Cockpit Display of Traffic Information (CDTI) Assisted Separation on Approach (CAS-A) Aware Scheduling Operational Description

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Record of Revisions

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1.0	6/3/2022	Initial Draft Release
2.0	10/18/2022	All comment resolutions from the initial draft release incorporated
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1.0	3/30/2023	Final Version

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1 INTRODUCTION

This document defines the Operational Description for the Cockpit Display of Traffic (CDTI) Assisted Separation on Approach (CAS-A) Aware Scheduling. The purpose of this document is to describe the operational flow and considerations when executing CAS-A Aware Scheduling and identify the Center Traffic Management Coordinator (TMC) tasks, roles, and responsibilities during these operations. This document does not go into detail on the technical implementation of functionality in the various systems support CAS-A Aware Scheduling operations.

1.1 Background

CAS-A is an ADS-B In operation that enables the use of pilot-applied separation operations during weather conditions that do not support pilot-applied separation. CAS-A will improve runway capacity during weather conditions that typically do not support pilot-applied separation. A CAS-A operation is initiated when the controller identifies a lead aircraft and provides the lead aircraft's identification and an approach clearance to the flight crew of the CAS-A capable aircraft (aka CAS aircraft). The flight crew of the CAS aircraft designates the lead aircraft in their avionics and may use the information on the CDTI as a substitute for visually acquiring the lead aircraft out-the-window. The operation continues similarly to a pilot-applied visual separation operation, except that the flight crew can maintain contact with the lead aircraft using the avionics, including the CDTI, and even enter Instrument Meteorological Conditions (IMC). CAS-A operations do not change any requirements for instrument or visual approach procedures. Refer to Figure 1-1 (FAA, American Airlines, ACSS, and NextGen Project, 2022) below that provides an overview of a CAS-A operation.

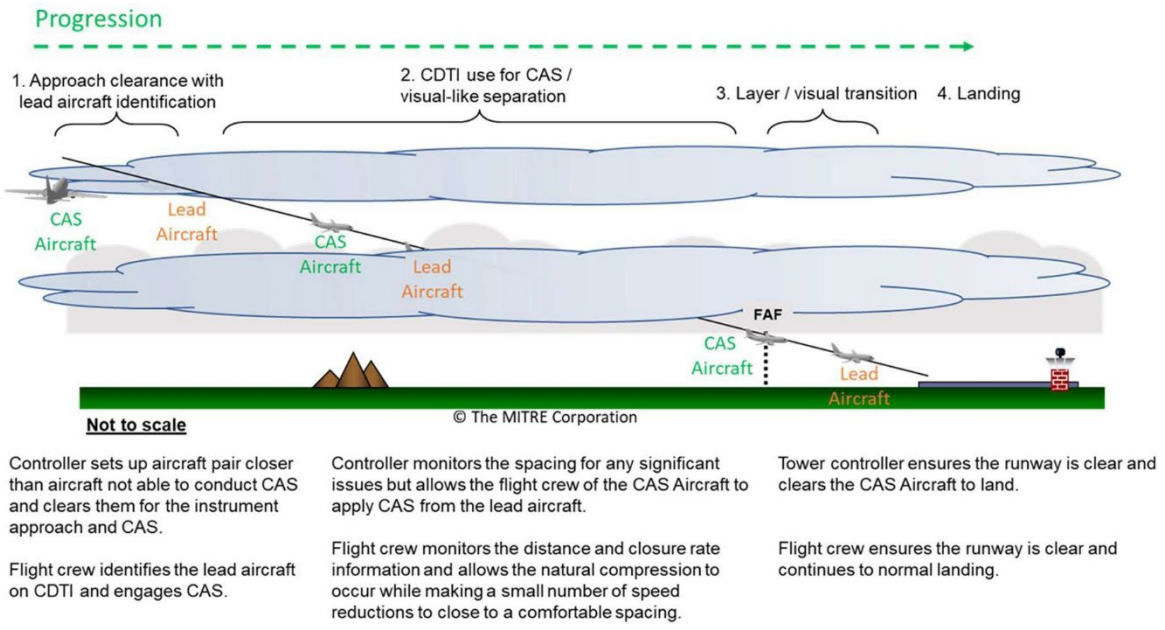

Figure 1-1. Overview of a CAS-A Operation

CAS-A Aware Scheduling includes new functionality for the Time-Based Flow Management (TBFM) system to identify aircraft that are CAS-A capable and would require tighter spacing.

As stated in the CAS-A Operational Description (FAA, American Airlines, ACSS, and NextGen Project, 2022), the flight crew that are using CAS-A may achieve spacing between 2 NM and 2.5 NM between the CAS aircraft and the lead aircraft. In comparison, when controller's space the aircraft, the aircraft typically result in spacing of 3 NM to 4 NM. Since not all aircraft will be CAS-A capable, the TBFM schedule needs to account for those aircraft that are CAS-A capable and only when CAS-A operations are expected to be used.

The initial deployment of ADS-B In applications will include CAS operations for both approaches and departures, as well as tactical Interval Management (IM) in en route and terminal airspace, where practical. These initial ADS-B In applications may require minimal automation enhancements across the Standard Terminal Automation Replacement System (STARS), En Route Automation Modernization (ERAM), Terminal Flight Data Manager (TFDM), Traffic Flow Management System (TFMS)/Flow Management Data and Services (FMDS), TBFM, and Flight Data Input/Output (FDIO). These automation enhancements will enable air traffic controllers to identify aircraft that are able to execute a CAS or IM operation. Additionally, National Airspace System (NAS) improvements for CAS-A within TBFM will improve airport capacity by properly identifying ADS-B In equipped aircraft within the automation schedule.

Upon completion of these initial ADS-B In applications, the FAA will begin deployment of the non-tactical IM applications in later years. The deployment of the IM applications will require further automation enhancements in ERAM, STARS, TBFM, and TFMS/FMDS as well as airlines equipping with ADS-B In avionics.

1.2 Document Overview

The remainder of the document is organized as follows:

- **Section 2** describes the assumptions and constraints, the operational environment, the supporting infrastructure, benefits, and the proposed concept for CAS-A Aware Scheduling.
- **Section 3** defines the roles and responsibilities of the Center TMC and the coordination with the Terminal Radar Approach Control (TRACON) Traffic Management Unit (TMU).
- **Section 4** provides a general procedure description and the possible abnormal modes.
- **Section 5** provides a sample scenario for CAS-A Aware Scheduling.

2 CAS-A AWARE SCHEDULING OPERATIONAL OVERVIEW

CAS-A Aware Scheduling includes new functionality for the Time-Based Flow Management (TBFM) system to identify aircraft that are CAS-A capable and would require tighter spacing. CAS-A operations take place within 10 NM of the runway threshold similar to visual approach operations. In the current TBFM, there is no functionality to capture the CAS-A operations in the TBFM Schedule. But in the current TBFM, when an airport is using pilot-applied separation operations, TBFM has functionality to account for the closer spacing at the runway during these pilot-applied separation operations. For CAS-A operations, the TBFM Schedule will capture the reduced spacing at the airport's runway. The following sections lay out the assumptions, the operational environment, the concept of the CAS-A Aware Scheduling, the supporting infrastructure to use CAS-A Aware Scheduling, and the potential benefits.

2.1 Assumptions

This operational description makes the following assumptions:

- CAS-A Aware Scheduling does not change controllers' roles and responsibilities;
- Controllers are able to identify CAS-A capable aircraft on STARS display;
- Controllers are trained for CAS-A;
- CAS-A procedures have been approved (for example, CAS-A operations will need to be authorized in FAA Order 7110.65);
- The weather and operational environment are conducive for CAS-A;
- Center TMCs are able to identify aircraft that are CAS-A capable in TFMS/FMDS and TBFM;
- Center TMCs are able to set their arrival rates in TFMS/FMDS to account for CAS-A operations occurring in the terminal; and
- All assumptions are met from the CAS-A Operational Description (FAA, American Airlines, ACSS, and NextGen Project, 2022).

The CAS-A operation is described in more detail by the CAS-A Operational Description (FAA, American Airlines, ACSS, and NextGen Project, 2022). The CAS-A Aware Scheduling Operational Description document will not cover the specifics of the CAS-A operation.

2.2 Operational Environment

The CAS-A Aware Scheduling operations described in this document will be performed when both metering and CAS-A are being used. As stated in the Assumptions section, in order for CAS-A to be used in the terminal environment, the controllers must be able to determine which aircraft are CAS-A capable and able to perform CAS-A operations. With these considerations, CAS-A Aware Scheduling operations should be implemented in environments where the terminal is using CAS-A operations and the en route is using TBFM to perform metering.

TBFM and TFMS/FMDS must identify CAS-A capable aircraft to provide information for the Center TMC to determine whether to turn on CAS-A Aware Scheduling. TBFM will need additional functionality to apply a tighter spacing for those aircraft that are CAS-A capable. The Center TMC will turn this functionality on or off depending on amount of aircraft with CAS-A capability, weather, TRACON TMU coordination, and facility procedures.

2.3 Concept of Operations

The CAS-A Aware Scheduling functionality is executed during metering and CAS-A to perform pilot-applied separation operations to gain the benefits of tighter spacing at the runway. The result from CAS-A Aware Scheduling will be increased throughput rates at the Meter Reference Points (MRPs) to increase arrival throughput enabled by CAS-A operations.

The Center TMC will use TFMS/FMDS aircraft equipage list, weather, TRACON TMU coordination, and facility procedures to determine whether to turn on CAS-A Aware Scheduling in TBFM. When enabled, CAS-A Aware Scheduling will allow TBFM to schedule aircraft that are CAS-A capable, in turn, accounting for their ability to achieve tighter spacing at the runway. The Center TMC may update the arrival rates in the TFMS/FMDS to accommodate the improved arrival rates. If arrival rates do not reflect the throughput enabled by the CAS-A operations, traffic demand will be constrained to lower rates and throughput benefits will not be achieved.

TBFM will identify CAS-A capable aircraft to apply the tighter spacing parameters as it schedules each flight. The tighter spacing will only apply to those aircraft that are CAS-A capable. Also, the TFMS/FMDS will identify CAS-A capable aircraft for the Center TMC to determine if aircraft are CAS-A capable to turn on the CAS-A Aware Scheduling in TBFM.

The Center TMC will coordinate with the TRACON TMU to determine whether CAS-A will be used in the terminal and execute the CAS-A Aware Scheduling within TBFM.

2.4 Supporting Infrastructure

Implementation of the CAS-A Aware Scheduling will require changes to TBFM and TFMS/FMDS. These changes are described in sections 2.4.1 and 2.4.2. This document does not provide details on these implementations but only that changes in these systems will need to occur to properly support CAS-A Aware Scheduling operations.

2.4.1 Time Based Flow Management (TBFM)

TBFM will need the following information and functionality to support the CAS-A Aware Scheduling operations as described in this document:

- Identify CAS-A capable aircraft and ADS-B Out aircraft;
- Has the ability to turn on and off the CAS-A Aware Scheduling functionality; and
- Schedule CAS-A capable aircraft based on their reduced spacing in the terminal environment.

2.4.2 Traffic Flow Management System/Flow Management and Distribution System (TFMS/FMDS)

TFMS/FMDS will need the following information and functionality in order to support the CAS-A Aware Scheduling operations as described in this document:

- Identify CAS-A capable aircraft;
- Display CAS-A capable aircraft; and
- Sort aircraft equipage lists by CAS-A capability.

2.5 Benefits

The potential benefits from CAS-A Aware Scheduling operations depend on CAS-A capable aircraft in the airspace. The more CAS-A capable aircraft, the more likely that there will be greater benefit to the airspace similar to the terminal environment is executing pilot-applied separation operations. The potential benefits from using CAS-A operations and having these operations accounted for in the TBFM schedule are the following (Weitz, 2021):

- Improvements in MRP throughput and improved runway throughput and
- Reductions in the amount of metering delay need to be absorbed in the TBFM schedule.

3 ROLES AND RESPONSIBILITIES

3.1 Center Traffic Management Coordinator (TMC)

For CAS-A Aware Scheduling operations, the following are the roles and responsibilities of the Center TMC:

- Coordinating with the TRACON TMU on whether the TRACON is or will be using CAS-A operations;
- Setting the arrival rates in TFMS/FMDS; and
- Turning on or off CAS-A Aware Scheduling in TBFM based on the aircraft equipage list in TFMS/FMDS, the weather, and facility procedures.

The TRACON TMU will coordinate with the tower and approach controllers on whether CAS-A is appropriate to use. This coordination between the TRACON TMU and tower and approach controllers is out of scope for this operational description and is covered in the CAS-A Operational Description (FAA, American Airlines, ACSS, and NextGen Project, 2022).

4 PROCEDURE DESCRIPTION

The following sections describe the procedure and operational flow of CAS-A Aware Scheduling. For these operations, there is no new phraseology for the coordination between the TRACON TMU and Center TMC. These communications will be similar to the coordination today.

4.1 Operational Flow

The operational flow of CAS-A Aware Scheduling operations is broken down in 3 phases:

- Determinating and coordinating turning on CAS-A Aware Scheduling;
- Monitoring that CAS-A is still being used in the TRACON; and
- Turning off CAS-A Aware Scheduling when it's no longer of use.

The following sections describe each phase of the operation. The order of the steps described in each section may vary from facility to facility. Therefore, there should be flexibility implementing CAS-A Aware Scheduling.

4.1.1 Turning On CAS-A Aware Scheduling

The initial steps for the Center TMC are to determine whether to turn on CAS-A Aware Scheduling in TBFM and set the arrival rates for TFMS/FMDS. The Center TMC will use the aircraft equipage list in the TFMS/FMDS, current weather in the terminal and en route environments, and the facility procedures for turning on CAS-A Aware Scheduling to make this determination. If the Center TMC determines CAS-A operations are appropriate, the Center TMC will coordinate with the TRACON TMU, usually by phone, to determine if CAS-A operations are currently being used or will be used in the TRACON.

The TRACON TMU will coordinate with the tower and approach controllers to determine whether CAS-A operations will be used. If the TRACON TMU determines CAS-A operations are/will be used, the TRACON TMU will communicate this via phone call to the Center TMC.

The Center TMC will then turn on the CAS-A Aware Scheduling for the TRACON. If appropriate, the Center TMC will also modify the arrival rates in the TFMS/FMDS.

The Center TMC does not need to confirm with the TRACON TMU that CAS-A Aware Scheduling is in use, since the coordination to use CAS-A operations was already established.

When CAS-A Aware Scheduling is turned on, TBFM will determine the runway schedule scheduled times of arrival based on the CAS-A capable aircraft and other adaptation parameters, including the arrival rate. Then TBFM will freeze this schedule when the CAS-A capable aircraft has crossed the freeze horizons, where CAS-A capable aircraft will have a reduction in spacing. This reduction between the CAS-A capable aircraft and the lead aircraft is similar to those used for pilot-applied separation operations, except this will be on an aircraft-to-aircraft basis instead of a stream of aircraft.

4.1.2 Monitoring use of CAS-A Aware Scheduling

The Center TMC will monitor the amount of CAS-A capable aircraft, weather, etc. to determine if CAS-A Aware Scheduling is still appropriate and the arrival rates in the TFMS/FMDS are appropriately set.

4.1.3 Turning Off CAS-A Aware Scheduling

Turning off CAS-A Aware Scheduling may be a joint decision between the TRACON TMU and the Center TMC or a decision that the Center TMC makes alone. There may be multiple factors to consider when making this decision that may include the amount of CAS-A capable aircraft, weather changes, etc. In the cases where the Center TMC decides to turn off CAS-A Aware Scheduling, the Center TMC may coordinate with the TRACON TMU; but this coordination is not required.

When CAS-A Aware Scheduling is turned off, TBFM will adjust the schedule so that it does not consider the tighter spacing for CAS-A capable aircraft. Also the Center TMC may need to adjust the arrival rate in TFMS/FMDS.

4.2 Abnormal Modes

While off-nominal conditions can consist of emergencies and other abnormal events, more often they are relatively common occurrences, such as aircraft deviations due to convective weather, sector overload, or traffic.

For CAS-A Aware Scheduling, an abnormal event may occur, if the Center TMC fails to turn off the CAS-A Aware Scheduling in TBFM and adjust the arrival rate in TFMS/FMDS due to other concerns than the amount of CAS-A capable aircraft. This could cause the CAS-A capable aircraft to be too tightly spaced when arriving into the terminal and over feed the terminal with aircraft.

5 SAMPLE SCENARIO

This sample scenario describes and provides a real-world example of the CAS-A Aware Scheduling operation.

5.1 Turning On CAS-A Aware Scheduling

The Center TMC analyzes the predicted weather and traffic flow for an upcoming arrival push to an airport. The Center TMC determines that the weather will be below the usual minimums for pilot-applied separation operations typically used on arrivals at this airport. The Center TMC also sees the predicted number of CAS-A capable aircraft to arrive during this period of time is roughly 35% of the overall arriving aircraft.

The Center TMC coordinates with the TRACON TMU on the use of CAS-A operations in the terminal. They agree the conditions are conducive for CAS-A operations. They also determine scheduling aircraft for CAS-A operations will increase throughput and reduce delays during the upcoming arrival push.

The Center TMC turns on CAS-A Aware Scheduling in TBFM and sets up TFMS/FMDS to have the separation reduced by 0.5 NM due to the use of CAS-A.

5.2 Monitoring and Using CAS-A Aware Scheduling

As the aircraft begin to arrive in the center for sequencing and spacing to an arrival airport, TBFM applies the reduced spacing intervals for CAS-A capable aircraft sequenced behind an aircraft equipped with ADS-B Out.

Both the TRACON and Center TMCs are monitoring the situation to ensure no issues are present that may limit the use of CAS-A, such as changing weather conditions, the terminal is not being overfed, and that no configuration changes occur that may impact the TBFM schedule and the use of CAS-A.

5.3 Turning Off CAS-A Aware Scheduling

As air traffic decreases and there are less CAS-A capable aircraft, the Center TMC determines there is no longer a need for CAS-A Aware Scheduling and turns off the functionality in TBFM. The Center TMC adjusts the arrival rate in TFMS/FMDS to reflect this. The Center TMC may communicate this to the TRACON TMU. The TRACON TMU will determine if the CAS-A operations will continue.

APPENDIX A. ACRONYMS

Acronym	Definition
ACSS	Aviation Communication & Surveillance Systems, LLC
ADS-B	Automatic Dependent Surveillance – Broadcast
CAS	CDTI Assisted Separation
CAS-A	CDTI Assisted Separation on Approach
CDTI	Cockpit Display of Traffic Information
ERAM	En Route Automation Modernization
FAA	Federal Aviation Administration
FDIO	Flight Data Input/Output
FMDS	Flow Management and Distribution System
IM	Interval Management
IMC	Instrument Meteorological Conditions
MRP	Meter Reference Point
NAS	National Airspace System
NextGen	Next Generation Air Transportation System
STARS	Standard Terminal Automation Replacement System
TBFM	Time Based Flow Management
TFDM	Terminal Flight Data Manager
TFMS	Traffic Flow Management System
TMC	Traffic Management Coordinator
TMU	Traffic Management Unit
TRACON	Terminal Radar Approach Control

APPENDIX B. AUTOMATION CONSIDERATIONS

During the development of the CAS-A Aware Scheduling concept, there were discussions on how to implement the functionality need to do CAS-A Aware Scheduling operations. The following subsections do not contain requirements and need further investigation to determine if any of these implementations should be pursued.

B.1 Implementing CAS-A Aware Scheduling in TBFM

There were several options discussed on how to implement the separation values for CAS-A capable aircraft for TBFM to determine the schedule (Weitz, 2021). These options were:

- Adding rows and columns to account for the CAS-A capable aircraft to the current separation matrix in TBFM or
- Adding a CAS-A capable aircraft only separation matrix.

Only one of these options would need to be implemented in TBFM for CAS-A Aware Scheduling . If implementing the CAS-A capable aircraft only separation matrix, the implementer should try to limit the number of separation matrices, since this will impact the ability of Second Level Engineering to manage them.

Another consideration is to allow the Center TMC to turn on CAS-A Aware Scheduling for certain traffic flows in the TRACON. For example, if only one runway is using CAS-A operations, then the Center TMC may want to apply the CAS-A Aware Scheduling for traffic scheduled for that runway only. To implement this, TBFM may need additional configurations. But this may not be a feasible solution for all facilities, some facilities have an abundant number of runway configurations.

B.2 Displaying CAS-A Capability in the TFMS/FMDS

Displaying the CAS-A capability in the aircraft equipage lists are not required for CAS-A Aware Scheduling operations. But this feature will help the Center TMC to plan and turn on CAS-A Aware Scheduling as well as aide their ability to monitor the operation. If this is not implemented, the Center TMC may still be able to use TFMS/FMDS to monitor the intervals between aircraft and determine that CAS-A operations are being used based on the smaller intervals achieved by the terminal using CAS-A operations.

An implementer should consider how CAS-A Aware Scheduling is implemented in TBFM. For example, if CAS-A Aware Scheduling can be turned on for specific traffic flows to the airport, the Center TMC may desire the flexibility to display the CAS-A capability for certain aircraft flows in order to determine which areas of the airport to turn on CAS-A Aware Scheduling.

A couple of options were discussed for implementing this. One option is to implement functionality to allow the aircraft equipage lists to be sorted based on CAS-A capability. Another option is to implement the ability to graph the amount of CAS-A capable aircraft per a runway. Both the sorting and the graphing options could be implemented into TFMS/FMDS.

To determine how to implement this functionality in TFMS/FMDS will depend on how CAS-A Aware Scheduling is implemented into TBFM and what the Center TMC will need to be able to make the determination on when to turn CAS-A Aware Scheduling on or off in TBFM.

APPENDIX C. REFERENCES

FAA, American Airlines, ACSS, and NextGen Project. (2022). *ADS-B In Retrofit Spacing (AIRS) CDTI Assisted Separation (CAS) Single Runway Operational Description Version 4.0.*

Weitz, L. A. (2021). *CDTI-Assisted Separtaion (CAS)-Aware Scheduling: Throughput Benefits and Sensitivity Analysis to Demand, CAS-Capability Rates, and Traffic Distribution.* MITRE.