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U. S. Department
of Transportation

Federal Aviation
Administration

FAA TECHNICAL CENTER

TRAFFIC MANAGEMENT ADVISOR (TMA)

FUNCTIONAL AND NON-INTERFERENCE

DEMONSTRATION RESULTS

(DENVER CONFIGURATION)

RELEASE 3.1.2t
Revision 3

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Engineering, Research, and Development Service
Research Directorate for Aviation Technology
FAA Technical Center
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LIST OF ACRONYMS

AAS	Advanced Automation System
AT	Air Traffic
ATC	Air Traffic Control
CM	Communications Manager
CTAS	Center-TRACON Automation System
DA	Descent Advisor
EDP	Expedite Departure Path
ETA	Estimated Time of Arrival
FAA	Federal Aviation Administration
FAST	Final Approach Spacing Tool
GPO	General Purpose Output
HCS	Host Computer System
MAPS	Measure Scale Analysis and Prediction System
NAPRS	National Airspace Performance Reporting System
NAS	National Airspace System
PAMRI	Peripheral Adapter Module Replacement Item
PTA	Planned Time of Arrivals
SDT	System Development Team
SMMC	Supervisory Maintenance Monitoring Console
STA	Scheduled Time of Arrival
TATCA	Terminal Air Traffic Control Automation
TM	Traffic Manager
TMA	Traffic Management Advisor
TMC	Traffic Management Coordinator
TMU	Traffic Management Unit
TRACON	Terminal Radar Approach Control

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SUMMARY

The first component of the Center-TRACON Automation System (CTAS) to be formally assessed in an operational environment will be the Traffic Management Advisor (TMA). This formal assessment at the Denver Center will be limited in scope, as the TMA will not be used operationally during the assessment period. Instead, the capabilities of the TMA will be displayed off-line to acquire relevant comments from the Traffic Management Coordinators (TMCs). As was the case during the TMA informal assessment, which was recently concluded at Denver Center, information acquired during the formal assessment will be used to further develop the TMAs potential as an operational tool.

The CTAS software was recently modified to correct some software deficiencies and to incorporate new TMA functionalities recommended by the TATCA System Development Team (SDT) and Denver Center TMCs. The CTAS software version to be utilized during the TMA formal assessment at Denver Center will be release 1.3.2t.

The functionalities of the TMA, CTAS release 1.3.2t, were formally demonstrated to a TMA Demonstration observer team, consisting of representatives from Air Traffic (AT) and the TATCA Program Office, on December 16, 1992, at the FAA Technical Center. TATCA Program personnel from ACD-340 conducted the TMA Functional and Non-Interference Demonstration. The observer team involved in the functional portion of the demonstration consisted of representatives from ATR-330, ATM-100, ATR-210, and ARD-40.

Following the functional demonstration, a Center HOST Non-Interference demonstration was completed by ACD-340 representatives. The detailed Functional and Non-Interference procedures used during the TMA Demonstration are contained in reference 2 identified on page 4 of this report. The results of the TMA demonstrations are contained in this report.

The TMA functionalities were considered by the observer team to be demonstrated satisfactorily; however, a variety of the demonstration cases passed with comments from the evaluators and observers. Their specific comments are contained in Appendix A of this report.

The non-interference aspect of the demonstration, conducted by ACD-340 personnel, was completed satisfactorily on December 22, 1992, after the TMA system successfully completed a 24-hour continuous operation.

Based on the satisfactory results or the FAA Technical Center TMA Functional and Non-Interference demonstration, it is determined that the TMA Formal Assessment at Denver Center can be initiated.

1. INTRODUCTION

This document describes the results of the Traffic Management Advisor (TMA) Functional and Non-Interference Demonstration held at the Federal Aviation Administration Technical Center December 16, 20, 21, and 22, 1992. TMA is the first automation tool to be demonstrated which is part of the Center-TRACON Automation System (CTAS) developed by NASA Ames Research Center. CTAS is an integral part of the Federal Aviation Administration (FAA) Terminal Air Traffic Control Automation (TATCA) Program.

1.1 BACKGROUND

The FAA initiated the TATCA Program in 1986 to provide solutions to the growth in air traffic and increased terminal area delays. The goal of TATCA is to provide automation tools which will aid in the handling of larger volumes of departing and arrival aircraft in major terminal areas. The program's objectives are to provide effective automation prior to the Advanced Automation System (AAS) and to develop plans to achieve increased automation for the AAS in the late 1990's. The FAA is in the process of evaluating an integrated set of automation tools, developed by the NASA Ames Research Center, known as CTAS.

CTAS was developed primarily to aid the Traffic Management Coordinator (TMC), and the Center and the Terminal Radar Approach Control (TRACON) controller to sequence and schedule arrival traffic at major center and terminal areas. The automation tools were developed to optimize traffic flow, increase fuel efficiency, reduce delays, and improve TMC and controller productivity. CTAS sequences, schedules, and generates clearance advisories to assist, not replace, the TMC and controller in making decisions.

CTAS comprises four primary automation components:

a. **the TMA** which gives the TMC at the Traffic Management Unit (TMU) automation tools to efficiently schedule and sequence arrival traffic;

b. **the Descent Advisor (DA)** which provides Center controllers recommended control actions to help aircraft meet the TMA schedule;

c. **the Final Approach Spacing Tool (FAST)** which assists TRACON controllers in sequencing and spacing aircraft on final approach so as to optimize runway throughput and reduce delays; and,

d. **the Expedite Departure Path (EDP)** tool which provides a method to merge satellite departures into the arrival stream at the primary airport.

1.2 PURPOSE

This document describes the results of the TMA Functional and Non-Interference Demonstration held at the FAA Technical Center. The demonstration was to ensure that TMA functionality as described in supportive documentation listed in the Plan and Procedures operated as proclaimed. Another purpose of the demonstration was to determine if the TMA is suitable for formal assessment at the Denver Center. The demonstration comprised two major areas:

a. TMA functional capabilities; and,
b. Center Host Computer System (HCS) non-interference.

Real (live) radar tracking and flight plan data from the Denver Center HCS was used during the demonstration.

1.3 DEMONSTRATION PERSONNEL

Don Roberts of the Air Traffic Control (ATC) Technology Branch, ACD-340, served as the TMA Demonstration Director. Chuck Johnson of the NASP and Future Systems Branch, ATR-330, Barbara Smith of the Office of Civil Operations (ATM-100), Ray Long of the Air Traffic Plans and Requirements Service Automation Planning Branch (ATR-210), and Craig Marina of the TATCA Program Office (ARD-40) were the official observers and evaluators during the demonstration.

Joe Pointkowski, of CTA INCORPORATED, exhibited and performed the procedures and functions described in Section 5 of [1] and [2]. Chris Ciolorito of CTA INCORPORATED installed CTAS release 1.3.2t and collected Measure Scale Analysis and Prediction System (MAPS) data prior to the demonstration.

The Center Host Non-Interference Demonstration was executed in two parts. The Failure Independence part (Demonstration Cases 4-1 through 4-6) and the Continuous Operations (Demonstration Case 4-7).

1.4 SOFTWARE CONFIGURATION

CTAS Software was received as version releases from NASA Ames. The FAA Technical Center tracked each release. New releases were installed as they were received, replacing previous versions. Demonstration procedures were dry run following each interim release. The version used for the FAA Technical Center TMA Functional and Non-Interference Demonstration was ctas_v1.3.2t received December 14, 1992 from NASA Ames Research Center.

1.5 DOCUMENT ORGANIZATION

This document is organized into four sections and one appendix. They are presented as follows:

a. section 1 provides background information;

b. section 2 provides a list of all reference materials;

c. section 3 describes the non-interference demonstration results;

d. section 4 describes the TMA functional demonstration results;

e. appendix A contains TMA Demonstration observer team comments made during and immediately after the TMA Demonstration.

2. REFERENCE DOCUMENTS

The following documents are referenced:

1. FAA Technical Center Traffic Management Advisor Demonstration Plan (Denver Configuration), Document No. ACD34093/4, December 16, 1992, FAA Technical Center.

2. FAA Technical Center Traffic Management Advisor Demonstration Procedures (Denver Configuration), Document No. ACD34093/5, December 16, 1992, FAA Technical Center.

3. Traffic Management Advisor (TMA) Reference Manual, ATC Field Systems Office, October 5, 1992, NASA Ames Research Center.

Reference documents supporting TMA Demonstration Plan and Procedures were also utilized.

Copies of the TMA Demonstration Plan and Procedures are available upon request from the ATC Technology Branch (ACD-340) at the FAA Technical Center.

3. CENTER HOST NON-INTERFERENCE DEMONSTRATION RESULTS

One of the principle objectives of the FAA Technical Center TMA Functional and Non-Interference Demonstration was to confirm that there is no adverse impact on the Center HCS due to the TMA interface or TMA operation. The FAA Technical Center TMA system employed a previously developed interface to the Denver Center HCS Peripheral Adaptor Module Replacement Item (PAMRI) General Purpose Output (GPO) port. This interface has been used to send radar track data, flight plan data, and metering data to the CTAS development group located at NASA Ames as well as the FAA Technical Center.

3.1 PERFORMANCE

During the Performance portion of the demonstration, the initial HCS CPU utilization was 16% with the NASA Ames patch off. When the patch was activated, the HCS CPU utilization remained at 16%. The HCS CPU utilization was based on the previous minute utilization from the Supervisory Maintenance Monitoring Console (SMMC) at the Denver Center.

3.2 FAILURE INDEPENDENCE

Five Failure Independence demonstrations were performed and completed. Expected results were achieved in all cases. These demonstrations showed that faults on the TMA side have no effect on the Denver Center HCS. The cases demonstrated are listed in Table 3-1.

Table 3-1. Host/TMA Failure Independence Demonstration Cases		
Case Description	Case Number	Plan Paragraph
RS-232C Cable Disconnect	4-2	4.2
Phone Line Disconnect	4-3	4.2
Traffic Manager (TM) Software Failure	4-4	4.2
Communications Manager (CM) Software Failure	4-5	4.2
Radar Daemon Software Failure	4-6	4.2

3.3 CONTINUOUS OPERATIONS

A TMA continuous operations demonstration was begun on Sunday, December 20, 1992 at 10:00 pm and terminated Monday, December 21, 1992, at 10:00 pm. During this period, three eight-hour shifts were staffed. Each shift used Case 4-7, [2] and performed the twelve functions, a through l, described in this Case (4-7 of [2]).

All functions were successfully performed without impact on continuous operations. Documentation of results is on file in the ACD-340 TATCA office at the FAA Technical Center.

4. TMA FUNCTIONAL DEMONSTRATION RESULTS

Time-lines, operational configurations, and auxiliary displays were the TMA functions formally demonstrated at the FAA Technical Center. Live Denver Center radar data was used for demonstrating TMA functional capabilities. The TMA Functional Demonstration procedures are described in Appendix B of [2]. It was determined by the TMA Demonstration observer team that all TMA functional cases passed satisfactorily; however, there were some comments and discrepancies identified by the observers. These are contained in Appendix A of this document.

4.1 TIME-LINES

The TMA presents metering and scheduling data in a graphical time-line format. The time-line may show any combination of Planned Time of Arrivals (PTAs), the Estimated Time of Arrivals (ETAs), and the Scheduled Time of Arrivals (STAs) as computed by the TMA scheduler for a given sequence of aircraft. The time-line extends upward with increasing future time. A distance-line may also be presented to reflect the distance in nautical miles from the runway threshold. The TMA time-line and scheduling features contained in Table 4-1 were completed successfully. However, some cases passed with comments from the observer team. Appendix A describes these comments.

Table 4-1. Time-line and Scheduling Demonstration Cases		
Case Name	Case Number	Plan Paragraph
Change Time-line Appearance	5-1 thru 5-6	5.1.1, 5.1.1.1
Scheduling Window Control	5-7	5.1.1.2
Automatic Schedule Generation	5-8	5.1.2
Scheduling Window Control	5-5	5.1.1.2
Automatic Schedule Generation	5-7	5.1.2.1
Blocked Time Intervals	5-18	5.1.3.1
Blocked Time Slots	5-19	5.1.3.2
Reschedule Aircraft	5-20	5.1.3.3
Suspend/Resume Scheduling	5-21/5-22	5.1.3.4
Pop-Ups	5-23	5.1.3.5
Additional TMA Functions - Traffic Count	5-31/5-32	5.1.4, 5.1.4.1
Rush Alert	5-33	5.1.4.2
NAPRS Delay Reporting	5-34	5.1.4.3
Feeder Airport Departure Release Time	5-35	5.1.4.4

4.2 OPERATIONAL CONFIGURATION

The TMA functions associated with airspace and/or runway configuration changes were demonstrated. These functions included changing the runway configuration, changing the airport acceptance rate, blocking runways, and gate balancing. The demonstration cases completed are listed in Table 4-2. Expected results were achieved; however, once again some passed with comments from the observer team which are identified in Appendix A.

Table 4-2. Operational Configuration Demonstration Cases

Case Name	Case Number	Plan Paragraph
Runway 26L/R at 80 AAR Configuration	5-11	5.2.4
Runway 8R and 17L at 60 AAR Configuration	5-12	5.2.4
Runway 8 at 32 AAR Configuration	5-13	5.2.4
Runway 26 at 45 AAR Configuration	5-14	5.2.4
Runway 26L/R at 80 AAR Configuration	5-15	5.2.4
AAR Change	5-16	5.2.1
Runway Blocking	5-24	5.2.2
Gate Balancing	5-25	5.2.3

4.3 AUXILIARY LOGICAL DISPLAYS

Three logical displays were demonstrated:

a. the **Situation Display**, which displays the current traffic.

b. the **Load Graph Display**, which displays graph information based on ETA, STA, ASP times, average delays, and flow rates that assist the TMCs at the Denver Center and TRACON in predicting threshold, final approach fix, or feeder gate loading.

c. the **Weather Display**, which displays weather information on the Plan-view Display, i.e. wind speed, wind direction, and temperature versus altitude.

The demonstration cases completed are listed in Table 4-3. Expected results were accomplished; however, some passed with comments from the observer team listed in Appendix A.

Table 4-3. Auxiliary Logical Display Demonstration Cases

Case Name	Case Number	Plan Paragraph
TMA Planview Display: (a) Windowed	5-26	5.3.2
TMA Planview Display: (b) Dragged	5-27	5.3.2
TMA Planview Display: (c) Expanded	5-28	5.3.2
Load Graph Display	5-29	5.3.3
Weather Display	5-30	5.3.1

APPENDIX A

TMA DEMONSTRATION OBSERVER TEAM COMMENTS

The ACD-340 demonstration team responded as described below.

Time-line functional demonstration cases:

CASE 5-1: What is the criteria for deciding to display the "?" in front of the ETA aircraft on a given time-line? How is it decided that this should be displayed? (ARD-40)

Response: The "?" appears when time data is obsolete; however the criteria or specifics are not clear.

Note: Based on subsequent review, according to the TMA Reference Manual, Release 1.3.0t, October 5, 1992, the "?" appears next to the aircraft identifier when time data is obsolete. There was no additional information provided in the TMA Reference Manual or the CTAS Operational Concepts document.

Based on our investigation of the software, the logic that makes this determination is located in a subroutine called "set_tag_display_parameters." This subroutine is called from the "do_timeline_tag" procedure. Both procedures are located in the "timeline.c" source file. Our cursory analogy of the code indicates that the "?" appears when the time data for ETA aircraft is older than the last ETA track update. Current documentation at the FAA Technical Center does not provide specific explanation.

CASE 5-4: During time-line gap adjustment the slider bars associated with the manual entries may become cumbersome. It was suggested that a keyboard entry needs to be added to make adjustments. (ATR-330)

CASE 5-5: Upon changing the font size via dwelling on the time-line and depressing the "f" key, it was suggested that the font size in the Timeline Options Panel (Shift-F9) reflect the change, particularly once the panel was inhibited and then redisplayed. (ATR-330)

CASE 5-7: Within the Scheduling Options Panel (Shift-F10) Center and TRACON Horizon by definition are incorrectly shown. (This was a general discussion between ATR, ATM, and ACD personnel.)

CASE 5-21: When suspending an aircraft, the aircraft disappears from the STA side of the timeline. There is no indication on the corresponding ETA that the aircraft has been suspended from the schedule. It was suggested that suspended STA aircraft should have an indicator on the corresponding ETA data tag to visually cue the TMC that the aircraft is currently suspended. (ATR-330, ATM-100)

TMA DEMONSTRATION OBSERVER TEAM COMMENTS (continued)

CASE 5-35: When changing a proposed aircraft departure schedule, a question (ARD-40) was raised about some departures having flight times and some not. What is the basis for this decision, HOST flight plan or CTAS generated? (ARD-40)

Response: We were unsure how the ETA is determined.
Note: Related information is not contained in documentation provided.

Operational Configuration functional demonstration cases:

CASE 5-14: When entering a Future Acceptance Rate with a keyboard entry, the slider bar should reflect the change once the rate is set. In general, this should be the case whenever keyboard/slider bar information changes are made. (ATR-330)

CASE 5-20: After a runway configuration change, the Rush Alert Configuration Panel (Shift-F12) does not reflect the runway change. This occurs even after the Rush Alert Option was turned on. It was suggested that the change should be reflected. (ATR-330 and ATM-100)

Auxiliary Display functional demonstration cases:

CASE 5-26: The TMA Planview Display during peak periods becomes too cluttered. (ATM-100)

Note: Other observers concurred with this observation.

CASE 5-29: Initial display of the Load Graph Window does not provide the user with the ability to define graphs. The user must manually re-size the display to select appropriate graphs to be built. It was suggested that the Load Graph Window be re-sized during initialization. (Discussed by all observers.)

CASE 5-29: During displaying the Load Graph using F2, the graphs are poorly defined and sometimes hard to read, especially during peak activity when both plots on the same graph represent similar periods. It was suggested that a possible solution would be an offset capability or different color presentation. (ATM-100)