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Energy Division

# A DECISION SUPPORT SYSTEM FOR THE MILITARY AIRLIFT COMMAND, THE AIRLIFT DEPLOYMENT ANALYSIS SYSTEM

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NOTICE: This document contains information of a preliminary nature. It is subject to revision or correction and therefore does not represent a final report.

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## ABSTRACT

Oak Ridge National Laboratory (ORNL) is assisting the Military Airlift Command (MAC) with the development of the Airlift Deployment Analysis System (ADANS). ADANS will improve MAC's automated capabilities for scheduling peacetime airlift missions, deliberate planning, execution planning, and analysis of the airlift system. ADANS will consist of four subsystems: airlift planning and scheduling algorithms, database management, user interface, and communications.

This paper describes MAC's current airlift planning and scheduling operations, the current automated systems used to develop airlift schedules and plans, approaches to developing ADANS, and major improvements that will result from the implementation of ADANS. This report is based on a series of in-depth interviews and working sessions that were conducted with MAC staff, a review of airlift scheduling literature, and the ongoing research effort at ORNL for the ADANS project.

# 1. INTRODUCTION

The Headquarters Military Airlift Command (HQ MAC) is upgrading its automated capabilities for scheduling peacetime missions, deliberate planning, execution planning, and analysis of the airlift system. MAC is also integrating its airlift scheduling processes so it will be easier for its staff to make the transition from their peacetime to wartime duties.

The system being developed is the Airlift Deployment Analysis System (ADANS), which will consist of four subsystems: airlift planning and scheduling algorithms, database management, user interface, and communications (Fig. 1). Data describing aircraft, network structures, and airfields used to constrain the airlift flow and information on cargo and passengers (movement requirements) to be moved will be transferred into ADANS, and airlift mission plans and schedules will be generated. ADANS will be hosted on two separate classified and unclassified local area networks of workstations at HQ MAC and the 21 and 22 Air Forces.[5]

This paper describes current airlift planning and scheduling at MAC, the current automated systems used to develop schedules and plans, approaches to developing ADANS, and major improvements that will result from the implementation of ADANS. Sections 2 and 3 describe processes and automation support for current peacetime and contingency airlift scheduling. Sections 4 and 5 describe the project approach and improvements in airlift scheduling and database management that will result from the development of ADANS. This paper is based on a series of in-depth interviews and working sessions with HQ MAC staff, a review of airlift scheduling literature, and the ongoing research effort now being done on the ADANS project.

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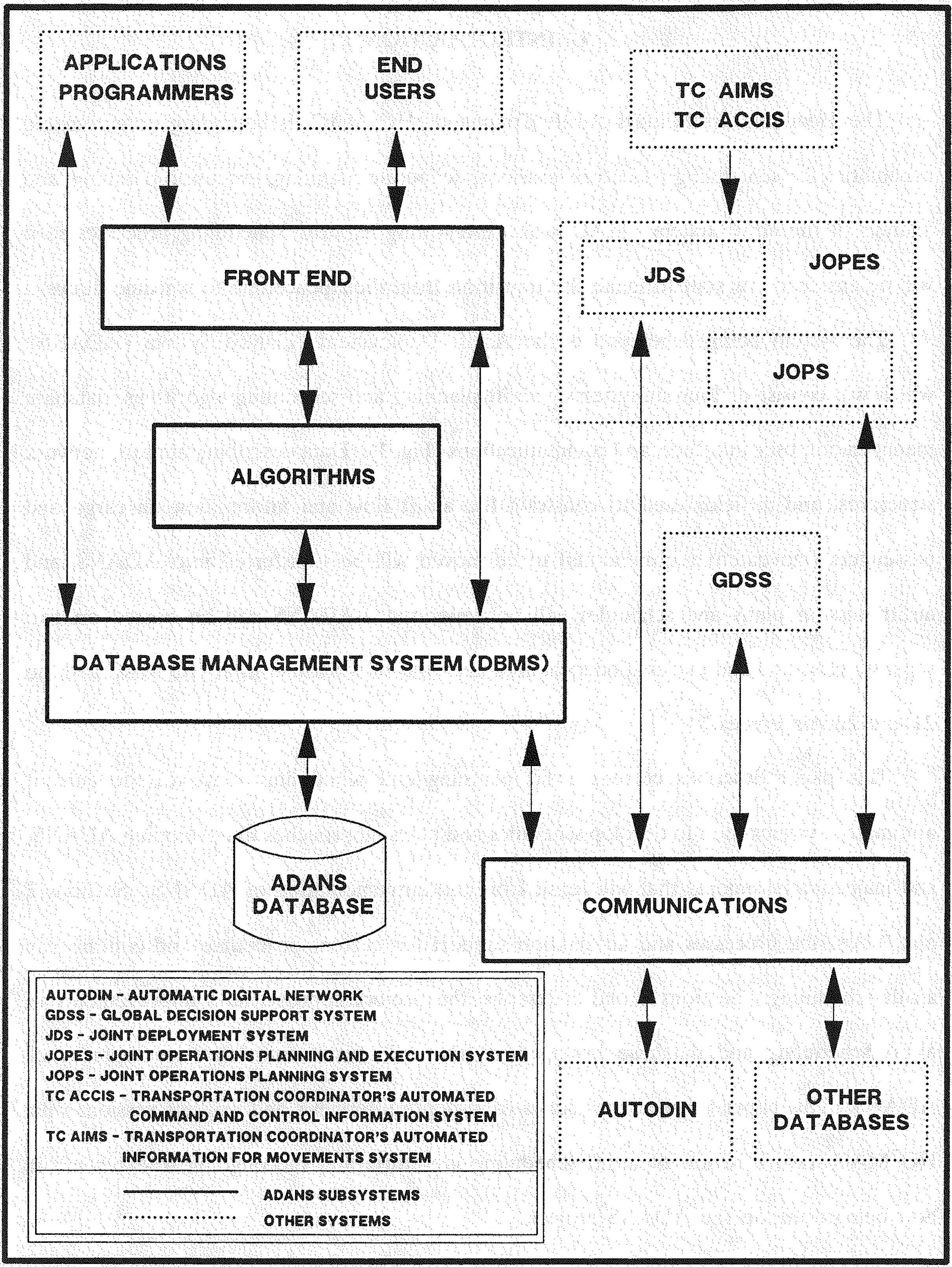


Fig. 1. Proposed ADANS configuration.

# 2. CURRENT AIRLIFT PLANNING AND SCHEDULING AT HQ MAC

## 2.1 MAC'S COMPLEX AIRLIFT ENVIRONMENT

MAC's airlift scheduling and operating environment complexities stem from the number of aircraft used in the operations, the various configurations of aircraft, the number of departures, the number of airfields served, the airfield workloads, the structures of the missions, and the variety of missions flown. MAC must keep aircrews, aircraft, and support resources prepared for deployment throughout the world at a moment's notice and concurrently operate an airlift system on a day-to-day basis.

The aircraft fleet used by MAC is larger and its operational environment is much more complex than that of any U.S. commercial airline. The military fleet consists primarily of C-5s, C-141s, and C-130s. In addition, the Air Force Reserves supply aircraft for some missions, and the Strategic Airlift Command's KC-10 fleet of refueling aircraft can be used. The Civil Reserve Air Fleet (CRAF) of commercial aircraft is also available during crisis. The CRAF consists of commercial airlines that have agreed to commit a portion of their fleet to military operations when requested. There are more than 30 configurations of aircraft in the CRAF. The commercial airlines that are members of the CRAF can contract with MAC during peacetime to move passengers and cargo. In total, MAC has more than 1,200 aircraft available for use in its operations.

The number of missions varies from year to year, depending on the budget appropriated for flying hours and emergency situations that require additional missions by MAC aircraft. The number of missions usually ranges from 115,000 to 135,000 each year.

Approximately 250 airfields around the world are served by MAC aircraft, with the workload varying from airfield to airfield. Table 1 shows the ranges of workload obtained during a three-month survey of 34 airfields taken in 1986.

Table 1. Three-Month Airfield Workload Survey

| Activity | Range | |
|---|---|---|
| | Low | High |
| Cargo moved (short tons) | 0 | 11,388 |
| Passengers moved | 1,104 | 38,210 |
| Aircraft used | 24 | 2,162 |

Each mission may consist of several segments, including home base to an onload airfield, onload airfield to an enroute airfield, enroute airfield to an offload airfield, offload airfield to a recovery or depositioning airfield, and finally a return to the home base. There may also be additional stops or rendezvous points for refueling on the ground or in the air (Fig. 2).

## 2.2 PEACETIME PLANNING

Congress establishes the number of flying hours for MAC training each year. The allocation of flying hours for peacetime missions is based on the amount of training needed for aircrews to maintain a constant state of readiness. The planning for the allocation of aircraft can begin several months in advance of the operating month, but decisions concerning the distribution of airlift resources must be made within the month of operation. The number of flying hours are allocated for each type of mission and for each type of military aircraft (C-5s, C-141s, and C-130s) (see Table 2).

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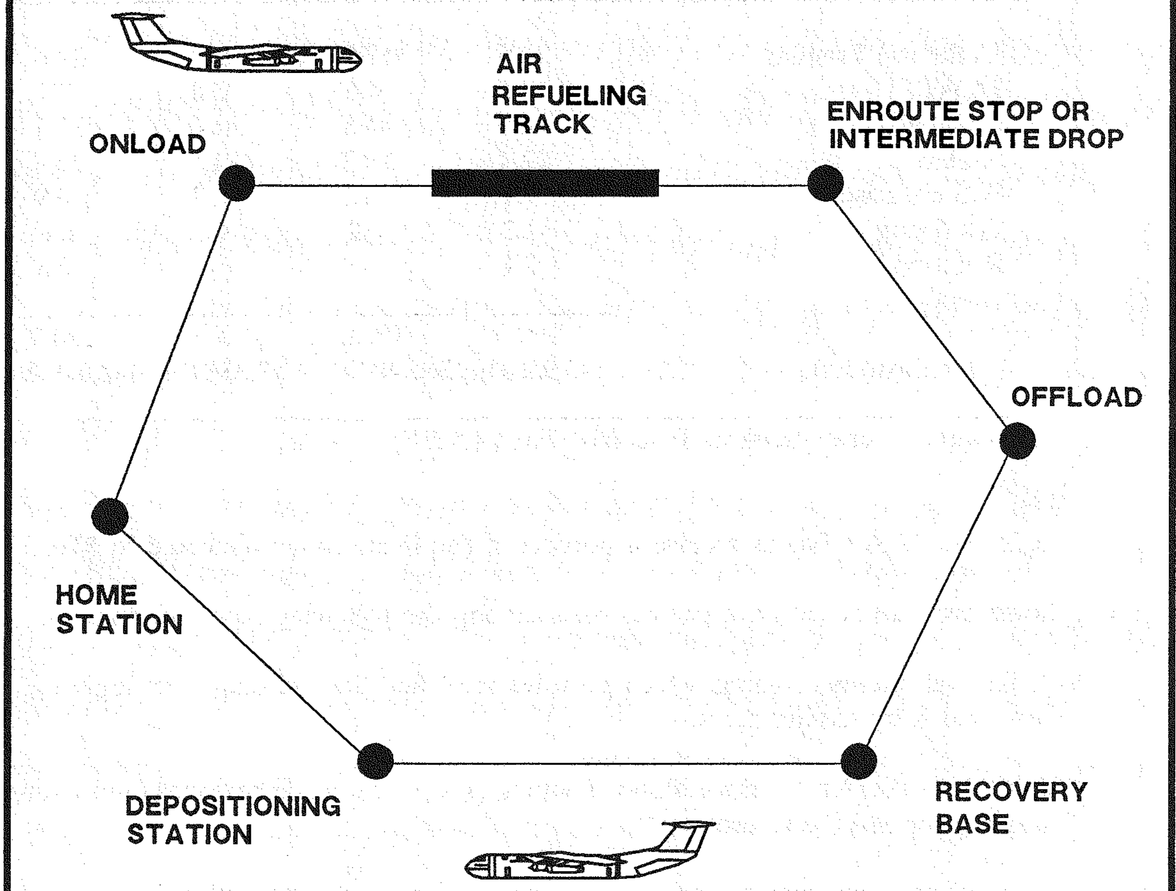


**Fig. 2. Potential airlift routing structure.**

Table 2. Military Aircraft Flying Hours by Mission Type - 1987

| Mission Type | C-130 (%) | C-141 (%) | C-5 (%) | Total Hours (%) |
|---|---|---|---|---|
| | Type of Aircraft | | | |
| Unilateral Training | 37.5 | 17.5 | 25.1 | 24.6 |
| JA/ATT | 14.5 | 4.6 | 2.0 | 7.4 |
| Channel | 14.5 | 44.5 | 44.0 | 35.1 |
| SAAM | 22.4 | 19.7 | 21.9 | 20.8 |
| JCS Exercise | 7.7 | 13.5 | 6.7 | 10.9 |
| Test/Ferry | 1.3 | 0.2 | 0.3 | 0.6 |
| Rotation | 2.1 | - | - | 0.6 |
| | 100.0 | 100.0 | 100.0 | 100.0 |
| Total (hours) | 143,936.0 | 265,401.0 | 53,339.0 | 462,676.0 |

Source: Airlift Services Industrial Fund (ASIF)

The 21 and 22 Air Forces receive a portion of the flying hours allocated to MAC. Flying hours are distributed on a priority basis among the following types of missions.

- o Unilateral aircrew training, which provides local and line training, plus logistics, test, and ferry requirements.
- o Joint Airborne/Air Transportability Training (JA/ATT), which provides joint airdrop training for MAC and users.
- o Channel missions, which support requirements for regularly scheduled service.
- o Special Assignment Airlift Missions (SAAMs), which are specially chartered missions to satisfy specific user's needs to move cargo between locations not served by the channel system or that have a specific required delivery date.
- o Joint Chiefs of Staff (JCS) exercises, which test MAC's contingency planning procedures during Command Post Exercises (CPXs) and Field Training Exercises (FTXs).

Only peacetime operations for channels, SAAMs, and JCS exercises are discussed in this report, because unilateral training and JA/ATT missions will not be scheduled using ADANS.[4,5,8]

### 2.2.1 Channel Missions

Channels are regularly scheduled airlift missions that deliver cargo and passengers throughout the world. Cargo movements are divided between MAC's military aircraft and commercial contract carriers. Passengers are generally moved by commercial aircraft. Currently, there are 760 channels, which constitute approximately 35% of MAC's total flying hour allocation.

The cargo requirements for channel scheduling come directly from users (the military services and the Defense Logistics Agency), who send them to the HQ MAC Air Transportation division via Automatic Digital Network (AUTODIN) or hardcopy for processing. Users send their cargo tonnage forecasts for each channel for the month that is being scheduled. After adjustments by users and MAC's Air Transportation staff, a forecast of the amount of cargo to be moved is forwarded to the Current Operations channel schedulers at HQ MAC.

Passenger forecasts come from the MAC Passenger Reservations Centers. The information on the number of passengers is forwarded to the Current Operations channel schedulers, who in turn contact the commercial airline company that has been contracted to fly each mission.

Channel schedules are developed 100 days before the month in which the missions are flown, but they are subject to change. Channel missions are scheduled each month along a fixed set of routes. While the general routes are fixed, there are usually some deviations in the schedule from month to month because of airfield closings and flight restrictions in some parts of the world. The channel airlift schedules are developed and modified using the Airlift Mission Planning and Scheduling (AMPS) System.[3]

When the schedules are completed, they are published and sent to the Passenger Reservations Centers' Passenger Reservations and Manifesting System (PRAMS) and the Global Decision Support System (GDSS). GDSS is a central repository for all unclassified missions scheduled by MAC.[1] Changes in the channel schedule caused by revisions in the user-supplied forecast are also distributed in this manner.

The network on which the channel missions are flown has evolved into its current form over several years. Requests can be made for additional channels, modifications to current channels, or elimination of channels. Whenever a user requests a change, Air Transportation, Current Operations, and the Comptroller's Office at HQ MAC review the request and make a recommendation to the Air Staff.

### 2.2.2 Special Assignment Airlift Missions

SAAMs are specially chartered missions to satisfy a specific user's need to move cargo or passengers between locations that are not served by the channel system or that have a specific required delivery date. SAAMs can be used in the initial stages of a contingency because they are flexible enough to provide an immediate response to crisis situations or they can be employed to begin prepositioning forces that may be used during operation plan (OPLAN) execution. When requesting a SAAM, the user specifies the type of aircraft desired, onload and offload airfields, pickup and delivery dates, and movement requirements.

SAAMs accounted for approximately 21% of MAC's flying hour allocation in 1987. In a month with high SAAM activity, as many as 350 to 450 SAAMs may be flown, while between 275 and 325 SAAMs may be flown during low activity months. Approximately 75%

of the SAAMs are flown between an onload airfield and an offload airfield, with an empty return. The remaining 25% consists of multiple onloads and offloads. Characteristically, 90% of all SAAMs are flown using military aircraft; commercial aircraft are used primarily for passengers.

Users request SAAMs as many as four months to as few as several hours before the mission is flown. Users frequently request changes in missions, typically in cargo characteristics, number of passengers, arrival and departure times, and onload and offload airfields. SAAM submissions can be made by telephone, AUTODIN, or hardcopy. SAAM requests are processed using a standard airlift request form in DD1249 format. Before the mission is processed, a service-appointed validator approves the mission to ensure that the user has adequate funds to pay for the mission. Once this approval has been granted, the Air Transportation staff for SAAMs processes the request, manually checking it for errors or inconsistencies. Air Transportation staff examine the feasibility of the proposed schedule, compatibility of aircraft with cargo, compatibility of mixed cargo and passengers, airfield restrictions, and diplomatic clearances. After the requirements have been processed by Air Transportation staff, the request is sent to Current Operations for SAAMs. Checks for errors and inconsistencies are performed again at this stage. The Current Operations Airlift Directors determine the availability of the appropriate aircraft for the mission and allocate the SAAM to the 21 or 22 Air Force. After an aircraft has been allocated, a record of the mission is made to reflect the use of the allotted aircraft for that month. A Mission Operating Directive (MOD) message is sent via AUTODIN to the user, the 21 and 22 Air Forces, wings, and other organizations affected by the mission. The MOD reiterates details of the mission that appeared on the original form DD1249, plus the tasking of the mission to the 21 or 22 Air Force. The 21 or 22 Air Force determines which of their wings will fly the mission, after which the wing schedules the mission and keys the schedule data into the Airlift Implementation and Monitoring System (AIMS).

2.2.3 Joint Chiefs of Staff Exercises

The two categories of JCS exercises are simulated exercises (CPXs) and actually flown exercises (FTXs), both of which are executed to measure and improve MAC's readiness capability. The objective of a CPX is to test OPLAN feasibility and the procedures to be used by MAC's Crisis Action Team (CAT) during Crisis Action System (CAS) activities. CPXs are simulated exercises that may involve personnel at HQ MAC or around the globe, depending on the size of the operation. One or more OPLANs are used during CPXs to test MAC's ability to schedule airlift to move forces during the simulated execution of an OPLAN. During CPXs, preplanned problems are injected into the exercise to determine MAC's ability to handle unexpected circumstances. MAC is involved in five or six CPXs each year, with each exercise lasting from 10 to 14 days. Movement requirements for the CPX are sent to MAC through the United States Transportation Command's (USTRANSCOM) Joint Deployment System (JDS). CPX planning within MAC is accomplished using the Integrated Military Airlift Planning System (IMAPS) for airlift schedule planning.[2]

During FTXs, MAC's objective is to provide airlift for deployment, employment, and redeployment of military forces conducting exercises in the field. MAC is involved in more than 70 FTXs each year, which account for about 11% of MAC's allocated flying hours. The larger FTXs are scheduled using IMAPS, and the smaller ones are planned manually. The FTX is planned by the Supported Commander-in-Chief (CINC) in conjunction with JCS and USTRANSCOM's Component Commands. When the Supported CINC has identified forces and resupply to be moved for the exercise, MAC uses IMAPS to develop schedules that will move these requirements. A series of meetings is then held between the Supported CINCs, MAC, and other USTRANSCOM Component Commands to finalize the FTX airlift schedules. Even after the FTX schedule has been published, additional changes may be made to the departure and arrival times, aircraft configurations, and onload and offload airfields. These last minute requests currently involve manual manipulation of the schedule.

## 2.3 AIRLIFT PLANNING AND SCHEDULING FOR CONTINGENCY OPERATIONS

MAC is responsible for deliberate planning during peacetime and CAS activities during contingency and crisis situations in support of unified and specified commands.

### 2.3.1 Deliberate Planning

The purpose of deliberate planning at MAC is to provide for the development, coordination, dissemination, review, and approval of OPLANs and OPLANs in concept form (CONPLANs).[9] During deliberate planning, IMAPS is used to develop OPLANs that provide a set of airlift schedules designed to meet the Supported CINC's requested timetable for delivery of forces. In addition, mission support resources required to sustain the airlift schedule are determined, asset needs are evaluated, and network configurations are developed. OPLANs produced during deliberate planning are available for implementation during crises.

### 2.3.2 Crisis Action System Activities

CAS activities consist of situation development, crisis assessment, course of action development, course of action selection, execution planning, and execution.[9] Most of MAC's direct involvement is in course of action development, execution planning, and execution. During course of action development, MAC uses IMAPS to analyze its ability to provide airlift resources either for the execution of specific OPLANs and CONPLANs or to support situations not covered in an existing plan. Closure estimates for delivery of forces may be required in a few hours if the contingency is rapidly developing or if several potential courses of action are being prepared. In execution planning, an approved OPLAN or other designated course of action is adjusted and refined to fit the prevailing situation and converted into an Operations Order that can be executed at a designated time. Execution includes the implementation of an OPLAN and the adaptation to changing situations during OPLAN implementation in a real-time environment.

# 3. AUTOMATED SYSTEMS CURRENTLY USED FOR AIRLIFT PLANNING AND SCHEDULING

AMPS and IMAPS are the only mainframe-based automated systems currently used for airlift planning and scheduling at HQ MAC. Some microcomputer-based software has been written by MAC planners and analysts to assist with closure estimates and analysis of plan feasibility, but other airlift scheduling activities are performed manually.[6]

## 3.1 AIRLIFT MISSION PLANNING AND SCHEDULING SYSTEM

AMPS, which is used for channel mission planning and scheduling, is an accounting model in which cargo and passengers are assigned to aircraft for movement in average payload increments for each mission.[3] The system has very limited editing and analytical capability.

## 3.2 INTEGRATED MILITARY AIRLIFT PLANNING SYSTEM

IMAPS is used for airlift planning and scheduling during JCS exercises, deliberate planning, and CAS activities.[2] It is a system of COBOL programs that uses movement requirement, aircraft, airlift network, plan status, and airfield information. Movement requirements used by IMAPS can be manually entered or automatically retrieved from the Joint Operation Planning System (JOPS) or JDS.

### 3.2.1 Data Storage

IMAPS plan sets and JOPS data used by IMAPS are generally stored on magnetic tape. Some of the reference files are stored on disk mass storage systems. IMAPS is not integrated with any database management systems (DBMS) or other scheduling systems at HQ MAC or within the Joint Deployment Community. If JDS data are required, JDS-supplied software is used to extract movement requirements from IMAPS and update JDS.

### 3.2.2 Data Validation

The IMAPS subsystem, Automated Airlift Analysis (AAA), is used to check JOPS Time-phased Force Deployment Data (TPFDD) for errors and to preprocess that data before an IMAPS run. JDS movement requirements are assumed to be error-free because they are preprocessed in JDS before being loaded into IMAPS and validated using AAA during deliberate planning. Movement requirements entered manually are not validated by any software tools.

### 3.2.3 Plan Setup

The two objectives of developing an IMAPS plan set are to establish a "concept of operations" in which an airlift schedule can be built and to identify specific parameters under which that schedule can be implemented. Each time IMAPS is used to construct a new airlift schedule, planners must build a plan set. Plan sets consist of airfield, aircraft, aircrew, and airlift network information that are the initial input data for IMAPS. Plan sets from previous IMAPS runs may be used, or new plan sets can be built. Although old plan sets can be reused, it is difficult to do so because the plan will need to be tailored, and complex plan sets are difficult to understand and interpret. If a new plan set is developed, action officers or their assistants must interactively enter much of the aircraft, airfield, and airlift network data to be used. Designing a new airlift network is an arduous manual task for planners. The only way to test the airlift network and the consequences of the concept of operations represented by the plan setup data is to run IMAPS and manually interpret the diagnostics.

### 3.2.4 Scheduling Airlift

Flow Generator (FLOGEN), the IMAPS scheduler, usually takes several iterations to achieve an acceptable schedule. The first run, which is made to determine station workloads and identify where bottlenecks occur in the network, gives the planner suggested locations for mission support resources. After mission support resources have been manually allocated, FLOGEN is rerun, and a revised schedule is generated that accounts for the additional missions needed to position the mission support resources. Once feasible plans and airlift schedules are developed, they can be stored on MAC and Joint Deployment Community systems for access during exercises or contingencies.

#### 3.2.5 Distribution

After an IMAPS run, airlift schedules can be copied to a JOPS tape, distributed via AUTODIN, sent directly to JDS and AIMS, or printed to hardcopy reports.

### 3.3 AIRLIFT SCHEDULING AND ANALYSIS DEFICIENCIES

IMAPS is the most sophisticated, large-scale, automated transportation planning and scheduling system used by USTRANSCOM's Component Commands. However, IMAPS has neither the flexibility nor responsiveness to fully support deliberate planning or the rapidly changing contingencies addressed by execution planning. Some automated support is available for planning and scheduling for peacetime activities, but many of those processes remain manual. Further, there is no integration between peacetime scheduling and planning systems and contingency-readiness systems, which seriously impacts MAC's ability to transition effectively and efficiently from peacetime to wartime operations. Specific deficiencies are listed below.[7]

#### 3.3.1 Input Deficiencies

- o MAC's Command and Control Information Processing System (IPS), GDSS, and systems being developed by the services under the generic name Transportation Coordinators' Automated Information for Movements System (TC AIMS) will provide current, detailed data on capabilities, constraints, and requirements. However, because IMAPS can only use summary level data, it will not be able to use this detailed information to improve the accuracy of planning and execution.

- o The quality of schedules created by FLOGEN is overly dependent on operator skill in setting up model runs.

- o The manual setup for FLOGEN is prone to error and the system has poor error diagnostics. As a result, the entire setup process is overly time consuming and critical errors in the FLOGEN run may not be apparent until the processing is complete.

- o IMAPS does not have relational data base management capabilities for editing and revising input for the scheduling model.

### 3.3.2 Scheduling Program Deficiencies

- o There is no single system support of deliberate, execution, and peacetime airlift planning, scheduling, and analysis.

- o IMAPS cannot produce airlift schedules in a timely manner during crisis situations because of the extensive setup, processing, and analysis time required.

- o FLOGEN does not constrain the airlift flow based on the availability of key station resources or aircrews.

- o FLOGEN does not allow simultaneous runs of multiple scenarios while accounting for the resulting competition for airlift and airfield resources.

- o Because FLOGEN schedules do not adequately reflect real-world constraints, planners at the NAFs must extensively refine and modify FLOGEN schedules to make them more efficient and economical. This includes selecting in-system aircraft that may be available to reduce aircraft positioning time, changing schedules to use aircrews more efficiently, and changing operator assignments to be consistent with aircraft availability.

- o FLOGEN operates independently of other systems so it cannot overlay a planned flow onto the unilateral training, JA/ATT, channel, and SAAM schedules.

- o FLOGEN lacks the flexibility to reflect real-world changes to published schedules resulting from diversions, mechanical breakdown, and other sources during execution planning.

### 3.3.3 Output Deficiencies

- o IMAPS does not have the capability to address "what if" questions concerning airlift allocation and availability of aircrews and airfield resources.

- o IMAPS does not have graphics capabilities to enhance input, output, and analysis of scheduling results.

- o IMAPS does not have relational data base management capabilities for developing reports and conducting queries against plan data.

- o There is no capability to analyze the "goodness" of a plan or airlift schedule within IMAPS based on planner-selected criteria.

# 4. APPROACH TO ADANS' DEVELOPMENT

## 4.1 OVERALL APPROACH TO THE DEVELOPMENT OF ADANS

To effectively execute MAC's tasks during peacetime and contingency operations, its airlift planners and schedulers must interact with a myriad of automated systems that operate at several security classification levels. Many of the automated systems with which ADANS must interact are being upgraded in parallel with ADANS, and coordination among the various upgrades consumes tremendous resources. Examples include HQ MAC's GDSS, the individual service's TC AIMS, and USTRANSCOM's Joint Operation Planning and Execution System (JOPES).[5,9] JOPS and JDS are scheduled to be integrated within JOPES.

The functions of several existing systems at HQ MAC will be integrated within ADANS. During the integration process, functionality will be improved and additional capabilities will be added. Implementation of ADANS is especially delicate because existing systems must remain operational until users are sufficiently confident that ADANS is ready to replace those systems.

Because of the enormous complexity of scheduling airlift, aircrews, and airlift support worldwide for more than 1,200 aircraft, off-the-shelf approaches to planning and scheduling are inadequate. Research is being done in the areas of scheduling and planning algorithms, hardware and software architectures, man-machine interfaces, and artificial intelligence applications for the ADANS project. Advances in parallel processing, artificial intelligence, and mathematical and database management techniques during the development of ADANS could change ADANS' implementation strategy.

The following general guidelines will be adhered to during the development of ADANS.[5]

- o Consistency will be maintained as much as possible between peacetime and crisis procedures.
- o Users will be involved in every aspect of development that affects their operational environment.
- o The automation concept will be based on distributed processing principles.
- o Communication and analytical functions will be kept separate from one another.
- o Individuals will not be required to be responsible for data that are not pertinent to the performance of their assigned responsibilities.
- o Existing automated decision support systems will be used whenever possible if they adequately support user needs.
- o Appropriate machine-to-machine links will be used to facilitate the flow of large amounts of data.
- o Automated decision support systems will be scaled to the need and level of operations within each organization.
- o User interfaces will be tailored for individual functions, but screen faces should be as similar as possible to allow the user to transition from one task to another with minimal retraining.
- o System design will allow for fall back capabilities to ensure continued system operation even if part of the system fails.
- o Design decisions will consider the evolutionary nature of hardware and software and plan for upgrades and modifications.
- o Commercial off-the-shelf software should be used wherever possible.

## 4.2 INCREMENTAL APPROACH TO THE DEVELOPMENT OF ADANS

ADANS is being developed and implemented in three increments, with final system delivery in 1992. Phased system implementation will allow developers to take advantage of changes in hardware and software and in airlift planning and scheduling techniques. At the same time, an operational system will be installed as quickly as possible. The goal of each phase is to upgrade MAC's airlift planning and scheduling system and to identify strategies for implementation of subsequent phases.

During Phase I, a new user interface and a communications subsystem are being developed, and a relational DBMS is being implemented to replace the existing COBOL-managed data file system. IMAPS and AMPS will be replaced with new scheduling systems during Phase I. Algorithmic techniques that may benefit later phases will be investigated, and prototype systems using those techniques will be implemented.

During Phase II, the scheduler, DBMS, user interface, and communications subsystems will be upgraded. Scheduling capabilities will be developed for SAAMs and requirements processing procedures will be improved for SAAMs and channels. Prototyping and research into new scheduling and planning techniques will continue.

During Phase III, the ADANS' airlift planning and scheduling system, DBMS, user interface, and communications subsystems will be upgraded; a schedule simulation capability will be added; aircrew scheduling will be coordinated with the mission scheduling capabilities; and final system delivery will be made to HQ MAC.

Detailed functional requirements analyses will be performed during each phase to identify and document the efforts at MAC that need additional automation. Next, rather than simply automating the tasks identified during the requirements analysis, system designers will interpret how best to accomplish the tasks using database management and mathematical techniques. The end-user will be consulted constantly regarding the appropriateness of the approaches. When institutional or environmental impediments are reached, senior MAC staff will be consulted regarding the impacts of those barriers on the approaches being considered.

# 5. SPECIFIC IMPROVEMENTS IN ADANS

The ADANS scheduling subsystem will require data input via the communications and DBMS subsystems. Scheduling subsystem algorithms are being designed specifically to provide schedules and plans for channel missions, SAAMs, and JCS exercises. ADANS will also support contingency operations during deliberate planning, course of action development, and execution planning. Inputs for the scheduling subsystem consist of movement requirements, airfield characteristics, aircraft characteristics, geographic locations, and mission support. Movement requirements will originate from JOPS, JDS, DD1249 forms, user forecasts, and TC AIMS. Initial interfaces developed for ADANS will be with JOPS and JDS, but connectivity with JOPES will be established when it is completed. Schedules output from ADANS will be sent to JOPS, JDS, JOPES, GDSS, and PRAMS. In addition, AUTODIN messages will be sent to users who do not have access to systems that contain published schedules.

## 5.1 PEACETIME MISSIONS

### 5.1.1 Channel Mission Improvements

Channels are regularly scheduled airlift missions that deliver cargo and passengers throughout the world. Channel mission functions automated within ADANS will

- o provide automated requirements processing and forecasting within one system with a direct interface to a channel mission scheduler,
- o provide an automated channel scheduling system, and
- o furnish automated tools to evaluate proposed changes in the channel structure.

The majority of improvements in channel requirements processing and scheduling will result from having a single system to easily edit files and schedule missions. Movement requirement forecasts will be entered into ADANS and revised by the Air Transportation staff. When the forecasts have been adjusted to an appropriate level, they will be made available to the Current Operations channel scheduler in a centralized database. AMPS will be replaced by a system of interactive editing and scheduling programs within the ADANS DBMS, which will be used by channel schedulers to develop a set of monthly channel missions. The monthly schedule will continue to be published and sent to GDSS and PRAMS.

A network design algorithm will also be developed to analyze the efficiency of the existing channel network structure. This network design algorithm will be used to determine how to most efficiently add, delete, or modify channel missions.

### 5.1.2 Special Assignment Airlift Mission Improvements

SAAMs are specially chartered missions to satisfy specific user's needs to move cargo between locations not served by the channel system or that have a specific required delivery date. SAAM functions automated within ADANS include

- o error checking and cross referencing requirements, verifying that user-requested aircraft are appropriate for the mission, and validating airfield data in the DD1249 memorandum;
- o simultaneous updating of the documentation used by the Airlift Director; and
- o developing proposed SAAM schedules.

The processing of SAAM requests will be revised within ADANS. The Air Transportation staff will process SAAM movement requirements using ADANS DBMS functions. Within ADANS, the requirements will be validated, and errors and inconsistencies will be flagged. Current forms used to allocate aircraft will be automated and concurrently updated. ADANS will provide the capability for the Airlift Director to develop a proposed SAAM schedule within the framework of the user's request. The wings will retain the responsibility for finalizing SAAM schedules in coordination with the user.

## 5.2 AIRLIFT PLANNING FOR CONTINGENCY OPERATIONS AND JOINT CHIEFS OF STAFF EXERCISES IMPROVEMENTS

Automated procedures for JCS exercises and airlift planning for contingency operations within ADANS will include

- o extracting movement requirements information from JOPS, JDS, JOPES, GDSS, or construction of a movement requirements file from information supplied by the Supported and Supporting CINCs;
- o providing enhanced abilities to diagnose problem areas in the CINC's TPFDD and suggesting changes;
- o providing automated tools for airlift network development;
- o automating error checking and assessing the quality of the network by making a rough flow of the requirements through the network to detect bottlenecks;
- o approximating numbers and configurations of aircraft needed;
- o developing preliminary deployment estimates for the scenarios being evaluated;
- o incorporating a limited look-ahead capability to aid MAC planners in the optimal use of limited airlift resources;
- o providing automated techniques to assist planners in assigning MAC mission support to airfields;
- o developing an airlift schedule;
- o evaluating the amount of throughput at an airfield as a function of airfield characteristics and level of MAC mission support;

- o evaluating the schedule alternatives in terms of resources used and probability of schedule success under various constraints;
- o modifying existing airlift schedules by adding or deleting missions; and
- o updating JDS, JOPS, JOPES, and GDSS with schedule information.

One of the primary reasons for the development of ADANS is to improve overall airlift scheduling capabilities at HQ MAC. As a result, IMAPS subsystems for receiving and reporting data and airlift scheduling will be replaced during the implementation of Phase I. The data management and reporting subsystems will be replaced by the ADANS DBMS and user interface. The scheduling subsystem will contain scheduling algorithms and a user-friendly interface designed to help planners develop schedules quickly and efficiently.

**Data Storage.** Movement requirement data used by ADANS will come from GDSS, JOPS, JDS, and JOPES. JOPS movement requirements will be used during deliberate planning and JDS movement requirements will be used during crises. During exercises, the most up-to-date movement requirements available will be used. Data must be stored so that one or more OPLANs can be extracted and used by ADANS simultaneously.

**Data Validation.** Each set of movement requirements to be scheduled by ADANS will be validated so that errors and inconsistencies can be resolved and movement requirements can be grouped for optimal processing. The validation software will flag errors, and the system will recommend potential solutions to problems found.

**Plan Setup.** The plan setup subsystem will provide airlift network development tools and preliminary estimates on the size and configuration of the fleet of aircraft required to implement the airlift schedule. Planners will begin by describing a general "concept of operations" and work with the graphics and text-based tools to refine an airlift network and fleet configuration that can accommodate the required airlift flow.

**Airlift Scheduling.** Although similar data validation and plan setup tools can be used for JCS exercises, deliberate planning, and CAS activities; scheduling algorithms will be tailored to the specific requirements of the various mission categories. FTXs and the execution phase of CAS are similar in that missions are actually flown; however, because exercises can be set up and tailored months ahead of execution, there will be differences in some of the automated tools used in developing their schedules.

The ADANS scheduling algorithm will initially be run to determine station workloads and locations where potential scheduling bottlenecks could occur. At that point, the output from the algorithm will identify locations where MAC mission support resources are needed to supplement mission support at overloaded airfields or reroute some of the missions to lessen or eliminate the bottlenecks. Some movement requirements may then need to be added to the plan so that the support personnel and equipment can be moved to these key airfields. Once the additional movement requirements have been incorporated into the plan, a revised schedule will be generated. When an acceptable schedule has been developed, it will be sent to JDS where it can be retrieved by members of the Joint Deployment Community.

### 5.2.1 Deliberate Planning Improvements

The purpose of deliberate planning at MAC is to provide for the development, coordination, dissemination, review, and approval of OPLANs and CONPLANs. The deliberate planning algorithms for developing OPLAN airlift schedules will allow interactive access and will rely on heuristic and optimization procedures to develop a feasible and efficient use of aircraft and mission support resources. The first algorithm will determine the feasibility of the plan, based on the proposed time limit and available resources. If the proposed plan cannot be successfully executed within these limits, adjustments can be made. Once the plan is found to be feasible, a second algorithm will make the actual assignment of cargo and passengers to specific missions. An aircraft load planning algorithm being developed as an ADANS subsystem will be incorporated into this step to ensure the efficient use of aircraft resources. In the final algorithm, the mission itineraries will be refined to ensure that the mission objectives are met as efficiently as possible. This could include minimizing cost or shortfalls or maximizing on-time delivery. At each stage in the modeling process, the user interface will provide the planner with graphic and textual analysis tools that help planners make mission scheduling decisions.

### 5.2.2 Joint Chiefs of Staff Exercises Improvements

The two categories of JCS exercises are CPXs and FTXs, both of which are executed to measure and improve MAC's readiness capability. Many of ADANS' design features developed for deliberate planning and CAS activities will be appropriate for JCS exercises because JCS exercises are used to simulate contingencies. Procedures used in exercises that are the same as those used in contingencies involve adapting or developing an OPLAN and implementing it in a real-time environment.

#### 5.2.2.1 Command Post Exercises

CPXs are used to test the feasibility of implementing OPLANs that have been developed. During a CPX, aircraft are not actually flown. CPXs are implemented as procedural exercises that are carried out to test MAC's command and control capability. One or more OPLANs are used during each CPX. The OPLAN's movement requirements for the CPX will be put into the ADANS DBMS from tape or through its connection with

JDS. The reference files in the ADANS DBMS will also be used as input to develop the schedules for the CPX.

A major improvement in ADANS over IMAPS will be its ability to simultaneously develop schedules for multiple OPLANs. When multiple OPLANs are used in a CPX, the algorithm will account for shared station workloads and mission support resources.

The CPX TPFDD will be pulled from JDS to initiate the exercise. As the exercise is being implemented, problems that may result in schedule changes and reallocation of aircraft will be injected into the scenario. These problems could include the elimination of an airfield being used by MAC aircraft, a reduction in the number of aircraft supporting the exercise, or the elimination of specific routes over which MAC aircraft would normally fly to bring forces to the contingency location. These changes will be handled by a mission insertion-modification-deletion algorithm in ADANS. This algorithm will be a heuristic that modifies the schedule based on requested changes.

5.2.2.2 Field Training Exercises

FTXs are exercises in which missions are actually flown. The Supported CINC develops the plan for an FTX in coordination with JCS and USTRANSCOM Component Commands. The movement requirements for the exercise will be put into USTRANSCOM's JDS database or submitted on form DD1249. The ADANS DBMS will access these movement requirements through its connection to JDS or the requirements will be directly keyed into the system. The DBMS will also use its own reference files to set constraints on the schedules developed. When developing an FTX schedule, a budget constraint will be built into the FTX scheduling algorithm so MAC can evaluate the cost of the exercise.

Schedule refinements for the FTX will continue to be made as the execution date approaches. The ability of ADANS to schedule in more detail than FLOGEN will mean that fewer adjustments will need to be made. Nonetheless, there will still be change requests made by the users just before and during the exercise. ADANS will have a greater capability than IMAPS to manage these last minute changes and to adjust the schedules through an integrated DBMS and scheduling subsystem.

### 5.2.3 Crisis Action System Activities Improvements

CAS activities consist of situation development, crisis assessment, course of action development, course of action selection, execution planning, and execution. Most of MAC's direct involvement is in course of action development, execution planning, and execution.

During CAS activities, ADANS will provide automated tools for rapid preplanning, planning, scheduling, schedule evaluation, and schedule updating for existing OPLANs and rapid development of OPLANs from CONPLANs. When more than one alternative could be employed, ADANS will be used to evaluate each alternative. If an OPLAN or CONPLAN does not exist, ADANS will be used to develop an executable OPLAN from information provided by Supported and Supporting CINCs and other members of the Joint Deployment Community.

ADANS will acquire information concerning airlift and mission support resources and gather airfield information that might be used during the impending crisis from MAC command and control systems. The Worldwide Military Command and Control System (WWMCCS) Intercomputer Network (WIN) and GDSS will be used to communicate movement requirement and schedule information among ADANS, MAC's lower echelons, and the Joint Deployment Community.

ADANS will schedule airlift missions for small-scale contingencies, such as Grenada, or for potentially large-scale contingencies, such as the defense of Western Europe. MAC planners will be able to determine the amount of detail considered by ADANS for movement requirements, aircraft, airfield, and mission support resources. For example, if MAC only needs to schedule a few missions, ADANS will identify the numbers and types of aircraft required and schedule the missions based on the most detailed aircraft and airfield data available. If MAC needs to quickly schedule thousands of missions, ADANS will be used to approximate the numbers and types of aircraft needed and to test the general feasibility of alternative scheduling scenarios.

ADANS will provide a series of bookkeeping functions to evaluate aircraft committed, percent of allowable cabin load available, movement requirements to be delivered, missions scheduled, and airfield workloads. As a crisis unfolds, ADANS will be used to revise schedules by adding, deleting, diverting, or modifying missions, groups of missions, routes, aircraft, or airfields to meet changing needs. Effects of changes made to the schedule on the overall plan will be measured. The objective of the planning and scheduling algorithms will be flexible, incorporating user provided weights for mission priority, mission loss or delay, mission costs, effects on disruption to planned schedules, and commitments of aircraft resources by type.

Schedule evaluation tools provided by ADANS will allow planners to examine the schedule at different levels of detail and from perspectives of station workloads, closure profiles, aircraft used, or cargo delivered.

# 6. CONCLUSION

HQ MAC and the NAFs have a large complex planning task. The automated systems currently used for airlift planning and scheduling need to be improved. Airlift schedule development and airlift system analysis are performed using a combination of manual procedures and separate automated systems. The current systems do not provide state-of-the-art data processing and scheduling algorithms, which creates the need for a revision of most of the schedules before those schedules can be effectively implemented. Because separate systems are used, it is difficult to efficiently transition from peacetime operations to a contingency posture.

ADANS will improve MAC's airlift planning, scheduling, and analysis capabilities. Efficient airlift schedules will be rapidly developed. MAC planners will have access to a consistent user interface and a more comprehensive overview of MAC's airlift resources and commitments than is currently available. Peacetime scheduling; execution planning, scheduling, and analysis; and deliberate planning will be carried out within a single system. When implemented, ADANS will enhance MAC's ability to maintain its forces in a constant state of readiness by eliminating many of the dated automated systems and manual procedures that are currently used at MAC.

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# APPENDIX A

## ACRONYMS

| | |
|---|---|
| AAA | Automated Airlift Analysis |
| ADANS | Airlift Deployment Analysis System |
| AIMS | Airlift Implementation and Monitoring System |
| AMPS | Airlift Mission Planning and Scheduling |
| ASIF | Airlift Services Industrial Fund |
| AUTODIN | Automatic Digital Network |
| CAS | Crisis Action System |
| CAT | Crisis Action Team |
| CINC | Commander-in-Chief |
| CONPLAN | Concept form of an operation plan (OPLAN) |
| CPX | Command Post Exercise |
| CRAF | Civil Reserve Air Fleet |
| DBMS | Database management system |
| FLOGEN | Flow Generator |
| FTX | Field Training Exercise |
| GDSS | Global Decision Support System |
| HQ MAC | Headquarters Military Airlift Command |
| IMAPS | Integrated Military Airlift Planning System |
| IPS | Information Processing System |
| JA/ATT | Joint Airborne/Air Transportability Training |
| JCS | Joint Chiefs of Staff |
| JDS | Joint Deployment System |
| JOPES | Joint Operation Planning and Execution System |
| JOPS | Joint Operation Planning System |
| MAC | Military Airlift Command |
| MENS | Mission Element Need Statement |
| MOD | Mission Operating Directive |
| OPLAN | Operation Plan |
| ORNL | Oak Ridge National Laboratory |
| PRAMS | Passenger Reservations and Manifesting System |
| SAAMs | Special Assignment Airlift Missions |
| TC AIMS | Transportation Coordinators' Automated Information for Movements System |
| TPFDD | Time-phased Force Deployment Data |
| USTRANSCOM | United States Transportation Command |
| WIN | WWMCCS Intercomputer Network |
| WWMCCS | Worldwide Military Command and Control System |

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