified and prioritized, and documentation in the form of geographically separated libraries and repositories must be established and maintained to enable reconstitution of emergency ECS support capability. In addition, fielded or flight line extensions of ECS support facilities should be designed to include redundancy for key elements as a backup capability.

A.6 ACQUIRE AND MAINTAIN ECS TECHNOLOGY AND INTELLIGENCE BASES AND PROVIDE FOR INTERCOMMAND AND INTERSERVICE EXCHANGE AND USE OF DATA

Embedded computer systems and corresponding support systems are an outgrowth of technology and operational requirements for a flexible response to changes in enemy weapon systems and tactics. The use of embedded computers and software permits the developmentof highly flexible weapon systems. ECS technology is progressing at such a rapid rate, when compared to weapon system development, that the potential exists for the use of more advanced technology in ECS suport systems than is incorporated in the ECS itself. This is possible, however, only if the ECS support community is in the technology loop, and is postured to exchange the knowledge and apply it to ECS support needs. Intelligence data, on the other hand, is necessary to ensure ECS quick reaction as well as for preemptive engineering in an environment characterized by the continuous ''move-countermove'' techniques employed by adversaries. This interaction is dependent upon not only access to intelligence data but the ability to influence the collection, analysis and dissemination of the data through clearly stated requirements. The exchange and use of ECS technology and intelligence data enhances completeness and reduces duplication.

A.7 ENSURE AN ATTRACTIVE AND COMPETITIVE ECS MANAGEMENT AND ENGINEERING CAREER FIELD

ECS managers and engineers need improved career management programs. These programs should include qualification and classification standards along with new terms and series for job descriptions and professional degrees for all ECS support skill needs. Special experience identifiers (SEI's) should be established and used for tracking and assigning both military and civil service ECS personnel. The objective is to assign personnel to a challenging job within their area of professional education, training and interest, and provide growth to new challenges and responsibilities through demonstrated performance. Management should ensure equity in the system by using the standards, SEI's and personnel evaluations for assigning, tracking, and promoting ECS support personnel.

A.8 MINIMIZE CRITICAL ORGANIC ECS ENGINEERING, SCIENTIFIC AND TECHNICAL SKILL NEEDS

While the total number of ECS engineering, scientific and technical personnel needed is almost certain to increase in the next decade, this objective addresses the long held logistics maintenance support policy of striving to use lower skilled personnel for long term or extended support tasks. Although ECS support is an engineering intensive activity, certain aspects of the ECS support process, if properly structured and automated, can be definitized and procedurally implemented to change the current skill mix. Another facet of this objective is to reduce the numbers of highly skilled engineers and scientists by centralizing or collecting critical organic personnel resources, with augmentation from industry sources for complementary skills, to satisfy multiple source needs.

A.9 PROVIDE FOR EFFICIENT AND EFFECTIVE TRAINING AND CROSS-TRAINING IN ECS ENGINEERING, SCIENTIFIC AND TECHNICAL SKILLS

The relative immaturity of both management and technical ECS acquisition and support disciplines results in a short supply of experienced personnel. Furthermore, the problem is an engineering intensive and rapidly moving technology based area, such as ECS acquisition and support. Aggressively implemented education, training, retraining and cross-training programs at all levels on a continuing basis offers an opportunity for improvement.

A.10 OPTIMIZE THE COMPLIMENTARY STRENGTHS OF ORGANIC AND CONTRACTOR SKILLS

The acquisition and life cycle support of ECS offers opportunities for a wide variety of skills and disciplines. Industry has traditionally been positioned or postured to perform those tasks that the government has chosen not to do because of mission related requirements, or for economic or other reasons. In an engineering intensive and high technology area, such as ECS acquisition and support, direct competition for scarce highly skilled resources will benefit neither government nor industry. To minimize critical organic engineering, scientific and technical skill needs, industry provides the alternative source. The industry source is also applicable in those cases involving acquisition/support of "one-of-a-kind" or shorter duration, highly specialize activities as well as a complementary supplement for skill needs over a longer period of time. Initial acquisition/development of support systems and augmentation of skill concentrations are also areas particularly well suited and aligned with industry strengths.

A.11 ACCOMPLISH EFFICIENT AND EFFECTIVE ECS SUPPORT COST ESTIMATING, TRACKING AND ACCOUNTING

Management and engineering disciplines are employed in determining the cost of acquisition and ownership of ECS support systems. The separate but related cost functions of estimating, tracking and accounting are interdependent, in that accurate and realistic tracking and accounting provide the historical data base for future estimates. Cost estimating, which is probably the most difficult, is highly dependent upon an adequate financial and engineering data base. The structure of the data base, along with the tools and techniques employed for data collection and use, should address specific systems and categories as well as the ECS support system acquisition and operation and maintenance phases. In addition, all activities should be in concert with existing financial and budget requirements and cycles.

A.12 INFLUENCE THE PROLIFERATION OF ECS AND ECS SUPPORT SYSTEMS

The proliferation of ECS and their attendant support systems has proceeded during the past decade without apparent limits. This combined with technologies in hand and those on the horizon suggests that an increased deliberate effort will be needed to limit the introduction of new technology applications to a manageable and supportable level. A planned approach for the introduction and use of specific technologies is necessary in conjunction with other ongoing Department of Defense and service programs, such as the use of military standard computers, and adoption of the preferred DOD computer program language. Another approach to slowing ECS support system proliferation without impinging on technology is to aggressively pursue alternatives to the general practice of a dedicated one for one relationship between ECS and ECS Support systems.

APPENDIX B

ECS SUPPORT REQUIREMENTS

The support of embedded computer systems is relatively new to the Air Force and has had a significant impact on the Logistics Command. Support responsibilities and requirements have been defined at a top level but a consensus of what the step-by-step requirements are has envolved slowly. During Phase II of the study, TRW looked closely at support requirements for the five ECS categories and identified support requirements that were common to all categories and those that were unique to a particular category. The following sequential listing of ECS support requirements drive the ECS support process and the needed capabilities recommended in the long range ECS support plan.

B.1 ECS LIFE CYCLE SUPPORT REQUIREMENTS

ECS support life cycle responsibilities of AFLC are defined by AFR 800-14 and AFLCR 800-21 to be life cycle management, system engineering and training of support personnel.

B.1.1 Life Cycle Management

AFLC is responsible for support of CRWG activities, which include a coordinated definition of the CRISP. AFLC is also responsible for development of an O/S CMP, prior to PMRT. Following PMRT, they are responsible for management of the weapon system and its support system.

B.1.2 System Engineering

AFLC is responsible for development of a system engineering capability prior to PMRT, and for using this capability to assist in support system definition. After PMRT, they are responsible for system engineering support to the weapon system and its support system.

B.1.3 Training

AFLC is responsible for training its weapon system support personnel.

B 2 PRE-PMRT SUPPORT REQUIREMENTS

AFLC is responsible prior to PMRT for establishment of a support posture. This includes identification of their requirements for support systems to the CRWG, and training of personnel who will support the new weapon system and use the new support system. Also included is identification to the CRWG of support criteria affecting the system design (e.g., standard interfaces, languages, etc.).

B.3 ECS GENERIC SUPPORT REQUIREMENTS

In the Phase II Baseline Reports of the ECS Support Study, 19 generic ECS support activities were identified. These 19 activities were categorized into 6 generic ECS support requirements.

A summary of these generic support requirements follows.

B.3.1 ECS Change

The ECS change management requirement is composed of the following activities

- Receive and process change requests
- Perform preliminary analysis and problem/deficiency definition
- Perform preliminary resource allocation and scheduling

B.3.2 Change Analysis and Specification

This ECS change requirement is fulfilled by the following set of engineering activities, which culminate in a Computer Program Change Proposal (CPCP) for management approval.

- Change feasibility analysis
- Requirements definition/decomposition
- Preliminary design
- Detailed design
- Generate computer program change proposal

B.3.3 Engineering Development and Unit Test

Following approval of the CPCP, following engineering activities are performed.

- Develop the change
- Performed unit test

B.3.4 System Integration and Test

After the module level changes are implemented and unit tested, the following activities are performed to integrate and test the system

- Test ECS system performance
- Test weapon system performance
- Product test reports

B.3.5 Change Documentation

All implemented changes, minor or major, must be reflected in the system documentation, and the configuration management activities to identify and control the system and its documentation performed. The activities necessary to fulfill this requirement are

- Document the ECS Change
- Update the ECS Baseline
- Configuration Management

B.3.6 Certification and Distribution

A central point should exist within the System Manager's (SM) Office who has authority for the following activities

- Certify the change and its documentation
- Distribute revised ECS data
- Provide installation procedures/instructions

B.4 ECS CATEGORY UNIQUE SUPPORT REQUIREMENTS

Support requirements which are unique to certain categories of ECS are summarized in the following subsections and in Table 2-1. These category-unique support requirements are presented in more detail in the ECS Study Baseline Reports (Volumes III through VII).

B.4.1 Concurrency (ATD Category)

The configurations of the primary weapon systemand the ATD must be closely synchronized to provide valid training on the ATD. AFR 57-4 states, "Trainer modifications should lead the weapon system modifications by at least 90 days..." without delaying the weapon system modification release.

B.4.2 Shared Software Support (ATD and C-E Categories)

With modifications developed by the user teams or by contractor under AFLC control, more complex interagency coordination and configuration control is required to ensure a correct definition of contractual baselines, to ensure that the user support team has a knowledge of the LC's contractual activities, and to ensure that the ALC has, at all times, correct baseline umentation.

B.4.3 Intelligence Support (ATD, C-E, EW, and OFP Categories)

There is a growing trend to use embedded computers to give weapon systems a rapid configuration change capability. In the past the need for rapid changes in ECS software was limited to EW and ATD systems. However, the introduction of the Command Control Communications Countermeasures (C^3CM) programs will generate new ECS software change requirements, in addition to generating a host of new support problems. Most of the data needed to make C^3CM ECS software changes is classified secret or higher. In some case the supporting and background data required by the decision making process (technical assessments) is top secret or requires compartmented access.

B.4.4 Rapid Reprogramming (C-E, EW, and OFP Categories)

A dynamic threat environment exists in several areas of the world resulting in changing requirements for system capabilities. These urgent, multiple changes may simultaneously apply to more than one system, thus demanding a rapid reprogramming respc .

B.4.5 Respond to Frequent Change Requests (EW Category)

EW technology is constantly changing. This, coupled with a dynamic threat environment, causes EW system change requests at a higher frequency than the development responses to the changes. Consequently, there is a tendency for changes to compound each other.

B.4.6 Nuclear Safety Criteria (OFP Category)

Embedded computer systems that have a first or second level interface to a nuclear weapon as defined in AFR 122-9 fall in a special category with specific design and test requirements. This includes software used by automata which control critical functions of a nuclear weapon (first level interface) or which respond to or transmit information to automata having a first level interface.

APPENDIX C

SUMMARY OF BASELINE SUPPORT DEFICIENCIES

Current support deficiencies for the ATD, ATE, C-E, EW, and OFP categories were collected/summarized from the Embedded Computer System Study Phase II Report (Volumes III-VII). These summary deficiencies are presented in Tables C-1 through C-5, along with proposed corrective actions to resolve the deficiencies. The corrective actions are embodied in the recommended administrative and programmatic initiatives contained in the long range ECS support plan.

Table C-1. ATD Support Deficiencies Versus Requirements

Support Requirements	Support Deficiencies	Corrective Action
Life Cycle Management	• Mid- and long-term planning is not timely	• Timely preparation of CRISP's and O/S CMP's
System Engineering	• Requirements for trained engineers exceeds supply	• Increase salaries to comparable industrial levels, develop ECS support career ladders
	• Engineers tasked with non-engineering duties	• Expand use of technical support personnel such as technical librarians, data entry operators
Training	• Limited number of trained software engineers and technicians	• Establish career oriented continuing education program
	• No formal training program to upgrade engineering and technical skills	• Establish command wide continuing and cross training education programs
	• Limited understanding of CRWG responsibilities, including CRISP and O/S CMP preparation	• Prepare formal short course on CRISP and O/S CMP preparation and requirements definition for training of new CRWG personnel
Pre-PMRT ECS Support Support System Acquisition	• Timely, detailed CRISP's are not available for support systems planning	• Develop model CRISP's and O/S CMP's for each type of system and assign highly capable engineers to CRWG's for new systems

Table C-1. ATD Support Deficiencies Versus Requirements (Continued)

Support Requirements	Support Deficiencies	Corrective Action
ECS Change	• DEPS/ALC communication needs further improvement	• Further definitions of roles and responsibilities
Change Analysis and Specification	• Organic change specification capability limited due to shortage of engineering personnel	• Improved analysis tools
	• No baseline requirements maintained to allow changes to be specified relative to that baseline	• Maintain baseline requirements
Engineering Development and Unit Test	• Organic analysis of contracted change/unit test plans limited due to shortage of engineering personnel	• Automated CM and Documentation tools, improve S/W analysis tools
	• No interior milestones on even the most complex DEPS mod	• Management action
System Integration and Test	• Test requirements poorly defined due to lack of requirements baseline	• Maintain requirements baseline • Provide traceability of test to requirements in test plan

Table C-1. ATD Support Deficiencies Versus Requirements (Continued)

Support Requirements	Support Deficiencies	Corrective Action
Change Documentation	• Delays of up to 2.5 years were common in providing updated documentation of DEPS changes	• Automated documentation tools
	• No repository exists for ATD baseline data	• Establish repository for baseline data
	• Some ATD have no reliable documentation baseline of any kind	• Automated CM system, automated documentation system, independent quality assurance review of documentation
	• Dual update paths compound the configuration control problems	• Futher definition of roles and responsibilities
	• Configuration control is a laborious process fraught with possibility of error	• Automated CM tools
Certification and Distribution	• Change certification is slow	• Automated documentation tools
Concurrency	• ATD frequency lags weapon system changes by several years	• Analyze/Fund/Contract for ATD Changes concurrent with the weapon system • Determine feasibility of ATD simulator software maintenance on AISF

Table C-1. ATD Support Deficiencies Versus Requirements (Concluded)

Support Requirements	Support Deficiencies	Corrective Action
Commercial ECS	• Planning/Actions to prepare for phaseout of commercial support to commercial ECS frequently not accomplished	• Make CRWG responsible for providing 5 year plans for support/replacement of commercial ECS
Shared Software Support	• Introduces communications and configuration control complexity	• Further definitions of roles and responsibilities
	• Baseline for contracted mod sometimes ambiguous	• Automated CM tools

Table C-2. ATE Support Deficiencies Versus Requirements

Support Requirements	Support Deficiencies	Corrective Action
Life Cycle Management	• Mid- and long-term planning is not timely	• Timely preparation of CRISP's and O/S CMP's
System Engineering	• Requirements for trained engineers exceeds supply	• Increase salaries to comparable industrial levels, develop ECS support career ladders
	• Engineers tasked with non-engineering duties	• Expand use of technical support personnel such as technical librarians, data entry operators
Training	• Limited number of trained software engineers and technicians	• Establish career oriented continuing education program
	• No formal training program to upgrade engineering and technical skills	• Establish command wide continuing and cross training education programs
	• Limited understanding of CRWG responsibilities, including CRISP and O/S CMP preparation	• Prepare formal short course on CRISP and O/S CMP preparation and requirements definition for training of new CRWG personnel
Pre-PMRT ECS Support Support System Acquisition	• Timely, detailed CRISP's are not available for support systems planning	• Develop model CRISP's and O/S CMP's for each type of system and assign highly capable engineers to CRWG's for new systems

Table C-2. ATE Support Deficiencies Versus Requirements (Continued)

Support Requirements	Support Deficiencies	Corrective Action
ECS Change	• Process using MDR's is unresponsive	• Streamline MDR process and procedures
	• ATE test program proliferation	• Establish improved management Information System, auto documentation, and configuration management
	• ATE equipment proliferation	• Enforce MATE and standardization
	• Management understanding of ATE is lacking	• Improve management data and ATE management training
Change Analysis and Specification	• Engineering analysis is complex	• Apply design for testability, bit, etc. to acquisition
	• Analysis responsibility is vague and overlapping	• Consider centralization of analysis and testing responsibilities to one focal point
	• Inadequate test requirement documentation	• Improve acquisition procedure to get necessary documentation
	• RTOK rate is too high	• Improve quality of test programs

Tabie C-2. ATE Support Deficiencies Versus Requirements (Concluded)

Support Requirements	Support Deficiencies	Corrective Actions
Engineering Development and Unit Test	• Many weapon systems are not readily testable	• Apply design for testability emphasis
	• Test program quality is generally poor	• Expand emphasis to get tested programs as described by documentation
	• Technical knowledge is required for both UUT and ATE	• Improve testability, simplify ITAs, improve product quality, ensure adequate ATE
System Integration and Test	• Weapon systems changes sometimes occur with no attendant ATE changes	• Improved configuration management system
	• Many ITA's are too complex	• Resist inserting changes into ITA rather than into ATE
Change Documentation	• Inadequate test requirement documentation	• Improve acquisition planning and procedures to get necessary documentation
	• Inadequate configuration management	• Improve configuration management tools
Certification and Distribution	• No deficiency	• Adequate at present

Table C-3. C-E Support Deficiencies Versus Requirements

Support Requirements	Support Deficiencies	Corrective Action
Life Cycle Management	• Mid- and long-term planning is not timely	• Timely preparation of CRISP's and O/S CMP's
System Engineering	• Requirements for trained engineers exceeds supply	• Increase salaries to comparable industrial levels, develop ECS support career ladders
	• Engineers tasked with non-engineering duties	• Expand use of technical support personnel such as technical librarians, data entry operators
Training	• Limited number of trained software engineers and technicians	• Establish career oriented continuing education program
	• No formal training program to upgrade engineering and technical skills	• Establish command wide continuing and cross training education programs
	• Limited understanding of CRWG responsibilities, including CRISP and O/S CMP preparation	• Prepare formal short course on CRISP and O/S CMP preparation and requirements definition for training of new CRWG personnel
Pre-PMRT ECS Support Support System Acquisition	• Timely, detailed CRISP's are not available for support systems planning	• Develop model CRISP's and O/S CMP's for each type of system and assign highly capable engineers to CRWG's for new systems
	• Current support system funding concepts restrain multisystem ISF development	• Develop modular ISF capable of supporting a family of C-E systems

Table C-3. C-E Support Deficiencies Versus Requirements (Continued)

Support Requirements	Support Deficiencies	Corrective Action
Post-PMRT ECS Support (Generic) ECS Change	• ISF development lags need for ECS support	• Ensure early participation in system design process and ensure support system design is included in development contract
Change Analysis and Specification	• Lack of documentation and nonstandard configuration management procedures constrain rapid problem analysis and change specification	• Develop automated documentation systems • Develop standard configuration management system
Engineering Development and Unit Test	• Rapid change development and testing are constrained by the limited availabity of software support tools	• Develop a comprehensive set of software development tools • Design and develop modular ISF which are extendable • Develop scientific simulations and diagnostic emulators for each family of C-E systems supported by a modular ISF
System Integration and Test	• Integration and testing tools are limited to running the software in a target computer. Diagnostic emulators, simulations, or computer monitoring and control devices are not available to support integration testing	• Develop scientific simulation and diagnostic emulators for each family of C-E systems • Build reprogrammable computer monitoring and control devices capable of supporting multiple C-E systems

Table C-3. C-E Support Deficiencies Versus Requirements (Continued)

Support Requirements	Support Deficiencies	Corrective Action
Change Documentation	• The documentation process consumes an inordinate amount of the change cycle	• Develop standard automated documentation preparation and distribution system
	• Documentation procedures are not uniformally applied to each system	• Emphasize timely preparation of O/S CMP's
	• O/S CMP defining documentation responsibilities are not available for SEL C-E systems	
Certification and Distribution	• Most systems do not have signed O/S CMP	• Emphasize timely preparation of O/S CMP's
	• The TCTO distribution process is slow and cumbersome for distribution of combat system ECS software	• Study automated distribution systems and methods to find more responsive methods of distributing CPCI and documentation
Post-PMRT ECS Support (Category Unique)		

Table C-3. C-E Support Deficiencies Versus Requirements (Concluded)

Support Requirements	Support Deficiencies	Corrective Action
Intelligence	• Properly cleared support facilities and personnel are not in places to support classified ECS software • An intelligence distribution and control system is not in place • Intelligence support requirements have not been clearly defined	• Conduct comprehensive review of intelligence and security requirements • Initial activities necessary to obtain properly cleared facilities and personnel equippped with the required automated support systems
Rapid Reprogramming	• Rapid reprogramming requirement for C-E ystem has not been clearly defined	• Request operational user define need for rapid reprogramming and preemptive engineering
High Change Frequency		

Table C-4. EW Support Deficiencies Versus Requirements

Support Requirements	Support Deficiencies	Corrective Action
Life Cycle Management	• Mid- and long-term planning is not timely	• Timely preparation of CRISP's and O/S CMP's
	• Requirements for trained engineers exceeds supply	• Increase salaries to comparable industrial levels, develop ECS support career ladders
	• Engineers tasked with non-engineering duties	• Expand use of technical support personnel such as technical librarians, data entry operators
Training	• Limited number of trained software engineers and technicians	• Establish career oriented continuing education program
	• No formal training program to upgrade engineering and technical skills	• Establish command wide continuing and cross training education programs
	• Limited understanding of CRWG responsibilities, including CRISP and O/S CMP preparation	• Prepare formal short course on CRISP and O/S CMP preparation and requirements definition for training of new CRWG personnel
Pre-PMRT ECS Support Support System Acquisition	• Timely, detailed CRISP's are not available for support systems planning	• Develop model CRISP's and O/S CMP's for each type of system and assign highly capable engineers to CRWG's for new systems
	• Current support system funding concepts restrains multisystem ISF development. ISF development often lags needs for ECS support	• Develop modular ISF capable of supporting a family of C-E systems

Table C-. EW Support Deficiencies Versus Requirements (Continued)

Support Requirements	Support Deficiencies	Corrective Action
ECS Change	• Inadequate baseline documentation	• Require proper documentation with delivered systems and support systems
	• Improved communications needed	• Networking of key elements
	• Additional software analysis tools	• Improve analysis tools
	• Improved intelligence data interfaces	• Further define roles and responsibilities for intelligence
Change Analysis and Specification	• Additional software analysis tools	• Improve analysis tools and engineering training
	• System flexible EWOLS capability needed	• Develop flexible EWOLS and scenario generator
	• Need improved engineering data	• Require proper engineering data
Engineering Development and Test	• Additional test tools needed	• Develop test tools
	• Standard test scenarios needed	• Develop scenario generator
	• Need improved engineering data	• Automated documentation tools
		• Configuration manatement tools

Table C-4. EW Support Deficiencies Versus Requirements (Continued)

Support Requirements	Support Deficiencies	Corrective Action
System Integration and Test	• Improved capability to test integrated system	• Develop test tools and analysis tools
		• Exchange capabilities and expertise where practical
Change Documentation	• Incomplete documentation	• Automated documentation tools
	• Slow change process via using TCTOs	• Develop alternative method to TCTOs for software changes
	• No repository exists for baseline data	• Establish repository capabilities
	• Configuration control is inadequate	• Configuration management tools and a centralized data base
Certification and Distribution	• Inadequate automated documentation tools	• Automated documentation tools
Rapid Reprogramming	• Inadequate communication for changing deployed systems	• Develop area reprogramming capability and improve interfaces to intelligence data
	• Only manual capability exists	• More automated analysis, CM, and documentation tools
Frequent Changes	• Change requests frequency higher than response capability for some systems	• Establish block changes to EW systems except for emergencies

Table C-5. OFP Support Deficiencies Versus Requirements

Support Requirements	Support Deficiencies	Corrective Action
Life Cycle Management	• Mid- and long-term planning is *not* timely	• Timely prepration of CRISP's and O/S CMP's
System Engineering	• Requirements for trained engineers exceeds supply	• Increase salaries to comparable industrial levels, develop ECS support career ladders
	• Engineers tasked with non-engineering duties	• Expand use of technical support personnel such as technical librarians, data entry operators
Training	• Limited number of trained software engineers and technicians	• Establish career oriented continuing education program
	• No formal training program to upgrade engineering and technical skills	• Establish command wide continuing and cross training education programs
	• Limited understanding of CRWG responsibilities, including CRISP and O/S CMP preparation	• Prepare formal short course on CRISP and O/S CMP preparation and requirements definition for training of new CRWG personnel
Pre-PMRT ECS Support Support System Acquisition	• Timely, detailed CRISP's are not available for support systems planning	• Develop model CRISP's and O/S CMP's for each type of system and assign highly capable engineers to CRWG's for new systems
	• Current support system funding concepts restrains multisystem ISF development. ISF development often lags need for ECS support	• Develop modular ISF capable of supporting a family of OFP systems

Table C-5. OFP Support Deficiencies Versus Requirements

Support Requirements	Support Deficiencies	Corrective Action
ECS Change	• Procedures established locally and implemented manually	• Standardized and automated procedure and process to reduce workload and permit aggregate tracking and status accounting
Change Analysis and Specification	• Baseline and analysis tools not well defined	• Improved analysis tools and documented baselines
	• Nonstandard procedures and terminology	• Adoption of standard procedure and terminology
Engineering Development and Unit Test	• Lacks common structure and implementation	• Adopt standard structure, terminology and procedure
System Integration and Test	• Various integration and test configurations and capabilities	• Standardize capabilities • Establish modular reconfigurable facilities
Change Documentation	• Manual labor intensive systems with varying quality	• Standardize documentation set and automatic process
	• No standard set of documents or procedures	• Automated configuration management tools
Certification and Distribution	• May take up to 4-6 months after photo copy is produced, no priority with ALC technical publications	• Automate documentation generation and publication processes

Table C-5. OFP Support Deficieincies Versus Requirements (Continued)

Support Requirements	Support Deficiencies	Corrective Action
Nuclear Safety Criteria	• No provisions for other than ICBM's	• Not currently required for aircraft systems • Adopt ICBM approach for cruise missiles and aircraft when and if required
ECM and ECCM	• No provisions for intelligence gathering or application and no capability for preemptive engineering	• Establish ECS readiness capability

APPENDIX D

EISF CONCEPT APPLIED TO GROUND EW SYSTEMS

The extendable integration support facility (EISF) concept presented in Section 4.2 was developed to satisfy a wide variety of embedded computer system support needs. This appendix illustrates how this concept could be applied to a ground EW ISF by incorporating the current investment and with minimum impact on the current ISF design. Table D-1 lists the ground EW systems which are operational or will PMRT in the next three years. The ISF network shown in Figure D-1 accommodates these systems and could serve as a model for a more definitive prototype design. All of the systems shown in Figure D-1, enclosed in solid symbols, are currently in place except for the Network Interface Units (NIU) and additional INTEL microprocessor development system (MDS), which host the hardware simulation kernels. Work is in process at SM-ALC on Simulation Kernel design, however, only one prototype has been started. The efficiency of this ISF architecture could be improved by adding a communications network and sharing of peripheral systems.

The network interface unit shown in Figure D-2 and its associated network communication protocols have not been designed beyong the conceptual level. Additional engineering design and software development are required prior to building the EISF prototype. In addition to development of the communications software, a multiprocessor/multiuser operating system must be developed or adapted from commercially available software. This software and the NIU design and support software are crucial components and are prototype development pacing items. However, with a decision to develop ECS support networks, the design of protocols which are compatible with both long haul and local networks may become the pacing item.

Once a standard work station has been specified, designed, and built, the S-100 work stations, shown in this example, should be replaced. The development of a standard work station prototype could be developed as a separate project of as a total development package for eventual use in other ISF's.

Table D-1. Ground EW Systems (ECS Support Required)

Title	Designation	PMRT	Host
EW Range Radar System	MPS-T1	OPER	Motorola 68000
Tactical Radar Threat Generator	TRTG	4/80	Motorola 6800
AAA Radar Simulator	MPQ-T3	2/81	NOVA-4
Multiple Threat Emitter System	MST-T1A	3/81	Eclipse S130
Multiple Receiver Analysis System	MSR-T1	3/82	HP-1000F(2)
Modular Threat Emitter	MTE	2/83	NOVA 4
Ground Jammer	MLQ-T4	3/83	LSI 11/23

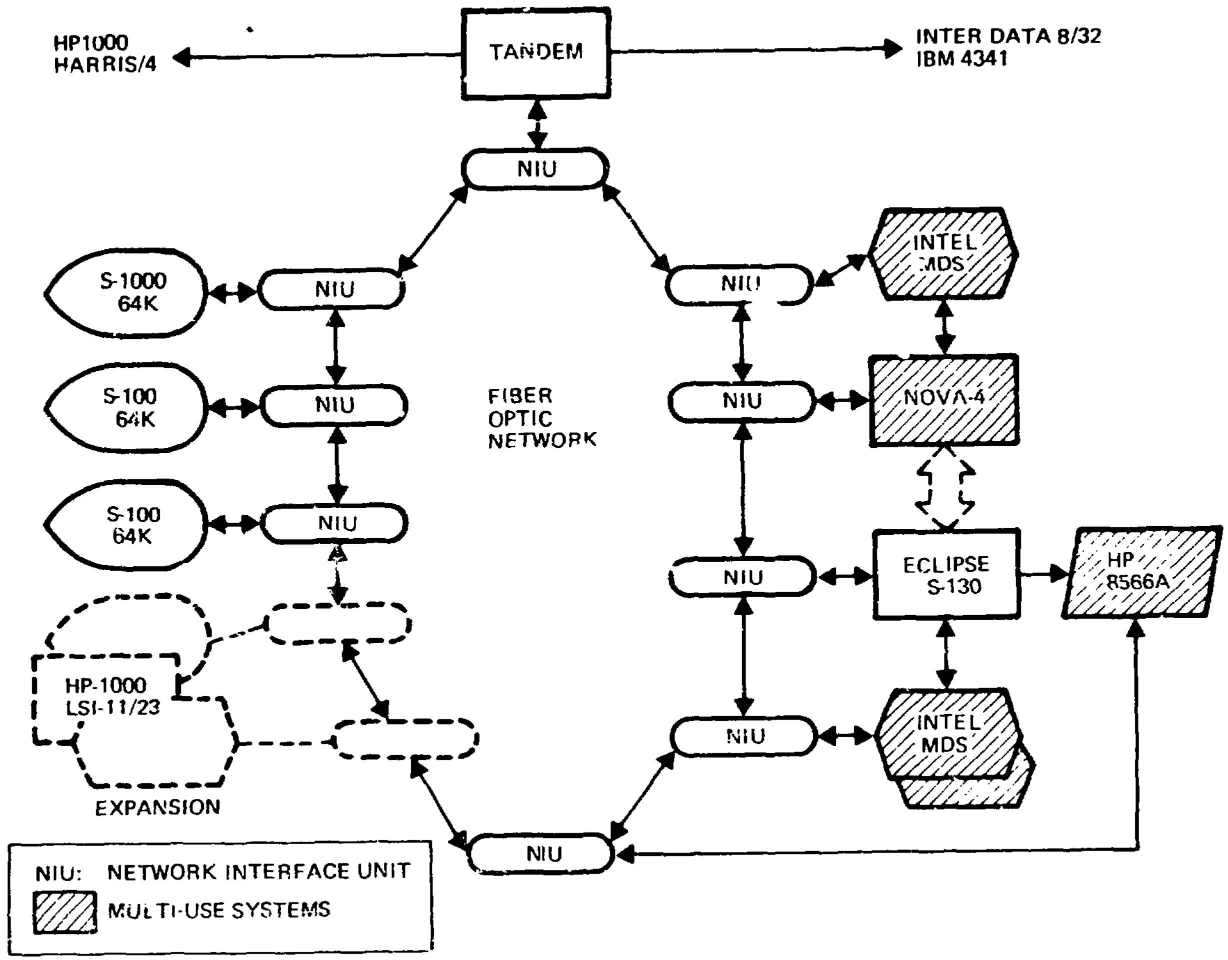

Figure D-1. Prototype ISF Network

The network interface unit shown in Figure D-2 and its associated network communication protocols have not been designed beyond the conceptual level. Additional engineering design and software development are required prior to building the EISF prototype. In addition to development of the communications software, a multiprocessor/multiuser operating system must be developed or adapted from commercially available software. This software and the NIU design and support software are crucial components and are prototype development pacing items. However, with a decision to develop FCS support networks, the design of protocols which are compatible with both long haul and local networks may become the pacing item.

Once a standard work station has been specified, designed and built, the S-100 work stations, shown in this example, should be replaced, The development of a standard work station prototype could be developed as a separate project or as a total development package for eventual use in other ISF's.

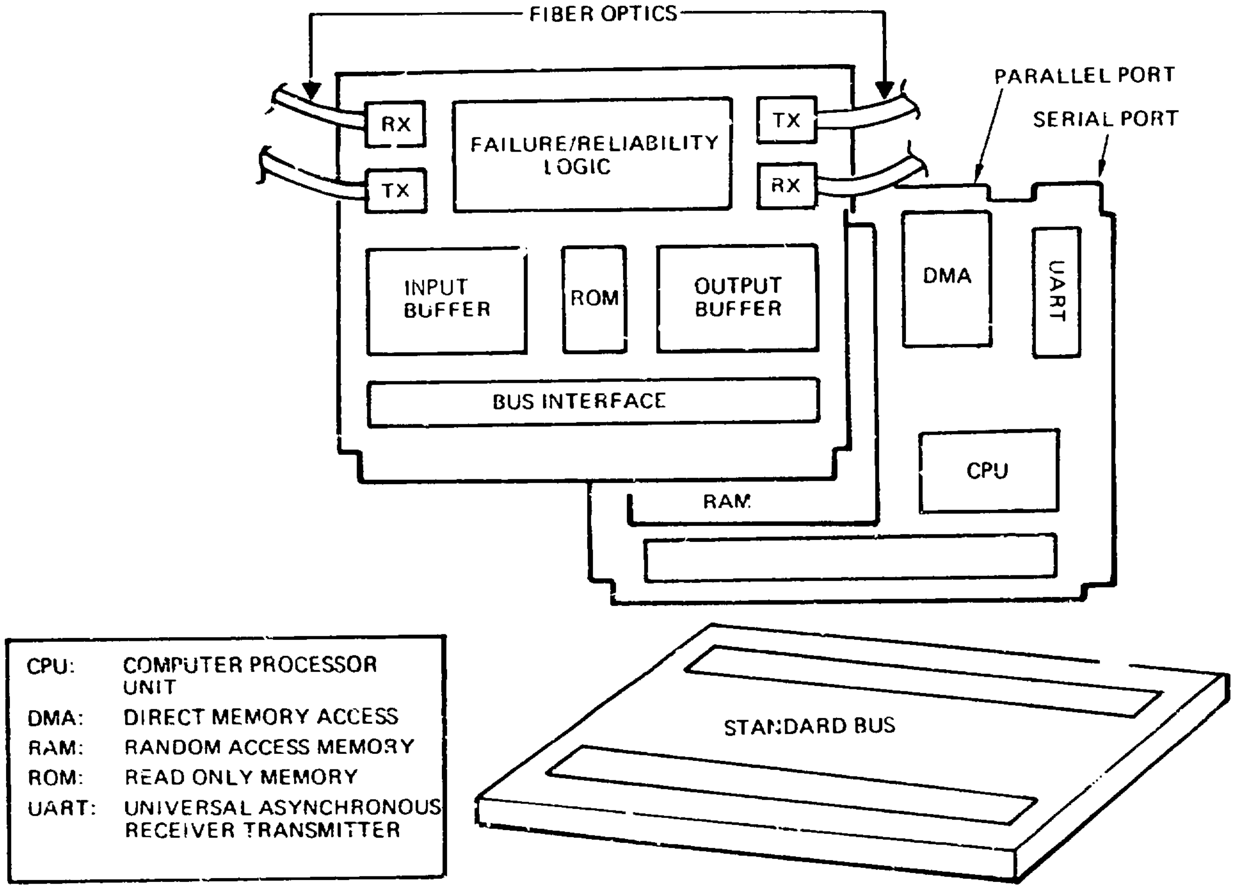

Figure D-2. Network Interface Unit