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MTR-1875

MODELS OF INFORMATION EXCHANGE AND DATA RATES FOR A POST-1975 AUTOMATED TACTICAL AIR CONTROL SYSTEM DEPLOYMENT

E.A. Babineau
E.D. Howes

OCTOBER 1971

Prepared for

DEPUTY FOR PLANNING AND TECHNOLOGY
ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
L. G. Hanscom Field, Bedford, Massachusetts

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Project 603B

Prepared by
THE MITRE CORPORATION
Bedford, Massachusetts

Contract F19(628)-68-C-0365

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FOREWORD

This document has been prepared by The MITRE Corporation under Project 603B of Contract F19(628)-68-C-0365 as part of the development efforts for the automation of the Tactical Air Control Center. It deals with the elements of the Tactical Air Control System and the information flow therein. The contract is sponsored by the Electronic Systems Division, Air Force Systems Command, L. G. Hanscom Field, Bedford, Massachusetts.

REVIEW AND APPROVAL

Publication of this technical report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.

Daniel E. McPherson Jr.

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ABSTRACT

Some changes in operations and technology will be introduced in the post-1975 TACS. Among these will be the use of digital secure voice and data management automation. To permit the development of Air Force ground environment communications requirements for the TACS of this era, estimated total point-to-point data rates are needed. The anticipated TACS operations, with some expected changes, are modeled. The resulting information exchange data rates for the total ground environment is about three megabits. This total data rate is impacted far more because of use of digital, secure voice than because of introducing data management automation. The two operational concepts which are modeled prove to have nearly identical data rate patterns.

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GLOSSARY

AAVD	Aerospace Audio Visual Detachment
AC&S	Aircraft Control and Warning
AECC	Aeromedical Evacuation Control Center
AELO	Aeromedical Evacuation Liaison Office
AELT	Aeromedical Evacuation Liaison Team
AES	Armament and Electronic Squadron
AFCC	Air Force Component Commander
AFCCP	Air Force Component Command Post
AFCTC	Air Force Combat Theater Communications
AFSC	Air Force System Command
AFW/S	Attack Fighter Wing/Squadron
ALCC	Airlift Control Center
ALCE	Airlift Control Element
APCC	Aerial Port Control Center
APS/D	Aerial Port Squadron/Detachment
ARRS/D	Air Rescue and Recovery Squadron/Detachment
ASRT	Air Support Radar Team
ATH	Air Transportable Hospital
AWACS	Aircraft Warning and Control Squadron
BACP	Base Airlift Command Post (MAC)
CAS	Close Air Support
CCT	Combat Control Team
CES	Civil Engineering Squadron
CRC	Control and Reporting Center
CRP	Control and Reporting Post
CRT	Cathode Ray Tube (Display Device)
CSF	Casualty Staging Facility
CSG	Combat Support Group
CSPS	Combat Security Police Squadron
DALO	Director of Airlift Operations
DASC	Direct Air Support Center
DCO	Director of Combat Operations
DI	Director of Intelligence
ERU	Emergency Reaction Unit
ESD	Electronic System Division (of AFSC)

GLOSSARY (Continued)

FAC	Forward Air Controller
FACP	Forward Air Control Post
FEBA	Forward Edge of the Battle Area
FMS	Field Maintenance Squadron
HS	Hospital Squadron
IFAO	Internal Flight Administration Organization
JOC	Joint Operational Command
JSARC	Joint Service Air Rescue Center
JTF	Joint Task Force
LBRS/D	Local Base Rescue Squadron/Detachment
MAC	Military Airlift Command
MCE	Mobile Communications Element
RECCE	Reconnaissance
RHU	Red Horse Unit
RITS	Reconnaissance Intelligence Technical Squadron
RTS	Reconnaissance Technical Squadron
SS	Supply Squadron
SOS	Special Operations Squadron
SVS	Service Squadron
TAB	Tactical Air Base
TABWE	Tactical Air Base Weather Element
TACC	Tactical Air Control Center
TACP	Tactical Air Control Party
TACS	Tactical Air Control System
TALO	Tactical Airlift Liaison Officer
TASS/D	Tactical Air Support Squadron/Detachment
TATCE	Terminal Air Traffic Control Element
TAW/S	Tactical Airlift Wing/Squadron
TEWS/E	Tactical Electronic Warfare Squadron/Element
TFW/S	Tactical Fighter Wing/Squadron
TH	Tactical Hospital
TOC	Tactical Operation Center (U. S. Army)
TRW/S	Tactical Reconnaissance Wing/Squadron
TS	Transportation Squadron
TUOC	Tactical Unit Operation Center

GLOSSARY (Continued)

WXS/E/D	Air Weather Squadron/Element/Detachment
407L	A generic term used to describe TACS equipment of the era circa 1970. Derived from the number of the procurement program for this equipment.

1.0 INTRODUCTION

The advances of technology in the field of Tactical Command and Control must be of concern to those who plan the future requirements for communications in a tactical environment. In particular, the use of digital trunking in the point-to-point TACS ground environment communications is anticipated because of the growing interest in security, better multiplexing, flexibility, adaption of anti-jam methods, the introduction of data management automation, and other related technical improvements. Because final configurations of most of these factors have not been determined to date, it makes specific system design efforts on the supporting tactical communications an impossibility. However, a parametric analysis of the impact of these technical changes to TACS on the future tactical communications has been initiated by ESLT* to prepare for such a design effort. This study is being conducted by MITRE under Project 603B. This report provides a description of communications traffic models which have been evolved to provide a basis for the study.

1.1 Summary of Findings

The information exchanges carried out using a centralized operational concept differ greatly from those of a distributed operational concept in both content and direction of flow. However, the net, point-to-point digital traffic rates flowing between the key locations within the ground environment communications of the TACS are essentially the same for the two concepts. The total digital traffic circulation for the busy hour is about three megabits without imagery transmission local to the theater. By introducing a projected simple tactical imagery distribution subsystem to some key theater points, the total busy hour circulation rises to about fifteen megabits. Although some differences are projected for data transmission with the introduction of automation, voice traffic o. a digital nature (under the MALLARD system assumption of an all-digital communication system using 19.2K bit secure voice) will still comprise 80 to 90 percent of the total non-imagery traffic. Users of the digital traffic rates developed in this paper must carefully consider the constraints placed on the development, and properly apply them to the system under analysis to achieve consistent results. Figure 1-1 provides a summary of the developed traffic figures effective for both operational concepts.

1.2 Purpose

At present, a variety of approaches to modernizing the TACS are under consideration; each approach would require some unique support capabilities from a tactical communication subsystem. To

* ESLT (now XRL) is the symbol for the General Purpose Forces Systems Planning Division under ESD's Deputy for Planning and Technology.

RECEIVING LOCATIONS

SENDING LOCATIONS

	TAB 1	TAB 2	TAB 3	TAB 4	TAB 5	TAB 6	TAB 7	DASC 1	DASC 2	CRC	CRP 1	CRP 2
TAB 1		16.3 / 30.7	68.1 / 11,580	18.3 / 32.7	16.3 / 30.7	13.7	16.3	18.2	17.8	42.6	7.8	
TAB 2	16.3 / 30.7		71.0 / 11,590	18.2 / 32.6	16.2 / 30.6	13.7	16.7	10.0	10.3	42.1		7.8
TAB 3	61.5 / 75.9	58.1 / 72.5		62.6 / 77.0	67.0 / 81.4	65.3	70.4	35.8 / 50.2	35.8 / 50.2	55.8		
TAB 4	18.3	18.2	36.5		18.2	16.8	16.3	2.6	2.6	40		
TAB 5	16.3	16.2	95.8	18.9		13.7	18.9	2.6	2.6	45.5		
TAB 6	13.7	13.7	75.8	14.8	13.7		19.1	2.6	2.6	21.4		
TAB 7	16.2	16.8	79.0	16.6	17.3	19.1		6.6	6.6	43.2		
DASC 1	4.3	3.9	36.8	2.2	2.2	0.3	2.0		9.4	14.5	3.7	
DASC 2	3.9	4.3	36.8	2.2	2.2	0.3	2.0	9.4		14.5		3.7
CRC	53.2	48.8	162.5	45.4	51.1	26.9	36.7	25.6	25.6		27.2	27.2
CRP 1	7.8		1.0					3.4		27.2		24.0
CRP 2		7.8	1.0						3.4	27.2	24.0	

KILOBITS PER SECOND / PER BUSY HOUR

POINT TO POINT TRAFFIC SUMMARY DENSITIES FOR DISTRIBUTED OR CENTRALIZED CONCEPT

FIGURE 1 - 1

analyze the impact of these modernizing efforts, a tool is needed. This tool should provide total and point-to-point digital data rates for the communication environment to be studied. The purpose of this paper is to describe the development of the required tool, and make the resulting data rate tables available for use by analysts who are weighing various communication configurations.

1.3 Scope

In an attempt to bound the operational concepts expected for the TACS in the post-1975 era with the resulting data rates, two models of TACS operations are needed. One deals with a centralized approach to operations and introduces large computer complexes with remote entry and retrieval capabilities. The other covers a distributed approach introducing small computers in most centers with communications between them. In both concepts, 19.2K bit secure digital voice, teletype, and facsimile data transfer methods are used in addition to the digital transfer inspired by the introduction of computers. The communications traffic resulting from the two models contain many "worst case" requirements permitting evaluations which will hopefully bound the expected problems. Changes to today's operational doctrine are held to a minimum.

The communication models cover only the ground environment exchange of information within the TACS; all interchanges between non-colocated TACS operating centers are covered. Air-air, air-ground, or ground-air-ground interchanges are covered only to the extent that they are part of an interchange between two ground stations; in general, exchanges with aircraft are not covered. Intra-base exchanges (between colocated operating centers) are not covered. In short, the organic TACS communications used for base-to-base information exchange are being studied.

1.4 Background

Any modeling of communications for an altered TACS must be developed from the capabilities and practices of today's TACS. This requires an appropriate scenario/model of a deployed TACS from which the modeling and analyses can be initiated. ESLT/ESD has provided a combat theater force deployment and TACS communications model as products of contract number F19(628)67-C-0426 with the Bunker-Ramo Corporation. These products, describing the Air Force theater component required to support a two-Corps Army deployed in Western Europe, relates to an Army model developed by the MALLARD Project.

The AF/MALLARD model specifically emphasizes communication requirements, traffic volumes and flow patterns. It employs the current techniques of using point-to-point, 3 KHz, frequency-multiplexed voice channgels coupled with today's primarily manual command and control techniques, as building blocks for the tactical theater communication subsystem. As such, the AF/MALLARD model demonstrates a picture of today's TACS in sufficient detail to allow it to be used as a base for this effort in model building. Moreover, the geographical layouts and troop lists used for the AF/MALLARD models are sufficient to allow their use in the new model. The thorough definition of traffic volumes and flow patterns of the AF/MALLARD model form a definite point-of-departure for derivation of similar figures/patterns for the new models. The MALLARD assumption of an all digital communications system using 19.2K bit secure voice is employed in the new models.

2.0 CENTRALIZED OPERATIONAL CONCEPT

The object of developing this operational concept of automating a post-1975 TACS is to present an approach in which the computer placements and resulting processing functions are highly centralized. The overall goal of any TACS operational effort is improvements in the efficiency and effectiveness of planning and controlling the mission activities of the air component. This centralized concept involves detailed planning of all air missions at a single center. Execution of the missions is decentralized. The overall approach to doing business is similar to that found in today's TACS.

The centralized operational concept features the following:

a. Maintenance of the data base at two large processing centers where planning and control originate.

b. Flight following at Complex A from summaries produced from sensor data processed at Complex B.

c. Detailed mission and flight planning performed at Complex A for combat and airlift missions except close air support, and defensive counterair.

d. Complex B plans and controls defensive counterair missions.

e. All close air support missions planned at DASC's.

The description of this concept begins by locating the operational components which make up the changes to today's TACS and then outlining their functions. With the locations and functions of these components established, the operational approach to fighting the tactical theater air battle is developed. The information flow patterns of several types of missions are then traced.

2.1 The Components of TACS

The centralized operational concept is implemented with two types of equipment aggregates: computer complex and exchange terminal complex. Figure 2-1 shows a generalized geometric layout of a tactical theater; the types of equipment are shown distributed throughout this theater in the manner envisioned for the centralized operational concept. The names used to identify the operating centers in today's TACS are carried over into the centralized concept for convenience; the functions of these centers may be changed to fit this operational concept.

2.1.1 The Computer Complexes

True centralization would call for all capability to be located at a single center. The vulnerability of so large a concentration plus the chaos which would result from loss of capability precludes this absolute approach. Therefore, it was decided that the centralized operational concept would incorporate two computer complexes as a basis; each would handle a portion of the tasks which lend themselves to automating, and each would supply some back-up support to the other. Each of these information complex nodes will be equipped with a large, multi-processor, computer configuration using third/fourth generation techniques coupled with a large scale memory subsystem. The sizes of these processing nodes or the hardware/software approaches used to meet the requirements placed on these nodes are beyond the scope of this paper; other organizations are working on the definition of these specifications. What is more important for this study is the functions performed by each node, and the movement of information resulting from their needs and performance.

The first computer complex fulfills the role of a headquarters unit and is located at the AFCCP/TACC/ALCC campus of today's TACS. The second computer complex acts as a sensor summary center monitoring all theater-related activity; it is located at the CRC site in today's TACS. Specific functions performed by each of these information nodes are:

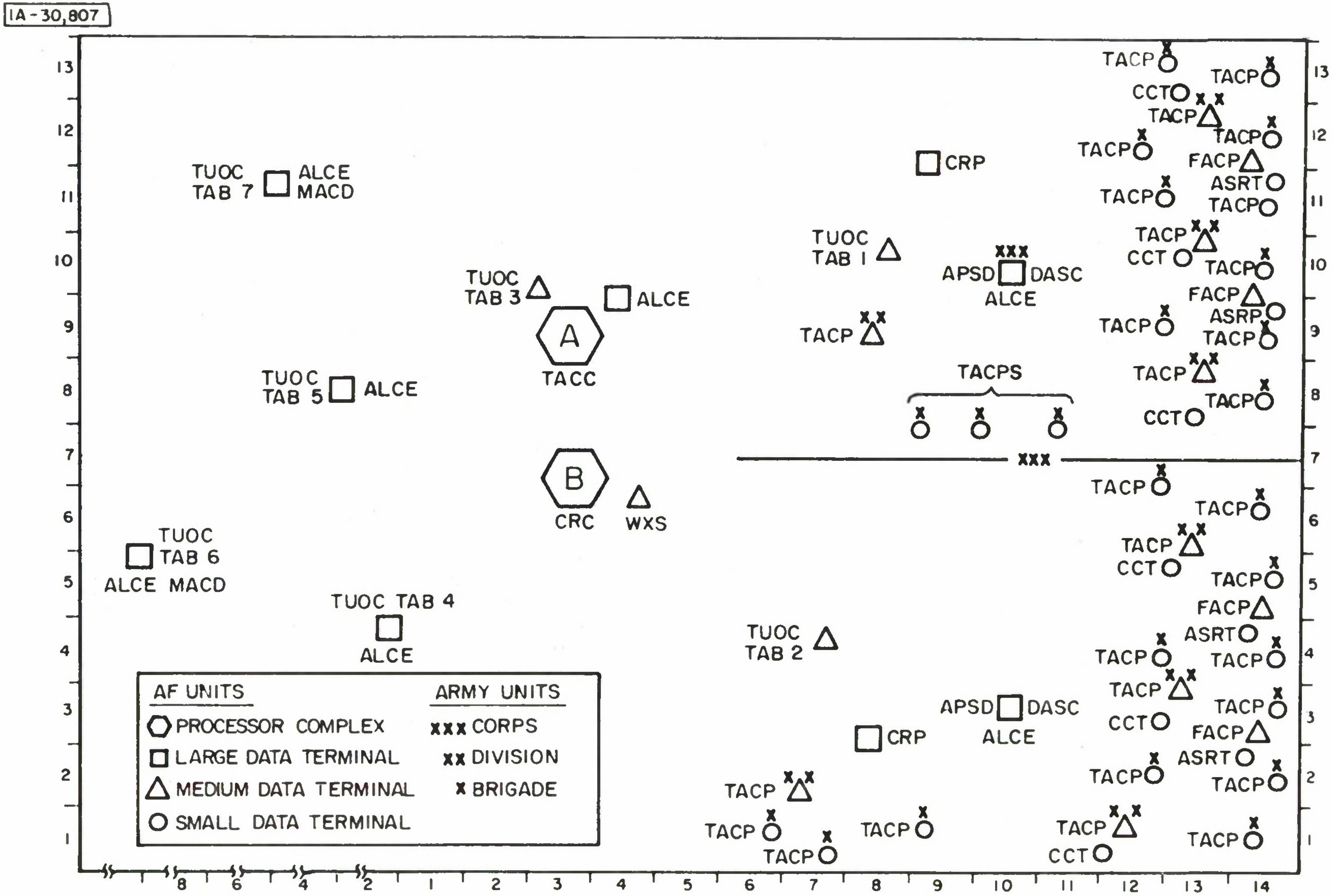

Figure 2-1 : GENERALIZED GEOMETRIC LAYOUT OF ELEMENTS CENTRALIZED OPERATIONAL CONCEPT

A. The Headquarters Processing Node

This processing node serves the Air Force Component Commander and his staff. The three major users of the processing node are the Director of Intelligence (DI), the Director of Combat Operations (DCO), and the Director of Airlift Operations (DALO). This would include the functions of the TACC and ALCC in today's TACS. For identification purposes, this processing node is shown on Figure 2-1 as Complex A and is denoted as the TACC to correspond to a similarly located center in the AF/MALLARD deployment. Specific functions performed by Complex A for the three major users include:

a. The Director of Intelligence Functions

Complex A will provide the DI staff with the capability to store and update an intelligence data base, including information concerning enemy disposition, capabilities and intentions. Order of battle information, including both air and electronic situations will also be maintained by Complex A. A significant portion of the intelligence data base will come as sensory data summaries from Complex B. The DI staff will use Complex A to perform sorts of the intelligence data base to produce target lists and develop target systems. The DI staff will analyze these targets with the aid of Complex A, assign priorities, and forward target recommendations to the DCO staff. Intelligence estimates of the enemy threat and individually localized dangers to flight operations will be developed by the DI staff using the capabilities of Complex A, and will be disseminated to all affected organizations in the tactical theater. Reconnaissance mission requirements will be produced by Complex A in a similar manner under direction of the DI staff. The DI staff will assemble and given intelligence briefings, as required, using the intelligence data base and processing capabilities of Complex A. The type of intelligence functions to be performed using Complex A are, therefore, of the policy-making nature in contrast to the data compilation functions performed using Complex B.

b. <u>The Director of Combat Operations Functions</u>

The DCO with his staff is charged with planning for and commanding the activities of the combat family of interest within the Air Force tactical theater component, subject to the overall direction of the AFCC. Among the missions performed by the combat family of interest are: Counter-air, Interdiction, Close Air Support, Reconnaissance, Aerial Refuelling, and Search/Rescue. Complex A will provide the DCO and his staff with the capability to store and update a resource data base for the combat family. This data base includes the status of each resource within the combat family and located in the theater; it is normally updated from the TUOC's and other elements. Complex A will receive summaries of the current theater air and weather situations from Complex B and store them as part of the data base. Complex A will provide the DCO and his staff the ability to perform various sorts and ordering of portions of the data base. This will aid the DCO and his staff in planning the activity of the combat family, monitoring the process of the air battle, and reacting to emergency situations. By virtue of the stored data base, Complex A will allow easier dissemination of information throughout the DCO staff. This will promote closer coordination of the support activities, such as refuelling and ECM activity, with the actual combat mission planning. Complex A will also provide the means of formatting and distributing mission requirements to all affected organizations in a timely manner.

c. <u>The Director of Airlift Operations Functions</u>

The DALO with his staff is charged with planning for and commanding the activities of the airlift family of interest within the Air Force tactical theater component, subject to the overall direction of the AFCC. Among the missions performed by the airlift family of interest are: logistic airlift operations consisting of air movements of material or personnel; airborne operations consisting of delivery and resupply of airborne units directly into combat positions; and aeromedical evacuation of casualties from forward staging areas. Complex A will provide the DALO and his staff with the capability to store and update the status of all resources associated with the airlift family and located in the tactical theater. Complex A will receive and store requests and priorities for airlift support received from the joint transport management board, from deployed elements of the theater component, and from the diverse sources throughout the theater which require such support. All summary cargo information, status and updates, will be listed and stored in Complex A as an active item from the time the cargo unit enters the theater until it is delivered to the ultimate user. Complex A will provide the capability to manipulate this large data base under direction of the DALO and his staff to produce a prioritized airlift movements list and match it to airlift missions planned to make maximum use of available resources. This activity includes the coordination of all pertinent factors in the airlift data base as well as required support from the combat family of interest. Complex A will receive, store, display and maintain the status of all airlift missions, following both aircraft and cargo throughout the mission. As emergencies arise, the DALO and his staff will use the capabilities and data base of Complex A to evaluate the situations and develop alternate courses of action to alleviate the emergency. Complex A will also provide the means of formatting and distributing mission requirements to all affected organizations in a timely fashion.

B. The Sensor and Control Processing Node

This processing node is a natural focal point for data derived from aircraft-to-ground communications. In this operational concept, the node also acts as a focal point for all data obtained from sensors deployed/operated by the Air Force tactical theater component. The three major functions performed by this node are: aircraft control, defensive counterair mission control, and sensor data processing. For identification purposes, this processing node is shown on Figure 2-1 as Complex B, and is denoted as the CRC to correspond to a similarly located center in the AF/MALLARD deployment. Specific functions performed by Complex B include:

a. Aircraft Control

Complex B will assume the role of controller of the activities of the Aircraft Control and Warning family. One prime function of the AC and W family is control of the friendly aircraft flying within the combat theater airspace. Complex B provides the capability to receive, store and update mission flight plans and other information relating to friendly aircraft passing through the airspace.

In addition, Complex B will store and update information concerning various real or potential hazzards to aircraft in the theater. From this data base, the staff of the complex can use the processors to sort, identify, and assign priority to various missions to be flown in the airspace during a given performance period. The parameters of the mission flight paths can be pulled out of the data base by Complex B and distributed to the other AC&W family locations for relay to appropriate aircraft. As a given mission progresses, Complex B will receive status on the mission from the AC&W family. This status will be condensed by Complex B, and distributed to Complex A and other affected centers. Complex B will interact with local (host nation) air controllers, with the International Flight Administration Organization (IFAO), and other service air controllers to produce a homogeneous operation in the theater.

b. Defensive Counterair Operations

Complex B will be the control point for all counterair operations carried on by the Air Force tactical theater component. The DCO and his staff at Complex A, acting on hostile air threat evaluations prepared in part at Complex B, will assign a block of aircraft/missions to be used for defensive counterair operations during the next performance period. This block allocation will be under control of the battle commander located at Complex B; all resource status and information on the block allocation will be stored and maintained by Complex B. When a hostile track is identified by the sensor section of Complex B or by one of the other AC&W theater operating locations, the air defense staff will evaluate the threat using Complex B to provide detailed flight parameters. The air defense staff will direct Complex B to sort through the resource data base to produce alternative plans for neutralizing the threat. When the air battle commander approves one of the alternatives, Complex B will prepare and distribute directives (such as scramble orders) to affected organizations, and will continually pass information to the aircraft control section of Complex B and other AC&W centers to enable proper control of air defense aircraft. Complex B will aid the air defense staff to interact with the Army theater air defense organizations to maintain a consistent and effective application of all forces to the defensive counterair tasks. Complex B will receive, store and maintain a status data base on all defensive counterair activities.

From this data base, summary bulletins of these operations will be prepared and distributed by Complex B to Complex A and other affected organizations as required.

c. Sensor Data Processing Operations

In the current TACS, the AC&W family radar operations supply a large portion of the sensor-derived data in the tactical theater. Many other types of sensors are beginning to be given widespread use in a tactical theater. In the post-1975 era, such volumes of data from diverse sensor systems located throughout the theater are expected that large scale processing, screening, and condensing of the data to gleen the intelligence it contains will be required to prevent the raw data from overwhelming the future TACS. This operational concept calls for Complex B to receive, store and process all this sensor-derived data including radar data. Each sensor system will require Complex B to apply a different screening technique to its data, but the general approach will emphasize and highlight changes in the environment monitored by the sensor system. The sensor processing staff will be presented with screened information by Complex B; they will evaluate this information and decide on how it is to be used. Complex B will then assemble advisaries from the information selected and evaluated by the sensor staff, format these advisaries and distribute them as required. Complex B will aid the sensor staff in interacting with other sensor systems operated by other services/host nation organizations to allow the exchange of useful information.

2.1.2 The Terminal Complexes

Throughout the last section on computer complexes, mention was made of interactions between the Air Force staff personnel and the processor/memories. Some mechanism or mechanisms are required to facilitate this interchange. For this reason, the centralized operational concept calls for terminal complexes. Each of the computer complexes has colocated with it a terminal complex. In addition, various sized terminal complexes are located at each element of the Air Force tactical theater component to promote a digital message exchange capability throughout the theater. Several configurations are possible for terminal complexes depending upon location and the use to which the terminal is put. Some of the types of terminals and their functions are:

A. Colocated Planning Terminals

One general type of terminal used in this operational concept is colocated with the computer complex and driven by it. The function of these terminals is to display information stored in the processor/memory system to allow an operator to assimilate, manipulate, update and evaluate that information. Among the individual categories of terminals of this type are:

a. Alpha-Numeric Manipulators

This type of terminal is composed of a CRT viewing screen, an alpha-numeric keyboard, and a set of controls. By means of the keyboard and controls, an operator can communicate with the processor. The communication usually involves a request to display certain information, a request to remove information from the display, or a request to apply a certain process to some information. Cursor indicators and other control functions allow the operator to request that the processor add to, delete, rearrange, or otherwise manipulate information. The terminal also allows an operator to specify the disposition of information by the processor. This type of terminal will be used in both Complex A and Complex B by personnel interested in assimilating information, or preparing messages for distribution to other locations in the theater. Several terminals will be located as a terminal complex colocated with each computer complex.

b. Sensor Display Terminals

This type of terminal is composed of a CRT viewing screen especially set up to present a diagram or pictoral representation of information gained from a particular sensor system, such as radar returns. Light-pen, Q-ball or other controls allow an operator to request manipulation or alteration of the information by the processor. Other controls also allow the operator to specify the disposition of information on the screen. This type of terminal will be used with Complex B to manage the information derived from the various sensor systems. To a lessor extent this type of terminal will be used with Complex A to aid operators to understand the significance of the summary bulletins of sensor-derived data.

B. Remoted Data Terminals

For those Air Force elements of a combat theater not located at one of the computer complexes, the use of one of a family of terminal complexes is envisioned. These terminals, remoted from the central processor nodes, provide the means for exchange of information with these nodes. In essence, these terminals extend the influence and support of the central computers to the outlying locations. Three levels of sophistication within this family of terminal complexes/facilities can be identified; location of each class of terminal depends on their function and position as well as the size and amount of traffic associated with their using elements.

a. Small Terminals

For elements, such as TACP's, CCT's, ASRT's, located near the FEBA and with a rapidly changing environment demanding the capability to be man-transportable, the data terminal to be used will be a simple device capable of transmission and reception of digital data over HF radio-links or any other media available in these front line locations. These terminals will be used on voice channels, with voice transmission as a back-up. Pre-formatted messages and easy entry will be featured; simple printers will provide for reception of information. The advantages of burst communications on the crowded spectrum plus the use of digital techniques compatible with the computers make these small terminals practical for forward elements.

b. Medium Terminals

For elements, such as FACP's, APS', WX's, small TUCP's, which have requirements for display and manipulation of information beyond that of the small terminal simplified operations, a medium capability terminal complex is postulated. This terminal complex will employ one or two alpha-numeric manipulator terminals as described in Paragraph Aa. Although some pre-formatted messages will be handled by this terminal, free form information will be the normal mode of operation. The display and controls will allow evaluation of information, and will provide for easier message composition. Although no true processor capability would be incorporated into this terminal complex, sufficient memory would be included to allow the required buffering for the terminals and for a printer which would be used to receive information and provide hard copy records.

c. Large Terminals

For elements, such as DASC's, ALCE's and large TUCP's which require several display terminals and printers to handle the volume and diversity of work, a large terminal complex is envisioned. In these locations, several organizations may be working independently; an alphanumeric manipulator terminal would be supplied to each of these organizations. The central memory and control facility for each site would be capable of handling several terminals, a number of printer/transmitter devices, and possibly a large screen display used for status-keeping. Sufficient buffering would be required to drive all the display terminals and devices, as well as handle the number and diversity of information flow to/from them. As a special case of this type of terminal complex, the CRP's would be supplied with sensor display terminals and a processor capability equivalent to that organic to today's TACS center of that name. This is the largest scale of this class of terminal complex, however, with the other site complexes "slaved" to the processing capabilities of the central computers. This terminal complex can supply data from its memory to the central processor node upon demand, or on a pre-set schedule. The terminal complex can request the central processor node to refresh or update its memory bank under control of a terminal operator. Status can be entered into the terminal complex memory independent of the central processing node operations.

2.2 Operational Techniques for Combat Missions

As previously stated, the combat family of interest performs the missions of Counterair, Interdiction, Close Air Support, Reconnaissance, Aerial Refuelling and Search/Rescue. Although each of these missions has some unique requirements and performance techniques, they all progress through two general phases: planning; and execution/monitoring. To evaluate the impact of technical changes on the communications required to command and control these missions, it is necessary to trace the roles of each tactical theater center in performing each mission. When these roles are defined, the information flows and patterns which must occur to support the activities of the centers can be developed. These information flows and patterns, developed into a model of centralized operations of the TACS, becomes the tool by which various communications techniques/approaches will be evaluated in the next portion of the study. The following are descriptions of the roles of tactical theater centers in the performance of the missions of the combat family of interest.

2.2.1 Combat Mission Planning

Per the operational doctrine of today's TACS, mission activity for the tactical theater is planned for a 24-hour performance period; the missions to be flown "tomorrow" would be planned "today". In an attempt to reduce variables, this practice has been incorporated into the centralized operational concept even though it is recognized that the introduction of automated processes offers promise of significantly improving the current cycle. The planning phase of a combat mission involves three distinct steps: (a) preparing the mission requests/requirements for the performance period; (b) evaluating the resources available for the performance period and making gross allocations to the various types of combat missions; and (c) detailed planning of specific missions including preparation, approval and distribution of the fragmentary (frag) orders. Figure 2-2 provides a general information flow diagram for the activity associated with planning combat missions using a centralized concept of operations.

A. Mission Requirements

The theater Joint Operation Command headquarters supplies the Air Force component commander with general guidance as to the conduct of the theater air battle. This general guidance, in the form of general battle orders and operational priorities, forms the basis for examining projected daily activities to determine the use of air power during the performance period. The DI and his staff receive, evaluate and prepare intelligence data for use by the DCO staff, including estimates of enemy disposition, capability and intentions, order of battle information, and locations of all friendly forces. In addition, the DI and his staff provide interdiction target recommendations and preplanned reconnaissance mission requirements developed from results of previous reconnaissance missions as transmitted from the reconnaissance technical squadron plus sensor returns processed at Complex B. Complex A also receives and stores intelligence from other service organizations in the theater as well as enemy threat evaluations and reports of damage inflicted by friendly forces. This entire intelligence data base stored at Complex A is used by the DI and his staff to help develop all mission requirements.

From the DASC/TACP operations comes the projected needs for close air support and reconnaissance missions to support the Army operations during the next performance period as well as a definition of the planned ground order of battle. The support mission needs of any allied ground forces are also considered. Intelligence estimates of the hostile air threat are used to develop estimates

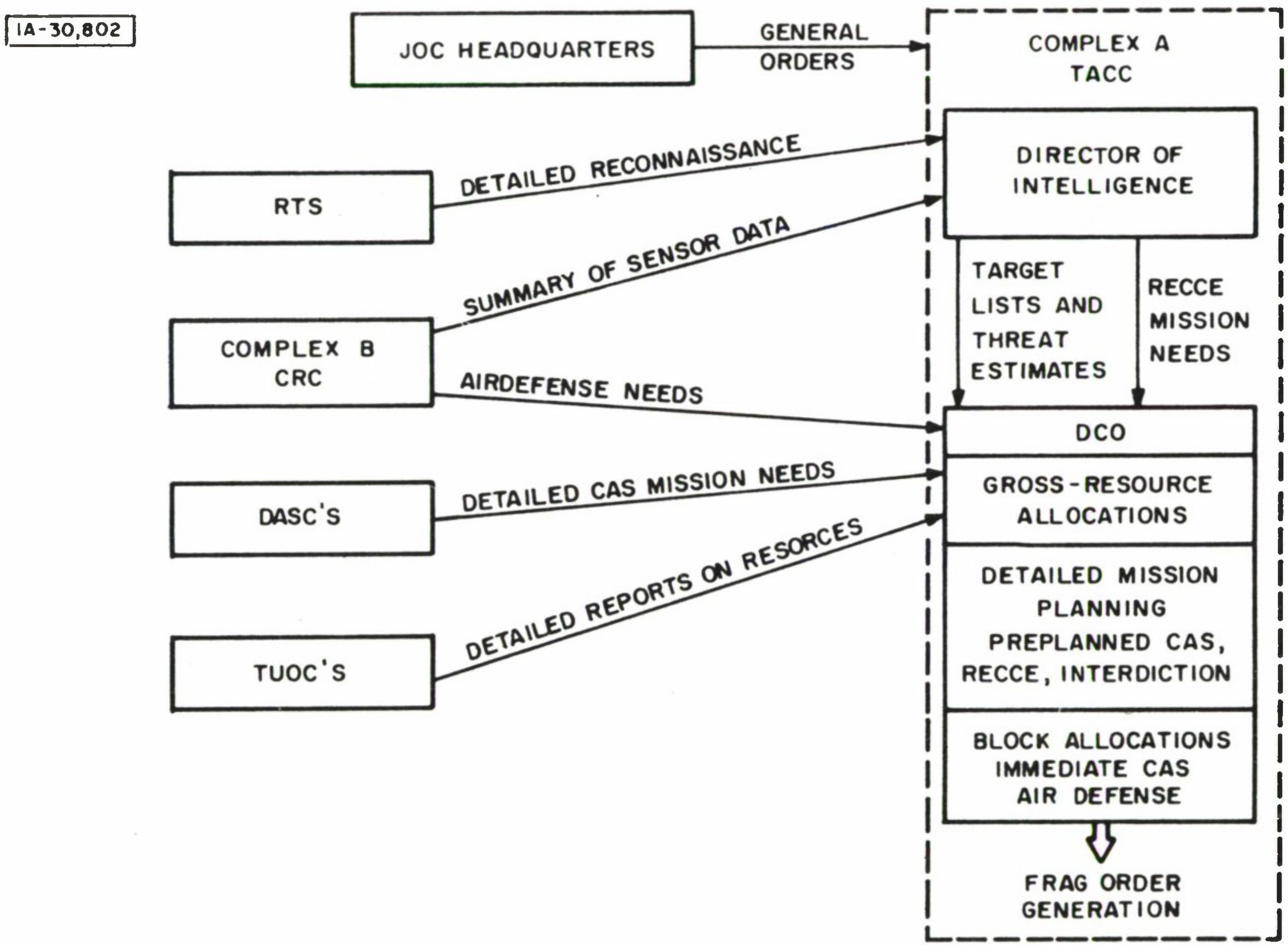

Figure 2-2: GENERAL INFORMATION FLOW; COMBAT MISSION PLANNING

of the quantity of counterair operations required during the next performance period. From these diverse sources, the DCO and his staff compile a list of mission requirements for counterair, interdiction, close air support, and reconnaissance operations to be conducted during the next performance period. From past practices, these quantities and types of missions permit the DCO and his staff to estimate requirements for aerial refuelling and search/rescue missions. The entire list of mission requirements are prioritized by the DCO and his staff to assure the most urgent missions are considered first.

B. Resource Allocation

While the process of assembling the prioritized mission requirements list is going on, an effort is also being made by the DCO and his staff to assemble a status data bank on the resources of the combat family of interest which will be available during the performance period. Each TUOC serving a combat aircraft wing or support wing prepares and sends to Complex A a report of the status of all air combat resources under its supervision. This status report would contain the condition of each aircraft, the availability of each flight crew, and the amounts and types of weapons/munitions which are capable of use. Complex A maintains a complete status data base on the resources in the theater; this data is arranged so that, by request, the entire status of a particular resource or portions of that file can be obtained. As a change takes place in the status of any combat resource, a message is sent from the source location to Complex A where the data base is amended. Complex A then distributes the resource status change to affected organizations, as required.

When the resource data base has been updated, the TACC war plans branch compares the prioritized mission requirements list to the available resources. Block allocations of resources by priority are made for each of the combat missions. Some of these block allocations are made against missions, such as pre-planned reconnaissance, interdiction, pre-planned close air support, and aerial refuelling, which will be further planned in detail at the TACC. These block allocations along with the prioritized mission requirements list for these missions are passed from the TACC war plans branch to the TACC weapons and force plans branches for further handling.

The remaining block allocations are made against missions which will not be further planned or controlled at the TACC. Both combat and reconnaissance close air support missions are flown each day as immediate reactions to Army or allied troop engagements/ operations. Based on priorities and an evaluation of the situation, each DASC is given a block of aircraft and flight crews to be used at their discretion. The actual mission specification and use of these resources are defined by the DASC as part of the execution/ monitoring functions of these combat missions. Another block of aircraft and flight crews are allocated to the defensive counterair and search/rescue missions under control of the CRC staff at Complex B. The missions to be flown by these units are specified by the CRC as part of the execution/monitoring functions for these missions. The weapon mix and pertinent status/conditions for these units are specified by the TACC in the block allocation frag orders because the quick reaction requirements of the missions do not allow the CRC to feasibly make these specifications.

C. Detailed Mission Planning

The TACC weapons and force plans branches begin the task of detailing the pre-planned combat missions as soon as they receive the block allocations and prioritized requirements list. This detailed planning activity involves consideration of many factors which could influence performance of the mission; the final mission frag orders must specify use of appropriate resources to provide the capability to handle anticipated problems. For each mission, the planner must consider the action required and determine the weapon system and quantities required to accomplish it. The planner will evaluate the need for ECM or refuelling support for the mission and detail what is needed. The flight path, potential hazzards, and weather conditions are evaluated to produce an optimum route into and out of the target area. The timing and check points for the mission are developed. In short, each parameter required to specify the mission right down to tail numbers on aircraft and crew designators are developed by the planner. Each of the missions is planned in this detail in turn, until the resources available for the performance period have been delegated.

In performing this involved task, the planner is aided in many ways by Complex A and the planning terminals. The data base stored by Complex A is sorted such that when a planner selects a type of mission on his terminal, blocks of data relating to various aspects of the mission can be displayed by Complex A at his request. As the planner makes his decisions at the terminal, selecting or specifying various parameters relating to a given mission, Complex A records and stores these parameters (which can be reviewed by the planner at any time on his terminal). Certain portions of the mission may be simulated on the planning terminal by Complex A to allow an operator to "fly" various alternative approaches to executiing a mission, and select the most appropriate one including the complete flight plans. As part of the stored data on each type of mission, Complex A will have a list of parameters which must be specified as a minimum to permit proper formatting of a frag order. If the planner attempts to complete the planning of a mission without specifying all the required criteria, Complex A will use his planning terminal to remind him of the mission parameters. When a planner completes the detailing of a mission, he so signals Complex A which stores the completed mission for later review. As each type of resource is specified for a particular mission, the totals available for the performance period are adjusted by Complex A to present the planner with the latest figures. If a mission is cancelled by a planner, the totals are also adjusted accordingly by Complex A.

When an identifiable portion of the missions for the performance period have been detailed, they must be reviewed and approved by the Air Force component commander. Using a planning terminal and other display aids, the DCO and his staff review for the AFCC summaries of the planned activities for the performance period. These summariers, showing the requirements and priorities of the theater and the planned efforts to satisfy them, are prepared by Complex A. Changes to the plans suggested by the AFCC are cranked into the plans, using the terminal. When he is satisfied, the AFCC approves the plans; this is entered into the terminal and sent on to Complex A. Complex A then transmits the frag orders stored in the data banks to all affected organizations throughout the theater. This frag order defines the responsibilities of each of the organizations for the next performance period. When the frag order is received, and preparation begins for the performance period, the planning phase is complete; the execution/monitoring phase has begun.

2.2.2 Combat Mission Execution/Monitoring

In the description of planning combat missions, three classes of mission were defined. The first, including pre-planned reconnaissance, interdiction, pre-planned close air support and aerial refuelling, are planned in detail and controlled by the TACC. The second class, including immediate close air support and reconnaissance, are allocated in blocks and controlled by the DASC's in the theater. The third class, including defensive counter-air and search/rescue, are allocated in blocks and controlled by the CRC in the theater. Although the information flow caused by each of these mission classes is similar to that of the others, the differences can be brought up only by covering each class separately from the others.

A. Class I Mission Execution/Monitoring

For this class of mission, the frag orders sent from Complex A specify aircraft, flight crew and weapons to be used for each individual mission. The time of departure, route, checkpoints and return time are also specified in detail. Figure 2-3 provides a diagram of the general information flow associated with this class of mission. When the TUOC's receive the frag orders from Complex A, they prepare the aircraft units and dispatch them at the required times.

When Complex B receives the frag orders from Complex A, it sorts and stores all the flight path information so as to be able to develop and display a complete picture of air activity. This information is used to identify friendly and hostile activities from sensor returns. It is also useful in avoiding interference between pre-planned activity and the "quick reaction" missions ordered by the DASC and by the CRC. Complex B also provides the various AC and W centers with those portions of the flight plans which affect them. The information from Complex B includes the checkpoints and guidance to be given to the aircraft units by the AC and W center.

As soon as the mission aircraft units are dispatched by a TUOC, they are picked up by the base TATCE; from this point they are under control of some AC and W center. Throughout the mission, the AC and W centers provide control information to the aircraft units and obtain status information on the mission in return. This status is fed to Complex B where it is checked against the mission plan. Summary status reports and bulletins, including such things as position, activity, check-in, take-off, and landing reports, are sent to Complex A and other affected centers to maintain the necessary mission-function on each Class I combat mission for the TACC current operations division. Running talleys of unexpended resources in the theater are also kept by Complex A and displayed for the current operations personnel. When some emergency condition arises whereby a change to a pre-planned mission must be undertaken, one of the current operations staff, using a planning terminal in a manner similar to that described by Section 2.2.1, formulates a new mission plan. Once approved, this change in the activities of the performance period would generate some more of the same information flow patterns as shown on Figure 2-3.

B. Class II Mission Execution/Monitoring

For this class of mission, the frag orders sent from Complex A specify a block of unique resources to be used by the

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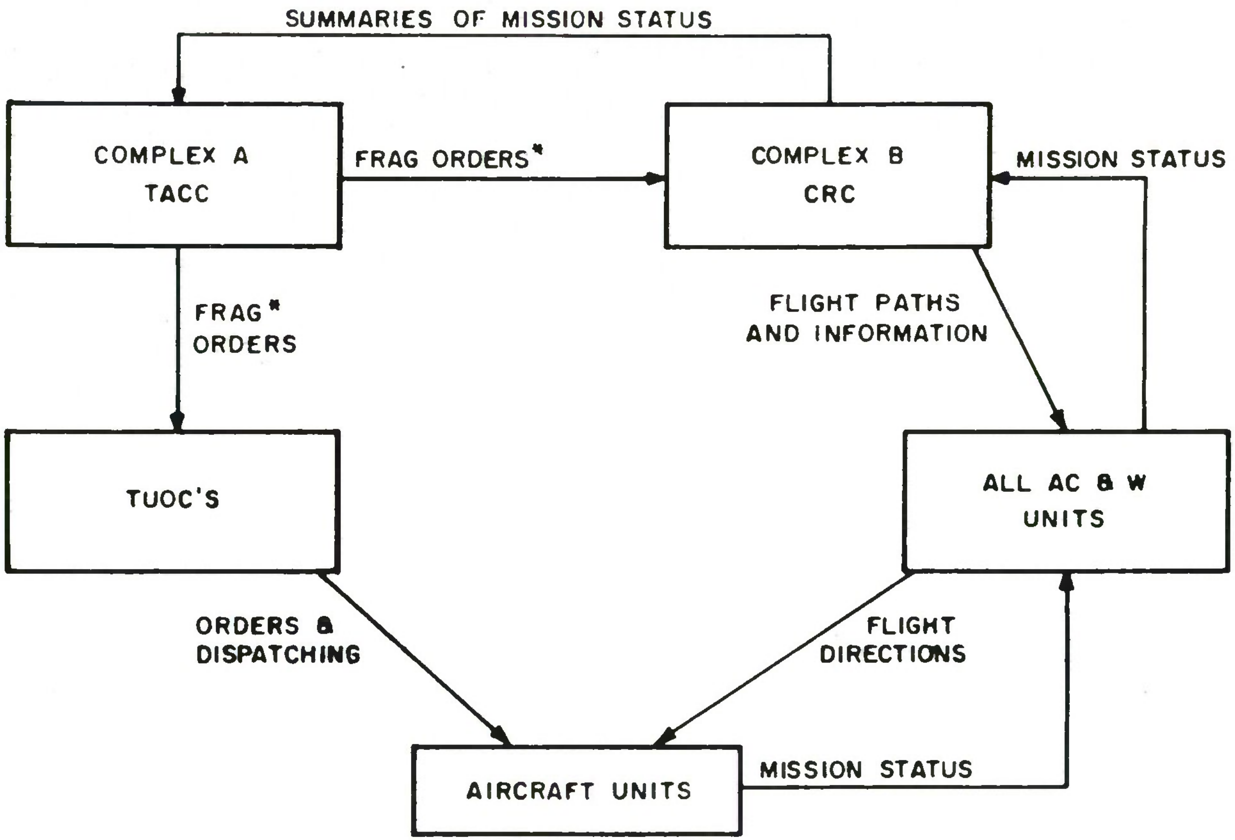

* FRAG ORDERS IN DETAIL INCLUDE FLIGHT PLANS, AIRCRAFT SPECIFICATIONS, ETC., WHERE APPLICABLE.

FIGURE 2 - 3 GENERAL INFORMATION FLOW: EXECUTION AND MONITORING CLASS I COMBAT MISSION

DASC during the performance period. Figure 2-4 displays the general information flow generated by this class of mission during the execution/monitoring phase. When the DASC receives a request for air support from the Army or allied forces by way of the TACP net, it performs a brief planning cycle. The target location and type, the resources to be used to neutralize it, and a time-over-target range are specified in an abbreivated frag order. Using the remoted data terminal, DASC personnel can request and receive the latest situation information from Complex A to aid in the formulation of this immediate support frag order. When ready and approved by the DASC commander, the frag orders are sent to the TUOC's affected and to Complex B.

The TUOC's use the frag order to prepare and scramble the required aircraft units which are located at an airbase. If a combat air patrol or mission flight is to be diverted to the new target, Complex B uses the individual mission parameters in the frag order to inform AC and W centers of the action required. In either case, Complex B checks the current theater air activity to avoid interference with other missions while developing flight path information for the mission and sending it to affected AC and W centers. While airborne, the aircraft units are fed flight directions and guidance by the AC and W units who are supplied status information in return. All status information is sent to Complex B where status reports, bulletins and summaries are prepared and sent to the DASC and to Complex A.

The DASC performs the flight following function for Class II missions. If additional action is required on a particular target, the DASC follows the same procedure as above to allocate additional resources to the problem. Complex A maintains an overall watch on Class II missions as part of its activity monitoring for the performance period. If a DASC expends allocated resources before the end of the performance period, or if it has resources to spare, the TACC current operations division at Complex A will act to reallocate portions of the resource block as required. The general information flow patterns of Figure 2-4 would apply to any frag orders generated by current operations to alter the planned activity.

C. <u>Class III Mission Execution/Monitoring</u>

For this class of mission, the frag orders sent from Complex A specify a block of unique resources to be used by the CRC during the performance period. Figure 2-5 displays the general information flow generated by this class of mission during the execution/monitoring phase. The sensor management portion of

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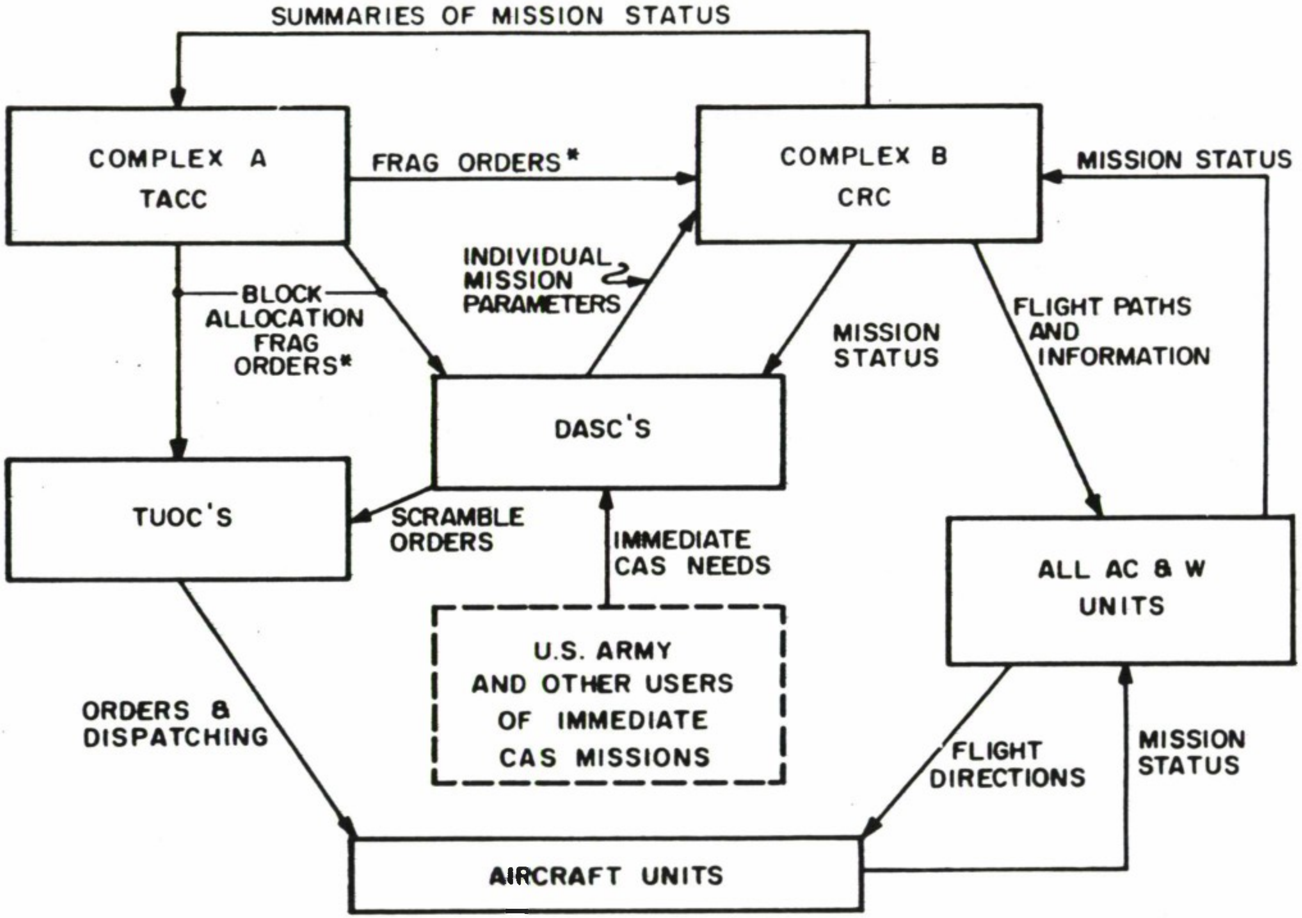
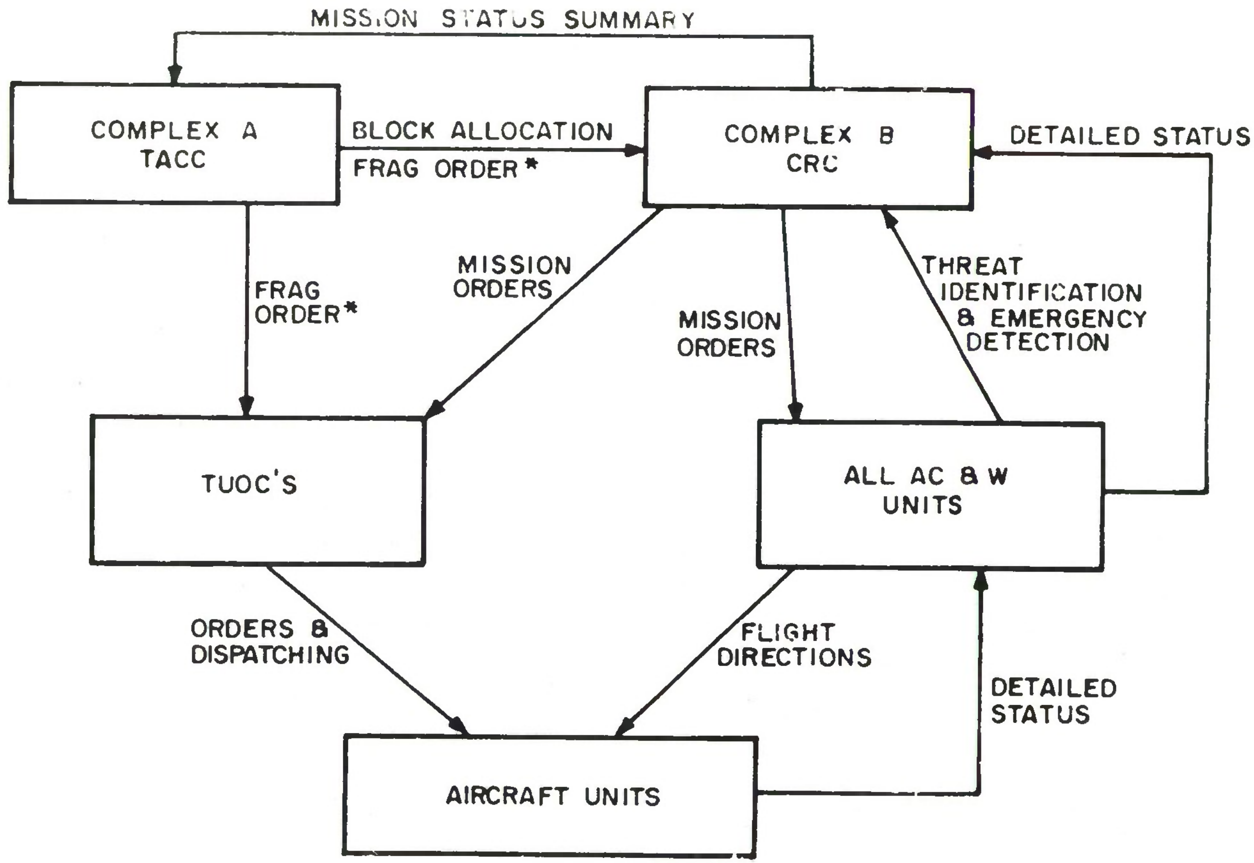


* FRAG ORDERS IN DETAIL INCLUDE FLIGHT PLANS, AIRCRAFT SPECIFICATIONS, ETC., WHERE APPLICABLE.

Figure 2-4 : GENERAL INFORMATION FLOW; EXECUTION AND MONITORING CLASS II COMBAT MISSION



* FRAG ORDERS IN DETAIL INCLUDE FLIGHT PLANS, AIRCRAFT SPECIFICATIONS, ETC., WHERE APPLICABLE.

Figure 2-5: GENERAL INFORMATION FLOW; EXECUTION AND MONITORING CLASS III COMBAT MISSION

Complex B receives and evaluates large numbers of returns from all types of sensors and from aircraft in the theater. These are compared to known activity planned for the theater during the performance period. All the AC and W family participate in this activity; their radar facilities supply much of the data for identifying hostile flights. In addition, the AC and W centers are the relay points for much of the status from missions currently being flown by the Air Force theater component.

When an AC and W unit detects a hostile flight or an emergency situation requiring a search/rescue mission, it relays all pertinent information to Complex B. The display terminals at each center are used to pass this information along to Complex B, where it is displayed for the CRC battle staff. These personnel make a quick analysis of the situation. Complex B is used to produce alternate plans for handling the situation; evaluations are made as to what aircraft from what theater position (on-base or airborne) can get to the situation quickest or most effectively. The automation of Complex B allows several trade-offs to be evaluated in a matter of seconds. When the CRC battle staff decides which alternative to employ, Complex B issues scramble orders to appropriate TUOC's if required. In this case the TUOC and TATCE on the base get the flight up and headed in the proper direction.

Complex B also develops and supplies flight path information to the AC and W centers to get the aircraft units to the situation. If a flight has to be diverted, a radio link to the flight is established and the flight so directed. Otherwise, the flight is picked up upon turn-over from the TATCE and directed by the AC and W centers. With the information underway, and with sensor information on the situation coming in, Complex B continually calculates the intercept parameters, and relays flight path changes to the aircraft units through the AC and W centers. As the mission progresses, the CRC battle staff continually monitors the situation status while developing back-up plans to be put into action if required. By monitoring incoming status, the CRC battle staff can initiate this back-up plan as appropriate using the same process as described above and creating much the same information flow. While all this action is going, Complex B prepares status summaries and sends them to Complex A for the TACC current operations division which are coordinating overall theater resources as for Class II missions. In this manner, the theater air defense and search/rescue missions are coordinated with affected organizations throughout the theater.

2.3 Operational Techniques for Airlift Missions

Among the missions performed by the airlift family of interest are logistics operations, airborne support, and aeromedical evacuation. Tracing through these missions will provide the basis for developing information flow quantities and patterns for the airlift operations. The Military Airlift Command (MAC) performs the related mission of airborne transportation of men and material into and out of the combat theater; MAC operates its own control centers, but coordination with the ALCC on cargo manifest and timing factors is essential. Although control of the MAC mission is not part of this concept, the information flow between MAC and the theater airlift family is included in the traffic estimates. The airlift missions progress through two general phases: planning, and execution/monitoring. Development of these missions will be similar to the techniques used in Section 2.2 to describe combat missions. The orientation of this description is toward ground environment communications and air environment communications are de-emphasized.

2.3.1 Airlift Mission Planning

The planning of the various missions required of the tactical airlift forces is accomplished in the ALCC located at Complex A. With this centralized concept, the ALCC can be colocated with the TACC as an integral unit, or can be a separated function located in the vicinity of the TACC. Complex A becomes the communications, data base storage, and processing focal point for both units. As was the case with the combat family, the airlift missions in today's TACS and for this concept are planned for a 24-hour performance period. The planning phase of an airlift mission involves three steps: (a) assembling and consolidating the needs for airlift support during the performance period; (b) making gross allocations of available resources against those needs; and (c) detailed planning of specific aircraft and cargo units movement to satisfy the needs. Figure 2-6 provides a general information flow diagram for the activity associated with planning airlift missions using a centralized concept.

A. Mission Needs

The theater JOC through its subordinate Joint Military Transport Board supplies the Air Force component commander with general guidance on the application of airlift support to the needs of the theater. This guidance, in the form of general battle orders and priorities associated with particular theater activities,

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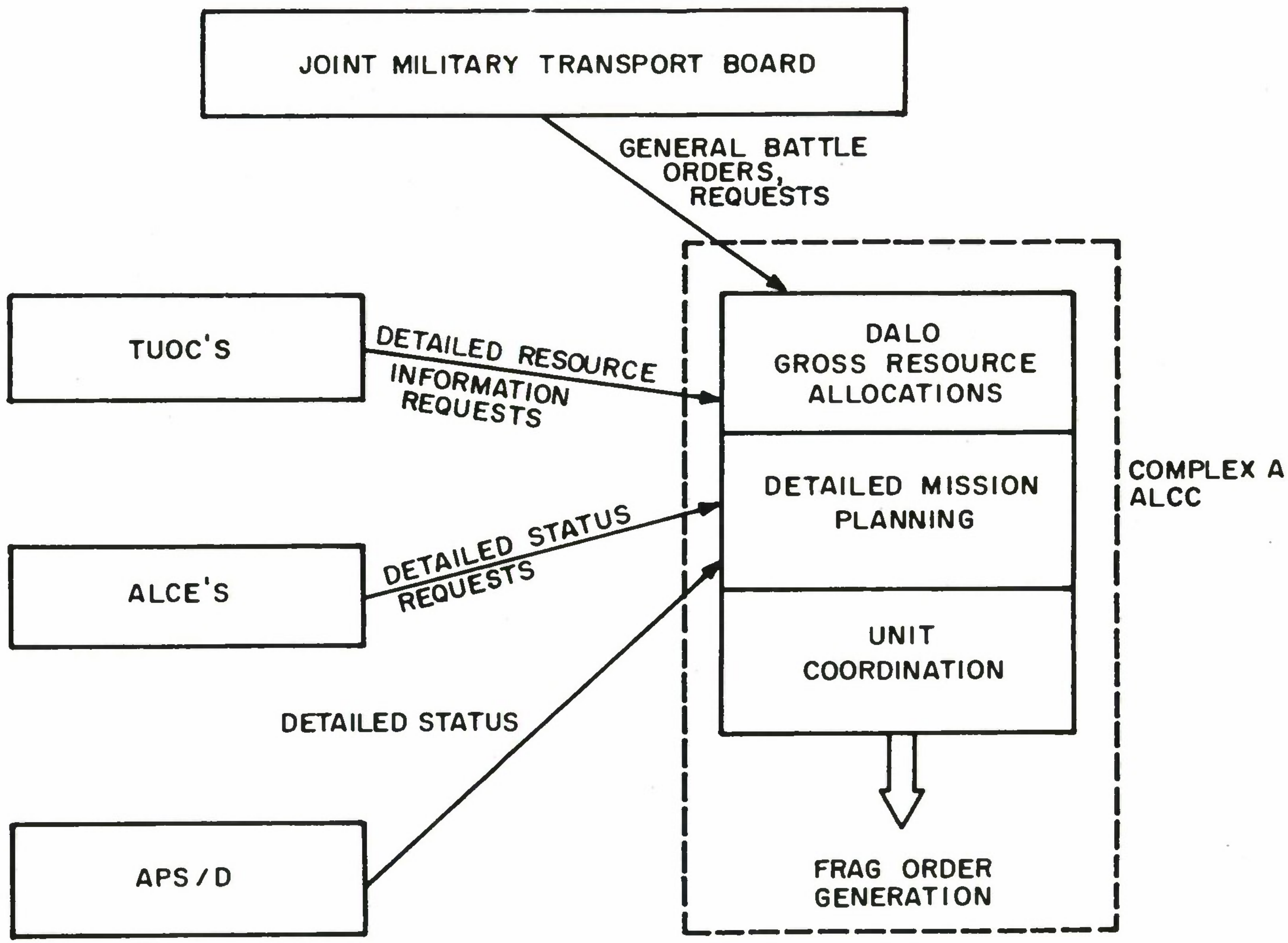

Figure 2-6: GENERAL INFORMATION FLOW; PLANNING AIRLIFT MISSIONS

forms the basis for examining the needs for airlift support during the next performance period. Each unit within the allied forces in the theater develops requests for transporting needed material and troops; these requests are processed through the logistics chain of command within each organization. If the needs can be handled by the organic capabilities (non-airlift) of the organization, it is taken care of at that level. Only those requests for transportation which must be handled by the airlift are sent to Complex A where they are stored in the airlift data bank. Each request carries a "needed time" and urgency index to define the handling requirement; a set of qualifying parameters, such as quantity, size, weight, etc.; and a location where it is needed. Using the capabilities of Complex A, the DALO and his staff add other clarifying information to the stored request, such as the current location of the requested cargo units, plus an airlift priority rating. The stored list of requests is then sorted and consolidated by Complex A under direction of the DALO staff. The result is a prioritized list of needs for the movement of cargo units by the airlift for the performance period. From this point of departure, resources to fulfill these needs can be allocated.

B. Allocation of Resources

While the process of assembling the prioritized requirements list is being carried out, the DALO and his staff are making an effort to develop a list of airlift forces available to perform the indicated missions. This list forms the airlift resource data base stored at Complex A. The data base is collected in two parts: the aircraft system status and the cargo unit status. At the conclusion of activity for each performance period, each airlift TUOC reports on the status of aircraft systems expected to be available for use during the next performance period. The term "aircraft system" is defined to include airlift aircraft (by numbers and types); aircrews; and support personnel for inflight duties; e.g., medical personnel required an aeromedical evacuation missions. In short, the aircraft system data base at Complex A includes the status of any ingredient essential to permit execution of a flying aircraft mission.

The cargo unit data base includes the status of batches of material. This status is initiated when a unit of cargo is off-loaded in the theater from a MAC flight, a cargo ship, or some other inter-theater transportation mode. The status of a cargo unit is kept at Complex A until it is delivered to the final user or location. Airborne assault troops or casualties to be evacuated can be thought of as unique cargo units with specified pickup and delivery points. Status on cargo units and their disposition is sent to Complex A by ALCE's, APS/D's and CCT's located throughout the theater. Reporting is on an "exception basis"; that is, the status of a cargo unit is reported only when it changes.

The DALO staff apportions the available aircraft systems to the three categories of airlift missions in accordance with the gross priorities established for the performance period. They direct Complex A to sort cargo units by origination/destination, and then make a gross marriage of aircraft to cargo units by request priority. Complex A develops alternate, generalized plans to use the available resources to accomplish the maximum number of requests by priority, under direction of the DALO staff. From these alternative approaches, a general resource allocation plan matching aircraft quantities and types to cargo unit movements is developed. At this point, the DALO staff can begin detailing specific, individual missions.

C. Mission Detailing

The DALO staff beings detailed mission planning using the approved allocation plan. Each mission is covered, working down the priority list, until all the resources available are assigned to duties during the performance period. Using a planning terminal, a planner specifies various mission parameters. For support to an airborne assault operation, the general attack plan has been developed and given to the DALO staff, and a block of aircraft is available. The planner works out drop times and assigns aircraft by tail numbers to fly specified mission routes. Troop loading times and flight departure times are specified. Flight paths, formation positions, and drop patterns are given. Return paths and aircraft return times and locations are logged. The entire operation is coordinated with the TACC to obtain combat aircraft coverage, ECM support, search/rescue standby aircraft, and any other activities from the combat family which are of vital interest to the air drop operation. As each parameter is specified by a planner, it is sent to and stored by Complex A.

For a logistic or aeromedical evacuation mission, the planner selects an aircraft unit by tail number. He specifies departure and arrival times for each flight to be made by the unit during the performance period. The cargo unit movements at each stop in the flight are described in detail. The flight patch of the aircraft is developed and specified. The availability of aircraft controllers and cargo handling crews at each stop is examined. If controllers are not available, a CCT will be assigned to accompany the flight into and out of the required area. Potential hazzards to the mission are gleaned from intelligence and detailed in the plan. Coordination with the TACC arranges any required support from the combat family. As each parameter of a mission is specified by a planner, it is sent to and stored by Complex A.

When the airlift resources available to the DALO for the performance period have been incorporated into a detailed plan, the DALO staff review for the AFCC the overall activity of the performance period from summaries prepared by Complex A. Changes required by the AFCC are incorporated into the planning. Complex A is informed when the AFCC is satisfied with the plans and gives his approval. Complex A then transmits the frag orders stored in the data bank after converting the specified parameters to the approved format. All affected organizations throughout the theater receive frag orders which defines their responsibilities for the next performance period. When the frag orders are received, and preparation begins for the performance period, the planning phase is complete; the execution/monitoring phase has begun.

2.3.2 Airlift Mission Execution/Monitoring

The current operations division of the ALCC has the responsibility for monitoring the progress of the planned airlift missions during the execution phase conducted within the performance period. Figure 2-7 provides a description of the general information flow patterns taking place during the execution phase. To aid in the discharge of the monitoring responsibility, Complex A services and updates status displays and planning terminals for the use of the current operations staff. During the performance period, it is necessary to monitor two types of operations to get the full picture of airlift activities: (a) each aircraft flight, and (b) each movement of a cargo unit. When emergency or unusual situations arise, the current operations staff must perform a replanning action to alter the preplanned missions to allow for the emergency.

A. Airlift Flight Following

Each time an airlift aircraft departs from or arrives at an airfield in the theater, a TATCE, CCT or allied force equivalent controls the activity. These units, as a part of or affiliated with the AC and W family, generate take-off and landing reports for each aircraft movement. This reports are relayed to Complex B where each airlift frag order is stored. The reports are compared to the frag orders, and Complex B formats and transmits status summaries of the flight progress to Complex A. Complex A uses the status to update the large screen, flight-following display operated for the current operations staff. When a serious deviation from the schedule for a given flight is received, Complex A generates a tracer message to obtain greater detail, and also highlights that schedule on the status display. When the deviation details are received and provided to the current operations staff, they can instruct Complex A to ignore the deviation as not serious, or they can elect to initiate mission replanning activity.

B. Cargo Movement Following

Each unit of cargo to be handled by the airlift during the performance period is given a unique designation in the frag orders. Complex A maintains a complete list of these cargo units and their scheduled movements; it services a large screen display of these schedules for the use of the current operations staff in

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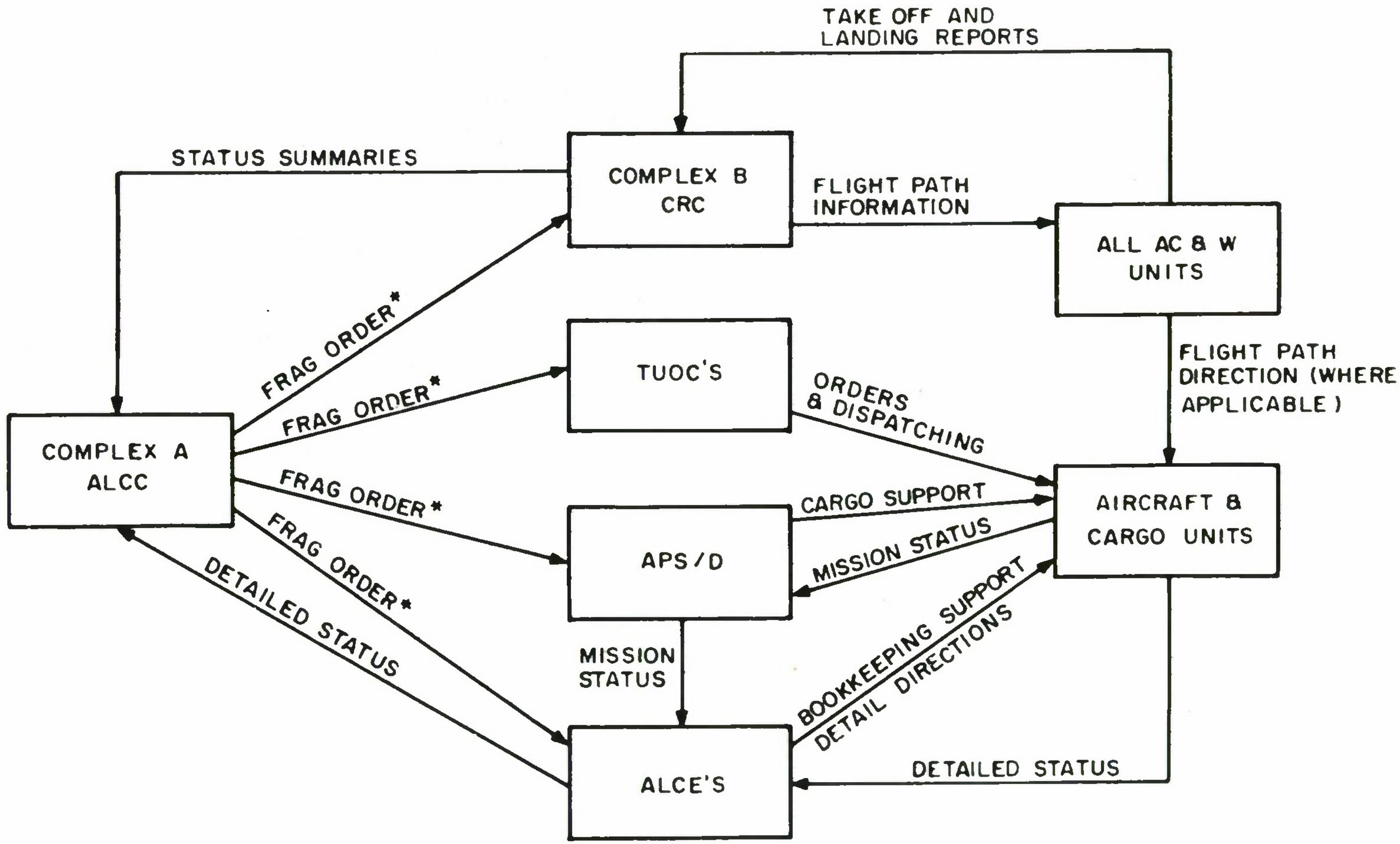

* FRAG ORDERS IN DETAIL INCLUDE FLIGHT PLANS, AIRCRAFT SPECIFICATIONS, ETC., WHERE APPLICABLE.

Figure 2-7 : GENERAL INFORMATION FLOW; EXECUTION AND MONITORING AIRLIFT MISSIONS

following cargo units. The aerial port squadrons or detachements, the aircrews, and the personnel associated with the area ALCE jointly have an obligation to report all airlift cargo unit movements in the theater; the ALCE acts as a focal point for this information. As a cargo unit is on-loaded or off-loaded, the information is passed through the ALCE to Complex A, where it is filed with and compared against the movement schedules. Deviations by a pre-set amount from the schedules will cause Complex A to put out a tracer message to obtain greater detail, and to highlight that deviated schedule on the status display. When the details of the deviation are known, the current operations staff can instruct Complex A to ignore the deviation as not serious, or they can elect to initiate mission replanning activity.

C. Mission Replanning

When a serious deviation from schedule for an airborne assault or aeromedical evacuation mission occurs, the current operations staff must replan the affected portions of the frag order to compensate for the deviation. One possibility in these cases may be substitution of an aircraft being held in reserve for the one failing to fly the mission. Cancellation of the affected portion of the mission may be an alternate possibility. In either case, a new frag order must be developed in detail at Complex A, coordinated as required, and approved. Then the amended frag order is distributed and made a part of the overall mission plan for the performance period. The entire activity of replanning these mission deviations must be done with a quick reaction time.

For logistics support missions, a deviation may prove far more complicated. Intricate schedules are often developed for critical cargo units which call for the unit to be dropped off by one aircraft to be picked up by another at a later time. If a flight cannot be completed, these transfers can be missed; in addition, some high priority cargo units on that flight may require the rescheduling of some other flight carrying lower priority cargo units. The replanning effort caused by one of these potentially complicated deviations must make extensive use of the data base and status stored in Complex A. The processors can perform various sorts under direction of the current operations staff to develop acceptable alternate plans. Extensive coordination in a short time is required to examine and approve such alternate plans, issue the amended frag orders, and get on with the activities of the performance period. When an acceptable alternate plan is approved, it is issued by Complex A to the affected organizations in the theater, and becomes a part of the overall mission plan for the perfomance period.

3.0 TRAFFIC MODEL: CENTRALIZED OPERATIONAL CONCEPT

The overall operational concepts, involved Air Force tactical theater components, and general information flow patterns of a TACS centralized operational concept have been presented in Section 2.0. To complete the forging of the tool required to evaluate communication techniques' support capabilities, it is necessary to develop traffic flow quantities/distribution for this centralized concept plus the physical, geographical layout of the TACS operating centers. This combination provides a basis for the construction, sizing and costing of theater ground communication models.

3.1 Traffic Flow Analysis

The basic communication configuration used to support this centralized concept of TACS will feature an all digital common user network with provisions for dedicated service. The information exchange between centers will be conducted using voice, teletype, facsimile, computer/computer, computer/terminal, and imagery system interchanges. The general flow diagrams of Section 2 are used as a point of departure for developing point-to-point information exchanges between the various organizations operating in the theater.

If the TACS described by the Bunker-Ramo produced, Air Force/MALLARD deployment were to be defined in operational terms, it would be regarded as a manual, centralized concept. As such, the traffic figures produced for this AF/MALLARD deployment form a solid base for the traffic estimates to be derived for the new concept of a centralized TACS. The approach to be used for this derivation calls for identification of the similarities and differences in the two deployments and adjust the traffic figures accordingly.

The following subsections of this analysis description give the details of the derivation process described above, and then present the traffic figures resulting from the analysis.

3.1.1 Derivation

The traffic flow analysis was performed by a logical, step-by-step procedure. The following are detailed descriptions of the approach and assumptions made for the steps taken. Appendix A provides some of the data compiled to complete each step.

A. Identification of Organizations

The AF/MALLARD deployment provided a long list of organizations in the tactical theater plus a five character identification code uniquely defining each organization. Many of the organizations identified were non-Air Force organizations, and another group were support units which do not play a significant role in the operation of the TACS. When these organizations were eliminated from the AF/MALLARD lists as not applicable to this analysis, a group of one hundred and two (102) organizations were left for this study. These organizations can be defined as performing an information exchange with at least one other organization within the theater TACS using ground environment communications. The MALLARD code for each organization was examined for possible use in this study, but was rejected as not defining proper criteria. A new set of codes were defined. This new five character code retained the first three characters of the MALLARD code which identified the Armed Service Branch ("F" for Air Force) plus the generic unit function/assignment ("PZ" for aerial port unit). The fourth and fifth characters differed from the AF/MALLARD code in that the fourth provides a unit's theater location, and the fifth the unit's make-up/sizing (wing, group, squadron, etc.). Section 1 of Appendix A provides a complete listing of the 102 theater organizations considered in this study plus their identifying codes.

B. Definition of Information Exchange

At this point in the traffic analysis, it was necessary to combine the general information flow diagrams of Section 2.0 with the organization list to determine who exchanged information with whom, and what was the general nature of this exchange. In this case, an information exchange was defined as a one-way transfer of date from organization code XXXXX to organization code YYYYY; duplex exchanges produced two separate entries, one for each direction. Only those exchanges are defined that take place within the ground communications environment of the tactical theater; air-ground exchanges were not covered. Exchanges between organizations at the same location were not defined because they take place over the local base facilities which were defined as not being a part of this study.

The approach used called for each of the 102 organizations previously identified to be treated individually; all the organizations to which the given organization transmits information were then defined. The AF/MALLARD exchange lists were used as a guide to this activity. A brief summary of the type of information crossing the exchange was also recorded to provide a guide to developing traffic density estimates (step C). Any information exchanges between two "families" which have direct subordinate units at the same location is assumed to take place over the local base exchange at that location, and therefore, were not defined. The result of this step of the derivation of traffic figures was the definition of some five hundred and forty nine (549) separate information exchanges. Section 2 of Appendix A provides a listing of the 549 exchanges.

C. <u>Traffic Figures Development</u>

Having developed the information exchange list, sufficient information was available to begin estimating the traffic densities caused by these exchanges. The approach used called for the comparison of the basic AF/MALLARD traffic densities with the deployment differences and the information exchange list. From this comparison, adjustments to the AF/MALLARD figures were made. Each of the 549 defined exchanges were covered. The summation of this effort is presented in Paragraph 3.1.2. Appendix A, Section 3 provides a printout of the figures developed for the information exchanges. The basic assumptions and ground rules used to translate the AF/MALLARD traffic figures are:

a. A basic unit of kilobits per busy hour was used for all types of traffic. This was a good common denominator unit on which all calculations could be based. The MALLARD definitions for various translation calculations were used. These called for the busy eight hours to be five times the busy hour, and the twenty-four hour traffic quantity to be eight times the busy hour.

b. The AF/MALLARD traffic figures were given in terms of five varieties of traffic: voice, teletype, facsimile, command data, and logistics data. These were translated into kilobits per busy hour (assuming an all-digital system) and then summed to obtain a figure for each information exchange. The MALLARD digital voice data rate of 19.2 kilobits per second was used for the voice traffic. Teletype traffic was adjusted by the formula groups times 36 divided by 1000 yields kilobits. Facsimile exchanges were converted by the formula 1 page yields 1300 kilobits. The data exchanges were directly translatable to kilobits.

c. The traffic for Complex A of this study included the traffic figures in the AF/MALLARD deployment attributed to the AFCCP/RITS, the TACC, the ALCC and the DCS entry terminal. The traffic for Complex B of this study included the traffic figures for the AFFOR as well as the CRC figures from the AF/MALLARD deployment.

d. The AF/MALLARD deployment listed traffic independently for wings and squadrons. In this study, one squadron's traffic figures were added to the wing totals for one or two colocated squadrons; 1.5 times squadron traffic was added for three colocated squadrons.

e. The AF/MALLARD deployment listed the DASC traffic as a single set of figures. For this study, this set of figures was divided in half with each half attributed to one of the deployed DASC's.

f. The net operated by the DASC/TACP organizations for the purpose of forwarding and coordinating immediate close air support requests was considered to be unchanged from today's system, except for the introduction of some digital traffic. As such, it would be the same for both concepts, using HF radio operation outside of the ground trunking environment considered by this study. The traffic figures for this operation cancel out; they were not developed for this study.

3.1.2 Traffic Density Summary

To consolidate the data shown in Section 3 of Appendix A into a more easily understood and usable form, the traffic figures for the information exchanges were summed on a location-to-location basis. Twenty-one key locations within the tactical theater were found to be sufficient to define the ground environment, point-to-point information exchanges of the TACS in this study. Table 3-1 shows the results of the summing, providing point-to-point traffic densities in kilobits per busy hour. Blank spaces in the table occur where no point-to-point exchanges occur between those locations.

To make the traffic density figures more usable to those personnel developing communications models as the next part of this study, a translation of the figures of Table 3-1 was made. Table 3-2 shows the point-to-point traffic densities in kilobits per second per busy hour. This means the figures indicate the average bit per second loading during the busy hour. To investigate the

RECEIVING LOCATIONS

(IN KILOBITS PER BUSY HOUR)

SENDING LOCATIONS

	TAB 1	TAB 2	TAB 3	TAB 4	TAB 5	TAB 6	TAB 7	DASC 1	DASC 2	JTF	CRC	CRP 1	CRP 2	FACP 1	FACP 2	FACP 3	FACP 4	ASRT 1	ASRT 2	ASRT 3	ASRT 4	
TAB 1		58,609	245,334	65,681	58,609	49,393	58,579	65,564	64,194		171,298	28,143										TAB 1
TAB 2	58,609		255,399	65,599	58,527	49,393	60,103	35,873	37,243		151,136		28,143									TAB 2
TAB 3	221,592	208,876		225,511	241,433	234,595	253,521	129,045	129,045	352,405	560,663											TAB 3
TAB 4	65,681	65,599	311,625		65,599	60,290	58,579	9,347	9,347		143,698											TAB 4
TAB 5	58,609	58,527	344,894	68,041		49,393	68,198	9,347	9,347		163,934											TAB 5
TAB 6	49,391	49,393	272,492	53,388	49,393		68,606	9,347	9,347		76,945											TAB 6
TAB 7	58,562	60,086	284,261	59,714	62,431	68,609		23,860	23,860	44,726	155,100											TAB 7
DASC-1	15,439	14,069	132,169	8,052	8,052	1,253	7,116		33,801		52,424	13,374										DASC-1
DASC-2	14,069	15,439	132,159	8,052	8,052	1,253	7,116	33,801			52,424		13,374									DASC-2
JTF			104,164				14,530				31,643											JTF
CRC	191,276	175,406	580,641	163,676	183,912	96,923	132,044	92,380	92,380	44,726		97,840	97,840									CRC
CRP-1	28,148		3,568					12,423			97,840		86,967	44,405	44,405			7,533	7,533			CRP-1
CRP-2		28,148	3,568						12,423		97,840	86,967				44,405	44,405			7,533	7,533	CRP-2
FACP-1												54,187						7,508	7,508			FACP-1
FACP-2												54,187						7,508	7,508			FACP-2
FACP-3													54,187							7,508	7,508	FACP-3
FACP-4													54,187							7,508	7,508	FACP-4
ASRT-1												7,533		7,508	7,508							ASRT-1
ASRT-2												7,533		7,508	7,508							ASRT-2
ASRT-3													7,533			7,508	7,508					ASRT-3
ASRT-4													7,533			7,508	7,508					ASRT-4

Table 3-1 POINT-TO-POINT TRAFFIC DENSITIES FOR CENTRALIZED CONCEPT KILOBITS/BUSY HOUR

18-30,812

RECEIVING LOCATIONS

SENDING LOCATIONS

	TAB 1	TAB 2	TAB 3	TAB 4	TAB 5	TAB 6	TAB 7	DASC 1	DASC 2	JTF	CRC	CRP 1	CRP 2	FACP 1	FACP 2	FACP 3	FACP 4	ASRT 1	ASRT 2	ASRT 3	ASRT 4
TAB 1		16.3 / 30.7	68.1 / 11,580	18.3 / 32.7	16.3 / 30.7	13.7	16.3	18.2	17.8		42.6	7.8									
TAB 2	16.3 / 30.7		71.0 / 11,590	18.2 / 32.6	16.2 / 30.6	13.7	16.7	10.0	10.3		42.1		7.8								
TAB 3	61.5 / 75.9	58.1 / 72.5		62.6 / 77.0	67.0 / 81.4	65.3	70.4	35.8 / 50.2	35.8 / 50.2	98.0 / 112.4	155.8										
TAB 4	18.3	18.2	86.5		18.2	16.8	16.3	2.6	2.6		40.0										
TAB 5	16.3	16.2	95.8	18.9		13.7	18.9	2.6	2.6		45.5										
TAB 6	13.7	13.7	75.8	14.8	13.7		19.1	2.6	2.6		21.4										
TAB 7	16.2	16.8	79.0	16.6	17.3	19.1		6.6	6.6	11.9	43.2										
DASC-1	4.3	3.9	36.8	2.2	2.2	0.3	2.0		9.4		14.5	3.7									
DASC-2	3.9	4.3	36.8	2.2	2.2	0.3	2.0	9.4			14.5		3.7								
JTF			28.9				4.0				8.6										
CRC	53.2	48.8	162.5	45.4	51.1	26.9	36.7	25.6	25.6	11.9		27.2	27.2								
CRP-1	7.8		1.0					3.4			27.2		24.0	12.3	12.3			2.1	2.1		
CRP-2		7.8	1.0						3.4		27.2	24.0				12.3	12.3			2.1	2.1
FACP-1												15.0						2.1	2.1		
FACP-2												15.0						2.1	2.1		
FACP-3													15.0							2.1	2.1
FACP-4													15.0							2.1	2.1
ASRT-1												2.1		2.1	2.1						
ASRT-2												2.1		2.1	2.1						
ASRT-3													2.1			2.1	2.1				
ASRT-4													2.1			2.1	2.1				

(IN KILOBITS PER SECOND PER BUSY HOUR)

xx / yy — WITHOUT / WITH IMAGERY TRANSMISSION

zz — WITHOUT IMAGERY TRANSMISSION

Table 3-2 POINT TO POINT TRAFFIC DENSITIES FOR CENTRALIZED CONCEPT KILOBITS PER SECOND PER BUSY HOUR

impact of imagery transmission techniques on these traffic densities, a traffic density option was included on Table 3-2. This imagery transmission included a high resolution circuit from each tactical reconnaissance squadron to the RITS at base 3; these circuits operated only two hours a day. Also included were some medium/low resolution circuits to distribute the imagery among the organizations which require it. These medium/low resolution circuits were operated 24 hours a day. Suggested configurations for the imagery transmission operations were obtained from:

> MTR-878, dated 29 August 1969, "Technology Application Study, 'Transmission of High Resolution Imagery via Satellite': Volume I - Study Report", pages 5-39 and 5-40.

3.2 Geometric Layout

To provide a realistic environment for a three-dimensional analysis of communications models requires more than the generalized grid shown on Figure 2-1. A real theater must be selected. Project MALLARD has provided a scenario for a two-corps Army deployment set in Western Europe. The AF/MALLARD deployment can be adapted to such a location. It is the locality chosen by this study for its communication modeling efforts.

Figure 3-1 shows the area involved. The specific deployment is bounded on the map by a heavy line. Sites of the key twenty-one elemental locations given in Tables 3-1 and 3-2 are shown on the map. An average terrain involving mountains, valleys, plains and other typical features is included within the bounds. The forward edge of the battle area is on the right side of the theater. Out theater access is obtained at the top and center left of the theater. The political environment of the area is not factored into the considerations of this study.

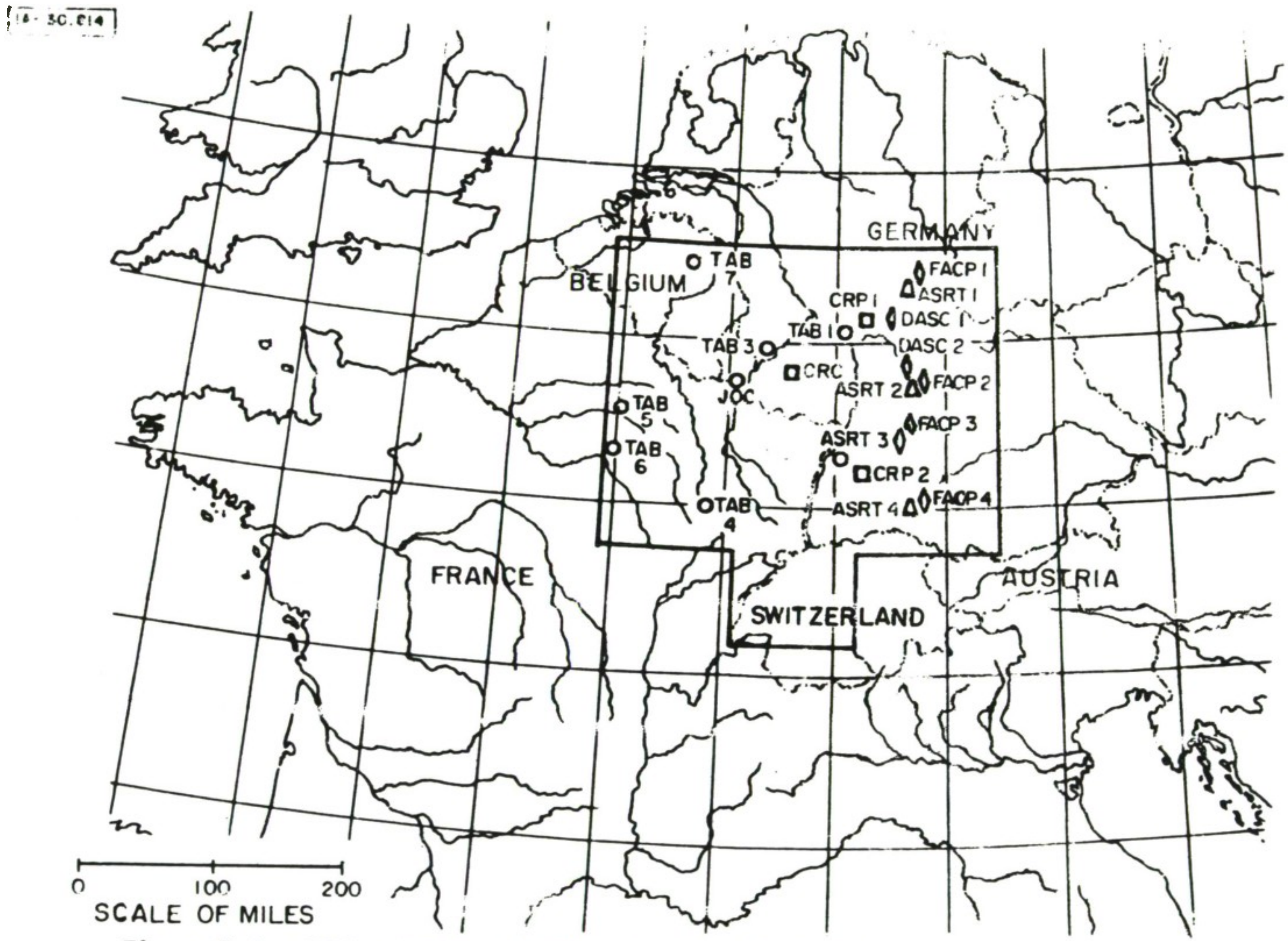

Figure 3-1 GEOMETRIC LAYOUT : AFCTC COMMUNICATION STUDY DEPLOYMENT

4.0 DISTRIBUTED OPERATIONAL CONCEPT

The distributed operational concept was developed to present an alternate means of operation for TACS which would also be compatible with current operational doctrine. To achieve this, a philosophy of management by exception was established. Routine operations were to be monitored at elements which were as close to the action as possible and only problems affecting the success of assigned missions and/or impacting on other missions were to be sent to and considered by the higher echelon personnel. This approach is in contrast to current trends in operations where it is considered desirable to transmit all data to a central headquarters location for monitoring and possible use by the commander.

This operational concept of the TACS incorporates the use of computers at many locations throughout the theater of operations rather than a large central computer complex. While the locations of the deployed elements and the major functional responsibilities remain the same as for today's manual system (and for the centralized operational concept), the maintenance of resource status is considerably different. It was assumed that the flow of data to support the distributed data bases and decentralized operation would also be significantly different and would provide a communications model which contrasted with that of the centralized operational concept.

The distributed operational concept features the following:

a. Maintenance of detailed resource status files at the airbases rather than at the planning elements.

b. Flight following of all missions by the parent TUOC's rather than the CRC.

c. Detailed flight planning and control of all preplanned combat missions at the TUOC's.

d. Responsibility for planning, assignment, and control of all airlift operations at the ALCC.

e. Responsibility for assignment and control of all Tactical Air Support operations at the DASC.

f. Responsibility for assignment and control of all Defensive Counterair Operations at the CRC.

In the centralized concept, which parallels today's mostly manual operation, each item of data is continuously updated as changes occur throughout the system and the data flow from the subordinate elements to the TACC reflects the requirement to keep the central data bank current at all times. (It should be noted that the operation of the CRC is currently semi-automated and decentralized from TACC real-time control.) In the distributed concept, the responsibility to keep up-to-date resource status is distributed throughout the theater of operations. For example, in the current operation (and in the centralized concept), takeoff, abort, and landing reports for individual aircraft are transmitted from each TUOC to the TACC, where the status of all aircraft are maintained. In the distributed concept, the bookkeeping associated with the maintenance of resource status for all of the operational units which are based at a given airbase will be accomplished at that base and the resulting status summary stored in the computer at the base. When the TACC or ALCC planning operation requires up-to-date aircraft status, each airbase computer having responsibility for the desired aircraft type(s) will be queried as the information is needed and a summary status report transmitted to the cognizant planning element. Summary status reports from all elements will also be transmitted periodically to the TACC and used to maintain theaterwide resource status summary files for use by the commander and his staff in the AFCCP.

It is assumed for the purpose of this distributed concept that during the time period of interest, a capability will exist to flight follow any aircraft from any major command and control element. This may or may not be provided by the current PLRACTA concept. In any event, the distributed concept includes the position reporting portion of PLRACTA without necessarily embracing the time ordered communications feature, since the analysis of communications is the ultimate goal of this conceptual study. This capability will allow each TUOC to maintain the up-to-date status and location of their allocated airborne aircraft. It will also provide the CRC with the capability to control its allocated interceptors throughout the theater, whether they are within the system's radar coverage or not.

4.1 Equipment Allocation

In the distributed concept, processors will be located at the Tactical Air Control Center (TACC), the Airlift Control Center (ALCC), the Control and Reporting Center (CRC), the Control and Reporting Post (CRP), and at each Direct Air Support Center (DASC) and Tactical Air Base (TAB). In general, each of these processors will serve all of the automation needs of the individual elements. An exception is a processor at a Tactical Air Base which will be used as a central

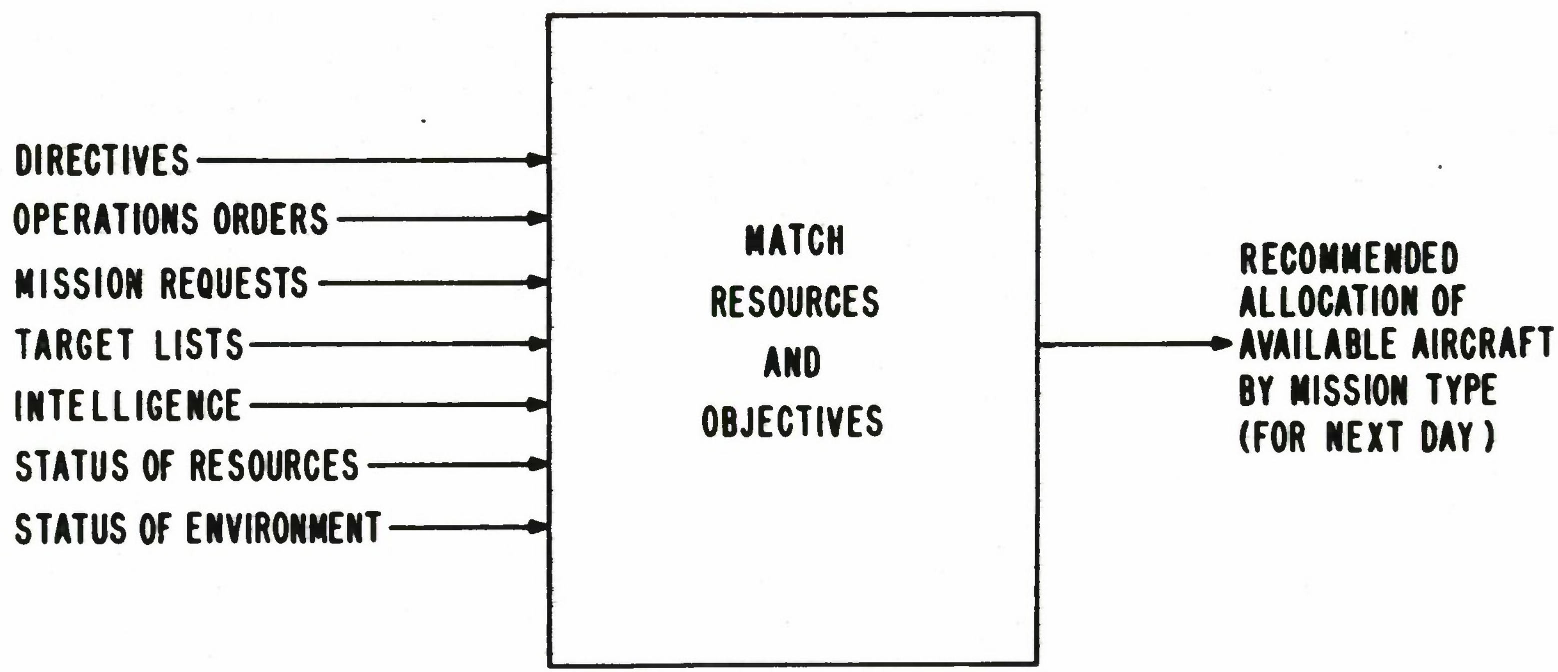

Figure 4-1 DAILY ALLOCATION OF RESOURCES (TACC)

orders for these missions. In conducting the planning exercise, the TACC computer will automatically interrogate the computers at the appropriate airbases for up-to-date status of resource data.

Daily planning commences at the echelon above the TACC (AFCCP) with the development of a target list from files of target status and classification and the specification of constraints and objectives by the Air Force Component Commander. These provide direction for the TACC planning activities. Available resources (aircraft, manpower, and weapons) as compiled from the summaries received upon request from individual airbases are then matched against the target list and desired objectives. The detailed planners must match missions to targets and develop a schedule for each mission. The scheduling process must include refueling calculations for coordinating strike and reconnaissance aircraft with tanker missions. The orders which go to the individual Tactical Unit Operations Centers (TUOC's) will define the number and type of aircraft and ordnance, the rendezvous time, time over target and associated locations for each mission. The TUOC's will assign specific aircraft, aircrews, and call signs, will develop the detailed flight plans, and will coordinate these plans with other concurrent flights through the CRC. Flight plans from all sources will be correlated by the CRC and the originators notified of any potentially conflicting plans.

The TACC Current Operations Division responds to critical situations and deviations from mission plans as in the manual system. Here, however, the detailed mission monitoring is accomplished at the TUOC's and reports of mission progress or problems are automatically transmitted to the TACC from each monitoring airbase. In responding to these problems, the TACC operator can instantly query the data base of any TUOC as needed to replan the mission and to evaluate the impact of tentative changes on other missions in progress or planned.

4.2.2 ALCC

The ALCC is separate from the TACC and is responsible for all airlift operations. Like the TACC, it is responsible for matching aircraft, personnel, and equipment to requirements which all too frequently change prior to or during the mission execution phase. Airlift missions fall into three general categories. In the first, the planning and execution are similar to the operation of a scheduled airline. Individual bases or units require a given tonnage of airlift and a predictable flow of personnel on specific days of the week. Specific aircraft can be pre-scheduled to accomplish these missions. The second type of operation is more like a special delivery service. Critical spare parts, blood plasma, or ammunition may be urgently needed at a specific base, or wounded personnel may require airlift to rear hospitals. In some instances, these requirements may be anticipated by prior knowledge of a forthcoming ground operation and factored into the planning. In many cases, however, emergency requests force the rescheduling or diversion of aircraft which have been assigned to lower priority missions and this in turn leads to additional replanning cycles. The third type of airlift mission provides support for large ground operations where the requirement for support is known sufficiently in advance to allow detailed preplanning. Here, considerable coordination is required, both within the Air Force and with other services. Large airdrop operations are an example of this type of mission.

Both planning and replanning operations will use resource status data on aircraft, personnel, and cargo which are maintained in the individual airbase computers. Because of the system's capability to maintain up-to-date status data, the ALCC will plan and control all airlift missions including the fraction of immediate tactical airlift missions formerly assigned to the DASC. The DASC will forward the Army requests for airlift directly to the ALCC.

4.2.3 CRC/CRP

The CRC operation is somewhat modified from present day operation and from the centralized concept because the inclusion of a PLRACTA position reporting capability in the TACS allows any element to flight follow and control its mission aircraft. The CRC and other elements of the AC and W subsystem are thus relieved of the responsibility for control of any missions other than Defensive Counterair missions. (The CRC is fully responsible for all phases of the Defensive Counter air missions from planning thru execution.) As in the centralized concept, the CRC will provide a centralized capability for identification of hostile aircraft and will manage the Defensive Counterair activity. The CRC will scramble its allocated air defense fighters and control their intercept activities. It will also assign air defense targets to Army surface-to-air missiles as appropriate, and will coordinate all operations of the AC and W subsystem. The CRC will receive reports of hostile or unknown radar tracks from the CRP's and from its own sensors. These are tracks which do not correlate with stored flight plan data or with PLRACTA position data and which do not respond properly to IFF/SIF interrogation.

Each CRP correlates the data from its own sensors and the data from the FACP's under its cognizance with stored flight plan data selected for its area of coverage and transmitted to it by the CRC. Data on hostiles and unknowns are forwarded to the CRC. If the CRC is unable to correlate the unknowns with PLRACTA data, the tracks are considered hostile and assigned to the CRC's threat evaluation, resource allocation, scramble order issuance sequence. The CRC will include the capability to control interceptors using either radar or PLRACTA data, thus assuring maintenance of control throughout the airspace right down to the ground.

As in the current system, the CRP's will include the full capability to assume the CRC functions at any time.

In this concept, the CRC's airspace regulation task is performed differently than in the centralized concept. Flight scheduling data from all sources are automatically screened when received at the CRC to detect potential high density airspace utilization. In case of potential conflict, the respective planning elements are notified and they will subsequently replan and resubmit the flight schedules based upon the direction and guidance supplied by the CRC in order to lower the possibility of flight conflict.

PLRACTA position data from all airborne aircraft are compared with the stored approved flight plan data received from the TUOC's on a real time basis to provide an additional check on aircraft separation. Here, each TUOC monitors the execution of its assigned missions while the CRC insures that the missions do not conflict with one another. In the centralized concept, the CRC controls the aircraft of all mission types. (In the distributed concept, the DASC and the CRC control Close Air Support and Defensive Counterair missions respectively.)

4.2.4 DASC

The DASC provides immediate and preplanned Close Air Support and immediate Reconnaissance support to the Army. Upon receipt of Army requests for support, it assigns resources which have been allocated to it by the TACC, and issues orders to satisfy the support requirements. It coordinates these operations with the Army and with the TACC. Requests for Close Air Support which are received from the Army sufficiently ahead of the desired time on target to place them in a "preplanned" category are forwarded to the TACC and factored into the planning operation. The allocation of resources to the DASC will include aircraft to handle both preplanned and immediate missions. By assuming responsibility for both types of missions the DASC can better coordinate the use of its allocated resources with the Army and reassign these resources to where they are most urgently needed without the requirement to request approval from the TACC as in the centralized concept.

In this concept, the DASC will automatically maintain the up-to-date status of all allocated resources via the system's PLRACTA capability. The DASC computer will assist the operators in providing immediate response to requests and the DASC will control the allocated resources throughout the mission from takeoff through handover to a terminal controller (such as an airborne FAC). In the centralized concept, the CRC provides the control through handover.

4.2.5 Tactical Airbase

In the distributed concept, the TUOC's, ALCE's, and APSD's are given automation aids and increased responsibilities in the operation of the TACS. At each airbase, they will share a central airbase computer by use of remote terminals at their respective locations within the airbase complex.

The TUOC will develop the detailed flight plans for each assigned mission to which it has assigned specific aircraft and aircrews. It will flight follow and execute control for each of its aircraft except in the cases of immediate Close Air Support and Defensive Counterair when it will only monitor the control of its aircraft by the DASC and CRC. Each TUOC will maintain complete up-to-date status of all of its resources including aircraft, flight personnel and ordnance. The APSD's will use the base computer to maintain status of all cargo for which it is responsible as well as all cargo handling equipment. The computer will notify the base TATCE when incoming aircraft are imminent and will facilitate handover to the terminal controller based upon the PLRACTA track data.

4.3 Operational Description

4.3.1 Daily Allocation of Resources

The theaterwide allocation of aircraft to tactical missions is accomplished by the TACC on a daily basis with a one day lead time. Figure 4-1 summarizes this process. Overall constraints and guidelines are received by the TACC from the Air Force Component Commander, target lists with priorities assigned are usually supplied by a Joint Targeting Board, mission requests are received through the DASC's, and requests for fighter escort support are received from the ALCC. Intelligence data and environmental data are received on a continuous basis, interpreted by the cognizant staff personnel, and summarized and stored in the TACC computer. The matching of resources to objectives within the given constraints requires considerable human decision making. The operators will be aided by the computer's capability to rapidly sort, summarize, and display stored files. Resource status data will be received from the TUOC's computer under control of the TACC computer. A TACC operator may request and receive the status of only a specific type of aircraft, or of all aircraft at a specific base, or of all aircraft in the theater which can respond to a given mission request. The planners will interact with the computer by means of a CRT display console and will prepare a list of recommended aircraft type and number for each mission type to be flown the next day. Upon approval by the commander, the lists will be transmitted to the appropriate detailed mission planning groups, i.e., to the DASC for preplanned and immediate CAS and immediate Reconnaissance missions, to the CRC for Defensive Counterair Missions, to the ALCC for airlift support missions such as escort mission, and to the mission planners in the TACC for all other missions. The allocations will be promulgated by means of frag orders to the subordinate elements. All airlift aircraft are normally under the jurisdiction of the ALCC in this concept and are not factored into the TACC planning.

4.3.2 Mission Planning; One Day Leadtime

Detailed mission planning is accomplished at the TACC for preplanned combat functions (except for preplanned Close Air Support) and for support missions, and at the ALCC for airlift functions. These operations are shown in Figures 4-2 and 4-3 respectively. The status of cargo and passengers awaiting airlift will be obtained by the ALCC from each airbase computer and the planning personnel will match the allocated aircraft to the airlift requirements with the aid of assignment algorithms, using the computer. Some airlift resources will be held in reserve to satisfy requests for immediate airlift support. The percentage reserved for immediate missions will be at the discretion of the airlift commander and will be influenced by the overall planned operations for the next day. A large preplanned ground offensive, for example, might dictate the requirement to airdrop large quantities of personnel and/or supplies and to evacuate expected casualties, and a block of resources to accomplish these tasks would be reserved in advance.

The TACC operational planners will be aided by computerized weapons effects computations and stored tables of ordnance data. As the mission planners call up data files on their displays and develop the plans and assignments for the next day's operations, the decisions and assignments made during the planning process will be recorded in the computer. The actual generation of the frag orders, a lengthy process when done manually, can then be automatically composed and addressed to the proper recipients. The computer can selectively send only that portion of the frag order which is pertinent to each recipient. The computer can also aid in insuring that interdependent missions (i.e., strike, VG-31,337

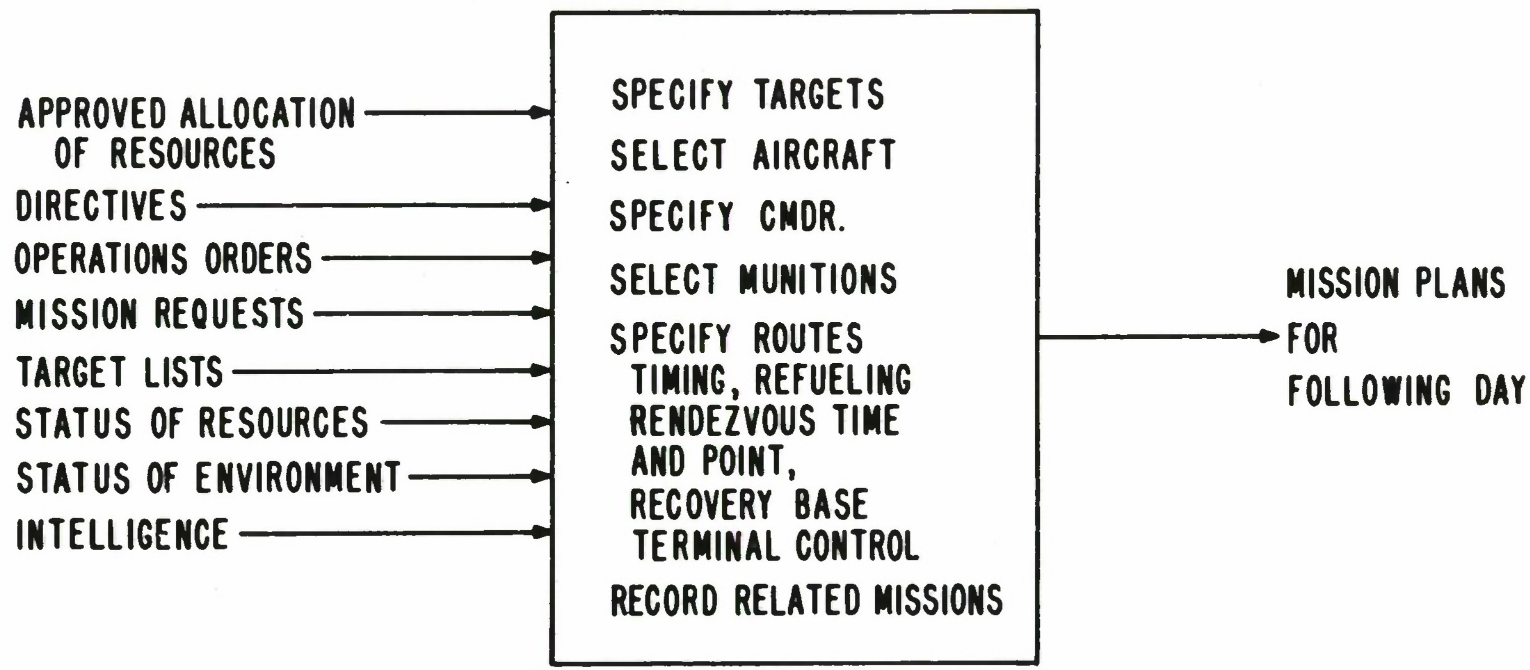

Figure 4-2 MISSION PLANNING (INTERDICTION, OFFENSIVE COUNTERAIR, RECCE)(TACC)

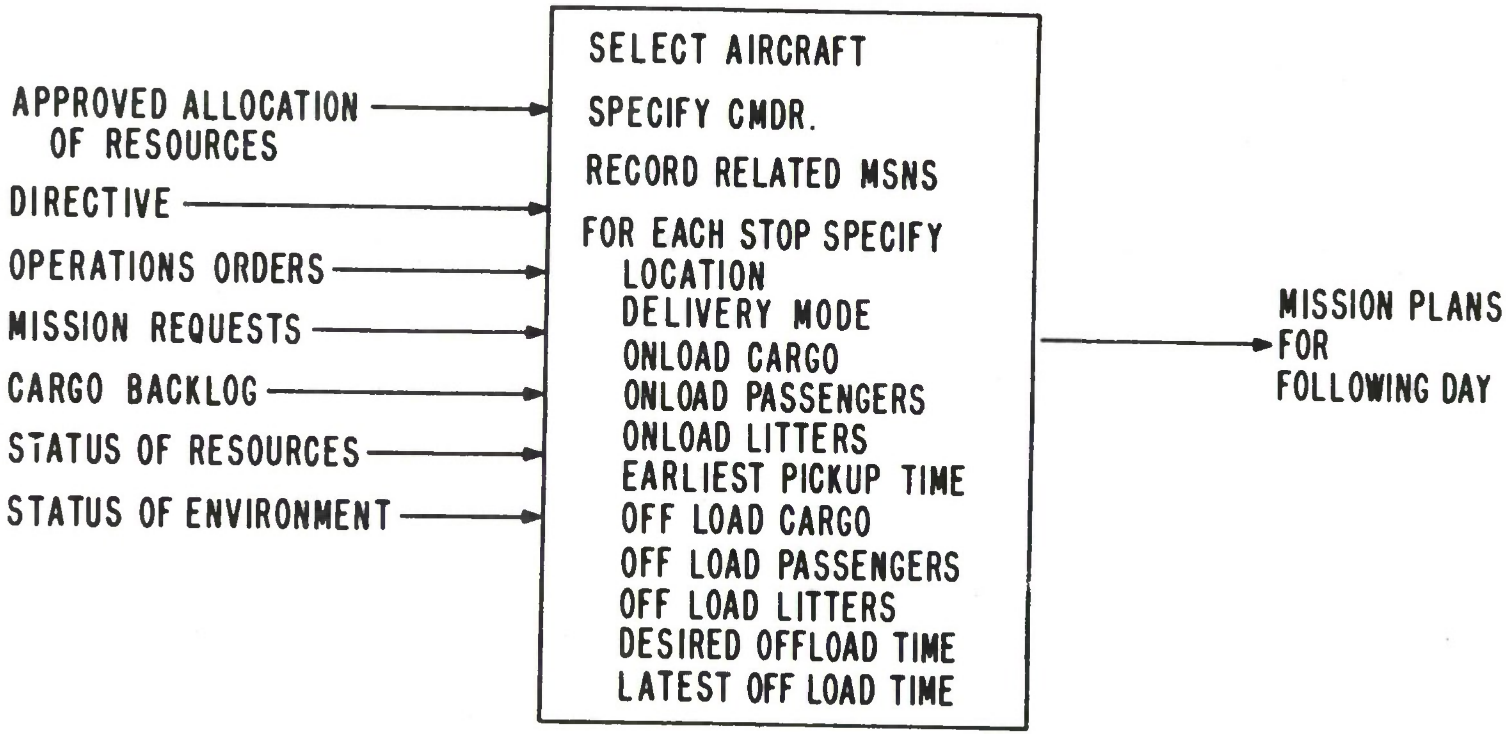

Figure 4-3 MISSION PLANNING (PREPLANNED OR EMERGENCY AIRLIFT) (ALCC)

refueling, and escort) are feasible by computing mission timing and specifying rendezvous parameters.

4.3.3 Preplanned Combat Mission Operations

Figure 4-4 summarizes the operation for preplanned combat missions including Interdiction, Offensive Counterair, and Reconnaissance. Frag orders are transmitted to each TUOC contributing to the mission execution. These frag orders will include mission objectives, resources required, targets and alternates, and timing and rendezvous data. The TUOC's will develop detailed flight plans and assign specific aircraft, aircrews, and call signs to the missions. Flight plan data will be transmitted to the CRC which will correlate the flight plans from all TUOC's as part of its air traffic regulation and identification tasks. Each TUOC will be responsible for scrambling its mission resources at the correct time and notifying the TACC of any problems which will result in delays or lack of mission support. The airborne mission aircraft will continuously report their status including location to their parent TUOC and to the CRC.

A. Resource Status Monitoring

Detailed monitoring of resources will be accomplished by the TUOC's prior to and during the execution phase of each mission. The process is shown in Figure 4-5. Prior to takeoff, the TUOC may substitute other available resources for any committed mission resources which develop problems. After takeoff, however, problems and deficiencies noted must be immediately transmitted to the TACC where decisions will be made regarding corrective action as part of the mission monitoring task.

B. Environment Monitoring

The TACC will monitor all environmental factors which could affect the preplanned missions for which it is responsible. The DASC and CRC will determine what effects environmental changes will have on the Immediate Tactical Air Support and Defensive Counterair missions. In addition, each TUOC will monitor its aircraft and will notify the TACC if environmental changes threaten to affect the execution of its assigned missions. These actions are shown in Figure 4-6.

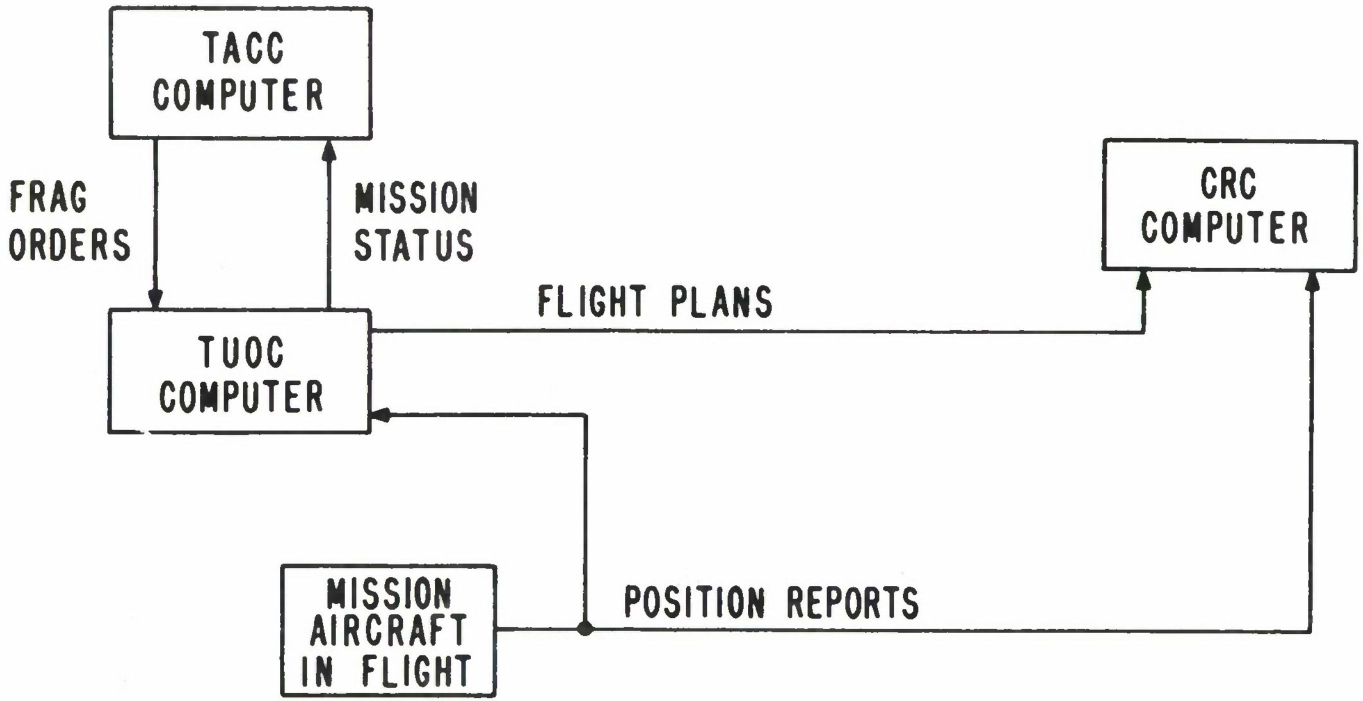

Figure 4-4. INTERDICTION, OFFENSIVE COUNTERAIR, RECONNAISSANCE OPERATIONS

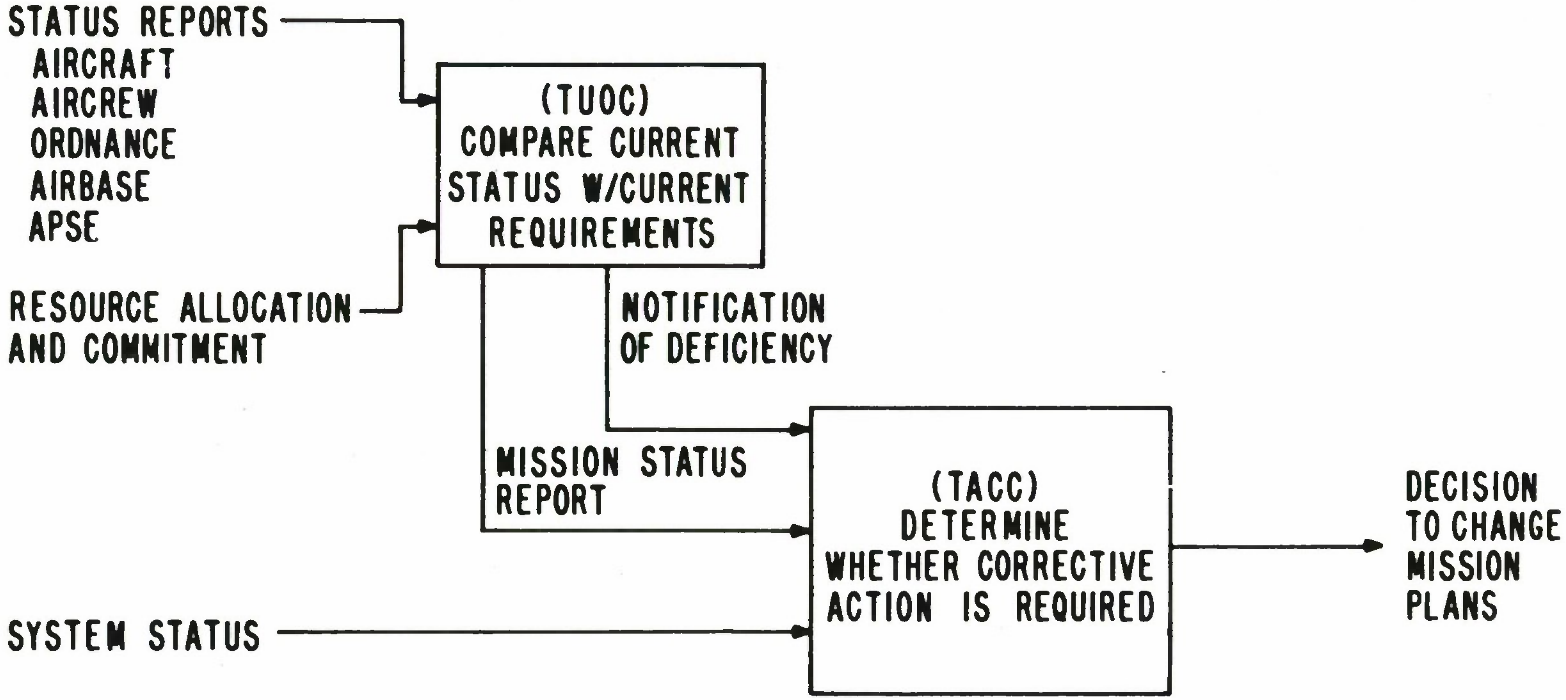

Figure 4-5 RESOURCE STATUS MONITORING

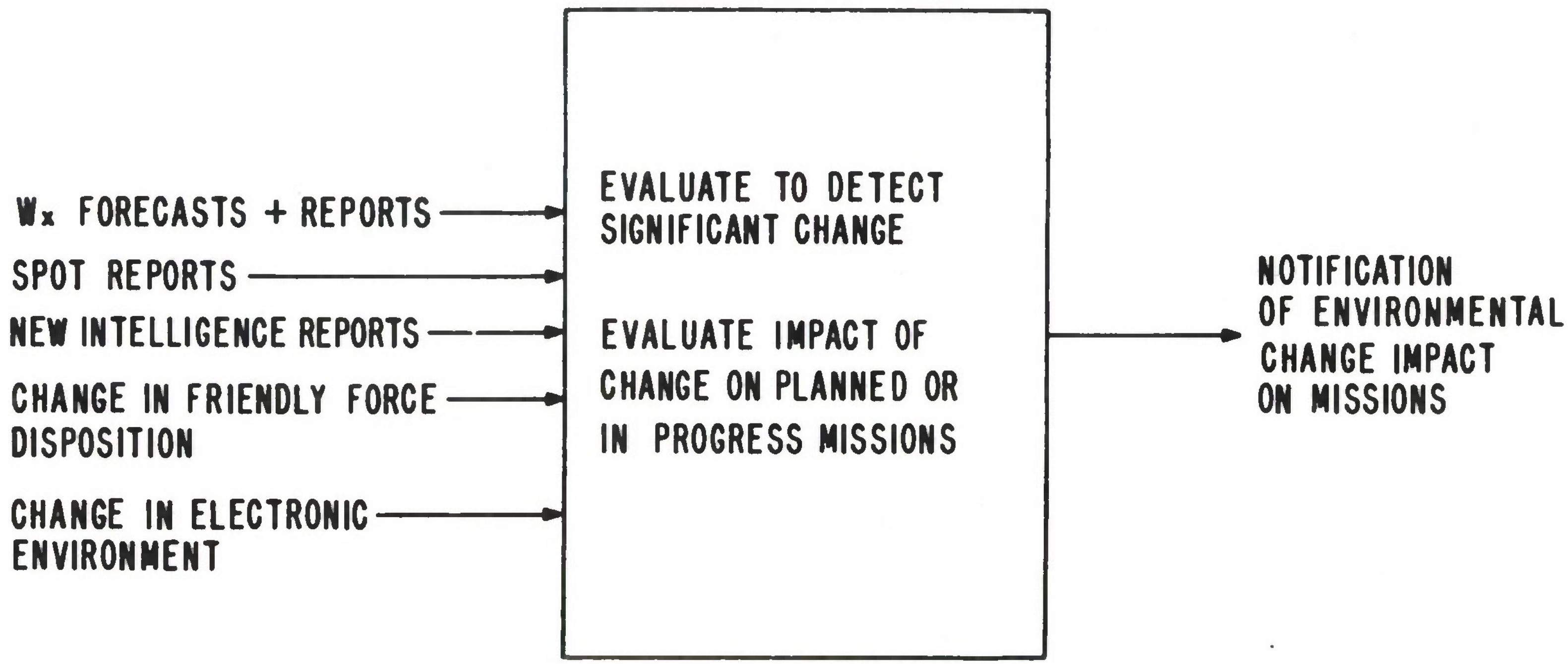

Figure 4-6 ENVIRONMENT MONITORING

C. Mission Monitoring

Mission monitoring of all preplanned combat missions in progress is conducted by the TACC (see Figure 4-7). Immediate Close Air Support and Reconnaissance missions and preplanned Close Air Support missions are monitored by the DASC. Defensive Counterair missions are monitored by the CRC. If problems or deficiencies are noted which are not within the capability of the DASC or CRC to handle with allocated resources, the TACC is notified and additional resources requested. Using mission status data and notification of problems/deficiencies from the TUOC's and the other combat control elements and the capability to interrogate the data bases of all Tactical Airbases for timely resource status data, decisions will be made in the TACC as to the adequacy of the current mission execution and if necessary, what changes must be made to the mission plans.

D. Replanning

If the mission monitoring task indicates that the deficiencies and/or changes are significant to warrant changes in the mission plans, the TACC must take corrective action. This process is described in Figure 4-8. Sometimes a deficiency may require the change of many other missions. In other cases, lower priority missions may be cancelled or postponed and the resources diverted. In others, a revised allocation of resources must be prepared and transmitted to the affected units and control elements. In all cases, the impact of changes on the overall mission plans for the day must be assessed.

4.3.4 Airlift Mission Operations

Figure 4-9 summarizes the operations for airlift missions, both preplanned and immediate. The ALCC will be in full command of all airlift resources, only interfacing with the TACC for purposes of coordination with other type missions and for requesting support missions such as fighter escort. Airlift aircraft will report their status to the parent TUOC which maintains detailed resource status files, to the CRC for its air traffic regulation and identification tasks, and to the ALCC which maintains a file on the status and location of all airborne airlift aircraft to expedite diversion and rescheduling to satisfy requests for high priority immediate missions.

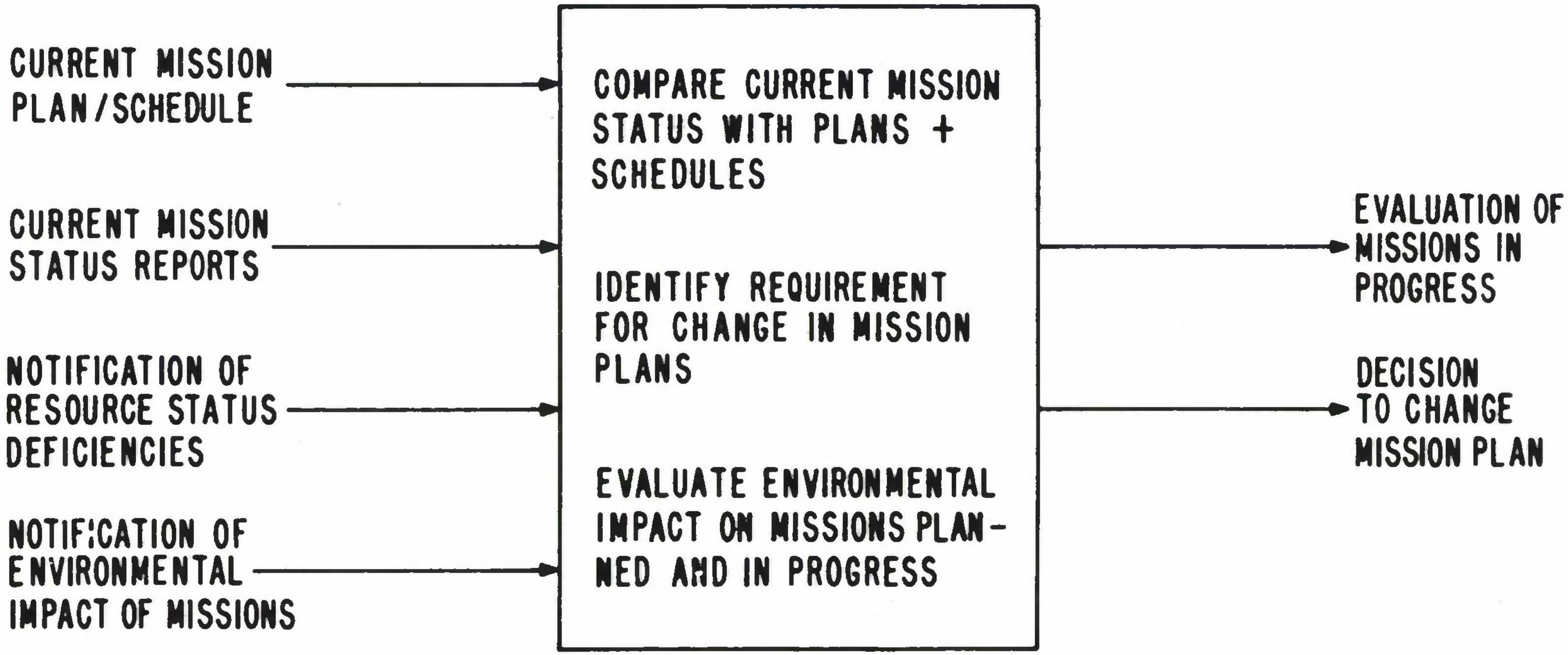

Figure 4-7 MISSION MONITORING (TACC-COMBAT FCNS, ALCC-AIRLIFT FCNS)

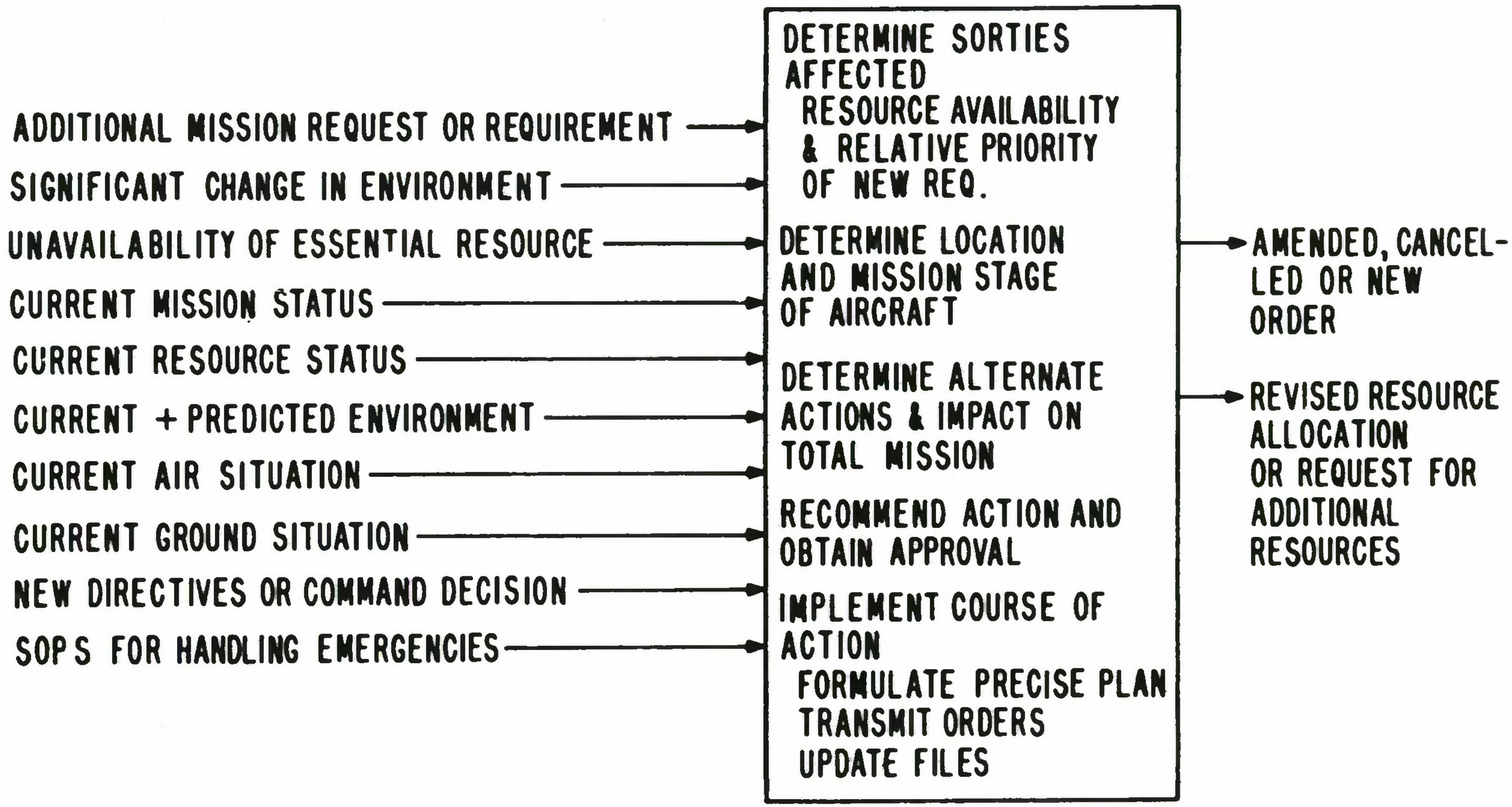

Figure 4-8 REPLANNING

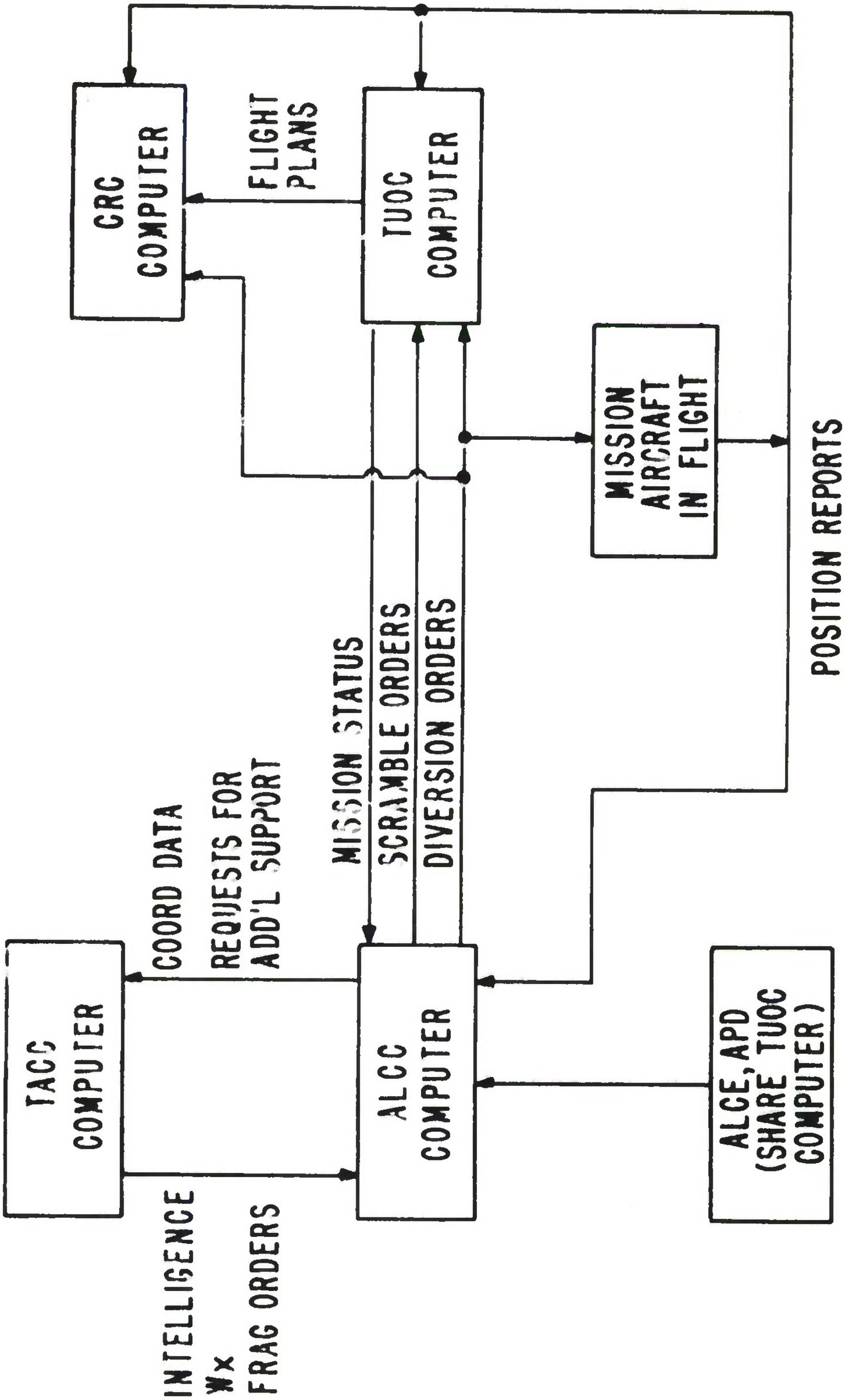

Figure 4-9 AIRLIFT OPERATIONS

A. Resource and Environmental Status Monitoring

Detailed monitoring of airlift resources will be accomplished by the cognizant TUOC's prior to and during each mission (see Figure 4-5). Deficiencies noted will be transmitted to the ALCC where decisions will be made regarding corrective action as part of the mission monitoring task. The ALCC will conduct environmental monitoring as in Figure 4-6.

B. Mission Monitoring and Replanning

The ALCC monitors the execution of all airlift missions within the tactical theater using data from the TUOC's, which are closely monitoring their aircraft and reporting any problems to the ALCC. Ground emergencies which may affect missions in progress are also transmitted from the ALCE's to the ALCC so that they may be factored into the replanning process. By knowing the up-to-date locations of all available airlift resources and cargo/passengers awaiting shipment, the ALCC is able to respond to emergencies as well as to any new high priority requests in a timely manner using the computer for selective retrieval and assignment algorithm tasks. Operations follow those of Figures 4-7 and 4-8.

4.3.5 Defensive Counterair Operations

In the distributed operational concept, Defensive Counterair Operations are fully decentralized to the CRC. (See Figure 4-10). The CRC will be allocated a given block of aircraft each day by the TACC for the Defensive Counterair mission. These aircraft will be under the positive control of the CRC during the allocation period. Resource status monitoring will be conducted by the parent TUOC while the aircraft are on the ground and any deficiencies noted will be immediately transmitted to the CRC. The CRC (as well as the parent TUOC) will receive airborne status reports from its allocated aircraft and thus will have timely data available on all allocated resources to scramble or divert as the air situation dictates.

As indicated above, the CRC receives detailed flight plans of all missions and periodic airborne location reports from all airborne aircraft. It is responsible for correlation of these with radar data as part of its identification task. The CRC transmits selected flight plan data to its subordinate CRP's which are assigned specific geographic areas of responsibility.

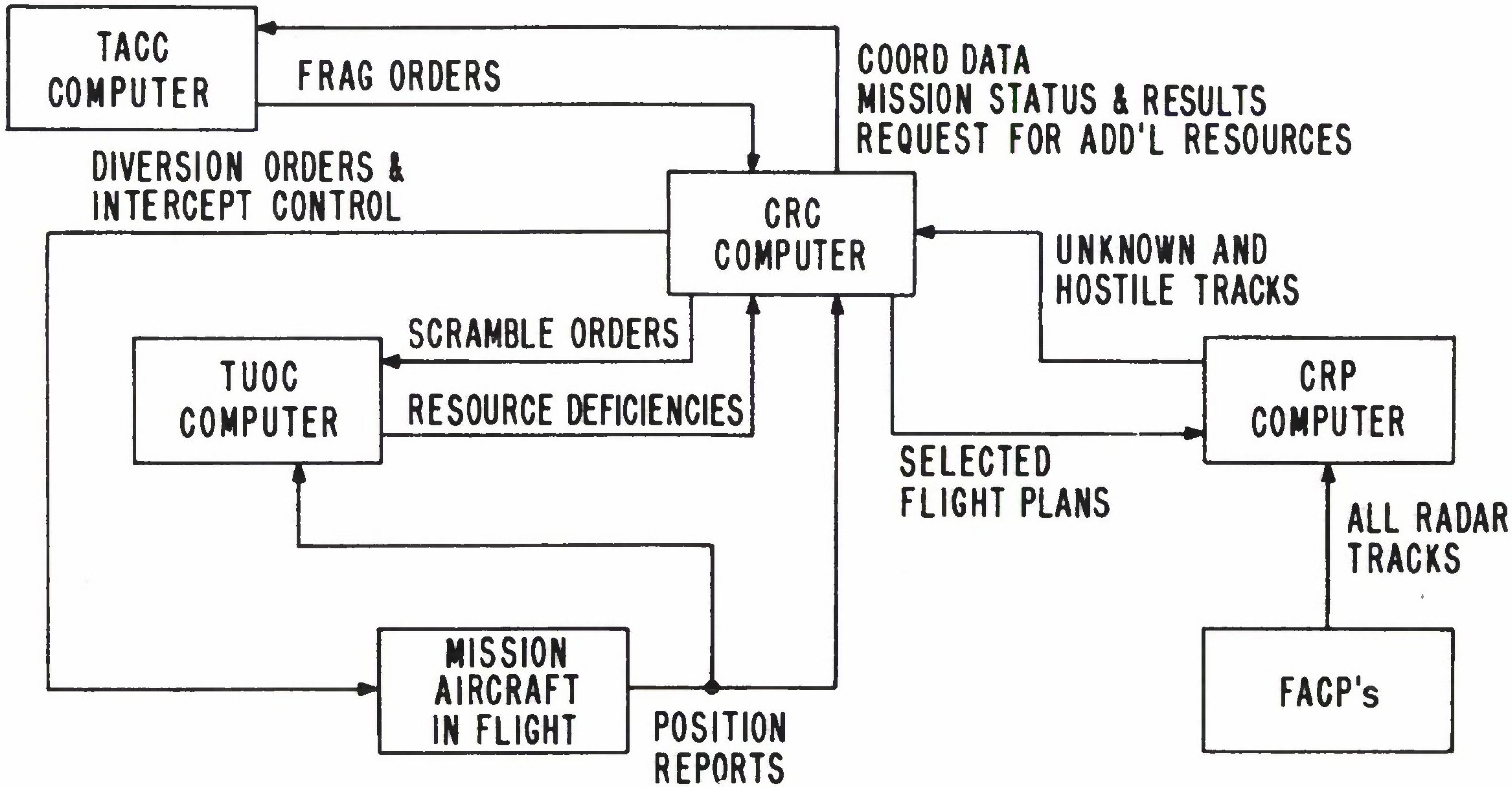

Figure 4-10 DEFENSIVE COUNTERAIR OPERATIONS

Each FACP within a CRP's area of responsibility reports all radar targets to its CRP. The CRP computer automatically correlates the FACP track data and its own radar and track data with the stored flight plan data received from the CRC. Data on unknown and hostile tracks are transmitted to the CRC, which manages the air battle, assigning aircraft or missiles as appropriate to the interception task and providing the assigned weapon system with target location and predicted track data (see Figure 4-11).

These operations apply to situations where the threat is within the capability of the allocated defensive forces. Throughout the operation, the CRC will judge the adequacy of this allocation in a replanning task (see Figure 4-8). Additional resources must be requested from the TACC if the allocated resources are deemed insufficient. The TACC must then weigh the consequences of revising the air defense allocation on the overall theater air situation and act accordingly in a replanning task of its own.

The TACC will also monitor and evaluate the mission status reports received from the CRC and will issue directives and guidance as required.

4.3.6 Close Air Support Operations

Tactical Air Support missions are fully decentralized to each DASC in support of an Army Corps, in this concept. These missions include immediate and preplanned Close Air Support, and immediate Reconnaissance. The TACC will allocate resources to accomplish these missions on a daily basis. Figure 4-12 summarizes these operations. The DASC responds directly to Army requests for air support. Requests for immediate airlift support are forwarded directly to the ALCC. Close liaison is maintained between the Air Force and Army personnel at the forward locations (TACP's). In this concept, target data and locations of friendly forces are transmitted to the DASC computer by the Army's TOC computer to maintain the most up-to-date information base and coordination between the two services.

The DASC will positively control its allocated aircraft during the allocation period. Each TUOC will monitor the resource status while the aircraft are on the ground and will report any deficiencies to the DASC immediately. The DASC will specify the alert status of each aircraft as well as the ordnance load and the TUOC will be responsible for maintaining aircraft in the specified alert and load conditions. The DASC will maintain files of the location and status (ordnance and fuel remaining)

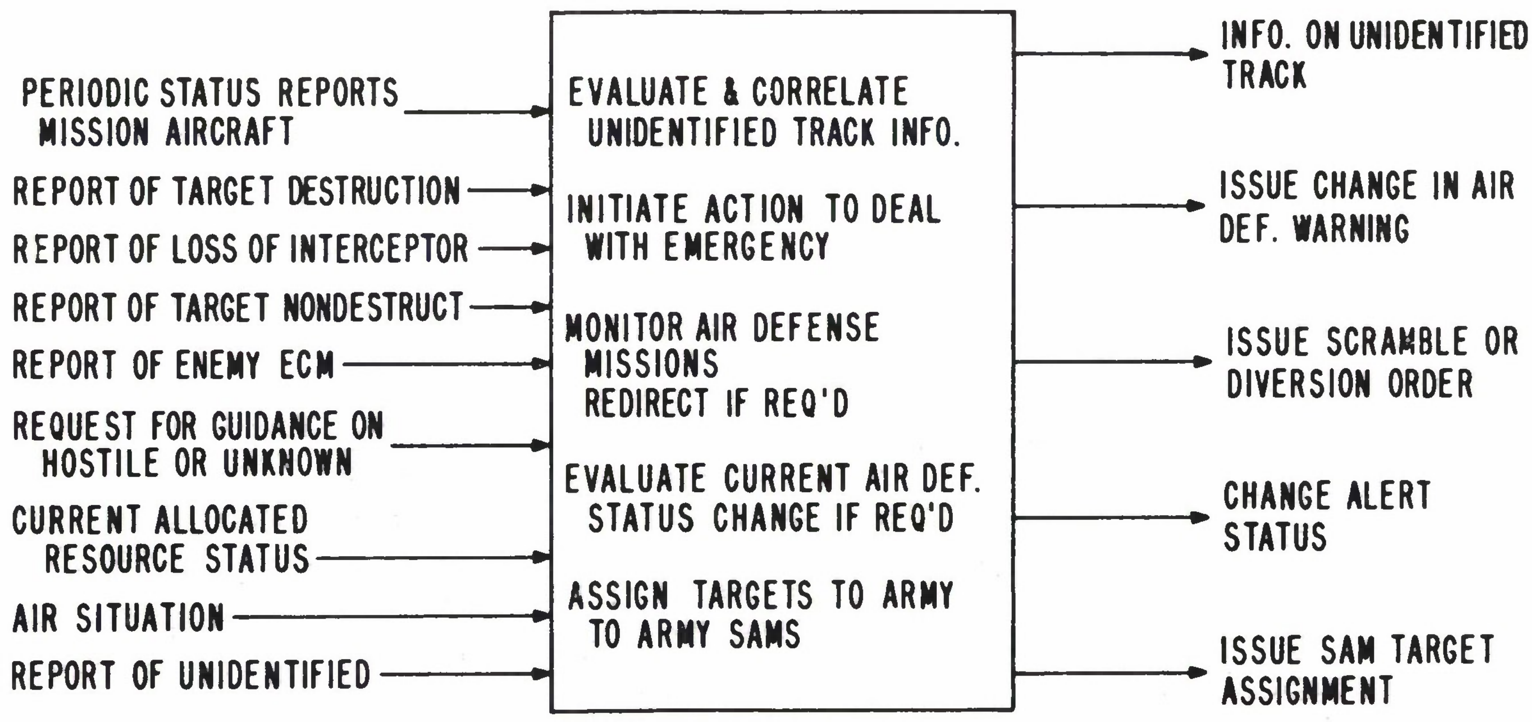

Figure 4-11. IMMEDIATE AND EMERGENCY MISSION PLANNING/REPLANNING-CRC

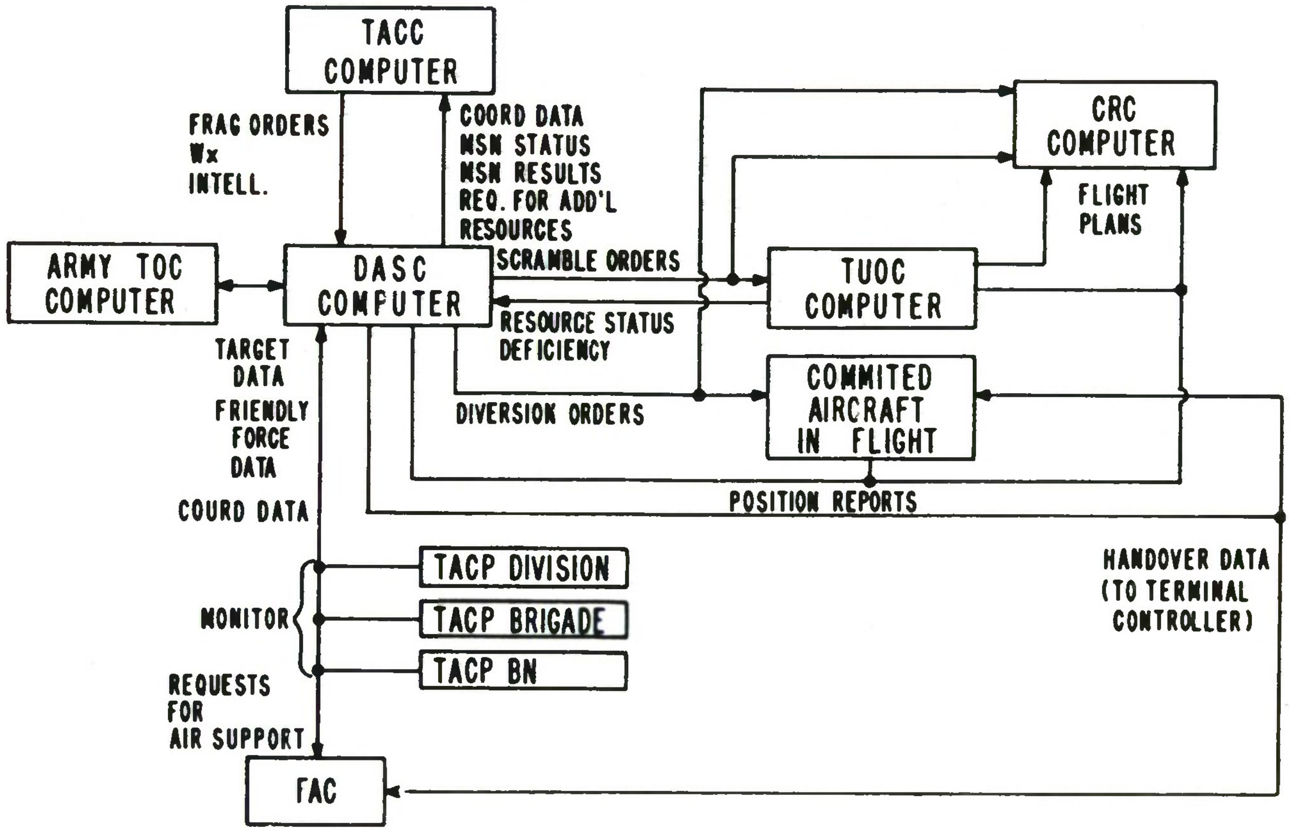

Figure 4-12 CLOSE AIR SUPPORT OPERATIONS

of all allocated airborne aircraft and thus can reassign them or divert them to provide immediate support most efficiently.

Using the computer, the DASC operators can call up data selectively based upon location, ordnance type, time to reach target, fuel remaining, or any combination of these to facilitate the assignment of resources to a given request for air support.

As in the CRC's Defensive Counterair operation, the DASC will monitor the adequacy of the mission's execution and request additional resources from the TACC if necessary (see Figure 4-8).

5.0 TRAFFIC MODEL: DISTRIBUTED OPERATIONAL CONCEPT

The intent of this phase of the AFCTC study was to show the impact of two different operational concepts on the TACS ground-to-ground communications link requirements. Two concepts have been presented above (in Sections 2 and 4). Both concepts were constrained by the requirement to comply with current TAC doctrine and the messages were based upon the current manual operation as defined in the Bunker-Ramo Tactical Traffic and Systems Analysis (TTSA) catalog. This section describes the method used to estimate the communications traffic for the distributed operational concept.

In order to assess the impact of the differences in the two operational concepts on the traffic loading between the TACS ground elements, a differential communications traffic analysis was conducted. This analysis was based upon the assumption that the two concepts were more similar than dissimilar and considered only the differences between the two based upon a determination of how the operations using the distributed concept differed from the operations as diagramed in the TTSA catalog and thus from the centralized concept. As it turned out, the concepts were more similar than expected as reflected in the differential link traffic figures. These results are presented below and are discussed in Section 6.0.

5.1 Derivation of Differential Traffic

The TACS operations were examined on a message-by-message basis to determine how the distributed concept with its management-by-exception philosophy of operation differed from the centralized system where all data, both routine and priority, were sent to the command center. The term message includes all information exchanges, regardless of the media used. Each message was examined in detail and a judgement made as to (a) whether or not the message was valid for the distributed concept, (b) if the receiving and/or sending locations changed from that shown in the TTSA catalog, and (c) if the frequency and distribution changed from that given in the TTSA catalog. All messages which were affected in any way by the operating procedures of the distributed concept were listed. Then all endpoint pairs which experienced changed traffic flow for each specific message type were identified, and the traffic changes for each were computed. Finally, the differential loading for each point-to-point link was computed by adding each message's contribution to the differential link traffic (link contributions were either additive or subtractive depending on the operational variations from the centralized concept to the distributed concept). This procedure is shown in Table 5-1.

ΔL_m = Differential communications load in kilobits per busy hour <u>between two points for a given message type</u>. Note that a given message type may produce ΔL_m between several end-point pairs.

$$\Delta L_m = \left(S_m \right)\left(F_d \right)\left(R \right)\left(M \right)\left(C \right) \text{ where}$$

S_m = Message size in kilobits based upon the message structure and number of items in the message. Derived from the Bunker-Ramo TTSA message catalog data.

F_d = Distribution fraction. In some instances the message flow is divided and subsequent flow in each branch is a fraction of the initial flow. This number accounts for that situation. An example is a case in which CAS requests are sent to the two DASC's and it is assumed that each DASC receives one half of the total CAS requests, i.e, $F_d = 0.5$.

R = Message rate expressed in message/time period or messages/ mission type or messages/sortie.

M = Message rate multiplier - depends upon units of message rate. Typical values are number of CAS missions per day or number of sorties.

C = Constant for converting to messages/busy hour.

ΔL = Differential communications load between points = $\Sigma\Delta L$ for all applicable message types

TABLE 5-1

DIFFERENTIAL LOAD COMPUTATIONS

For example, aircraft arrival reports (message number 256 in the TTSA catalog) are not used in the distributed concept because the minute-by-minute resource status data are maintained at the Tactical Airbases rather than at the ALCC. Each squadron updates its resource status files using data received via air-to-ground links. Consequently, in this analysis, traffic attributed to message number 256 was subtracted from the total traffic on each applicable link as computed by Bunker-Ramo Corporation for the given deployment. According to the flow diagrams in the TTSA message catalog and assumed for the centralized automation concept, message number 256 was sent from each TAB to the ALCC so the message link load was subtracted for all TAB to ALCC links except that of TAB 3 (because the ALCC is located at TAB 3 in this deployment).

Message number 256 contains six items, is of fixed structure, and may include narrative remarks. Using the message length distribution data in Appendix II of the TTSA message catalog (Volume I) and assuming a fifty percent probability, the number of characters per item is given as 36 and the numbers of characters which must be added to the length of the message to account for the narrative remarks is fifty. The message size is then 266 characters. Using a conversion of six bits per character, the message length is 1.59 kilobits.

The message rate for message number 256 is five per airlift mission. There are 96 airlift missions per day in this model and if it is assumed that the sorties are evenly distributed among the seven airbases, the message rate multiplier is 96 divided by 7 or 13.7 missions per day. The conversion to busy hour traffic is: traffic per day divided by 8. Thus the message per hour for each link is computed: (5) (13.7) (1/8) = 8.5 messages per busy hour. The differential link traffic for message number 256 is then (1.59) (8.5) = 13.5 kilobits per busy hour which is subtracted from the baseline link traffic on each of the following links: TAB 1 to TAB 3, TAB 2 to TAB 3, TAB 4 to TAB 3, TAB 5 to TAB 3, TAB 6 to TAB 3, and TAB 7 to TAB 3. A similar set of computations is made for each applicable message type.

Mission rates and sortie rates upon which to base the traffic loading were derived from data received from the Bunker-Ramo Corporation and which had been used to derive the baseline figures. These data required modification to account for a change in the number of Tactical Airbases. These rates are shown in Table 5-2 for various functions of tactical air and for a seven airbase deployment. Tables 5-3 and 5-4 provide the breakdown of immediate and preplanned missions used in this study.

TAB		AIR DEFENSE	INTERDICTION	CAS	RECCE	AIRLIFT	AIR REFUEL	SPEC OPS	AIR SUPPORT	ELECTRONIC	MAC SUPPORT	RESCUE + RECOVERY	TOTAL SORTIE	TOTAL FLT.	TAB
1	S			38	38				80	10		24	190		1
	F			19	30				72	5		12		137	
2	S	38	24	54	38				80	10		24	268		2
	F	10	6	27	30				72	5		12		161	
3	S			38	38	80			80		12		248		3
	F			19	30	71			72		12			204	
4	S	38	48	32		80			80	10		24	272		4
	F	10	12	16		71			72	5		12		162	
5	S	38	48	32		80	12			10	22	24	266		5
	F	10	12	16		71	9			5	22	12		157	
6	S					160		63			22		245		6
	F					142		43			22			207	
7	S		24	16		80					22	24	166		7
	F		6	8		71					22	12		119	
TOTAL SORTIES		114	144	210	114	480	12	63	280	40	78	120	1655		
FLIGHTS		30	136	105	90	426	9	43	252	20	78	60		1147	

Table 5-2 : FLIGHT ACTIVITY

IMMEDIATE COMBAT MISSIONS / DAY				
TAB NO.	CAS	AIR DEFENSE	INTERDICTION	TOTAL
1	6			6
2	8	5		13
3	6			6
4	5	5	1	11
5	5	5	1	11
6				
7	2			2
TOTAL	32	15	2	49

Table 5-3 IMMEDIATE MISSIONS

PREPLANNED COMBAT MISSIONS / DAY					
TAB NO.	CAS	AIR DEFENSE	INTERDICTION	RECCE	TOTAL
1	13			30	43
2	19	5	6	30	60
3	13				13
4	11	5	11	30	57
5	11	5	11		27
6					
7	6				6
TOTAL	73	15	28	90	206

Table 5-4 PREPLANNED MISSIONS

5.2 Traffic Figures

The differential link traffic contributions from all applicable message types were added and results are shown in Table 5-5. Total link traffic for the distributed system is the sum of the traffic shown in Tables 3-1 and 3-2 for the centralized concept and the differential link traffic for specific endpoint pairs shown in Table 5-5. These results are summarized in Table 5-6.

RECEIVING LOCATIONS

SENDING LOCATIONS	TAB 1	TAB 2	TAB 3	TAB 4	TAB 5	TAB 6	TAB 7	DASC 1	DASC 2	CRC	CRP 1	CRP 2
TAB 1			+109					-17	-17	-26	-27	-27
TAB 2			+95					-20	-20	-38	-40	-40
TAB 3	-78	-155		-170	-127	-140	-94	-190	-190	-1434	-656	-656
TAB 4			+101					-16	-16	+38	-22	-22
TAB 5			+96					-16	-16	+35	-27	-27
TAB 6			+211					+1	+1	+123		
TAB 7			+90					-13	-13	+54	-8	-8
DASC 1	+48	+52	+35	+48	+9	+1	+5			+53	-2	
DASC 2	+48	+52	+35	+48	+9	+1	+5			+53		-2
CRC	-38	-56	-613	-21	-33	+13	-4	+7	+7		-62	-62
CRP 1	-27	-38	-670	-21	-25		-8			-259		
CRP 2	-27	-38	-670	-21	-25		-8			-259		

Table 5-5 DIFFERENTIAL POINT TO POINT TRAFFIC - KILOBITS / BUSY HOUR DISTRIBUTED CONCEPT COMPARED TO CENTRALIZED CONCEPT

RECEIVING LOCATIONS

SENDING LOCATIONS	TAB 1	TAB 2	TAB 3	TAB 4	TAB 5	TAB 6	TAB 7	DASC 1	DASC 2	CRC	CRP 1	CRP 2
TAB 1		58609	245443	65681	58609	49393	58579	65547	64177	171272	28116	
TAB 2	58609		255494	65599	58527	49393	60103	35853	37223	151038		28103
TAB 3	221514	208721		225421	241306	234455	253427	128855	128855	559199		
TAB 4	65681	65599	311726		65599	60290	58579	9331	9331	143736		
TAB 5	58609	58527	344990	68041		49393	68198	9331	9331	163969		
TAB 6	49391	49393	272703	53388	49393		68606	9348	9348	77068		
TAB 7	58562	60086	284351	59714	62431	68609		23847	23847	155154		
DASC 1	15487	14121	132204	8100	8061	1254	7121		33801	52477	13372	
DASC 2	14117	15491	132194	8100	8061	1254	7121	33801		52477		13372
CRC	191238	175350	580028	163655	183879	96936	132040	92387	92387		97778	97778
CRP 1	28121		2898					12423		97581		86967
CRP 2		28110	2898						12423	97581	86967	

Table 5-6 POINT TO POINT TRAFFIC DENSITIES FOR DISTRIBUTED CONCEPT KILOBITS / BUSY HOUR

6.0 CONCLUSIONS AND OBSERVATIONS

As a result of developing and studying the traffic densities and patterns involved with the two operational concepts of the TACS, some conclusions can be drawn. In addition, the information obtained during these studies plus the various aspects of communicating within the tactical theater touched upon during the studies has caused the formulation of certain observations on the overall theater situation and an approach to handling it.

6.1 Conclusions

The table of point-to-point traffic densities for the centralized concept is given in Section 3.0. The results of a differential analysis between the two concepts is given in Section 5.0. The differential traffic density figures are of a sufficiently small magnitude as to be negligible when compared to the overall point-to-point densities and the tolerances of the developed data. It is concluded that, for practical purposes, the two operational concepts given in this paper produce identical traffic patterns and densities. Therefore, the tables given in Section 3.0 are to be used as the results of this study.

This conclusion was unexpected; some thinking as to why the results of the studies came out this way seems to be in order. The following reasons are given as a partial explanation of the conclusion:

a. Both operational concepts were restricted from differing significantly from today's TACS operational doctrine. Both utilized the messages derived from current manual operations. The organizations involved in both deployment concepts and their locations in the theater were identical. These steps were taken to minimize the variables being studied. However, these basic assumptions contributed to the similarity of resulting traffic developed for the two concepts.

b. Centralized planning contrasts with distributed planning when viewing both concepts, but both concepts call for a decentralized and nearly identical execution process. The data flow differentials within a tactical theater ground environment communications caused by different planning techniques are minimal.

c. Many of the messages required by the centralized concept but not needed in the distributed concept were offset by requirements to add coordination messages needed to maintain the distributed data bases.

The similarity of traffic figures for the two concepts results from limitations intentionally built into the study to limit the scope to fit the time and resources available. Because these conditions were known and documented into the planning for the study, the results obtained are regarded as valid. With an understanding of the basis of the traffic analysis, no hesitation should be involved in using the results in Section 3.0 as a foundation for suceeding studies comparing various parameters of tactical theater communications trunking to support the ground environment.

6.2 Study Omissions

In addition to the technical limitations of the study discussed in the previous paragraph, there are certain other potential areas which produce tactical theater traffic, would normally be included in any communications design process, and were not considered in this study because of limited resources. Among these areas which should be covered in any future effort are:

a. Intelligence Traffic:

The intelligence community within a tactical theater produces and distributes large quantities of data of a perishable nature. New types of sensor technology are being developed and introduced into the tactical theater. No effort to truely define theater communications can exclude this large source of data/traffic. In this study, the intelligence traffic estimates were based on the original AF/MALLARD deployment figures per the study ground rules without attempting to assess the impact of new technology.

b. Logistics Traffic:

In this category also, estimates were based on the original AF/MALLARD deployment figures without attempting to assess the impact of new technology and techniques employed in this area. The logistics traffic in a tactical theater is significant with respect to the amount of command/control traffic. Efficiency of design and resource use dictates that these be handled by the same types of communications and perhaps even share the same facilities. Definition of the traffic from the logistics operations in the post-1975 era is a necessary input into any communications design.

c. Air-Ground Traffic:

The traffic between aircraft and the ground is vital to the performance of the Air Force tactical theater component. New technology, such as AWACS or PLRACTA, will increase the importance and quantities of this type of traffic. Interfaces between ground environment and air-ground communications must be clearly defined to permit proper operation of the TACS. This traffic becomes another necessary input into any overall communication design for the tactical theater.

d. Emergency Condition Traffic:

Although back-up capabilities for processing centers were mentioned in both concepts, no attempt was made to define traffic densities in the ground environment resulting from the degradation or loss of a processing center. It is reasonable to believe the traffic peaks resulting from some emergency condition of the nature described would exceed the peaks established in Section 3.0. A study of such emergency conditions and their impact on the point-to-point densities shown for the normal condition would be required to validate the use of the Section 3.0 figures in any design process.

e. Operational Changes:

If automation is introduced into the TACS, the new capabilities gained may make possible new and different methods of operation which are more efficient than merely automating today's manual methods. Any changes to today's operational doctrine brought about by automation would perhaps have a significant impact on the traffic patterns and densities given in Section 3.0. Before initiating any design based on these figures, automation's impact on operational doctrine with resulting changes in traffic should be analyzed.

6.3 Tactical Communications System Development

There is an increasingly apparent gap between the development of communications systems to support the TACS and the new sensor and data management subsystems for use with the TACS centers. In the post-1975 period, the Air Force tactical theater component must have the ability to deploy a communications capability to support: an automation-aided TACS with the automated TACC complex (Seek Flex), tactical reconnaissance imagery transmissions between airbase and TACC locations, real-time SLR from reconnaissance aircraft, AWACS, TAFIES, remote interdiction sensors. In addition, interfaces will be required for MALLARD, PLRACTA/UCNI, TACSAT, DSCS, JIFDATS, TACFIRE, TOS, MDTS, NDTS and possibly many other in-theater operations. The required communications capability will include air-air-, ground-air-ground and ground-ground links systems. To the maximum extent practical, common equipment types and subsystems should be considered for cost effectiveness in procurements, operations and maintenance concepts.

This study was an attempt to measure the impact on communications by differing operational concepts. As such, it was limited in scope and fragmented, in nature, from the overall required capability. And yet, in looking at various new technology programs, some common communications needs and suggested techniques similar to those suggested in this study become apparent. In a report[1] prepared by the Bunker-Ramo Corporation under the TTSA study contract, it was concluded that in the baseline configuration, inter-node trunking is highly desirable to obtain multiple long range channels. The study's ba eline networks were implemented with equipment either available or realizable by the 1970 to 1975 time frame and which for the most part, were represented by 407L equipment capabilities and operational concepts. Improved coverage to disadvantaged users (i.e., subscribers to the system that are constrained by size, weight, power, and mobility of their communication equipment) was also recommended in the report. The source study by the Bunker-Ramo Corporation found that some improvements would be required in 407L equipment to handle the digital data load expected for the early 1970's period. This study, with its 3 Megabit total traffic circulation pattern, also appears to indicate this conclusion. Further study of this aspect of communications is now underway.

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[1] Bunker-Ramo Corporation - A Preliminary Description of the Communication System Requirements for the Air Force Tactical Command and Control System, January, 1969.

The use of time-division multiplexing techniques are almost universally accepted. The use of satellite and/or airborne relays is projected in many cases. Computer-to-computer communication frequently appears. Each program is currently studying how much communication support it will require and how to get it without regard to the needs of other programs which often have similar requirements. For example, a communication system supporting one system could, with proper multiplex design, support the communications of several subsystems with similar requirements. If the current new technology programs are allowed to pursue their communication planning toward independent conclusions, the tactical theater will be flooded with special use communications. Interface and interference problems will be extensive, and overall theater operations will be degraded.

It seems evident that an all-inclusive communication "needs" assessment for the deployed Air Force in a tactical theater would uncover a number of similar requirements. Similar requirements can often be satisfied by common equipment. A common relay platform might, for example, serve ground-to-ground as well as air-to-air or air-ground communications by use of different electronics packages. A ground terminal might receive data of different types, from a common relay, using a single antenna system. The concept formulation of an Air Force tactical communication system should be cognizant of as many of the service needs as possible in order to produce an overall, integrated theater communications capability.

APPENDIX A

BACKGROUND MATERIAL FOR THE TACS CENTRALIZED OPERATIONAL CONCEPT

A. BACKGROUND MATERIAL

This appendix supports the discussions of Sections 3.0 and 5.0 of this paper. It provides the greater depth of detail developed during the derivation of traffic figures for the centralized concept of operating the TACS. Some of the developed criteria were also used during the derivation of traffic figures for the distributed concept of operating the TACS. Details are given in the order that they were developed during the analysis.

A-1 The Organization

As a first step to defining traffic requirements for the centralized concept, a five character alpha-numeric code was used to identify each organization within the tactical theater which participates in an information exchange beyond its immediate location, and which uses the ground environment communications. All independently located organizations are coded except for the various TACP's; any organization colocated with its parent, such as a squadron with its wing, is not coded. The TAB and its support units are lumped together under a single entry and called a combat support group. The codes developed for the Bunker-Ramo AF/MALLARD deployment were used as a guide to defining these codes, but variations were made to provide for anticipated different uses to which the codes will be put. The technique used for coding the organizations called for the following:

First Character: Represents parent branch of service to which the unit belongs. F = Air Force; A = Army; N = Navy; M = Marine Corps; J = Joint Forces.

Second and Third Characters: Describes the type of organization; e.g., AW = attack fighter; FG = tactical fighter; EW = tactical electronic warfare.

Fourth Character: This denotes the approximate unit location or physical arrangement within the theater; 0 = AC and W units (special independent locations); 1 = TAB 1; 2 = TAB 2; 3 = TAB 3; 4 = TAB 4; 5 = TAB 5; 6 = TAB 6; 7 = TAB 7; 8 = Colocated with Army unit; 9 = other.

Fifth Character: This denotes the size or military description of the unit; D = detachment, S = squadron; W = wing; E = element; C = group; N = other.

CODE	ORGANIZATION
FAGON	AIR SUPPORT RADAR TEAM
FAHON	AIR SUPPORT RADAR TEAM
FAION	AIR SUPPORT RADAR TEAM
FAJON	AIR SUPPORT RADAR TEAM
FWXOG	AIR WEATHER GROUP (AT CRC)
FWYOD	AIR WEATHER DETACHMENT (AT CRP)
FWXOD	AIR WEATHER DETACHMENT (AT CRP)
FCHON	CONTROL AND REPORTING CENTER
FGHON	CONTROL AND REPORTING POST
FGGON	CONTROL AND REPORTING POST
FFGON	FORWARD AIR CONTROL POST
FFHON	FORWARD AIR CONTROL POST
FFION	FORWARD AIR CONTROL POST
FFJON	FORWARD AIR CONTROL POST
FPZ1D	AERIAL PORT DETACHMENT
FAR1D	AIR RESCUE AND RECOVERY DETACHMENT
FLC1E	AIRLIFT CONTROL ELEMENT J
FWX1D	AIR WEATHER DETACHMENT
FAW1W	ATTACK FIGHTER WING
FCZ1G	COMBAT SUPPORT GROUP
FLR1D	LOCAL BASE RESCUE DETACHMENT
FEW1E	TACTICAL ELECTRONIC WARFARE ELEMENT (SEPARATE)
FTR1S	TACTICAL RECONNAISSANCE SQUADRON (SEPARATE)
FSS1S	TACTICAL AIR SUPPORT SQUADRON (SEPARATE)
FQF1E	TERMINAL AIR TRAFFIC CONTROL ELEMENT
FPZ2D	AERIAL PORT DETACHMENT
FAR2D	AIR RESCUE AND RECOVERY DETACHMENT
FLC2E	AIRLIFT CONTROL ELEMENT
FWX2D	AIR WEATHER DETACHMENT
FCZ2G	COMBAT SUPPORT GROUP
FLR2D	LOCAL BASE RESCUE DETACHMENT
FFG2W	TACTICAL FIGHTER WING
FEW2E	TACTICAL ELECTRONIC WARFARE ELEMENT (SEPARATE)
FTR2S	TACTICAL RECONNAISSANCE SQUADRON (SEPARATE)
FSS2S	TACTICAL AIR SUPPORT SQUADRON (SEPARATE)
FQF2E	TERMINAL AIR TRAFFIC CONTROL ELEMENT
FPZ3S	AERIAL PORT SQUADRON
FXH3S	AIRBORNE WARNING AND CONTROL SQUADRON
FVF3N	AIRLIFT CONTROL CENTER
FWX3D	AIR WEATHER DETACHMENT
FAW3S	ATTACK FIGHTER SQUADRON (SEPARATE)
FCZ3G	COMBAT SUPPORT GROUP
FSI3N	EMERGENCY REACTION UNIT
FLR3D	LOCAL BASE RESCUE DETACHMENT
FBC3D	MAC SUPPORT DETACHMENT
FRC3N	RESCUE COORDINATION CENTER
FTR3W	TACTICAL RECONNAISSANCE WING
FSS3G	TACTICAL AIR SUPPORT GROUP

CODE	ORGANIZATION
FTH3N	TACTICAL AIR CONTROL CENTER
FAL3N	TACTICAL AIRLIFT DIVISION
FAL3S	TACTICAL AIRLIFT SQUADRON (SEPARATE)
FQF3E	TERMINAL AIR TRAFFIC CONTROL ELEMENT
FPZ4D	AERIAL PORT DETACHMENT
FAR4S	AIR RESCUE AND RECOVERY SQUADRON
FLC4E	AIRLIFT CONTROL ELEMENT
FWX4D	AIR WEATHER DETACHMENT
FCZ4G	COMBAT SUPPORT GROUP
FLR4D	LOCAL BASE RESCUE DETACHMENT
FFG4W	TACTICAL FIGHTER WING
FEW4S	TACTICAL ELECTRONIC WARFARE SQUADRON
FAL4S	TACTICAL AIRLIFT SQUADRON (SEPARATE)
FSS4D	TACTICAL AIR SUPPORT DETACHMENT
FQF4E	TERMINAL AIR TRAFFIC CONTROL ELEMENT
FPZ5D	AERIAL PORT DETACHMENT
FRF5S	AIR REFUELING SQUADRON
FAR5S	AIR RESCUE AND RECOVERY SQUADRON
FLC5E	AIRLIFT CONTROL ELEMENT
FWX5D	AIR WEATHER DETACHMENT
FCZ5G	COMBAT SUPPORT GROUP
FLR5D	LOCAL BASE RESCUE DETACHMENT
FBC5S	MAC SUPPORT SQUADRON
FFG5W	TACTICAL FIGHTER WING
FEW5E	TACTICAL ELECTRONIC WARFARE ELEMENT (SEPARATE)
FAL5S	TACTICAL AIRLIFT SQUADRON (SEPARATE)
FQF5E	TERMINAL AIR TRAFFIC CONTROL ELEMENT
FPZ6D	AERIAL PORT DETACHMENT
FLC6E	AIRLIFT CONTROL ELEMENT
FWX6D	AIR WEATHER DETACHMENT
FCZ6G	COMBAT SUPPORT GROUP
FLR6D	LOCAL BASE RESCUE DETACHMENT
FBC6S	MAC SUPPORT SQUADRON
FOR6S	SPECIAL OPERATIONS SQUADRON
FAL6W	TACTICAL AIRLIFT WING
FQF6E	TERMINAL AIR TRAFFIC CONTROL ELEMENT
FPZ7D	AERIAL PORT DETACHMENT
FAR7G	AIR RESCUE AND RECOVERY GROUP
FLC7E	AIRLIFT CONTROL ELEMENT
FWX7D	AIR WEATHER DETACHMENT
FCZ7G	COMBAT SUPPORT GROUP
FLR7S	LOCAL BASE RESCUE SQUADRON
FBC7S	MAC SUPPORT SQUADRON
FFG7S	TACTICAL FIGHTER SQUADRON (SEPARATE)
FAL7W	TACTICAL AIRLIFT WING
FQF7E	TERMINAL AIR TRAFFIC CONTROL ELEMENT
FWX8D	AIR WEATHER DETACHMENT (I CORPS)
FWY8D	AIR WEATHER DETACHMENT (II CORPS)

CODE	ORGANIZATION
FDH8N	DIRECT AIR SUPPORT CENTER (I CORPS)
FDI8N	DIRECT AIR SUPPORT CENTER (II CORPS)
FWX9D	AIR WEATHER DETACHMENT (JFOC)
JCC9N	JOINT FORCES OPERATING CENTER
JAR9N	JOINT SEARCH AND RESCUE CENTER
JTM9N	JOINT TRANSPORT MANAGEMENT BOARD

A-2 Information Exchange List

Before actual traffic figures can be generated for the units of the centralized concept, the pattern of information exchanges between organizations must be defined. For the purpose of this exercise, an information exchange was defined as a one-way transfer of data from one organization to another. The exchange was identified by the originator/sender. The medium (voice, teletype, facsimile, etc.) was disregarded at this stage of model development. Exchanges which do not travel beyond the local communication distribution facility (local base exchange) were not defined at this time.

To begin this information exchange definition, each organization on the code list was considered, individually and one at a time. All the organizations to which the subject organization would transmit data were then identified. The Bunker-Ramo information exchange printout was used as a guide. A brief summary of the rationale for the exchange was also given with each receiving organization so identified. Coordination between two organizations when one or both have subordinate units on the same TAB was assumed to take place at the local level; this coordination was not defined in the inter-base traffic.

A-2.1 Combat Family

FAW1W Attack Fighter Wing

FAW3S	AFS	Admin. traffic; coordination
FTH3N	TACC	Wing status (less FAW3S); mission results; requests for Recce and intelligence info.
FDH8N	I-DASC	Immed. CAS resource status, wing (less FAW3S)
FDI8N	II-DASC	Immed. CAS resource status, wing (less FAW3S)
FCHON	CRC	Pilot intelligence observations; air defense resource status, wing (less FAW3S)
FFG2W	TFW	Coordination
FFG4W	TFW	Coordination
FFG5W	TFW	Coordination
FXH3S	AWACS	Coordination
FOR6S	SOS	Coordination

FAW3S Attack Fighter Squadron (separate)

FAW1W	AFW	Squadron status; admin. traffic; coordination
FDH8N	I-DASC	Immed. CAS resource status, squadron
FDI8N	II-DASC	Immed. CAS resource status, squadron
FCHON	CRC	Pilot intelligence observations; air defense resource status, squadron

FFG2W Tactical Fighter Wing

FFG7S	TFS	Admin. traffic, coordination
FTH3N	TACC	Wing status (less FFG7S); mission results; requests for Recce and intelligence info.
FDH8N	I-DASC	Immed. CAS resource status, wing (less FFG7S)
FDI8N	II-DASC	Immed. CAS resource status, wing (less FFG7S)
FCHON	CRC	Pilot intelligence observations; air defense resource status, wing (less FFG7S)
FAW1W	AFW	Coordination
FFG4W	TFW	Coordination
FFG5W	TFW	Coordination
FXH3S	AWACS	Coordination
FOR6S	SOS	Coordination

FFG7S Tactical Fighter Squadron (separate)

FFG2W	TFW	Squadron status; admin. traffic; coordination
FDH8N	I-DASC	Immed. CAS resource status, squadron
FDI8N	II-DASC	Immed. CAS resource status, squadron
FCHON	CRC	Pilot intelligence observations; air defense resource status, squadron

FFG4W Tactical Fighter Wing

FTH3N	TACC	Wing status; mission results; requests for Recce and intelligence info.
FDH8N	I-DASC	Immediate CAS resource status, wing
FDI8N	II-DASC	Immediate CAS resource status, wing
FCHON	CRC	Pilot intelligence observations; air defense resource status, wing
FAW1W	AFW	Coordination
FFG2W	TFW	Coordination
FFG5W	TFW	Coordination
FXH3S	AWACS	Coordination
FOR6S	SOS	Coordination
FTR3W	TRW	Coordination

FFG5W Tactical Fighter Wing

FTH3N	TACC	Wing status; mission results; requests for Recce and intelligence info.
FDH8N	I-DASC	Immediate CAS resource status, wing
FDI8N	II-DASC	Immediate CAS resource status, wing
FCHON	CRC	Pilot intelligence observations; air defense resource status, wing

FFG5W Tactical Fighter Wing (cont.)

FAW1W	AFW	Coordination
FFG2W	TFW	Coordination
FFG4W	TFW	Coordination
FXH3S	AWACS	Coordination
FOR6S	SOS	Coordination
FTR3W	TRW	Coordination
FSS3G	TASG	Coordination

FTR3W Tactical Reconnaissance Wing

FDH8N	I-DASC	Immed. Recce Resource Status, Wing (less 2 squadrons)
FDI8N	II-DASC	Immed. Recce Resource Status, Wing (less 2 squadrons)
FTR1S	TRS	Admin. traffic; coordination
FTR2S	TRS	Admin. traffic; coordination
FEW4S	TEWS	Coordination
FFG4W	TFW	Coordination
FFG5W	TFW	Coordination
FOR6S	SOS	Coordination
FCHON	CRC	Coordination
FRF5S	ARS	Coordination

FTR1S Tactical Reconnaissance Squadron

FDH8N	I-DASC	Immed. Recce Resource Status, Squadron
FDI8N	II-DASC	Immed. Recce Resource Status, Squadron
FTR3W	TRW	Squadron status; admin. traffic; coordination
FCHON	CRC	Coordination

FTR2S Tactical Reconnaissance Squadron

FDH8N	I-DASC	Immed. Recce resource status, squadron
FDI8N	II-DASC	Immed. Recce resource status, squadron
FCHON	CRC	Coordination
FTR3W	TRW	Squadron status; administration traffic; coordination

FEW4S Tactical Electronic Warfare Squadron

FEW1E	TEWE	Admin. traffic; coordination
FEW2E	TEWE	Admin. traffic; coordination
FEW5E	TEWE	Admin. traffic; coordination
FTH3N	TACC	Squadron status (less 3 elements)

FEW4S Tactical Electronic Warfare Squadron (cont.)

FCHON	CRC	Coordination
FTR3W	TRW	Coordination
FXH3S	AWACS	Coordination
FOR6S	SOS	Coordination
FSI3N	ERU	Coordination

FEW1E Tactical Electronic Warfare Element

FEW4S	TEWS	Element status; admin. traffic; coordination
FTH3N	TACC	Element status
FCHON	CRC	Coordination

FEW2E Tactical Electronic Warfare Element

FEW4S	TEWS	Element status; admin. traffic, coordination
FTH3N	TACC	Element status
FCHON	CRC	Coordination

TEW5E Tactical Electronic Warfare Element

FEW4S	TEWS	Element status; admin. traffic; coordination
FTH3N	TACC	Element status
FCHON	CRC	Coordination

FXH3S Airborne Warning and Control Squadron

FCHON	CRC	Coordination
FAW1W	AFW	Coordination
FFG2W	TFW	Coordination
FFG4W	TFW	Coordination
FFG5W	TFW	Coordination
FOR6S	SOS	Coordination
FRF5S	ARS	Coordination
FEW4S	TEWS	Coordination

FOR6S Special Operations Squadron

FTH3N	TACC	Squadron status; mission results; requests for Recce and intelligence info.
FCHON	CRC	Coordination; pilot intelligence observations
FAW1W	AFW	Coordination
FFG2W	TFW	Coordination
FFG4W	TFW	Coordination
FFG5W	TFW	Coordination

FOR6S Special Operations Squadron (cont.)

FSS3G	TASG	Coordination
FTR3W	TRW	Coordination
FEW4S	TEWS	Coordination
FXH3S	AWACS	Coordination
FDH8N	I-DASC	Status Reports
FDI8N	II-DASC	Status Reports

FRF5S Air Refueling Squadron

FTH3N	TACC	Squadron status; mission results
FCHON	CRC	Coordination
FFG4W	TFW	Coordination
FTR3W	TRW	Coordination
FXH3S	AWACS	Coordination

FSI3N Emergency Reaction Unit

FCHON	CRC	Intelligence Information; coordination
FEW4S	TEWS	Coordination
JCC9N	JFOC	Intelligence information; coordination

FTH3N Tactical Air Control Center

FAW1W	AFW	Combat frag orders, changes, intelligence	one copy sent to TUOC at TAB 1; multiple printouts
FTR1S	TRS	Combat frag orders, changes, intelligence	
FSS1S	TASS	Combat frag orders, changes, intelligence	
FAR1D	ARRD	Combat frag orders, changes, intelligence	
FFG2W	TFW	Combat frag orders, changes, intelligence	one copy sent to TUOC at TAB 2; multiple printouts
FTR2S	TRS	Combat frag orders, changes, intelligence	
FSS2S	TASS	Combat frag orders, changes intelligence	
FAR2D	ARRD	Combat frag orders, changes, intelligence	
FFG4W	TFW	Combat frag orders, changes, intelligence	one copy sent to TUOC at TAB 4; multiple printouts
FEW4S	TEWS	Combat frag orders, changes, intelligence	
FAR4S	ARRS	Combat frag orders, changes, intelligence	

FTH3N Tactical Air Control Center (cont.)

FDH8N	I-DASC	Combat frag orders, changes, intelligence, coordination	
FDI8N	II-DASC	Combat frag orders, changes, intelligence, coordination	
FCHON	CRC	Combat frag orders, changes, intelligence, coordination	
JCC9N	JFOC	Mission results; status of air component, combat	
FFG5W	TFW	Combat frag orders, changes, intelligence	one copy sent to TUOC at TAB 5; multiple printouts
FRF5S	ARS	Combat frag orders, changes, intelligence	
FAR5S	ARRS	Combat frag orders, changes, intelligence	
FOR6S	SOS	Combat frag orders, changes, intelligence	one copy sent to TUOC at TAB 6; multiple printouts
FFG7S	TFS	Combat frag orders, changes, intelligence	one copy sent to TUOC at TAB 7; multiple printouts
FAR7G	ARRG	Combat frag orders, changes, intelligence	

FSS3G Tactical Air Support Group

FSS1S	TASS	Admin. traffic; coordination
FSS2S	TASS	Admin. traffic; coordination
FSS4D	TASD	Admin. traffic; coordination
FCHON	CRC	Coordination
FFG5W	TRW	Coordination
FOR6S	SOS	Coordination
FDH8N	I-DASC	Coordination
FDI8N	II-DASC	Coordination

FSS1S Tactical Air Support Squadron

FSS3G	TASG	Squadron status; admin. traffic; coordination
FTH3N	TACC	Squadron status
FCHON	CRC	Coordination; mission results
FDH8N	I-DASC	Squadron status relative to immediate CAS missions
FDI8N	II-DASC	Squadron status relative to immediate CAS missions

FSS2S Tactical Air Support Squadron

FSS3G	TASG	Squadron status; admin. traffic; coordination
FTH3N	TACC	Squadron status
FCHON	CRC	Coordination; mission results
FDH8N	I-DASC	Squadron status relative to immediate CAS missions
FDI8N	II-DASC	Squadron status relative to immediate CAS missions

FSS4D Tactical Air Support Detachment

FSS3G	TASG	Squadron status; admin. traffic, coordination
FTH3N	TACC	Squadron status
FCHON	CRC	Coordination; mission status

FDH8N I Corps - Direct Air Support Center

FDI8N	II-DASC	Coordination
FAW1W	AFW	Immed. CAS frag orders, changes, intelligence
FAW3S	AFS	Immed. CAS frag orders, changes, intelligence
FFG2W	TFW	Immed. CAS frag orders, changes, intelligence
FFG7S	TFS	Immed. CAS frag orders, changes, intelligence
FFG4W	TFW	Immed. CAS frag orders, changes, intelligence
FFG5W	TFW	Immed. CAS frag orders, changes, intelligence
FTR3W	TRW	Immed. Recce frag orders, changes, intelligence
FTR1S	TRS	Immed. Recce frag orders, changes, intelligence
FTR2S	TRS	Immed. Recce frag orders, changes, intelligence
FOR6S	SOS	Immed. CAS frag orders, changes, intelligence
FTH3N	TACC	Immed. CAS/Recce resource requests; status of CAS/Recce
FSS3G	TASG	Status and frag orders, immed. support
FSS1S	TASS	Status and frag orders, immed. support
FSS2S	TASS	Status and frag orders, immed. support
FAR7G	ARRG	Coordination
FRC3N	RCC	Immediate requests; coordination
FGHON	CRP	Coordination
FCHON	CRC	Mission orders; information
FCZ1G	CSG	Needs, coordination

FDI8N II- Corps - Direct Air Support Center

FDH8N	I-DASC	Coordination
FAW1W	AFW	Immed. CAS frag orders, changes, intelligence
FAW3S	AFS	Immed. CAS frag orders, changes, intelligence
FFG2W	TFW	Immed. CAS frag orders, changes, intelligence
FFG7S	TFS	Immed. CAS frag orders, changes, intelligence
FFG4W	TFW	Immed. CAS frag orders, changes, intelligence
FFG5W	TFW	Immed. CAS frag orders, changes, intelligence

FDI8N II - Corps - Direct Air Support Center (cont.)

FTR3W	TRW	Immed. Recce frag orders, changes, intelligence
FTR1S	TRS	Immed. Recce frag orders, changes, intelligence
FTR2S	TRS	Immed. Recce frag orders, changes, intelligence
FOR6S	SOS	Immed. CAS frag orders, changes, intelligence
FTH3N	TACC	Immed. CAS/Recce resource request; status of CAS/Recce
FSS3G	TASG	Status and frag orders, immed. support
FSS1S	TASS	Status and frag orders, immed. support
FSS2S	TASS	Status and frag orders, immed. support
FAR7G	ARRG	Coordination
FRC3N	RCC	Immediate requests; coordination
FGGON	CRP	Coordination
FCHON	CRC	Mission requests; information
FCZ2G	CSG	Needs; coordination

A-2.2 Airlift Family

FAL3N Tactical Airlift Division

FAL6W	TAW	Admin. traffic; coordination
FAL7W	TAW	Admin. traffic; coordination
FCHON	CRC	Coordination
JTM9N	JTMB	Division status; coordination
FAR7G	ARRG	Coordination
JCC9N	JFOC	Division status; coordination
FLR7S	LBRS	Coordination
FAL4S	TAS	Admin. traffic; coordination
FAL5S	TAS	Admin. traffic; coordination

FAL6W Tactical Airlift Wing

FVF3N	ALCC	Wing status (less FAL4S); coordination
FAL4S	TAS	Admin. traffic; coordination
FCHON	CRC	Coordination
FAL7W	TAW	Coordination
FAR7G	ARRG	Coordination
FBC3D	MACSS	Coordination
FAL3N	TAD	Wing status (less FAL4S); coordination

FAL4S Tactical Airlift Squadron (separate)

FAL6W	TAW	Squadron status; admin. traffic
FVF3N	ALCC	Squadron status; coordination
FCHON	CRC	Coordination
FAL3N	TAD	Squadron status

FAL7W Tactical Airlift Wing

FAL3S	TAS	Admin. traffic; coordination
FAL5S	TAS	Admin. traffic; coordination
FVF3N	ALCC	Wing status (less FAL3S, FAL5S); coordination
FAL3N	TAD	Wing status (less FAL3S, FAL5S); coordination
FCHON	CRC	Coordination
FAL6W	TAW	Coordination
FBC3D	MACSS	Coordination

FAL3S Tactical Airlift Squadron (separate)

FAL7W	TAW	Squadron status; admin. traffic
FVF3N	ALCC	Squadron status; coordination
FCHON	CRC	Coordination
FAL7N	TAD	Squadron status

FAL5S Tactical Airlift Squadron (separate)

FAL7W	TAW	Squadron status; admin. traffic
FVF3N	ALCC	Squadron status, coordination
FCHON	CRC	Coordination
FAL3N	TAD	Squadron status

FBC3D MAC Support Detachment (In ALCC)

FBC5S	MACSS	Admin. traffic; coordination
FBC6S	MACSS	Admin. traffic; coordination
FBC7S	MACSS	Admin. traffic; coordination
FCHON	CRC	Coordination
FAL6W	TAW	Coordination
FAL7W	TAW	Coordination

FBC5S MAC Support Squadron

FBC3D	MACSD	Squadron status; cargo status
FCHON	CRC	Coordination

FBC6S MAC Support Squadron

FBC3D	MACSD	Squadron status; cargo status
FCHON	CRC	Coordination

FBC7S MAC Support Squadron

FBC3D	MACSD	Squadron status; cargo status
FCHON	CRC	Coordination

FLC1E Airlift Control Element

FVF3N	ALCC	Cargo and flight status; requests and needs
FRC3N	RCC	Coordination

FLC2E Airlift Control Element

FVF3N	ALCC	Cargo and flight status; requests and needs
FRC3N	RCC	Coordination

FLC4E Airlift Control Element

FVF3N	ALCC	Cargo and flight status; requests and needs
FRC3N	RCC	Coordination

FLC5E Airlift Control Element

FVF3N	ALCC	Cargo and flight status; requests and needs
FRC3N	RCC	Coordination

FLC6E Airlift Control Element

FVF3N	ALCC	Cargo and flight status, requests and needs
FRC3N	RCC	Coordination

FLC7E Airlift Control Element

FVF3N	ALCC	Cargo and flight status; requests and needs
FRC3N	RCC	Coordination

FPZ1D Aerial Port Detachment

FPZ3S	APS	Detachment status; needs
FAL3N	TAD	Detachment status; needs

FPZ2D Aerial Port Detachment

FPZ3S	APS	Detachment status; needs
FAL3N	TAD	Detachment status; needs

FPZ4D Aerial Port Detachment

FPZ3S	APS	Detachment status; needs
FAL3N	TAD	Detachment status; needs

FPZ5D Aerial Port Detachment

FPZ3S	APS	Detachment status; needs
FAL3N	TAD	Detachment status; needs

FPZ6D Aerial Port Detachment

FPZ3S	APS	Detachment status; needs
FAL3N	TAD	Detachment status; needs

FPZ7D Aerial Port Detachment

FPZ3S	APS	Detachment status; needs
FAL3N	TAD	Detachment status; needs

FPZ3S Aerial Port Squadron

FPZ1D	AFP	Admin. traffic; coordination
FPZ2D	APD	Admin. traffic; coordination
FPZ4D	APD	Admin. traffic; coordination
FPZ5D	APD	Admin. traffic; coordination
FPZ6D	APD	Admin. traffic; coordination
FPZ7D	APD	Admin. traffic; coordination
FCHON	CRC	Coordination

FVF3N Airlift Control Center

JCC9N	JFOC	Coordination
JTM9N	JTMB	Airlift status, needs
FAR7G	ARRG	Coordination
FCHON	CRC	Coordination
FLC1E	ALCE	Frag orders, changes, intelligence
FLC2E	ALCE	Frag orders, changes, intelligence
FLC4E	ALCE	Frag orders, changes, intelligence
FLC5E	ALCE	Frag orders, changes, intelligence
FLC6E	ALCE	Frag orders, changes, intelligence
FLC7E	ALCE	Frag orders, changes, intelligence
FAL7W	TAW	Frag orders, changes, intelligence
FAL5S	TAS	Frag orders, changes, intelligence
FAL6W	TAW	Frag orders, changes, intelligence
FAL4S	TAS	Frag orders, changes, intelligence
FLR7S	LBRS	Coordination

A-2.3 Joint Force

JCC9N Joint Forces Operating Center

JAR9N	JSARC	General orders; coordination
JTM9N	JTMB	General orders; coordination
FVF3N	ALCC	Coordination
FAL3N	TAD	Coordination
FSI3N	ERU	Direction; coordination
FTH3N	TACC	General orders, coordination
FCHON	CRC	Coordination

JTM9N Joint Transport Management Board

JCC9N	JFOC	Theater transport status; coordination
JAR9N	JSARC	General status; coordination
FAL3N	TAD	Coordination
FVF3N	ALCC	General orders; coordination
FCHON	CRC	Coordination

JAR9N Joint Search and Rescue Center

JCC9N	JFOC	Status; coordination
JTM9N	JTMB	Coordination
FRC3N	RCC	General orders; coordination
FAR7G	ARRG	General orders; coordination
FCHON	CRC	Coordination

A-2.4 Rescue Family

FAR7G Air Rescue and Recovery Group

FAR1D	ARRD	Administrative traffic; coordination
FAR2D	ARRD	Administrative traffic; coordination
FAR4S	ARRS	Administrative traffic; coordination
FAR5S	ARRS	Administrative traffic; coordination
FRC3N	RCC	Administrative traffic; coordination
JAR9N	JSARC	Status; projected needs
FAL3N	TAC	Coordination
FAL6W	TAW	Coordination
FVF3N	ALCC	Coordination
FTH3N	TACC	Coordination
FDH8N	I-DASC	Coordination
FDI8N	II-DASC	Coordination
FCHON	CRC	Coordination

FAR1D Air Rescue and Recovery Detachment

FAR7G	ARRG	Detachment status; coordination
FRC3N	RCC	Detachment status; coordination
FCHON	CRC	Coordination

FAR2D Air Rescue and Recovery Detachment

FAR7G	ARRG	Detachment status; coordination
FRC3N	RCC	Detachment status; coordination
FCHON	CRC	Coordination

FAR4S Air Rescue and Recovery Squadron

FAR7G	ARRG	Squadron status; coordination
FRC3N	RCC	Squadron status; coordination
FCHON	CRC	Coordination

FAR5S Air Rescue and Recovery Squadron

FAR7G	ARRG	Squadron status; coordination
FRC3N	RCC	Squadron status; coordination
FCHON	CRC	Coordination

FRC3N Rescue Coordination Center

FAR7G	ARRG	Status, immediate requests; coordination
FLR7S	LBRS	Coordination
FAR1D	ARRD	Immediate requests; coordination
FAR2D	ARRD	Immediate requests; coordination
FAR4S	ARRS	Immediate requests; coordination
FAR5S	ARRS	Immediate requests; coordination
JAR9N	JSARC	Status; coordination
FCHON	CRC	Coordination on missions
FGGON	CRP	Coordination on missions
FGHON	CRP	Coordination on missions
FDH8N	I-DASC	Coordination on missions
FDI8N	II-DASC	Coordination on missions
FLR1D	LBRD	Coordination
FLR2D	LBRD	Coordination
FLR4D	LBRD	Coordination
FLR5D	LBRD	Coordination
FLR6D	LBRD	Coordination

FLR7S Local Base Rescue Squadron

FLR1D	LBRD	Admin. traffic; coordination
FLR2D	LBRD	Admin. traffic; coordination
FLR3D	LBRD	Admin. traffic; coordination
FLR4D	LBRD	Admin. traffic; coordination
FLR5D	LBRD	Admin. traffic; coordination
FLR6D	LBRD	Admin. traffic; coordination
FRC3N	RCC	Coordination; status
FCHON	CRC	Coordination
FTH3N	TACC	Coordination
FAL3N	TAD	Coordination
FVF3N	ALCC	Coordination

FLR1D Local Base Rescue Detachment

FLR7S	LBRS	Detachment status; coordination
FRC3N	RCC	Detachment status; coordination

FLR2D Local Base Rescue Detachment

FLR7S	LBRS	Detachment status; coordination
FRC3N	RCC	Detachment status; coordination

FLR2D Local Base Rescue Detachment

FLR7S	LBRS	Detachment status; coordination
FRC3N	RCC	Detachment status; coordination

FLR3D Local Base Rescue Detachment

FLR7S	LBRS	Detachment status; coordination

FLR4D Local Base Rescue Detachment

FLR7S	LBRS	Detachment status; coordination
FRC3N	RCC	Detachment status; coordination

FLR5D Local Base Rescue Detachment

FLR7S	LBRS	Detachment status; coordination
FRC3N	RCC	Detachment status; coordination

FLR6D Local Base Rescue Detachment

FLR7S	LBRS	Detachment status; coordination
FRC3N	RCC	Detachment status; coordination

A-2.5 AC&W Family

FGHON Control and Reporting Post

FCHON	CRC	Sensor data; status of airspace, missions; handoffs
FGGON	CRP	Handoffs; status data
FFJON	FACP	Operating instructions; handoffs; status
FFION	FACP	Operating instructions; handoffs; status
FAGON	ASRT	Operating instructions; handoffs; status
FAHON	ASRT	Operating instructions; handoffs; status
FRC3N	RCC	Requests for missions; status
FDH8N	I-DASC	Coordination
FCZ1G	CSG	Logistics requests
FQF1E	TATCE	Coordination

FGGON Control and Reporting Post

FCHON	CRC	Sensor data; status of airspace, missions; handoffs
FGHON	CRP	Handoffs; status data
FFHON	FACP	Operating instructions; handoffs; status
FFGON	FACP	Operating instructions; handoffs; status
FAION	ASRT	Operating instructions; handoffs; status
FAJON	ASRT	Operating instructions; handoffs; status
FRC3N	RCC	Requests for missions; status
FDI8N	II-DASC	Coordination
FCZ2G	CSG	Logistics requests
FQF2E	TATCE	Coordination

FFJON Forward Air Control Post

FGHON	CRP	Sensor data; status of airspace, missions; handoffs
FAGON	ASRT	Handoffs; instructions
FAHON	ASRT	Handoffs, instructions

FFION Forward Air Control Post

FGHON	CRP	Sensor data; status of airspace, missions; handoffs
FAGON	ASRT	Handoffs; instructions
FAHON	ASRT	Handoffs; instructions

FFHON Forward Air Control Post

FGGON	CRP	Sensor data; status of airspace, missions; handoffs
FAION	ASRT	Handoffs; instructions
FAJON	ASRT	Handoffs; instructions

FFGON Forward Air Control Post

FGGON	CRP	Sensor data; status of airspace, missions, handoffs
FAION	ASRT	Handoffs; instructions
FAJON	ASRT	Handoffs; instructions

FAGON Air Support Radar Team

FFJON	FACP	Status; handoffs
FFION	FACP	Status; handoffs
FGHON	CRP	Status; handoffs

FAHON Air Support Radar Team

FFJON	FACP	Status; handoffs
FFION	FACP	Status; handoffs
FGHON	CRP	Status; handoffs

FAION Air Support Radar Team

FFGON	FACP	Status; handoffs
FFHON	FACP	Status; handoffs
FGGON	CRP	Status; handoffs

FAJON Air Support Radar Team

FFGON	FACP	Status; handoffs
FFHON	FACP	Status; handoffs
FGGON	CRP	Status; handoffs

FQF1E Terminal Air Traffic Control Element

FCHON	CRC	Status; handoffs
FGHON	CRP	Status; handoffs

FQF2E Terminal Air Traffic Control Element

FCHON	CRC	Status; handoffs
FGGON	CRP	Status; handoffs

FQF3E Terminal Air Traffic Control Element

FCHON	CRC	Status; handoffs

FQF4E Terminal Air Traffic Control Element

FCHON	CRC	Status; handoffs

FQF5E Terminal Air Traffic Control Element

FCHON	CRC	Status; handoffs

FQF6E Terminal Air Traffic Control Element

FCHON	CRC	Status; handoffs

FQF7E Terminal Air Traffic Control Element

FCHON	CRC	Status; handoffs

FCHON Control and Reporting Center

FAW1W	AFW	Mission status; coordination; air defense orders
FAW3S	AFS	Mission status; coordination; air defense orders
FFG2W	TFW	Mission status; coordination; air defense orders
FFG7S	FFS	Mission status; coordination; air defense orders
FFG4W	TFW	Mission status; coordination; air defense orders
FFG5W	TFW	Mission status; coordination; air defense orders
FTR3W	TRW	Mission status; coordination; air defense orders
FTR1S	TRS	Mission status; coordination; air defense orders
FTR2S	TRS	Mission status; coordination; air defense orders
FEW4S	TEWS	Mission status; coordination; air defense orders
FEW1E	TEWE	Mission status; coordination; air defense orders
FEW2E	TEWE	Mission statua; coordination; air defense orders
FEW5E	TEWE	Mission status; coordination; air defense orders
FXH3S	AWACS	Mission status; coordination; air defense orders
FOR6S	SOS	Mission status; coordination; air defense orders
FRF5S	ARS	Mission status; coordination; air defense orders
FSI3N	ERU	Mission status; coordination; air defense orders
FTH3N	TACC	Mission status summaries; air defense needs
FSS3G	TASG	Mission status; coordination
FSS1S	TASS	Mission status; coordination
FSS2S	TASS	Mission status; coordination
FSS4D	TASD	Mission status; coordination
FDH8N	I-DASC	Mission status; coordination
FDI8N	II-DASC	Mission status; coordination
FAL3N	TAD	Mission status; coordination
FAL6W	TAW	Mission status; coordination
FAL4S	TAS	Mission status; coordination
FAL7W	TAW	Mission status; coordination
FAL3S	TAS	Mission status; coordination
FAL5S	TAS	Mission status; coordination
FBC3D	MACSD	Coordination
FBC5S	MACSS	Coordination

FCHON Control and Reporting Center (cont.)

FBC6S	MACSS	Coordination
FBC7S	MACSS	Coordination
FPZ3S	APS	Coordination
FVF3N	ALCC	Mission status summaries, as applicable
JCC9N	JFOC	Mission status summaries, as applicable
JTM9N	JTMB	Mission status summaries, as applicable
JAR9N	JSARC	Mission status summaries, as applicable
FAR7G	ARRG	Mission status summaries, as applicable
FAR1D	ARRD	Mission status summaries, as applicable
FAR2D	ARRD	Mission status summaries, as applicable
FAR4S	ARRS	Mission status summaries, as applicable
FAR5S	ARRS	Mission status summaries, as applicable
FRC3N	RCC	Mission requests; summaries
FLR7S	LBRS	Mission requests; summaries
FGHON	CRP	Operating instructions; handoffs; status
FGGON	CRP	Operating instructions; handoffs; status
FQF1E	TATCE	Operating instructions; handoffs; status
FQF2E	TATCE	Operating instructions; handoffs; status
FQF3E	TATCE	Operating instructions; handoffs; status
FQF4E	TATCE	Operating instructions; handoffs; status
FQF5E	TATCE	Operating instructions; handoffs; status
FQF6E	TATCE	Operating instructions; handoffs; status
FQF7E	TATCE	Operating instructions; handoffs; status
FCZ3G	CSG	Logistics requests

A-2.6 <u>Weather Family</u>

FWXOG Air Weather Group - Central

FWX1D	AWD	Weather bulletins, advisaries and forecasts
FWX2D	AWD	Weather bulletins, advisaries and forecasts
FWS3D	AWD	Weather bulletins, advisaries and forecasts
FWX4D	AWD	Weather bulletins, advisaries and forecasts
FWX5D	AWD	Weather bulletins, advisaries and forecasts
FWX6D	AWD	Weather bulletins, advisaries and forecasts
FWX7D	AWD	Weather bulletins, advisaries and forecasts
FWX8D	AWD	Weather bulletins, advisaries and forecasts
FWY8D	AWD	Weather bulletins, advisaries and forecasts
FWX9D	AWD	Weather bulletins, advisaries and forecasts
FWXOD	AWD	Weather bulletins, advisaries and forecasts
FWYOD	AWD	Weather bulletins, advisaries and forecasts

FWX1D Air Weather Detachment

FWXOG		Reports of local weather conditions

FWX2D Air Weather Detachment

FWXOG Reports of local weather conditions

FWX3D Air Weather Detachment

FWXOG Reports of local weather conditions

FWX4D Air Weather Detachment

FWXOG Reports of local weather conditions

FWX5D Air Weather Detachment

FWXOG Reports of local weather conditions

FWX6D Air Weather Detachment

FWXOG Reports of local weather conditions

FWX7D Air Weather Detachment

FWXOG Reports of local weather conditions

FWX8D Air Weather Detachment I-DASC

FWXOG Reports of local weather conditions

FWY8D Air Weather Detachment II-DASC

FWXOG Reports of local weather conditions

FWX9D Air Weather Detachment JFOC

FWXOG Reports of local weather conditions

FWXOD Air Weather Detachment I-CRP

FWXOG Reports of local weather conditions

FWYOD Air Weather Detachment II-CRP

FWXOG Reports of local weather conditions

A-2.7 Support Family

FCZ1G Combat Support Group

FCZ2G	CSG	Status summaries; needs; coordination
FCZ3G	CSG	Status summaries; needs; coordination
FCZ4G	CSG	Status summaries; needs; coordination
FCZ5G	CSG	Status summaries; needs; coordination
FCZ6G	CSG	Status summaries; needs; coordination
FCZ7G	CSG	Status summaries; needs; coordination
FDH8N	I-DASC	Information and coordination
FGHON	I-CRP	Information and coordination

FCZ2G Combat Support Group

FCZ1G	CSG	Status summaries; needs; coordination
FCZ3G	CSG	Status summaries; needs; coordination
FCZ4G	CSG	Status summaries; needs; coordination
FCZ5G	CSG	Status summaries; needs; coordination
FCZ6G	CSG	Status summaries; needs; coordination
FCZ7G	CSG	Status summaries; needs; coordination
FDI8N	II-DASC	Information and coordination
FGGON	II-CRP	Information and coordination

FCZ3G Combat Support Group

FCZ1G	CSG	Status summaries; needs; coordination
FCZ2G	CSG	Status summaries; needs; coordination
FCZ4G	CSG	Status summaries; needs; coordination
FCZ5G	CSG	Status summaries; needs; coordination
FCZ6G	CSG	Status summaries; needs; coordination
FCZ7G	CSG	Status summaries; needs; coordination
FCHON	CRC	Information and coordination

FCZ4G Combat Support Group

FCZ1G	CSG	Status summaries; needs; coordination
FCZ2G	CSG	Status summaries; needs; coordination
FCZ3G	CSG	Status summaries; needs; coordination
FCZ5G	CSG	Status summaries; needs; coordination
FCZ6G	CSG	Status summaries; needs; coordination
FCZ7G	CSG	Status summaries; needs; coordination

FCZ5G Combat Support Group

FCZ1G	CSG	Status summaries; needs; coordination
FCZ2G	CSG	Status summaries; needs; coordination
FCZ3G	CSG	Status summaries; needs; coordination
FCZ4G	CSG	Status summaries; needs; coordination
FCZ6G	CSG	Status summaries; needs; coordination
FCZ7G	CSG	Status summaries; needs; coordination

FCZ6G Combat Support Group

FCZ1G	CSG	Status summaries; needs; coordination
FCZ2G	CSG	Status summaries; needs; coordination
FCZ3G	CSG	Status summaries; needs; coordination
FCZ4G	CSG	Status summaries; needs; coordination
FCZ5G	CSG	Status summaries; needs; coordination
FCZ7G	CSG	Status summaries; needs; coordination

FCZ7G Combat Support Group

FCZ1G	CSG	Status summaries; needs; coordination
FCZ2G	CSG	Status summaries; needs; coordination
FCZ3G	CSG	Status summaries; needs; coordination
FCZ4G	CSG	Status summaries; needs; coordination
FCZ5G	CSG	Status summaries; needs; coordination
FCZ6G	CSG	Status summaries; needs; coordination

A-3 Traffic Estimates

The comparison of the AF/MALLARD traffic densities with the projected flow patterns of information exchange developed and listed in Section A-2 resulted in the individual exchange quantity estimates recorded in this section. Each exchange listed in Section A-2 has a corresponding item in this section. The ground rules described in paragraph 3.1.1.c were used for this exercise. Each exchange estimate was recorded on an 80/80 punched card. The format used for this recording was:

Field 1: Columns 1 - 6; originating organization code
Field 2: Columns 7 - 12; receiving organization code
Field 3: Columns 13 - 22; voice traffic
Field 4: Columns 23 - 32; teletype traffic
Field 5: Columns 33 - 42; facsimile traffic
Field 6: Columns 43 - 42; command data traffic
Field 7: Columns 53 - 62; logistic data traffic
Field 8: Columns 63 - 80; total exchange traffic

Note: Fields 3 through 8 are right-justified; the units are kilobits per busy hour. The following presentation is sorted into sender-to-receiver framework by key locations.

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FAGON	FFION	7380			128		7508
FAGON	FFJON	7380			128		7508
FAGON	FGHON	7380	52		101		7533
FAHON	FFION	7380			128		7508
FAHON	FFJON	7380			128		7508
FAHON	FGHON	7380	52		101		7533
FAION	FFGON	7380			128		7508
FAION	FFHON	7380			128		7508
FFION	FAGON	7380			128		7508
FFION	FAHON	7380			128		7508
FFION	FGHON	53800	234		153		54187
FFJON	FAGON	7380			128		7508
FFJON	FAHON	7380			128		7508
FFJON	FGHON	53800	234		153		54187
FGGON	FAION	7380	52		101		7533
FGGON	FAJON	7380	52		101		7533
FGGON	FFGON	44200	59		146		44405
FGGON	FFHON	44200	59		146		44405
FAION	FGGON	7380	52		101		7533
FAJON	FFGON	7380			128		7508
FAJON	FFHON	7380			128		7508
FAJON	FGGON	7380	52		101		7533
FFGON	FAION	7380			128		7508
FFGON	FAJON	7380			128		7508
FFGON	FGGON	53800	234		153		54187
FFHON	FAION	7380			128		7508
FFHON	FAJON	7380			128		7508
FFHON	FGGON	53800	234		153		54187
FGGON	FGHON	86700	112		155		86967
FGGON	FCHON	97500	142		198		97840
FWXOD	FWXOG	6220	128	650	485		7483

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FGHON	FAGON	7380	52		101		7533
FGHON	FAHON	7380	52		101		7533
FGHON	FFION	44200	59		146		44405
FGHON	FFJON	44200	59		146		44405
FGHON	FGGON	86700	112		155		86967
FGHON	FCHON	97500	142		198		97840
FWYOD	FWXOG	6220	128	650	485		7483
FCHON	FGGON	97500	142		198		97840
FWXOG	FWXOD	11100	576	15600	185		27461
FCHON	FGHON	97500	142		198		97840
FWXOG	FWYOD	11100	576	15600	185		27461
FCZ1G	FGHON	1152	31			141	1297
FQF1E	FGHON	26500	210		141		26851
FAR1D	FCHON	5070	10		103		5183
FAW1W	FCHON	73500	67		145		73712
FEW1E	FCHON	1850	3		101		1954
FQF1E	FCHON	13200	130		122		13452
FSS1S	FCHON	39200	13		119		39332
FTR1S	FCHON	29300	118	650	114		30182
FWX1D	FWXOG	6220	128	650	485		7483
FCZ2G	FGGON	1152	31			141	1297
FQF2E	FCHON	13200	130		122		13452
FQF2E	FCHON	26500	210		141		26851
FSS2S	FCHON	39200	13		119		39332
FTR2S	FCHON	29300	118	650	114		30182
FWX2D	FWXOG	6220	128	650	485		7483
FAR2D	FCHON	5070	10		103		5183
FEW2E	FCHON	1850	3		101		1954
FFG2N	FCHON	57600	108		134		57842
FFC3N	FGGON	3456	10		102		3568
FRC2N	FGHON	3456	10		102		3568

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FAL3N	FCHON	3920	36		108		4064
FAL3S	FCHON	5760	32		104		5896
FAW3S	FCHON	60500	66		146		60712
FBC3D	FCHON	9216	11		108		9335
FCZ3G	FCHON	25200	360			138	25698
FPZ3S	FCHON	28100	42		105		28247
FQF3E	FCHON	39700	340		263		40303
FRC3N	FCHON	5070	10		103		5183
FSI3N	FCHON	60100	19	5200	129		65448
FSS3G	FCHON	53100	24		126		53250
FTH3N	FCHON	178000	3090	11700	667		193457
FTR3W	FCHON	37600	18	1300	117		39035
FVF3N	FCHON	10600	48		111		10759
FWX3D	FWXOG	6220	128	650	485		7483
FXH3S	FCHON	11520	68		205		11793
FAL4S	FCHON	5760	32		104		5896
FAR4S	FCHON	5070	10		103		5183
FEW4S	FCHON	3680	6		102		3788
FFG4W	FCHON	79500	131		151		79782
FQF4E	FCHON	39700	340		263		40303
FSS4D	FCHON	1152	13		108		1263
FWX4D	FWXOG	6220	128	650	485		7483
FAL5S	FCHON	5760	32		104		5896
FAR5S	FCHON	5070	10		103		5183
FBC5S	FCHON	9216	11		108		9335
FEW5E	FCHON	1850	3		101		1954
FFG5W	FCHON	79500	131		151		79782
FQF5E	FCHON	39700	340		263		40303
FRF5S	FCHON	13850	42		106		13998
FWX5D	FWXOG	6220	128	650	485		7483
FAL6W	FCHON	5760	32		104		5896

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FBC6S	FCHON	9216	11		108		9335
FGP6S	FCHON	13800	22		106		13928
FQF6E	FCHON	39700	340		263		40303
FWX6D	FWXOG	6220	128	650	485		7483
FAL7W	FCHON	5760	32		104		5896
FAR7G	FCHON	5070	10		103		5183
FBC7S	FCHON	9216	11		108		9335
FFG7S	FCHON	42400	41		118		42559
FLR7S	FCHON	5070	10		103		5183
FQF7E	FCHON	39700	340		263		40303
FWX7D	FWXOG	10400	3360	31900	981		46641
FDH8N	FCHON	37000	213		145		37458
FWX8D	FWXOG	6220	128	650	485		7483
FDH8N	FGHON	13150	104		120		13374
FDI8N	FCHON	37000	213		145		37458
FWY8D	FWXOG	6220	128	650	485		7483
FDI8N	FGGON	13150	104		120		13374
JAR9N	FCHON	12200	82		101		12383
JCC9N	FCHON	8064	11		104		8179
JTM9N	FCHON	3456	40		102		3598
FWX9D	FWXOG	6220	128	650	485		7483
FCHON	FAR1D	5070	10		103		5183
FCHON	FAW1W	73500	67		145		73712
FCHON	FFW1E	1850	3		101		1954
FCHON	FQF1E	13200	130		122		13452
FCHON	FSS1S	39200	13		119		39332
FCHON	FTR1S	29300	118	650	114		30182
FWXOG	FWX1D	11100	576	15600	185		27461
FGHON	FCZ1G	1152	31			114	1297
FGHON	FQF1E	26500	210		141		26851
FCZ2G	FCZ1G	39700	2610	3900		645	46855

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FFG2W	FAW1W	11520	124		110		11754
FAW3S	FAW1W	2304	36		125	10	2475
FCZ3G	FCZ1G	39700	2610	3900		645	46855
FPZ3S	FPZ1D	34600	19		142	57	34817
FRC3N	FAR1D	5770	22		112		5904
FRC3N	FLR1D	17300	42		112		17454
FSS3G	FSS1S	2304	121		116	53	2594
FTH3N	FAR1D	1382	650		190		2222
FTH3N	FAW1W	25800	1330		290		27420
FTH3N	FSS1S	1850	775		208		2833
FTH3N	FTR1S	4608	641		191		5432
FTR3W	FTR1S	4620	540		177	82	5419
FVF3N	FLC1E	65000	101		134	436	65671
FXH3S	FAW1W	2304	82		110		2496
FCZ4G	FCZ1G	39700	2610	3900		645	46855
FEW4S	FEW1E	6912	21		103	36	7072
FFG4W	FAW1W	11520	124		110		11754
FCZ5G	FCZ1G	39700	2610	3900		645	46855
FFG5W	FAW1W	11520	124		110		11754
FCZ6G	FCZ1G	39700	2610	3900		645	46855
FOR6S	FAW1W	2304	124		110		2538
FAR7G	FAR1D	2304	143		120		2567
FCZ7G	FCZ1G	39700	2610	3900		645	46855
FLR7S	FLR1D	8900	113		127		9140
FDH8N	FAW1W	6790			104		6894
FDH8N	FCZ1G	1152				218	1370
FDH8N	FSS1S	1152	52		108		1312
FDH8N	FTR1S	5760			103		5863
FDI8N	FAW1W	6790			104		6894
FDI8N	FSS1S	1152	52		108		1312
FDI8N	FTR1S	5760			103		5863

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FCHON	FAR2D	5070	10		103		5183
FCHON	FFW2E	1850	3		101		1954
FCHON	FFG2W	57600	108		134		57842
FCHON	FQF2E	13200	130		122		13452
FCHON	FSS2S	39200	13		119		39332
FCHON	FTR2S	29300	118	650	114		30182
FWXOG	FWX2D	11100	576	15600	185		27461
FGGON	FCZ2G	1152	31			114	1297
FGGON	FQF2E	26500	210		141		26851
FAW1W	FFG2W	11520	124		110		11754
FCZ1G	FCZ2G	39700	2610	3900		645	46855
FCZ3G	FCZ2G	39700	2610	3900		645	46855
FPZ3S	FPZ2D	34600	18		142	57	34817
FRC3N	FAR2D	5770	22		112		5904
FRC3N	FLP2D	17300	42		112		17454
FSS3G	FSS2S	2304	121		116	53	2594
FTH3N	FAR2D	1382	650		190		2222
FTH3N	FFG2W	15800	1110		269		17179
FTH3N	FSS2S	1850	775		208		2833
FTH3N	FTR2S	4608	641		191		5432
FTR3W	FTR2S	4620	540		177	82	5419
FVF3N	FLC2E	65000	101		134	436	65671
FXH3S	FFG2W	2304	82		110		2496
FCZ4G	FCZ2G	39700	2610	3900		645	46855
FEW4S	FEW2E	6912	21		103	36	7072
FFG4W	FFG2W	11520	42		110		11672
FCZ5G	FCZ2G	39700	2610	3900		645	46855
FFG5W	FFG2W	11520	42		110		11672
FCZ6G	FCZ2G	39700	2610	3900		645	46855
FOR6S	FFG2W	2304	124		110		2538
FAR7G	FAR2D	2304	143		120		2567

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FCZ7G	FCZ2G	39700	2610	3900		645	46855
FFG7S	FFG2W	1152	212		140	20	1524
FLR7S	FLR2D	8900	113		127		9140
FDH8N	FFG2W	6790			104		6894
FDH8N	FSS2S	1152	52		108		1312
FDH8N	FTR2S	5760			103		5863
FDI8N	FCZ2G	1152				218	1370
FDI8N	FFG2W	6790			104		6894
FDI8N	FSS2S	1152	52		108		1312
FDI8N	FTR2S	5760			103		5863
FCHON	FAL3N	3920	36		108		4064
FCHON	FAL3S	5760	32		104		5896
FCHON	FAW3S	60500	66		146		60712
FCHON	FBC3D	9216	11		108		9335
FCHON	FCZ3G	25200	360			138	25698
FCHON	FPZ3S	28100	42		105		28247
FCHON	FQF3E	39700	340		263		40303
FCHON	FRC3N	5070	10		103		5183
FCHON	FSI3N	60100	19	5200	129		65448
FCHON	FSS3G	53100	24		126		53250
FCHON	FTH3N	178000	3090	11700	667		193457
FCHON	FTR3W	37600	18	1300	117		39035
FCHON	FVF3N	10600	48		111		10759
FCHON	FXH3S	11520	68		205		11793
FWXOG	FWX3D	11100	576	15600	185		27461
FGGON	FRC3N	3456	10		102		3568
FGHON	FRC3N	3456	10		102		3568
FAR1D	FRC3N	8900	120		135		9155
FAW1W	FAW3S	2304	36		125	10	2475
FAW1W	FTH3N	37600	180	8080	245	25	46130
FAW1W	FXH3S	2304	124		110		2538

SEND	RCVF	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FCZ1G	FCZ3G	39700	2610	3900		645	46855
FEW1E	FTH3N	2304	2		101		2407
FLC1E	FRC3N	4608	22		104		4734
FLC1E	FVF3N	47000	133		170	1125	48428
FLK1D	FRC3N	17300	42		112		17454
FPZ1D	FAL3N	2304	65		101		2470
FPZ1D	FPZ3S	34600	18		116	872	35606
FSS1S	FSS3G	2304	121		116	53	2594
FSS1S	FTH3N	15700	228		137		16065
FTR1S	FTR3W	6912	54	1300	105	52	8423
FAR2D	FRC3N	8900	120		135		9155
FCZ2G	FCZ3G	39700	2610	3900		645	46855
FEW2E	FTH3N	2304	2		101		2407
FFG2W	FTH3N	57100	547	780	193	50	58670
FFG2W	FXH3S	2304	124		110		2538
FLC2E	FRC3N	4608	22		104		4734
FLC2E	FVF3N	47000	133		170	1125	48428
FLR2D	FRC3N	17300	42		112		17454
FPZ2D	FAL3N	2304	65		101		2470
FPZ2D	FPZ3S	34600	18		116	872	35606
FSS2S	FSS3G	2304	121		116	53	2594
FSS2S	FTH3N	15700	228		137		16065
FTR2S	FTR3W	6912	54	1300	105	52	8423
FAL4S	FAL3N	2304	20		101		2425
FAL4S	FVF3N	9100	67		104		9271
FAR4S	FRC3N	8900	120		135		9155
FCZ4G	FCZ3G	39700	2610	3900		645	46855
FEW4S	FSI3N	1152	22		104		1278
FEW4S	FTH3N	20800	30		112		20942
FEW4S	FTR3W	27500	210		141		27851
FEW4S	FXH3S	1152	22		104		1278

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FFG4W	FTH3N	65000	657	780	207	50	66694
FFG4W	FTR3W	3456	20		104		3480
FFG4W	FXH3S	2304	124		110		2538
FLC4E	FRC3N	4608	22		104		4734
FLC4E	FVF3N	47000	133		170	1125	48428
FLR4D	FRC3N	17300	42		112		17454
FPZ4D	FAL3N	2304	65		101		2470
FPZ4D	FPZ3S	34600	18		116	872	35606
FSS4D	FSS3G	2304	121		116	53	2594
FSS4D	FTH3N	8350	114		108		8572
FAL5S	FAL3N	2304	177		104		2585
FAL5S	FVF3N	61100	154		149		61403
FAR5S	FRC3N	8900	120		135		9155
FBC5S	FBC3D	20800	14		111		20925
FCZ5G	FCZ3G	39700	2610	3900		645	46855
FEW5E	FTH3N	2304	2		101		2407
FFG5W	FSS3G	2304	124		110		2538
FFG5W	FTH3N	65000	657	780	207	50	66694
FFG5W	FTR3W	3456	20		104		3480
FFG5W	FXH3S	2304	124		110		2538
FLC5E	FRC3N	4608	22		104		4734
FLC5E	FVF3N	47000	133		170	1125	48428
FLR5D	FRC3N	17300	42		112		17454
FPZ5D	FAL3N	2304	65		101		2470
FPZ5D	FPZ3S	34600	18		116	872	35606
FRF5S	FTH3N	12200	190		134		12524
FRF5S	FTR3W	2304	173		125		2602
FRF5S	FXH3S	2304	82		110		2496
FAL6W	FAL3N	2304	177		104		2585
FAL6W	FBC3D	2304	56		111		2471
FAL6W	FVF3N	61100	154		149		61403

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FBC6S	FBC3D	20800	14		111		20925
FCZ6G	FCZ3G	39700	2610	3900		645	46855
FLC6E	FRC3N	4608	22		104		4734
FLC6E	FVF3N	47000	133		170	1125	48428
FLR6D	FRC3N	17300	42		112		17454
FOR6S	FSS3G	2304	82		110		2496
FOR6S	FTH3N	21900	95		128		22123
FOR6S	FTR3W	2304	36		106		2446
FOR6S	FXH3S	2304	82		110		2496
FPZ6D	FAL3N	2304	65		101		2470
FPZ6D	FPZ3S	34600	18		116	872	35606
FAL7W	FAL3N	2304	177		104		5896
FAL7W	FAL3S	2540	26		101	50	2717
FAL7W	FBC3D	2304	177		104		2585
FAL7W	FVF3N	61100	154		149		61403
FAR7G	FAL3N	1152	68		101		1321
FAR7G	FRC3N	11200	180		154		11534
FAR7G	FTH3N	5760	12		104		5876
FAR7G	FVF3N	2304	82		105		2491
FBC7S	FBC3D	20800	14		111		20925
FCZ7G	FCZ3G	39700	2610	3900		645	46855
FLC7E	FRC3N	4608	22		104		4734
FLC7E	FVF3N	47000	133		170	1125	48428
FLR7S	FAL3N	1152	52		103		1307
FLR7S	FLR3D	8900	113		127		9140
FLR7S	FRC3N	13800	52		101		13953
FLR7S	FTH3N	3920	476		167		4563
FLR7S	FVF3N	2304	52		101		2457
FPZ7D	FAL3N	2304	65		101		2470
FPZ7D	FPZ3S	34600	18		116	872	35606
FDH8N	FAW3S	5540			103		5643

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FDH8N	FRC3N	22200			110		22310
FDH8N	FSS3G	1152	52		108		1312
FDH8N	FTH3N	89700	302	4160	188		94350
FDH8N	FTR3W	8300	105		119		8554
FDI8N	FAW3S	5540			103		5643
FDI8N	FRC3N	22200			110		22300
FDI8N	FSS3G	1152	52		108		1312
FDI8N	FTH3N	89700	302	4160	188		94350
FDI8N	FTR3W	8300	105		119		8554
JAR9N	FRC3N	17700	133		127		17960
JCC9N	FAL3N	2304	12		101		2417
JCC9N	FSI3N	1152	28		104		1284
JCC9N	FTH3N	31600	155		131		31886
JCC9N	FVF3N	20300	52		211		20563
JTM9N	FAL3N	8900	161		104	132	9297
JTM9N	FVF3N	20300	121		104	232	20757
FCHON	FAL4S	5760	32		104		5896
FCHON	FAR4D	5070	10		103		5183
FCHON	FEW4S	3680	6		102		3788
FCHON	FFG4W	79500	131		151		79782
FCHON	FQF4E	39700	340		263		40303
FCHON	FSS4D	1152	13		108		1263
FWX0G	FWX4D	11100	576	15600	185		27461
FAW1W	FFG4W	11520	124		110		11754
FCZ1G	FCZ4G	39700	2610	3900		645	46855
FEW1E	FEW4S	6912	21		103	36	7072
FCZ2G	FCZ4G	39700	2610	3900		645	46855
FEW2E	FEW4S	6912	21		103	36	7072
FFG2W	FFG4W	11520	42		110		11672
FAL3N	FAL4S	1152	52		103		1307
FCZ3G	FCZ4G	39700	2610	3900		645	46855

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FPZ3S	FPZ4D	34600	18		142	57	34817
FRC3N	FAR4S	8060	35		124		8219
FRC3N	FLF4D	17300	42		112		17454
FSI3N	FEW4S	1152	22		104		1278
FSS3G	FSS4D	2304	121		116	53	2594
FTH3N	FAR4S	3920	476		167		4563
FTH3N	FEW4S	3456	134		119		3709
FTH3N	FFG4W	17500	1265		291		19056
FTR3W	FEW4S	2304	23		104		2431
FTR3W	FFG4W	2304	19		103		2426
FVF3N	FAL4S	10100	18		106		10219
FVF3N	FLC4E	65000	101		134	436	65671
FXH3S	FEW4S	2304	82		110		2496
FXH3S	FFG4W	2304	82		110		2496
FCZ5G	FCZ4G	39700	2610	3900		645	46855
FEW5E	FEW4S	6912	21		103		7072
FFG5W	FFG4W	11520	42		110		11672
FRF5S	FFG4W	2304	33		105		2442
FAL6W	FAL4S	2540	26		101	50	2717
FCZ6G	FCZ4G	39700	2610	3900		645	46855
FOR6S	FEW4S	1152	22		104		1278
FOR6S	FFG4W	2304	124		110		2538
FAR7G	FAR4S	3456	143		120		3719
FCZ7G	FCZ4G	39700	2610	3900		645	46855
FLR7S	FLR4D	8900	113		127		9140
FDH8N	FFG4W	7942			110		8052
FDI8N	FFG4W	7942			110		8052
FCHON	FAL5S	5760	32		104		5896
FCHON	FAR5D	5070	10		103		5183
FCHON	FBC5S	9216	11		108		9335
FCHON	FEW5E	1850	3		101		1954

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FCHON	FFG5W	79500	131		151		79782
FCHON	FQF5E	39700	340		263		40303
FCHON	FRF5S	13850	42		106		13998
FWXOG	FWX5D	11100	576	15600	185		27461
FAW1W	FFG5W	11520	124		110		11754
FCZ1G	FCZ5G	39700	2610	3900		645	46855
FCZ2G	FCZ5G	39700	2610	3900		645	46855
FFG2W	FFG5W	11520	42		110		11672
FAL3N	FAL5S	1152	52		103		1307
FBC3D	FBC5S	20800	14		111		20925
FCZ3G	FCZ5G	39700	2610	3900		645	46855
FPZ3S	FPZ5D	34600	18		142	57	34817
FRC3N	FAR5S	8060	35		124		8219
FRC3N	FLR5D	17300	42		112		17454
FSS3G	FFG5W	1152	24		104		1280
FTH3N	FAR5S	3920	476		167		4563
FTH3N	FFG5W	17500	1265		291		19056
FTH3N	FRF5S	1850	370		151		2371
FTR3W	FFG5W	2304	19		103		2426
FTR3W	FRF5S	1152	22		104		1278
FVF3N	FAL5S	10100	13		106		10219
FVF3N	FLC5E	65000	101		134	436	65671
FXH3S	FFG5W	2304	82		110		2496
FXH3S	FRF5S	2304	82		110		2496
FCZ4G	FCZ5G	39700	2610	3900		645	46855
FEW4S	FEW5E	6912	21		103	36	7072
FFG4W	FFG5W	11520	42		110		11672
FCZ6G	FCZ5G	39700	2610	3900		645	46855
FOR6S	FFG5W	2304	124		110		2538
FAL7W	FAL5S	2540	26		101	50	2717
FAR7G	FAR5S	3456	143		120		3719

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FCZ7G	FCZ5G	39700	2610	3900		645	46855
FLR7S	FLF5D	8900	113		127		9140
FDH8N	FFG5W	7942			110		8052
FDI8N	FFG5W	7942			110		8052
FCHON	FAL6W	5760	32		104		5896
FCHON	FBC6S	9216	11		108		9335
FCHON	FOR6S	13800	22		106		13928
FCHON	FQF6E	39700	340		263		40303
FWXOG	FWX6D	11100	576	15600	185		27461
FAW1W	FOR6S	2304	124		110		2538
FCZ1G	FCZ6G	39700	2610	3900		645	46855
FCZ2G	FCZ6G	39700	2610	3900		645	46855
FFG2W	FOR6S	2304	124		110		2538
FAL3N	FAL6W	2304	177		104		2585
FBC3D	FAL6W	10400	125		111		10636
FBC3D	FBC6S	20800	14		111		20925
FCZ3G	FCZ6G	39700	2610	3900		645	46855
FPZ3S	FPZ6D	34600	18		142	57	34817
FRC3N	FLR6D	17300	42		112		17454
FSS3G	FOR6S	1152	24		104		1280
FTH3N	FOP6S	8064	35		149		8248
FTR3W	FOR6S	2304	36		106		2446
FVF3N	FAL6W	21000	18		111	53	21182
FVF3N	FLC6E	65000	101		134	436	65671
FXH3S	FOR6S	2304	82		110		2496
FAL4S	FAL6W	9226	200		131	62	9619
FCZ4G	FCZ6G	39700	2610	3900		645	46855
FEW4S	FOF6S	1152	22		104		1278
FFG4W	FOR6S	2304	124		110		2538
FCZ5G	FCZ6G	39700	2610	3900		645	46355
FFG5W	FOF6S	2304	124		110		2538

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FAL7W	FAL6W	11100	93		122		11315
FAR7G	FAL6W	1152	43		104		1299
FCZ7G	FCZ6G	39700	2610	3900		645	46855
FLR7S	FLR6D	8900	113		127		9140
FDH8N	FOR6S	1152			101		1253
FDI8N	FOR6S	1152			101		1253
FCHON	FAL7W	5760	32		104		5896
FCHON	FAR7G	5070	10		103		5183
FCHON	FBC7S	9216	11		108		9335
FCHON	FFG7S	42400	41		118		42559
FCHON	FLR7S	5070	10		103		1307
FCHON	FQF7E	39700	340		263		40303
FWXOG	FWX7D	11100	576	15600	185		27461
FAR1D	FAR7G	2304	150		130		2584
FCZ1G	FCZ7G	39700	2610	3900		645	46855
FLR1D	FLR7S	8900	113		127		9140
FAR2D	FAR7G	2304	150		130		2584
FCZ2G	FCZ7G	39700	2610	3900		645	46855
FFG2W	FFG7S	1152	212		140	20	1524
FLR2D	FLR7S	8900	113		127		9140
FAL3N	FAL7W	2304	177		104		2585
FAL3N	FAR7G	1152	52		103		1307
FAL3N	FLR7S	1152	52		103		1307
FAL3S	FAL7W	9226	200		131	62	9619
FBC3D	FAL7W	10400	125		111		10636
FBC3D	FBC7S	20800	14		111		20925
FCZ3G	FCZ7G	39700	2610	3900		645	46855
FLR3D	FLP7S	8900	113		127		9140
FPZ3S	FPZ7D	34600	18		142	57	34817
FRC3N	FAR7G	11200	180		154		11534
FRC3N	FLR7S	13800	52		101		13953

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LUG DATA	TOTAL DATA
FTH3N	FAR7G	3920	476		167		4563
FTH3N	FFG7S	3456	322		145		3923
FTH3N	FLR7S	3920	476		167		4563
FVF3N	FAL7W	21000	18		111	53	21182
FVF3N	FAR7G	2304	25		108		2437
FVF3N	FLC7E	65000	101		134	436	65671
FVF3N	FLR7S	2304	52		101		2457
FAR4S	FAR7G	2304	150		130		2584
FCZ4G	FCZ7G	39700	2610	3900		645	46855
FLR4D	FLR7S	8900	113		127		9140
FAL5S	FAL7W	9226	200		131	62	9619
FAR5S	FAR7G	2304	150		130		2584
FCZ5G	FCZ7G	39700	2610	3900		645	46855
FLR5D	FLR7S	8900	113		127		9140
FAL6W	FAL7W	11100	93		122		11315
FAL6W	FAR7G	1152	28		116		1296
FCZ6G	FCZ7G	39700	2610	3900		645	46855
FLR6D	FLR7S	8900	113		127		9140
FDH8N	FAR7G	5760			103		5863
FDH8N	FFG7S	1152			101		1253
FDI8N	FAR7G	5760			103		5863
FDI8N	FFG7S	1152			101		1253
JAR9N	FAR7G	14300	101		129		14530
FCHON	FDH8N	37000	213		145		37458
FNXOG	FWX8D	11100	576	15600	185		27461
FGHON	FDH8N	12200	104		119		12423
FCHON	FDI8N	37000	213		145		37458
FWXOG	FWY3D	11100	576	15600	185		27461
FGGON	FDI8N	12200	104		119		12423
FAW1N	FDH8N	37500	43		125		37668
FCZ1G	FDH8N	1152				218	1370

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FSS1S	FDH8N	12200	263		117		12580
FTR1S	FDH8N	13700	118		128		13946
FAW1W	FDI8N	37500	43		125		37668
FSS1S	FDI8N	12200	263		117		12580
FTR1S	FDI8N	13700	118		128		13946
FFG2W	FDH8N	9216	21		110		9347
FSS2S	FDH8N	12200	263		117		12580
FTR2S	FDH8N	13700	118		128		13946
FAW3S	FDH8N	29200	21		118		29339
FCZ2G	FDI8N	1152				218	1370
FFG2W	FDI8N	9216	21		110		9347
FSS2S	FDI8N	12200	263		117		12580
FTR2S	FDI8N	13700	118		128		13946
FSS3G	FDH8N	12200	263		117		12580
FRC3N	FDH8N	3456	10		102		3568
FTH3N	FDH8N	70200	237	780	153		71370
FTR3W	FDH8N	14900	72	650	134		15756
FAW3S	FDI8N	29200	21		118		29339
FRC3N	FDI8N	3456	10		102		3568
FSS3G	FDI8N	12200	263		117		12580
FTH3N	FDI8N	70200	237	780	153		71370
FTR3W	FDI8N	14900	72	650	134		15756
FFG4W	FDH8N	9216	21		110		9347
FFG4W	FDI8N	9216	21		110		9347
FFG5W	FDH8N	9216	21		110		9347
FFG5W	FDI8N	9216	21		110		9347
FOR6S	FDH8N	9216	21		110		9347
FOR6S	FDI8N	9216	21		110		9347
FAR7G	FDH8N	14400	12		101		14513
FAR7G	FDI8N	14400	12		101		14513
FFG7S	FDH8N	9216	21		110		9347

SEND	RCVE	VOICE	TTY	FACS	COM DATA	LOG DATA	TOTAL DATA
FFG7S	FDI8N	9216	21		110		9347
FDH8N	FDI8N	32800	779		222		33801
FDI8N	FDH8N	32800	779		222		33801
FCHON	JAR9N	12200	82		101		12383
FCHON	JCC9N	8064	11		104		1284
FCHON	JTM9N	3456	40		102		3598
FWXOG	FWX9D	11100	576	15600	185		27461
FAL3N	JCC9N	2304	177		104		2585
FAL3N	JTM9N	3400	392		192		3984
FRC3N	JAR9N	17700	133		127		17960
FSI3N	JCC9N	22200	413	780	176		23569
FTH3N	JCC9N	192000	3000	3380	651		199031
FVF3N	JCC9N	56000	67		136	92	56295
FVF3N	JTM9N	43200	191		304	286	43981
FA37G	JAR9N	14300	101		129		14530

APPENDIX B

BACKGROUND MATERIAL FOR THE TACS DISTRIBUTED OPERATIONAL CONCEPT

B. INTRODUCTION

This appendix provides the background material for the derivation of the differential link traffic figures presented in Section 5.0. Since the deployment models are the same for both concepts, the organization codes described for the centralized concept and defined in Appendix A, Section A-1 were used here also. This appendix presents the general information exchange of a TACS using the distributed concept and a listing of the messages affected by this concept on a point-to-point basis.

B-1 Information Exchange List

Before differential link traffic figures were generated for centralized vs. distributed comparison, the general information exchanges for the distributed concept were defined. These indicated the major types of information which flowed in each point-to-point link but did not attempt to define the individual messages which made up the information exchanges. These data were subsequently used in defining the message types which were affected by adopting the distributed concept's operating procedures, and this list was selected on a message-by-message basis from the Bunker-Ramo TTSA message catalog. The results are shown in the next section.

The information exchange list shown below presents one way transfer of data from each TACS element to each major recipient. As shown for the centralized automation concept in Appendix A, Section A-2, exchanges which are conducted within a base exchange such as Wing to co-located Squadron exchanges are not included here.

The exchanges in this section are broken down by major functions of Tactical Air as follows:

a. Interdiction, Offensive Counter Air, and Reconnaissance Operations including overall planning for all missions

b. Defensive Counterair operations

c. Close Air Support operations, and

d. Airlift operations

Since resuce, weather and support operations are conducted identically in both concepts, the appropriate information flow summaries for these operations may be found in Appendix A, Sections A-2.4, A-2.6, and A-2.7, respectively.

B-1.1 Interdiction, Offensive Counterair and Reconnaissance Operations

(includes overall planning functions for all missions)

FAW1W Attack Fighter

FAW3S	AFS	Admin. traffic, coordination	
FTH3N	TACC	Wing status (less FAW3S)	(upon request)
		Mission status and results	
FCHON	CRC	Flight plans	

FAW3S Attack Fighter Squadron (separate)

FAW1W	AFW	Admin. traffic, coordination	
FTH3N	TACC	Squadron status	(upon request)
		Mission status and results	
FCHON	CRC	Flight plans	

FFG2W Tactical Fighter Wing

FFG7S	TFS	Admin. traffic, coordination	
FTH3N	TACC	Wing status (less FFG7S)	(upon request)
		Mission status and results	
FCHON	CRC	Flight plans	
FFG4W	TFW	Coordination	
FFG5W	TFW	Coordination	

FFG7S Tactical Fighter Squadron (separate)

FFG2W	TFW	Admin. traffic, coordination	
FTH3N	TACC	Squadron status	(upon request)
		Mission status and results	
FCHON	CRC	Flight plans	

FFG4W Tactical Fighter Wing

FTH3N	TACC	Wing status	(upon request)
		Mission status and results	
FFG2W	TFW	Coordination	
FFG5W	TFW	Coordination	
FCHON	CRC	Flight plans	

FFG5W Tactical Fighter Wing

FTH3N	TACC	Wing status	(upon request)
		Mission status and results	
FFG2W	TFW	Coordination	
FFG4W	TFW	Coordination	
FCHON	CRC	Flight plans	

FTR3W Tactical Reconnaissance Wing

FTR1S	TRS	Admin. traffic, coordination	
FTR2S	TRS	Admin. traffic, coordination	
FTH3N	TACC	Wing status (less FTR1S and FTR2S)	(upon request)
		Mission status and results	
FCHON	CRC	Flight plans	

FTR1S Tactical Reconnaissance Squadron

FTR3W	TRW	Admin. traffic, coordination	
FTH3N	TACC	Squadron status	(upon request)
FCHON	CRC	Flight plans	

FTR2S Tactical Reconnaissance Squadron

FTR3W	TRW	Admin. traffic, coordination	
FTH3N	TACC	Squadron status	(upon request)
FCHON	CRC	Flight plans	

FEW4S Tactical Electronic Warfare Squadron

FEW1E	TEWE	Admin. traffic, coordination	
FEW2E	TEWE	Admin. traffic, coordination	
FEW5E	TEWE	Admin. traffic, coordination	
FTH3N	TACC	Squadron status (less FEW1E, FEW2E, FEW5E)	(upon request)
		Mission status and results	
FCHON	CRC	Flight plans	

FEW1E Tactical Electronic Warefare Element

FEW4S	TEWS	Admin. traffic, coordination	
FTH3N	TACC	Element status	(upon request)
		Mission status and results	
FCHON	CRC	Flight plans	

FEW2E Tactical Electronic Warfare Element

FEW4S	TEWS	Admin. traffic coordination	
FTH3N	TACC	Element status	(upon request)
		Mission status and results	
FCHON	CRC	Flight plans	

FEW5E Tactical Electronic Warfare Element

FEW4S	TEWS	Admin. traffic, coordination	
FTH3N	TACC	Element status	(upon request)
		Mission status and results	
FCHON	CRC	Flight plans	

FOR6S Special Operations Squadron

FTH3N	TACC	Squadron status	(upon request)
		Mission status and results	
FCHON	CRC	Flight plans	

FRF5S Air Refueling Squadron

FTH3N	TACC	Squadron status	(upon request)
		Mission status and results	
FCHON	CRC	Flight plans	

FSI3N Emergency Reaction Unit

FEW4S	TEWS	Coordination
JCC9S	JFOC	Intelligence information, coordination

FTM3N Tactical Air Control Center

FAW1W	AFW	Frag orders, changes, intelligence
FAW2S	AFS	Frag orders, changes, intelligence
FAW3S	AFS	Frag orders, changes, intelligence
FFG2W	TFW	Frag orders, changes, intelligence
FFG4W	TFW	Frag orders, changes, intelligence
FFG5W	TFW	Frag orders, changes, intelligence
FFG7S	TFS	Frag orders, changes, intelligence
FTR1S	TRS	Frag orders, changes, intelligence
FTR2S	TRS	Frag orders, changes, intelligence
FTR3W	TRW	Frag orders, changes, intelligence
FEW1E	TEWE	Frag orders, changes, intelligence
FEW2E	TEWE	Frag orders, changes, intelligence
FEW4S	TEWS	Frag orders, changes, intelligence

FEW5E	TEWE	Frag orders, changes, intelligence
FSS1S	TASS	Frag orders, changes, intelligence
FSS2S	TASS	Frag orders, changes, intelligence
FSS3G	TASG	Frag orders, changes, intelligence
FSS4D	TASD	Frag orders, changes, intelligence
FAR1D	ARRS	Frag orders, changes, intelligence
FAR2D	ARRS	Frag orders, changes, intelligence
FAR4S	ARRS	Frag orders, changes, intelligence
FAR7G	ARRS	Frag orders, changes, intelligence
FRF5S	ARS	Frag orders, changes, intelligence
FOR6S	SOS	Frag orders, changes, intelligence
FXH3S	AWACS	Frag orders, changes, intelligence
FDH8N	I-DASC	Coordination, intelligence
FDI8N	II-DASC	Coordination, intelligence
FCHON	CRC	Coordination, intelligence
JCC9N	JFOC	Mission results - status summary

FSS1S Tactical Air Support Squadron

FTH3N	TACC	Squadron status	(upon request)
FSS3G	TASG	Admin. traffic, coordination	
FCHON	CRC	Flight plans	

FSS2S Tactical Air Support Squadron

FTH3N	TACC	Squadron status	(upon request)
FSS3G	TASG	Admin. traffic,coordination	
FCHON	CRC	Flight plans	

FSS4D Tactical Air Support Detachment

FTH3N	TACC	Squadron status	(upon request)
FSS3G	TASG	Admin. traffic, coordination	
FCHON	CRC	Flight plans	

B-1.2 <u>Defensive Counterair Operations</u>

FFG2W Tactical Fighter Wing

FFG7S	TFS	Admin. traffic, coordination
FCHON	CRC	Resource status deficiency of allocated a/c

FFG7S Tactical Fighter Squadron

FFG2W	TFS	Admin. traffic, coordination
FCHON	CRC	Resource status deficiency of allocated a/c

FFG4W Tactical Fighter Wing

FCHON	CRC	Resource status deficiency of allocated a/c

FFG5W Tactical Fighter Wing

FCHON	CRC	Resource status deficiency of allocated a/c

FTH3N Tactical Air Control Center

FCHON	CRC	Frag orders, changes, intelligence
FFG2W	TFW	Frag orders, changes, intelligence
FFG7S	TFS	Frag orders, changes, intelligence
FFG4W	TFW	Frag orders, changes, intelligence
FFG5W	TFW	Frag orders, changes, intelligence

FCHON Control and Reporting Center

FTH3N	TACC	Coordination Mission status and results Requests for additional resources Air defense warning
FGHON	CRP I	Selected Flight plans Admin. and coordination Air defense warning
FGGON	CRP II	Selected flight plans Admin. and coordination Air defense warning
FFG2W	TFW	Scramble orders
FFG7S	TFS	Scramble orders
FFG4W	TFW	Scramble orders
FFG5W	TFW	Scramble orders

B-1.3 <u>Close Air Support Operations</u>

FAW1W Attack Fighter Wing

FAW3S	AFS	Admin. traffic, coordination
FDH8N	DASC I	Resource status deficiency of allocated a/c coordination
FDI8N	DASC II	Resource status deficiency of allocated a/c coordination
FCHON	CRC	Flight plans

FAW3S Attack Fighter Squadron (separate)

FAW1W	AFW	Admin. traffic, coordination
FDH8N	DASC I	Resource status deficiency of allocated a/c coordination
FDI8N	DASC II	Resource status deficiency of allocated a/c coordination
FCHON	CRC	Flight plans

FFG2W Tactical Fighter Wing

FFG7S	TFS	Admin. traffic, coordination
FDH8N	DASC I	Resource status deficiency of allocated a/c coordination
FDI8N	DASC II	Resource status deficiency of allocated a/c coordination
FCHON	CRC	Flight plans

FFG7S Tactical Fighter Squadron (separate)

FFG2W	TFW	Admin. traffic, coordination
FDH8N	DASC I	Resource status deficiency of allocated a/c coordination
FDI8N	DASC II	Resource status deficiency of allocated a/c coordination
FCHON	CRC	Flight plans

FFG4W Tactical Figher Wing

FDH8N	DASC I	Resource status deficiency of allocated a/c coordination
FDI8N	DASC II	Resource status deficiency of allocated a/c coordination
FCHON	CRC	Flight plans

FFG5W Tactical Fighter Wing

FDH8N	DASC I	Resource status deficiency of allocated a/c coordination
FDI8N	DASC II	Resource status deficiency of allocated a/c coordination
FCHON	CRC	Flight plans

FTR3W Tactical Reconnaissance Wing

FTR1S	TRS	Admin. traffic, coordination
FTR2S	TRS	Admin. traffic, coordination

FTR3W Tactical Reconnaissance Wing (cont.)

FDH8N	DASC I	Resource status deficiency of allocated a/c coordination
FDI8N	DASC II	Resource status deficiency of allocated a/c coordination
FCHON	CRC	Flight plans

FTR1S Tactical Reconnaissance Squadron

FTR3W	TRW	Admin. traffic, coordination
FDH8N	DASC I	Resource status deficiency of allocated a/c coordination
FDI8N	DASC II	Resource status deficiency of allocated a/c coordination
FCHON	CRC	Flight plans

FTR2S Tactical Reconnaissance Squadron

FTR3W	TRW	Admin. traffic, coordination
FDH8N	DASC I	Resource status deficiency of allocated a/c coordination
FDI8N	DASC II	Resource status deficiency of allocated a/c coordination
FCHON	CRC	Flight plans

FSS3G Tactical Air Support Group

FSS1S	TASS	Admin. traffic, coordination
FSS2S	TASS	Admin. traffic, coordination
FSS4D	TASD	Admin. traffic, coordination
FDH8N	DASC I	Resource status deficiency of allocated a/c coordination
FDI8N	DASC II	Resource status deficiency of allocated a/c coordination
FCHON	CRC	Flight plans

FSS1S Tactical Air Support Squadron

FSS3G	TASG	Admin. traffic, coordination
FDH8N	DASC I	Resource status deficiency of allocated a/c coordination
FDI8N	DASC II	Resource status deficiency of allocated a/c coordination
FCHON	CRC	Flight plans

FSS2S Tactical Air Support Squadron

FSS3G	TASC	Admin. traffic, coordination
FDH8N	DASC I	Resource status deficiency of allocated a/c coordination
FDI8N	DASC II	Resource status deficiency of allocated a/c coordination
FCHON	CRC	Flight plans

FSS4D Tactical Air Support Detachment

FSS3G	TASG	Admin. traffic, coordination
FDH8N	DASC I	Resource status deficiency of allocated a/c coordination
FDI8N	DASC II	Resource status deficiency of allocated a/c coordination
FCHON	CRC	Flight plans

FTH3N Tactical Air Control Center

FDH8N	DASC I	Frag orders, changes, coordination, intelligence
FDI8N	DASC II	Frag orders, changes, coordination, intelligence
JCC9N	JFOC	Mission results status summary Coordination

FDH8N Direct Air Support Center (same for FDI8N)

FTH3N	TACC	Coordination, mission status, mission results req. for additional resources
FCHON	CRC	Diversion orders
FAW1W	AFW	Scramble and diversion orders coordination
FAW3S	AFS	Scramble and diversion orders coordination
FFG2W	TFW	Scramble and diversion orders coordination
FFG4W	TFW	Scramble and diversion orders coordination
FFG5W	TFW	Scramble and diversion orders coordination
FTR3W	TRW	Scramble and diversion orders coordination
FTR1S	TRS	Scramble and diversion orders coordination
FTR2S	TRS	Scramble and diversion orders coordination

FDH8N Direct Air Support Center (same for FDI8N) (cont.)

FFS3G	TASG	Scramble and diversion orders coordination	
FFS1S	TASS	Scramble and diversion orders coordination	
FSS2S	TASS	Scramble and diversion orders coordination	
FSS4D	TASD	Scramble and diversion orders coordination	
FDI8N	DASC	Coordination	

B-1.4 <u>Airlift Operations</u>

FAL3N Tactical Airlift Division

FAL6W	TAW	Admin. traffic, coordination	
FAL7W	TAW	Admin. traffic, coordination	
JTM9N	JTMB	Division status, coordination	
FAR7G	ARRG	Coordination	
JCC9N	JFOC	Division status, coordination	

FAL6W Tactical Airlift Wing

FAL5S	TAS	Admin. traffic, coordination	
FVF3N	ALCC	Wing Status (less FAL4S) Mission status	(upon request)
FCHON	CRC	Flight plans	
FAL3N	TAD	Wing status (less FAL4S) Coordination	(upon request)

FAL5S Tactical Airlift Squadron (separate)

FAL6W	TAW	Coordination, admin. traffic	
FVF3N	ALCC	Squadron status Mission status	(upon request)
FCHON	CRC	Flight plans	
FAL3N	TAD	Squadron status	(upon request)

FAL7W Tactical Airlift Wing

FAL3S	TAS	Admin. traffic, coordination	
FAL4S	TAS	Admin. traffic, coordination	
FVF3N	ALCC	Wing status (less FAL3S, FAL4S) Mission status	(upon request)
FAL3N	TAD	Wing status (less FAL3S, FAL4S)	(upon request)
FCHON	CRC	Flight plans	

FAL3S Tactical Airlift Squadron (separate)

FAL7W	TAW	Coordination, admin. traffic	
FVF3N	ALCC	Squadron status	(upon request)
		Mission status	
FCHON	CRC	Flight plans	
FAL3N	TAD	Squadron status	(upon request)

FAL4S Tactical Airlift Squadron (separate)

FAL7W	TAW	Coordination, admin. traffic	
FVF3N	ALCC	Squadron status	(upon request)
		Mission status	
FCHON	CRC	Flight plans	
FAL3N	TAD	Squadron status	(upon request)

FBC3D MAC Support Detachment in ALCC

FBC5S	MACSS	Admin. traffic, coordination
FBC6S	MACSS	Admin. traffic, coordination
FBC7S	MACSS	Admin. traffic, coordination
FCHON	CRC	Coordination

FBC5S MAC Support Squadron

FBC3D	MACSD	Squadron status, cargo status, coordination

FBC6S MAC Support Squadron

FBC3D	MACSD	Squadron status, cargo status, coordination

FBC7S MAC Support Squadron

FBC3D	MACSD	Squadron status, cargo status, coordination

FLC1E Airlift Control Element

FVF3N	ALCC	Cargo and flight status	(upon request)
		Requests and needs	

FLC2E Airlift Control Element

FVF3N	ALCC	Cargo and flight status	(upon request)
		Request and needs	

FLC4E Airlift Control Element

FVF3N	ALCC	Cargo and flight status Requests and needs	(upon request)

FLC5E Airlift Control Element

FVF3N	ALCC	Cargo and flight status Requests and needs	(upon request)

FLC6E Airlift Control Element

FVF3N	ALCC	Cargo and flight status Requests and needs	(upon request)

FLC7E Airlift Control Element

FVF3N	ALCC	Cargo and flight status Requests and needs	(upon request)

FPZ3S Aerial Port Squadron

FPZ1D	APD	Admin. traffic, coordination
FPZ2D	APD	Admin. traffic, coordination
FPZ4D	AFP	Admin. traffic, coordination
FPZ5D	APD	Admin. traffic, coordination
FPZ6D	APD	Admin. traffic, coordination
FPZ7D	APD	Admin. traffic, coordination
FAL3N	TAD	Squadron status, needs

FPZ1D Aerial Port Detachment

FPZ3S	APS	Coordination	
FVF3N	ALCC	Detachment status	(upon request)

FPZ2D Aerial Port Detachment

FPZ3S	APS	Coordination	
FVF3N	ALCC	Detachment status	(upon request)

FPZ4D Aerial Port Detachment

FPZ3S	APS	Coordination	
FVF3N	ALCC	Detachment status	(upon request)

FPZ5D Aerial Port Detachment

FPZ3S	APS	Coordination	
FVF3N	ALCC	Detachment status	(upon request)

FPZ6D Aerial Port Detachment

FPZ3S	APS	Coordination	
FVF3N	ALCC	Detachment status	(upon request)

FPZ7D Aerial Port Detachment

FPZ3S	APS	Coordination	
FVF3N	ALCC	Detachment status	(upon request)

FVF3N Airlift Control Center

JCC9N	JFOC	Coordination
JTM9N	JTMB	Airlift status, needs
FTH3N	TACC	Req. for fighter cover and refueling
FCHON	CRC	Coordination, diversion orders
FLC1E	ALCE	Frag orders
FLC2E	ALCE	Frag orders
FLC4E	ALCE	Frag orders
FLC5E	ALCE	Frag orders
FLC6E	ALCE	Frag orders
FLC7E	ALCE	Frag orders
FAL3S	TAS	Scramble orders, diversion orders
FAL4S	TAS	Scramble orders, diversion orders
FAL5S	TAS	Scramble orders, diversion orders
FAL6W	TAW	Scramble orders, diversion orders
FAL7W	TAW	Scramble orders, diversion orders

FTH3N Tactical Air Control Center

FVF3N	ALCC	Intelligence, applicable fighter and refueling frags

B-2 <u>Differential Link Traffic</u>

The following table presents the differential link traffic (ΔLm) between the major TACS elements, broken down by message type, in kilobits per busy hour. The summation of these figures is given in Section 5.0 in Table 5.4.

From	To	Message Type	ΔLm
TAB 3	CRC	orbits points and routes for air def	- 8.1
TAB 3	CRC	CAS planning coordination	-103.8
TAB 3	CRC	flight plan clearance info	-655.0
TAB 3	CRC	immed fighter msn. data	- 20.2
TAB 3	CRC	msn diversion or add-on data	- 3.8
TAB 3	CRC	flight plan data	-591.0
TAB 3	CRC	flight plan data	+101.8
TAB 3	CRC	ATC handover data	- 63.8
TAB 3	CRC	req for inflight intell data	- 23.3
TAB 3	CRC	air traffic handling cap.	+ 1.8
TAB 3	CRC	airspace restriction changes	- 3.6
TAB 3	CRC	traffic control instructions	- 3.6
TAB 3	CRC	guidance for resol of flight conflicts	- 18.8
TAB 3	CRC	requests for track data	- 21.6
TAB 3	CRC	changes in track reporting reqs.	- 4.3
TAB 3	CRC	take off, landing, abort rpt	- 16.2
CRC	TAB 3	air def plan implement coord	+ 1.4
CRC	TAB 3	ATC handover data	- 63.8
CRC	TAB 3	track data report	-508.0
CRC	TAB 3	airspace restriction changes	+ 10.8
CRC	TAB 3	coordination of airspace conflicts	+ 0.6
CRC	TAB 3	traffic control instructions	+ 10.8
CRC	TAB 3	guidance for resol of flt. conflicts	+ 5.5
CRC	TAB 3	coord of airspace confl with airlift	+ 11.5
CRC	TAB 3	coord of airspace confl with prepl man	+ 11.1
CRC	TAB 3	msn change instructions	+ 1.0
CRC	TAB 3	coord of msn changes	+ 7.4
CRC	TAB 3	init track data rpt	-104.0
CRC	TAB 3	refuel reqs.	+ 2.7
CRC	TAB 3	status for check of inflight rpt	- 0.3

From	To	Message Type	ΔLm
TAB 1	CRC	takeoff, landing, abort rpt	- 16.8
TAB 1	CRC	ATC handover data	- 53.0
TAB 1	CRC	air traffic handling capabilities	+ 1.8
TAB 1	CRC	flight plan data	+ 41.6
TAB 1	TAB 3	flight clearance reqs	+185.0
TAB 1	TAB 3	takeoff landing abort rpt	- 21.0
TAB 1	TAB 3	aircraft arrival rpt.	- 13.5
TAB 1	TAB 3	aircraft departure rpt.	- 13.5
TAB 1	TAB 3	cargo on-load data	- 21.7
TAB 1	TAB 3	CAS alert status change rpt.	- 4.1
TAB 1	TAB 3	tactical unit status change rpt, recon	- 0.5
TAB 1	TAB 3	air traffic handling cap.	- 1.8
TAB 3	DASC1/DASC2	CAS planning coordination	- 53.0
		immed fighter msn data	- 10.1
		msn diversion/add on data, CAS/AI	- 1.9
		flight plan data	- 88.7
		immed msn req-recon	+ 3.2
		immed msn data-recon	- 7.3
		takeoff landing abort rpt	- 6.5
		req for inflight intell data	- 11.7
		airspace restriction changes	- 3.6
		CAS alert status change rpt	- 11.4
		tac unit status rpts	+ 0.9
TAB 2	TAB 3	flight clearance reqs	+174.0
		takeoff landing abort rpt	- 21.0
		aircraft arrival rpt.	- 13.5
		aircraft departure rpt.	- 13.5
		cargo on load data	- 21.7
		air def fighter status change rpt.	- 1.1
		CAS alert status change rpt.	- 5.8
		tac unit status chg rpt-recon units	- 0.5
		air traffic handling caps	- 1.8

From	To	Message Type	ΔLm
TAB 4	TAB 3	flight clearance reqs	+175.0
		takeoff, landing, abort rpt	- 21.0
		aircraft arrival rpt	- 13.5
		aircraft departure rpt	- 13.5
		cargo on load data	- 19.0
		air def ftr status change rpt	- 1.1
		CAS alert status change rpt	- 3.5
		tac unit status chg rpt. airlift	- 0.5
		air traffic handling cap	- 1.8
TAB 5	TAB 3	flight clearance reqs	+170.0
		takeoff landing abort rpt	- 21.0
		aircraft arrival rpt	- 13.5
		aircraft departure rpt	- 13.5
		cargo on load data	- 19.0
		air def ftr status chg rpt	- 1.1
		CAS alert status chg rpt	- 3.5
		tac unit status chg rpt, airlift	- 0.5
		air traffic handling cap	- 1.8
TAB 6	TAB 3	flight clearance reqs	+280.0
		takeoff landing abort rpt	- 21.0
		aircraft arrival rpt	- 13.5
		aircraft departure rpt	- 13.5
		cargo on load data	- 19.0
		tac unit status chg rpt, airlift	- 0.5
		air traffic handling cap	- 1.8
TAB 7	TAB 3	flight clearance reqs	+161.0
		takeoff landing abort rpt	- 21.0
		aircraft arrival rpt	- 13.5
		aircraft departure rpt	- 13.5
		cargo on load data	- 19.0
		CAS alert status chg rpt	- 1.7
		tac unit status chg rpt, airlift	- 0.5
		air traffic handling cap	- 1.8
TAB 1	DASC1/DASC2	takeoff landing abort rpt	- 6.5
		CAS alert status chg rpt	- 11.4
		tac unit status rpt	+ 0.9

From	To	Message Type	ΔLm
TAB 2	DASC1/DASC2	takeoff landing abort rpt	- 9.3
		CAS alert status chg rpt	- 11.4
		tac unit status rpt	+ 0.9
TAB 4	DASC1/DASC2	takeoff landing abort rpt	- 5.5
		CAS alert status chg rpt	- 11.4
		tac unit status rpt	+ 0.9
TAB 5	DASC1/DASC2	takeoff landing abort rpt	- 5.5
		CAS alert status chg rpt	- 11.4
		tac unit status rpt	+ 0.9
TAB 6	DASC1/DASC2	tac unit stats rpt	+ 0.9
TAB 7	DASC1/DASC2	takeoff landing abort rpt	- 2.8
		CAS alert status chg rpt	- 11.4
		tac unit status rpt	+ 0.9
DASC1/DASC2	TAB 1	CAS planning coord	+ 8.5
		req for status info	+ 1.1
		coord of AFAC reqs	+ 38.8
DASC1/DASC2	TAB 2	CAS planning coord	+ 12.4
		req for status info	+ 1.1
		coord of AFAC reqs	+ 38.8
DASC1/DASC2	TAB 3	CAS request	- 24.4
		CAS planning coord	+ 12.4
		immed msn data, recon	+ 7.3
		req for status info	+ 1.1
		status of check for inflight rpt	- 0.3
		coord of AFAC reqs	+ 38.8
DASC1/DASC2	TAB 4	CAS planning coord	+ 7.9
		req for status info	+ 1.1
		coord of AFAC reqs	+ 38.8

From	To	Message Type	ΔLm
DASC1/DASC2	TAB 5	CAS planning coord	+ 7.9
		req for status info	+ 1.1
DASC1/DASC2	TAB 6	req for status info	+ 1.1
DASC1/DASC2	TAB 7	CAS planning coord	+ 3.9
		req for status info	+ 1.1
CRC	TAB 1	ATC handover data	- 53.0
		airspace restriction changes	+ 3.6
		coord of airspace conflicts	+ 0.3
		traffic control instructions	+ 3.6
		guidance for resol of flt conflicts	+ 3.7
		coord of airspace conflt. w/preplan	+ 2.3
		msn change instructions	+ 1.2
CRC	TAB 2	orbit pts. and routes for air def.	+ 2.7
		ATC handover data	- 76.7
		airspace restriction changes	+ 3.6
		coord of airspace conflicts	+ 0.3
		traffic control instructions	+ 3.6
		guidance for resol of flt conflicts	+ 4.4
		coord of airspace confl w/preplan	+ 3.2
		msn change instructions	+ 1.6
		req for status info	+ 1.1
CRC	TAB 4	orbit pts and routes for air def	+ 2.7
		ATC handover data	- 41.0
		airspace restriction changes	+ 3.6
		coord of airspace conflicts	+ 0.3
		coord of airspace confl. w/preplan	+ 3.1
		mission change instructions	+ 1.5
		req for status info	+ 1.1
		traffic control instructions	+ 3.6
		guidance for resol of flt conflicts	+ 4.4

From	To	Message Type	ΔLm
CRC	TAB 5	orbit pts and routes for air def	+ 2.7
		ATC handover data	- 50.8
		airspace restriction changes	+ 3.6
		coord of airspace conflicts	+ 0.3
		traffic control instructions	+ 3.6
		guidance for resol of flt. conflicts	+ 4.2
		coord of airspace confl w/preplan	+ 1.5
		mission change instructions	+ 0.7
		req for status info	+ 1.1
CRC	TAB 6	airspace restriction changes	+ 3.6
		coord of airspace conflicts	+ 0.3
		traffic control instructions	+ 3.6
		guidance for resol of flt. conflicts	+ 3.6
CRC	TAB 7	ATC handover data	- 15.1
		airspace restriction changes	+ 3.6
		coord of airspace conflicts	+ 0.3
		traffic control instructions	+ 3.6
		guidance for resol of flt conflicts	+ 3.2
		coord of airspace confl w/preplan	+ 0.3
		mission change instructions	+ 0.2
CRC	CRP1/CRP2	orbit pts and routes for air def	- 4.0
		airspace clearance coord	- 65.0
		airspace restriction changes	+ 3.6
		traffic control instructions	+ 3.6
TAB 3	TAB 1	scramble order fighter a/c	- 2.0
		flight plan data	- 41.6
		scramble order recon a/c	- 9.1
		coord to obtain current a/c status	- 18.5
		req for status info	+ 1.1
		airspace restric changes	- 3.6
		traffic control instructions	- 3.6
		mission change instructions	- 1.1

From	To	Message Type	ΔLm
TAB 3	TAB 2	CAS planning coord	- 53.0
		scramble order fighter a/c	- 4.7
		flight plan data	- 62.0
		scramble order recon a/c	- 9.1
		coord to obtain current a/c status	- 18.5
		req for status info	+ 1.1
		airspace restric changes	- 3.6
		traffic control instructions	- 3.6
		mission change instructions	- 1.1
TAB 3	TAB 4	CAS planning coord	- 53.0
		scramble order fighter a/c	- 4.0
		flight plan data	- 90.3
		supp frag for spec msn	+ 2.2
		coord to obtain current a/c status	- 18.5
		req for status info	+ 2.2
		airspace restrict changes	- 3.6
		traffic control instructions	- 3.6
		mission change instructions	- 1.1
TAB 3	TAB 5	scramble order fighter a/c	- 4.0
		flight plan data	-100.2
		supp frag for spec msn	+ 2.2
		coord to obtain current a/c status	- 18.5
		req for status info	+ 2.2
		airspace restrict changes	- 3.6
		traffic control instructions	- 3.6
		mission change instructions	- 1.1
TAB 3	TAB 6	flight plan data	-120.0
		supp frag for spec msn	+ 4.4
		coord to obtain current a/c status	- 18.5
		req for status info	+ 2.2
		airspace restrict changes	- 3.6
		traffic control instructions	- 3.6

From	To	Message Type	ΔLm
TAB 3	TAB 7	scramble order fighter a/c	- 0.7
		flight plan data	- 71.8
		supp frag for spec msn	+ 2.2
		coord to obtain current a/c status	- 18.5
		req for status info	- 2.2
		airspace restrict changes	- 3.6
		traffic control instructions	- 3.6
CRC	DASC1/DASC2	airspace restriction changes	+ 3.6
		traffic control instructions	+ 3.6
DASC1/DASC2	CRC	msn diversion or add on data, CAS/AI	+ 1.9
		CAS planning coord	+ 53.0
		target changes	- 1.7
CRP1/CRP2	CRC	track data report	-259.0
DASC1/DASC2	CRP1/CRP2	target changes	- 1.7
TAB 2	CRC	Flight plan data	+ 62.0
		takeoff landing abort rpt	- 25.2
		air traffic hand cap	+ 1.8
		ATC handover data	- 76.7
TAB 4	CRC	flight plan data	+ 90.3
		takeoff landing abort rpt	- 13.1
		air traffic hand cap	+ 1.8
		ATC handover data	- 41.0
TAB 5	CRC	flight plan data	+100.2
		takeoff landing abort rpt	- 16.2
		air traffic hand cap	+ 1.8
		ATC handover data	- 50.8

From	To	Message Type	ΔLm
TAB 6	CRC	flight plan data	+120.9
		air traffic hand cap	+ 1.8
TAB 7	CRC	flight plan data	+ 71.8
		takeoff abort landing rpt	- 4.8
		air traffic hand cap	+ 1.8
		ATC handover data	- 15.1
TAB 1	CRP 1	ATC handover data	- 26.5
TAB 2	CRP 2	ATC handover data	- 38.4
		air def fighter status chg rpt	- 1.1

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13. ABSTRACT

Some changes in operations and technology will be introduced in the post-1975 TACS. Among these will be the use of digital secure voice and data management automation. To permit the development of Air Force ground environment communications requirements for the TACS of this era, estimated total point-to-point data rates are needed. The anticipated TACS operations, with some expected changes, are modeled. The resulting information exchange data rates for the total ground environment is about three megabits. This total data rate is impacted far more because of use of digital, secure voice than because of introducing data management automation. The two operational concepts which are modeled prove to have nearly identical data rate patterns.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
AIR TRAFFIC CONTROL						
AUTOMATIC DATA PROCESSING						
DATA PROCESSING						
DATA TRANSMISSION						
DIGITAL COMPUTERS						
DIGITAL TECHNIQUES						
MILITARY COMMUNICATION						
SECURE COMMUNICATION						
TACTICAL AIR CONTROL CENTERS						
TACTICAL COMMAND AND CONTROL						
TELECOMMUNICATION						