ADS-B In Tactical Terminal Interval Management (IM) Operational Description

Federal Aviation Administration
Surveillance and Broadcast Services

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1 INTRODUCTION

This document contains the operational description for terminal use of tactical Interval Management (IM) during the initial phase of the Automatic Dependent Surveillance-Broadcast (ADS-B) In deployment.

1.1 Background

ADS-B In applications can help address demand capacity problems. IM seeks to increase capacity, through the use of avionics and supporting ground automation, to reduce the variability of inter-aircraft times. IM operations consist of a controller identifying an IM capable aircraft (the "IM Aircraft" or "Trail Aircraft") and instructing its flight crew to achieve and/or maintain a desired spacing interval (termed the Assigned Spacing Goal [ASG]), relative to another aircraft (the "Lead Aircraft"). Flight-deck IM (FIM) equipment on board the IM Aircraft provides speed guidance to the flight crew to achieve then maintain the desired spacing relative to the Lead Aircraft until the Planned Cancellation Point (PCP), at which time the IM operation concludes. Safety and Performance Requirements (SPR) for these operations, as well as the avionics Minimum Operational Performance Standard (MOPS) have been worked through the joint government/industry Radio Technical Commission for Aeronautics (RTCA) process and published in DO-328B (RTCA, 2020b) and DO-361A (RTCA, 2020a), respectively.

The Federal Aviation Administration (FAA), American Airlines (AAL), and Aviation Communication & Surveillance Systems, LLC (ACSS) are participating in the ADS-B In Retrofit Spacing (AIRS) Evaluation to demonstrate the operational feasibility and value of ADS-B In using the ACSS SafeRoute+™ retrofit solution. The AIRS project is a multi-year effort where three ADS-B In operations will be evaluated during revenue service on the AAL A321 fleet. The ADS-B In operations are Cockpit Display of Traffic Information (CDTI)-Assisted Visual Separation (CAVS), CDTI-Assisted Separation (CAS), and IM. The operations enabled by this early adoption are referred to as Initial IM (I-IM) and are a subset of the capability envisioned in the approved standards. As SafeRoute+ development predates the publications of these standards, not all envisioned operations are supported.

Following the completion of the AIRS trials, 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 some level of 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 properly equipped aircraft able to execute a CAS or IM application. Planned enhancements to STARS will also allow the controller to denote in automation when an ADS-B In operation is active. Additionally, National Airspace System (NAS) improvements for CAS on Approach within TBFM will improve airport capacity by properly identifying CAS-capable flights within the automation schedule, and scheduling those flights closer together assuming CAS on Approach operations will be executed.

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/Flow Management Data and Services (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 proposed concept for tactical use of IM in terminal airspace and is intended to directly support the future development of a formal concept of operations.
- **Section 3** defines the roles and responsibilities of both Air Traffic Control (ATC) and flight crews when performing tactical IM operations in terminal airspace.
- **Section 4** provides a general procedure description with a specific emphasis on identifying the information needs of controllers in accomplishing IM-specific tasks.
- **Section 5** presents operational scenarios illustrating the use of IM operations in arrival and approach operations in terminal airspace.

2 ADS-B IN "TO BE" OPERATIONAL OVERVIEW

IM refers to a suite of applications enabling greater throughput and maneuver efficiency through increased precision in inter-aircraft spacing. IM can be performed during cruise, arrival, and approach phases of flight to increase overall stream consistency and throughput. An IM operation involves an air traffic controller clearing an IM-capable aircraft to achieve or maintain a desired time or distance-based ASG relative to a specified Lead Aircraft. The ASG can be based on an applicable separation standard, miles-in-trail (MIT) restriction, metering schedule, or any other ATC spacing objective. When the flight crew is issued an IM clearance, the flight crew enters the IM clearance into their FIM equipment, which provides IM speeds to assist the aircraft to achieve the ASG. During the initial IM deployment, IM clearances may be either of two defined clearance types: Cross or Maintain. For a Cross clearance, the spacing will be achieved at a predefined Crossing Point (CP) and then maintained until the operation concludes. For a Maintain clearance, the designated spacing will be captured quickly and then maintained until the operation concludes. In either case, the flight crew follows the IM Speeds until the IM operation is canceled, either by a controller or at a pre-determined location (the PCP).

2.1 Assumptions

Ground automation will only provide the assumed functionality for IM and not the full suite of functionality envisioned in DO-328B during the initial IM deployment, limiting controller support in identifying a full range of IM clearance information or satisfaction of initiation criteria. Because of this, and to simplify these initial operations, initiation of an IM operations is procedurally limited to when both the IM Aircraft and Lead Aircraft are in the same control area.

Additionally, ACSS SafeRoute+ is expected to be the predominant avionics during the initial deployment of IM and is not expected to provide significantly different IM capability than provided for the AIRS Evaluation in 2022-2023. ACCS SafeRoute+ is a stepping stone for IM deployment, but has significant limitations that directly impact controller and flight crew applications of IM. Initially, the capability indicator on the STARS display will not distinguish aircraft with DO-361A avionics from SafeRoute+, and therefore only IM operations that are compatible with the limitations of SafeRoute+ will be used. The operations described herein are supported by both SafeRoute+ and MOPS compliant equipment. MOPS compliance is expected new operators entering the assumed environment.

The operations described in this document were developed assuming the following:

- All FIM Equipment, SafeRoute+ or MOPS compliant, is capable of being used for both IM and CAS-A. These are achieved via different applications on the flight-deck, FIM and CAVS respectively.

- Enhancements to the Standard Terminal Automation Replacement System (STARS) displays is deployed which functionally includes the indication of an aircraft ADS-B In capability and the ability for a controller to record and monitor whether or not an aircraft is performing an ADS-B In operation.

- Terminal metering is not yet available.

- The operations described herein are defined to be supported by both SafeRoute+ and MOPS compliant equipment.

- It is assumed that all candidate Lead/Trail pairings for an IM operation are within ADS-B range of each other, given the limited types of operations pursued within this document (i.e., those within terminal airspace, in similar flows, managed by the same controller).

- Cross and Maintain are the only IM clearance types available.[1]

- Aircraft must be on the same route or direct to a common merge point – which will be the CP for a Cross clearance. In this case, direct to a common point means there can be no course changes between aircraft current position and the CP, though there may be other waypoints along the direct routing to the merge point. The CP must be within a 40° cone of both aircraft tracks, meaning if either aircraft has been vectored or has course changes in the route, the IM operation should not be initiated until both aircraft are headed toward the CP. Prior to the CP, the equipment will cancel the operation and notify the flight crew if either aircraft in the pair fails this conformance check. See Figure 2-1.

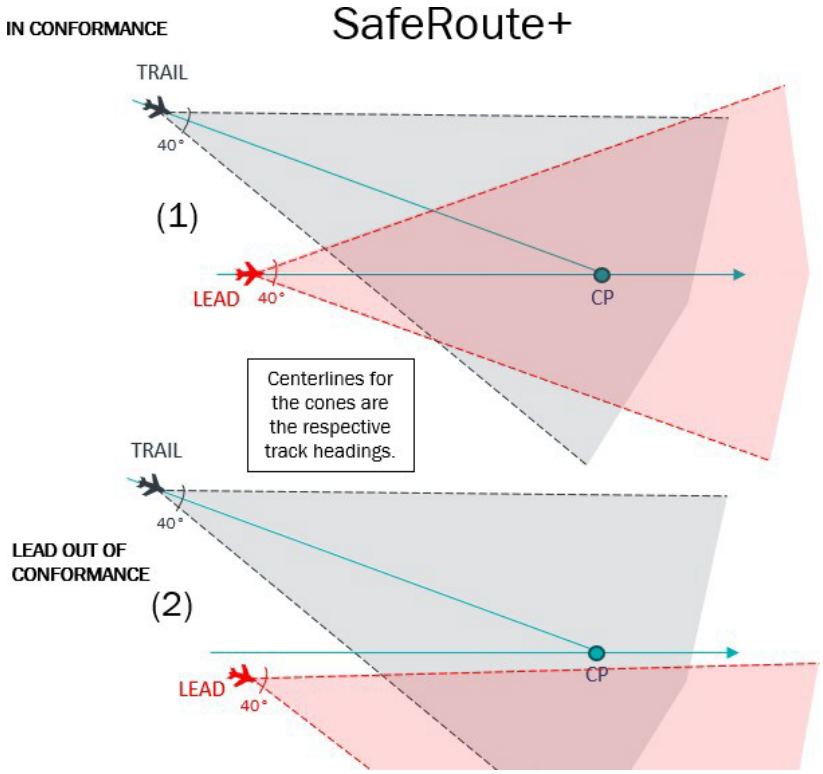

Figure 2-1. Example SafeRoute+ Cross clearance conformance check

[1] The community has made various changes to the terms used in DO-328B and DO-361A including using the term "Cross" rather than "Achieve-by then Maintain"; the term "Maintain" rather than "Capture then Maintain"; and "Cancellation" rather than "Termination", though it should be noted that achieve and capture are still used to describe certain states of the operation, and "Termination" and its variants may be used in the avionics.

- During the maintain stage (when both aircraft are on the same route, regardless of clearance type), the cross-track difference between the IM Aircraft current position and Lead Aircraft historical position must be within 4 NM. See Figure 2-2.

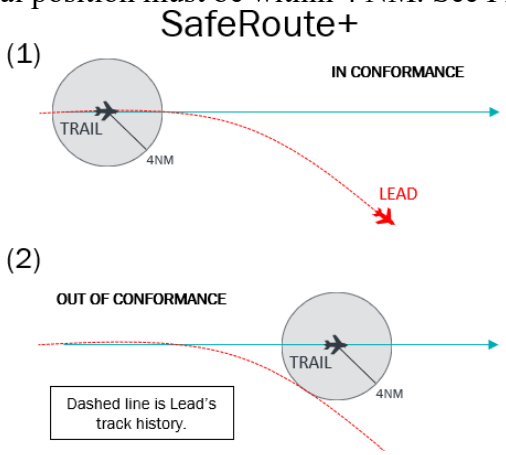

Figure 2-2. Example SafeRoute+ maintain stage conformance check

- To initiate a Maintain clearance, either the Lead or the IM Aircraft must be within a 6 NM swim lane around the other aircraft's instantaneous track as projected ahead of the IM Aircraft (or behind the Lead Aircraft), or the instantaneous tracks must have an intercept angle less than 90 degrees and intersect between the two aircraft positions. See Figure 2-3 and 2-4.

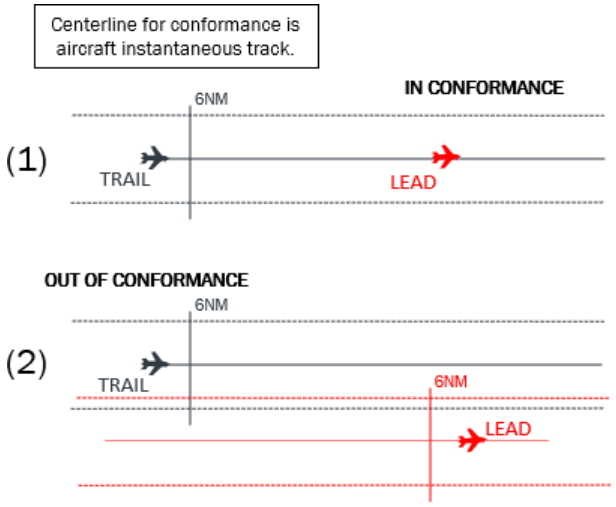

Figure 2-3. Example SafeRoute+ Maintain clearance initiation criteria - Swimlane

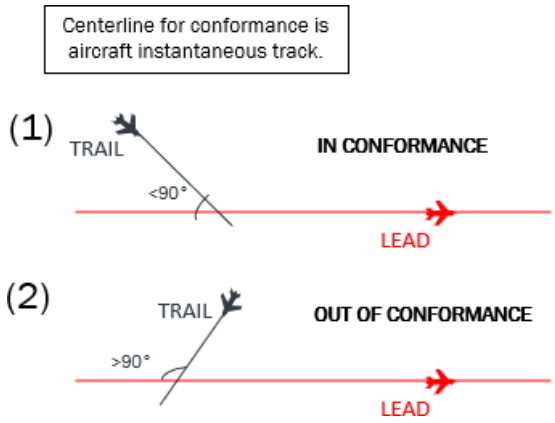

Figure 2-4. Example SafeRoute+ Maintain clearance initiation criteria – Intercept Angle

- The SafeRoute+ equipment does check the infeasibility of achieving the ASG by the CP prior to initiation for time-based Cross clearances; however, there is not an infeasibility check of operations with distance-based ASGs. Controllers must be cognizant that they cannot rely on the avionics to flag operations that are likely infeasible from the start. Controllers will rely on their experience and judgment, and facilities may develop best practices to ensure satisfactory initiation conditions.

- IM special points (i.e., for SafeRoute+, the PCP and CP) must be defined as a named fix.

- Given the arrival/approach terminal environment contains only descent segments on which distance-based IM performs poorly, clearance limitations, the geometric limitations of SafeRoute+ in establishing a Cross clearance, and that the SafeRoute+ equipment only being able accept distance-based ASGs in whole integer NM; only time-based ASGs will be used within the terminal.

Additional information on the SafeRoute+ behavior and its impact on operations can be found in the SafeRoute+ Impact on IM Operations whitepaper [2023].

2.2 Operational Environment

The IM operations described in this Operational Description will be performed in U.S. terminal airspace with suitably equipped aircraft. It is assumed that the initial IM operations are to be performed in an environment without terminal metering, using time-based ASGs (see §2.1). Operations will be conducted within the Terminal Radar Approach Control facilities (TRACONs), though some arrival operations may be initiated en route and continue into the terminal area. Airport Traffic Control Towers (ATCTs) will be made aware when IM operations have the potential to enter their airspace, but ATCTs are not expected to have any IM specific responsibilities. IM may be used to support the arrival and approach spacing objectives of both Feeder and Final controllers. The concepts rely on the deployment of the STARS enhancements to support the display of capability indicators to TRACON controllers on the STARS displays. Figure 2-5 shows a nominal TRACON IM environment where Feeder and Final controllers may apply IM clearances to meet delivery needs between control areas and at the runway threshold.

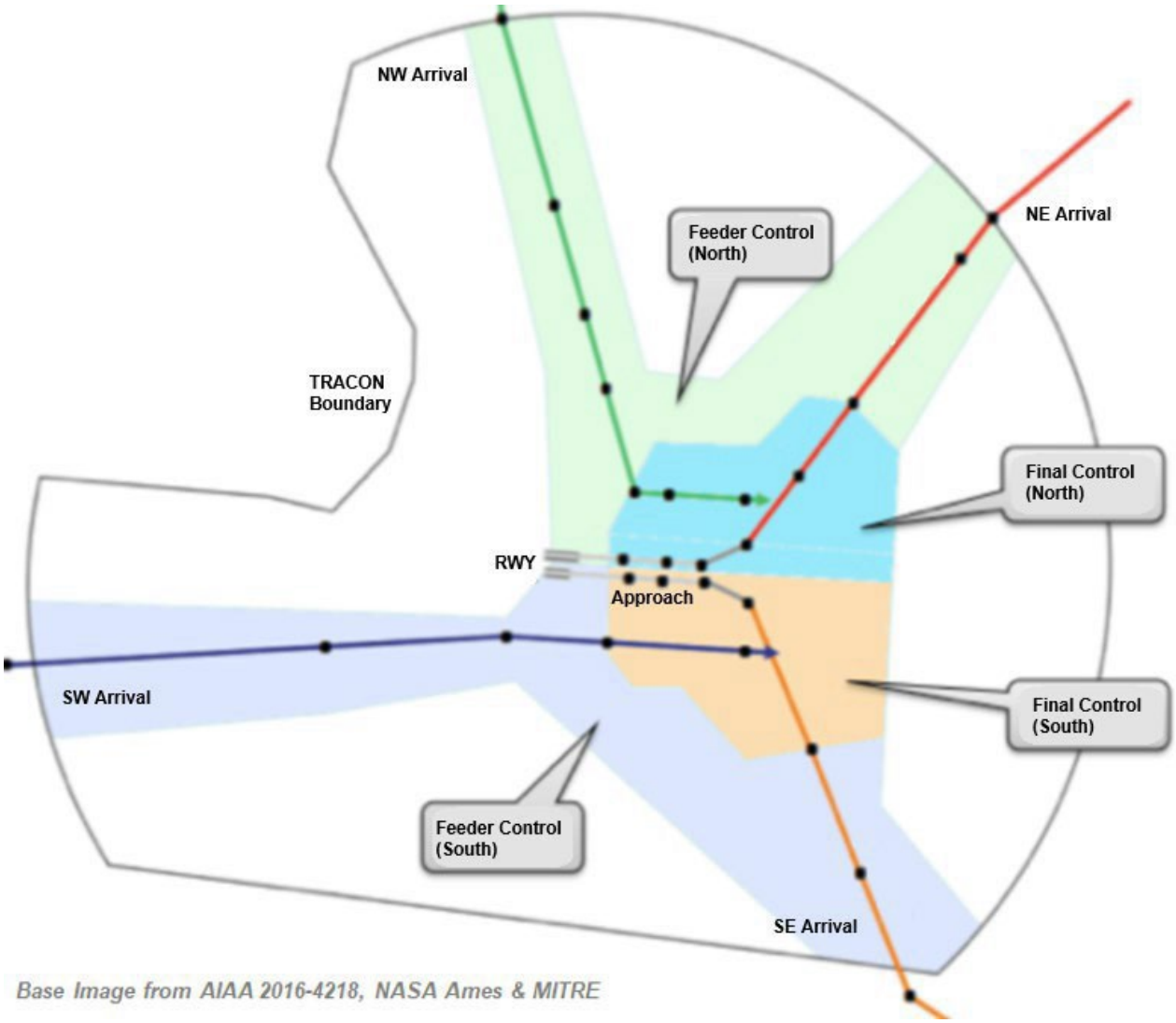

Figure 2-5. Example Terminal IM Operational Environment

2.3 Concept Operations

IM is one method controllers may use to achieve their spacing objectives. IM capabilities and procedures are designed to support the flight crew-managed relative spacing of aircraft. In this context, relative spacing refers to directly managing the interval between two aircraft as opposed to specifying a crossing time over a static point (e.g., a Scheduled Time of Arrival [STA]) for each. Tactical terminal IM operations will only be available for aircraft pairs in which the sequence and spacing objective is obvious to the controller, most often an IM Aircraft is directly behind a Lead Aircraft or merging in sequence at a common point. An IM operation involves ATC clearing an IM capable aircraft to achieve and/or maintain a desired ASG relative to a specified Lead Aircraft. The ASG is achieved at the CP and/or maintained for a specified route segment to the PCP.

In this initial deployment of tactical IM, ground automation will not be capable of proposing IM pairs and ASGs directly to the controller. Controllers, in coordination with the Traffic

Management Unit (TMU) or using to-be-defined tools, may identify suitable IM pairs and time-based ASGs to support arrival and approach operations. The time-based ASGs should be based on the controller's inter-aircraft spacing objective for the candidate IM Aircraft and Lead Aircraft and the relevant wind conditions. Arrival IM operations initiated en route may continue into terminal airspace with proper controller-to-controller coordination, which would provide terminal IM benefits without the need to set-up the operation in a busy terminal environment.

Based on the timeframe of tactical IM operations, it is expected that ATC will identify an IM capable aircraft, identify if there is a suitable Lead Aircraft and IM operation, and construct and communicate the IM clearance to the IM Aircraft flight crew via voice (not data link communications). Upon receipt, the IM Aircraft flight crew enters the IM clearance information manually into the FIM equipment. If the FIM capability determines the IM clearance is valid (e.g., the data in the Lead Aircraft's ADS-B Out message is of sufficient quality) and feasible, IM speeds are displayed to the flight crew, who then begin implementing them. The IM operation continues until reaching a pre-determined location (PCP) or until canceled by ATC (including times when a flight crew reports being unable to comply with an IM clearance).

The FIM equipment supports different IM clearance types, which govern the IM Aircraft's spacing behavior. Flight crews will input the IM clearance type issued by the controller. FIM capability functional behavior with respect to each type is described in detail in DO-328B (RTCA, 2020b) [2]. The two available for near-term operations are:

- **Cross**. Used when a particular spacing value is desired at a specific location (i.e., the CP) for any route geometry (subject to the limitations described in §2.1). If desired, spacing can be maintained (after the CP when the IM and Lead Aircraft are on the same route) until the cancellation.
- **Maintain**. Used when a particular spacing value is desired as soon as practical and then maintained. The controller can clear the IM Aircraft to maintain a specific ASG relative to the Lead Aircraft. This clearance type only applies to aircraft pairs on common, parallel, or near parallel routes.

Should conditions change after and IM operation has been initiated, the controller may choose to cancel, amend, or continue the IM operation. Controllers may cancel IM operations at any time if their objectives change, or they prefer another method to achieve their objectives.

It is expected that IM operations can be used to set up for a transition into CAS on Approach (CAS-A). A detailed operational description of CAS-A is beyond the scope of this document, but the objective of CAS-A is to maintain visual-like separation safely and more efficiently from the Lead Aircraft via fight crew use of a CDTI during approach procedures. CAS-A is expected to recapture some of the runway capacity benefits of visual separation operations when such operations are suspended due to weather. Additional detail on the concept is available in AIRS CAS Single Runway Operational Description (FAA, 2022). As CAS-A is a final approach ADS-B In application, IM may transition into CAS-A either by creating a consistent flow enabling the

[2] In DO-328B the IM Clearance 'Cross' as defined here is referred to as 'Achieve-by then Maintain' and the IM Clearance 'Maintain' as defined here is referred to as 'Capture then Maintain'.

use of CAS-A or by setting up appropriate spacing for CAS-A. Considerations for those transitions from IM are presented in this document.

2.4 Supporting Infrastructure

Implementation of the IM terminal capability as described in this Operation Description will require controller use of new functions in the STARS automation systems. This new functionality is in turn supported by En Route Automation Modernization (ERAM) systems flight plan processing. Although no other STARS and ERAM modifications are expected to be identified as a dependency for the use of tactical IM, additional engineering activities may define solutions that rely on, or modify, other systems. For example, continuation of en route initiated IM operations into terminal airspace would likely require additional changes to both ERAM and STARS. Controller and TMU reference materials, for ASG determination, not based in automation are also required.

Additionally, to enable IM operations to transition seamlessly from the STAR to the approach, procedures must be designed to provide continuous route definition. Similarly, to support more accurate speed profile determinations by MOPS-compliant IM aircraft procedures should provide speed constraints up to the PCP (FAF).

2.5 Benefits

The tighter feedback control-loop nature of IM allows for more frequent and accurate speed adjustments to be made to achieve the desired spacing for a given flight segment than can be provided by a ground system or periodic vectors and controller speed assignments alone. This leads to improved inter-aircraft spacing precision and allows aircraft to be consistently spaced closer to the separation standard or metering constraints, thus increasing throughput in capacity-constrained airspace. Additionally, by reducing controller reliance on vectors off the published procedures that lengthen the distances flown, the use of the avionics and the IM application will result in greater conformance to the published procedures and improved fuel efficiency.

Expected terminal improvements include:

- Reduced vectoring off of Required Area Navigation (RNAV) arrivals, and thus reduced fuel burn and path length flown by IM Aircraft;
- increased airport arrival capacity, accomplished through more consistent delivery of aircraft to final and reduced inter-aircraft arrival times at the runway; and,
- reduced overall controller workload for equivalent or better throughput.

3 ROLES AND RESPONSIBILITIES

Responsibilities for participating controllers and flight crews based on those specified in DO-328B (RTCA, 2020b) and the scope of terminal IM defined for tactical operations are summarized in Table 3-1.

Table 3-1. Controller and Flight Crew Responsibilities

Controller Responsibilities	Flight Crew Responsibilities
• Determining if an IM operation is desirable • Determining the IM Aircraft, the Lead Aircraft, the ASG, any applicable Special Points, and the IM clearance type • Verifying that all initiation criteria are met to ensure a reasonable expectation of a successful operation • Communicating the IM clearance to the IM Aircraft • Confirming the IM clearance is read back correctly • Recording active IM operation and other IM clearance information into ground automation as needed • Ensuring separation between the IM Aircraft and all other aircraft, including the Lead Aircraft • Monitoring for and detecting path and longitudinal deviations and providing instructions when necessary • Amending the IM operation as needed • Cancelling the IM operation if the goal is no longer applicable or is not being met • Resuming non-IM operations whenever the IM operation is canceled	• Determining whether to accept or reject the IM clearance • Confirming IM clearance information to the controller via readback and upon request • Entering the IM clearance information into the FIM equipment • Cross flight deck verification of IM clearance entry • Ensuring that IM Speeds do not conflict with the safe operation of the aircraft • Informing the controller if they are unable to accept the IM clearance • Implementing the IM Speed • Monitoring the FIM equipment for any notifications and alerts • Amending the IM operation as instructed by the controller • Cancelling the IM operation as instructed by the controller (at or prior to the PCP) • Informing the controller if they are unable to continue the IM operation • Self-reporting of IM status on frequency change

The Traffic Management Coordinator (TMC), Supervising Traffic Management Coordinator (STMC), and Area Supervisors/Controller in Charge (CIC) may also have roles in determining a time-based ASGs and coordinating that information with the appropriate controllers. This

information may be communicated directly or by way of a terminal Integrated Display System (IDS).

For those IM operations that transition into a CAS-A operation, additional responsibilities apply. Those responsibilities for participating controllers and flight crews based on those specified in DO-354 (RTCA, 2014) and AIRS CAS Single Runway Operational Description. Those associated with the IM transition to CAS-A are summarized in Table 3-2.

Table 3-2. IM Transitioning to CAS-A Controller and Flight Crew Responsibilities

Controller Responsibilities	Flight Crew Responsibilities
• Conducting IM tasks as defined for those operations • Determining if an IM to CAS-A transition is desirable • Verifying that any CAS-A initiation criteria are met to ensure a reasonable expectation of a successful operation • Communicating the CAS-A instruction clearance to the IM Aircraft flight crew • Confirming the CAS-A clearance is read back correctly • Removing active IM operation and other IM clearance information in ground automation as needed • Recording active CAS-A operation and other CAS-A clearance information into ground automation as needed • Monitoring the CAS-A operations, as needed • Cancelling the IM or CAS-A operation if the goal is no longer applicable or is not being met • Resuming non-IM or non-CAS-A operations whenever an operation is canceled	• Conducting IM tasks as defined for those operations • Determining whether to accept or reject the CAS-A instruction • Confirming the CAS-A instruction to the controller via readback and upon request • Making the CAS-A instruction information available to the FIM equipment • Cross-flight deck verification of CAS-A information entry • Conducting the CAS-A operation • Informing the controller if they are unable to conduct CAS-A • Monitoring the FIM equipment for any alerts • Discontinuing the IM or CAS-A operation as instructed by the controller

4 PROCEDURE DESCRIPTION

The following sections describe the nominal flow of operations as well as potential off-nominal modes of operation. Specific phraseology is not included in the body of this document, as it is subject to change over the course of deployment. Rather, overall considerations and general characteristics of phraseology are described in the AIRS Final Reports for I-IM at ZAB and CAS at D10.

4.1 Operational Flow

The IM procedures and tasks described are based on the detailed IM procedures defined in Appendix A of DO-328B (RTCA, 2020b), with the following exceptions.

1. Partial clearances will not be used with an active IM clearance.
2. IM described in this document is limited to terminal operations (however, the operations described here may have started in the en route environment).
3. IM Turns are not used.
4. Controllers are expected to cancel an IM operation if they need to direct either aircraft in the pair off route or issue a speed instruction to the IM Aircraft; they will not use a "suspend" instruction.
5. IM clearance information does not include target aircraft intended flight path information (IFPI) or traffic reference points (TRPs); target aircraft IFPI is still used by controllers when determining IM pairs and when initiation criteria are met but is not communicated as part of the clearance.
6. ASGs will be issued in time, distance-based ASGs will not be used.
7. Ground automation capabilities assumed in DO-328B (RTCA, 2020b) are not expected during the initial deployment of IM. Controllers may not have automation support to determine IM clearance information, verify initiation criteria are satisfied, identify an amendment is necessary, and monitor for automatic termination. The capability indicators, however, are assumed to be deployed nationwide. These procedures are agnostic to other new automation capabilities to directly support IM.
8. Based on these differences in ground automation and the need to capture ground-only procedures, additional controller tasks are defined, including recording IM clearance information, amendments, and status and coordinating with downstream controllers.
9. The community now uses the term "cancellation" in place of "termination" as used in the RTCA standard. It should be noted "termination" and its variants may be used in the avionics.

The application of these procedures is predicated on controllers in the facility being properly trained and aircraft operators properly filing IM capability.

The IM procedures are described in the four phases defined in DO-328B (RTCA, 2020b): pre-initiation, initiation, execution, and cancellation. The general process flow is expected to be consistent with the Phase Diagrams depicted in DO-328B and similar detail is not replicated in this document. A subset of information presented in the DO-328B Phase Tables is repeated and augmented here to support analysis of ATC tasks and specifically identify information gaps

related to IM operations. The avionics/flight deck support of flight crew tasking is assumed complete as specified in DO-328B and is not addressed further in this document[3].

4.1.1 Pre-Initiation Phase

The initial step to begin an IM operation is for ATC to identify an appropriately equipped aircraft using the capability indicators and to determine that IM is a suitable technique to achieve operational objectives. Once the IM Aircraft is identified, ATC will evaluate other aircraft to determine if a candidate Lead Aircraft exists. This determination is made considering several factors, such as initial spacing and operational goals. For IM to be successful, aircraft need to be appropriately equipped and in a sequence with adequate spacing so that they can transition to IM in a suitable configuration. ATC will monitor the position of the candidate IM Aircraft and will identify potential IM Aircraft pairs based on their expected sequence at a shared fix on their flight plans.

Once a candidate IM Aircraft pair has been identified by the controller, an appropriate time-based ASG must be determined. For IM operations ending prior to an approach segment, there may be a pre-determined ASG provided to the controllers that is suitable for all aircraft on a specific arrival given the prevailing wind conditions. For other IM operations, a time-based ASG may be determined by controller experience or through use of a reference table that translates a desired distance-based spacing to a time-based spacing relative to expected groundspeeds and/or headwinds. Controller training and familiarity with these tables and time-based spacing in general will be imperative for routine IM operation.

IM operations may span or cross control areas (positions) and facility boundaries, therefore involving multiple controllers. Controllers should consider the coordination tools in place when defining and initiating IM operations that cross boundaries. Controller-to-controller coordination may be supported by automation, standard operating procedures (SOPs), and/or interfacility agreements, such as a Letter of Agreement (LOA). For the operations defined in this document, controllers are procedurally limited to initiating operations only when both the IM Aircraft and Lead Aircraft are in the same control area and may be further limited such that they are canceled at or prior to hand-off.

Prior to issuing an IM clearance, controllers must ensure initiation criteria are satisfied. These criteria may include:

- The identified Lead Aircraft show operative ADS-B Out capability.
- The initiating controller has control authority over both aircraft.
- Both aircraft are on the same route or direct to a common fix and then on the same route for the remainder of the operation, and the CP and PCP (if used) are ahead of the IM Aircraft on its cleared flight path.

[3] In the phase tables that follow, all of these unaddressed operational needs are reflected by shaded boxes.

- The CP and PCP (if issued) are named Navigational Aids (NAVAIDs) or waypoints.
- The aircraft are positioned to achieve the desired spacing using speed alone.
- Both aircraft are in cruise or descent phase of flight.

Table 4-1. Pre-Initiation Tasks

Participant	Pre-Initiation Phase Tasks	Information Needs	Existing Sources	Potential Information Gap
ATC	Identify sequence and capabilities of aircraft	• Traffic picture • Aircraft IM capability	• IM Capability Indicator • Radar Scope • Non-ADS-B Indicator	
	Determine IM Operations are desirable	• Traffic management objectives • Environmental conditions	• Radar Scope • Sector Quick Look • Terminal IDS • Weather Display	
	Determine IM clearance parameters	• Candidate IM Aircraft Identification (ID) • Candidate Lead Aircraft ID • Candidate IM Aircraft routing • Candidate Lead Aircraft routing • ASG • Clearance type • CP if applicable • PCP	• Terminal IDS • Sector Quick Look • Radar Scope	• ASG[4]
	Ensure initiation conditions are met	• Initiation criteria • Candidate pair relative position and routing	• Radar Scope	• Initiation criteria[5]
Flight Crew	None			

[4] The ASG information gap here and in all subsequent tables is in reference to the time-based ASG required for these terminal operations. These ASGs are not easily determined without additional reference materials or automation support.
[5] Without automation support, it is up to the controller to determine if the aircraft pair is suitable and the routes are navigationally appropriate for the use of IM.

4.1.2 Initiation Phase

The Initiation phase begins when ATC issues an IM clearance to the flight crew. The clearance will include the type of clearance (Cross or Maintain), Lead Aircraft ID, ASG, CP (when issuing a Cross clearance), and optionally a PCP. The flight crew reads back then enters the clearance elements into the FIM equipment, performs a cross-flight deck verification of the entry, and executes the clearance, which causes the FIM equipment to provide the IM information, including the IM Speeds to fly (assuming initiation criteria are met).

The avionics may perform a check at initiation to determine if the ASG can be attained. In the case of a failed check or flight crew determination that the operation is not acceptable for other reasons, the flight crew notifies ATC and awaits further instructions.

Table 4-2. Initiation Tasks

Participant	Initiation Phase Tasks	Information Needs	Existing Sources	Potential Information Gap
ATC	Communicate IM clearance	• IM Aircraft ID • IM Clearance Information	• Terminal IDS • Sector Quick Look	• IM Clearance Information (as a complete set)[6]
	Respond to Flight Crew Requests	• IM Aircraft ID • IM Clearance Information	• Terminal IDS • Sector Quick Look	• IM Clearance Information (as a complete set)
	Record the IM clearance and status	• IM Aircraft ID • IM Clearance Information	• Flight Crew Readback (Acceptance) • Executing ADS-B In Operation Indication • Flight Scratchpad • Facility determined SOP	• IM Clearance Information (as a complete set)
Flight Crew	Read back the IM clearance	• IM Clearance Information		
	Assess IM Capability	• Lead Aircraft ID • FIM Equipment status • Navigation Database status		
	Assess IM clearance parameters	• IM Clearance Information • FIM Equipment status • Ownship routing information • Navigation Database Status		
	Notify ATC if Unable	• Unable reason (optional)		
	Make IM application parameters available to FIM equipment	• IM Clearance Information		

[6] Controllers must compose and record the IM Clearance. See phraseology considerations in Appendix B.

Participant	Initiation Phase Tasks	Information Needs	Existing Sources	Potential Information Gap
	Contact ATC for missing information / clarification, as needed	• IM Clearance Information • FIM Equipment status • Ownship routing information		
	Confirm Feasibility of IM Operation	• FIM Equipment status • Ownship Aircraft Performance Information • Airspace speed restrictions • Environmental conditions • IM Speed		

4.1.3 Execution Phase

The Execution phase begins when the IM Aircraft flight crew begins following the IM Speeds. The IM Aircraft flight crew is notified of a new IM Speed on the CDTI.

With the presentation of each IM Speed, the IM Aircraft flight crew ensures that the IM Speed is acceptable considering the current aircraft configuration, environmental conditions, and airspace speed restrictions. If the flight crew determines they are unable to fly the IM Speed, they will contact ATC and report "unable" and await instruction. Otherwise, the flight crew follows the IM Speeds in order for the IM Aircraft to achieve the ASG. Once the ASG is attained, the flight crew continues flying IM Speeds provided by the FIM equipment to maintain the ASG.

ATC continues to monitor the progress of the operation and is responsible for separation for all aircraft, including those involved in the IM operation, using existing surveillance capabilities and procedures. Under some circumstances ATC may need to coordinate with other positions as the aircraft progress through the airspace. In cases where one controller has the Lead Aircraft but does not have control of the IM Aircraft, coordination is required if ATC issues a heading instruction to the Lead Aircraft (in which case, the IM operation will need to be cancelled, as described in §4.2.1). If ATC issues a speed instruction to the Lead Aircraft, coordination should generally not be required. Controllers should recognize that the IM Aircraft will respond to changes in the Lead Aircraft speed and that response may vary based on the type of avionics or the stage of the IM operation; however, all changes in speed are made to achieve or maintain the desired spacing and are subject to the avionics' speed limiting. If controller spacing objectives change, they may choose to amend or cancel the IM clearance. Controllers may amend the ASG, IM clearance type, and/or PCP. A change in Lead Aircraft requires controllers cancel the existing IM Clearance and issue a new IM Clearance. If amending the clearance, the controller communicates the IM clearance amendment to the flight crew and records the amendment. As the flights of both aircraft (IM and Lead) progress, controllers will ensure downstream controllers are aware of the active IM operation prior to or at hand-off of the Lead Aircraft.

Table 4-3. Execution Tasks

Participant	Execution Phase Tasks	Information Needs	Existing Sources	Potential Information Gap
ATC	Monitor traffic conditions, separation, etc.	• Traffic picture	• Radar Scope • ATPA (on approach)	
	Decide to continue/amend/cancel IM operation	• Traffic management objectives • Traffic picture • Environmental conditions • IM Clearance Information • IM Status • IM Aircraft position • IM Aircraft speed • Lead Aircraft position • Lead Aircraft speed • IM Aircraft routing information • Lead Aircraft routing information	• TMU • Terminal IDS • Radar Scope • Executing ADS-B In Operation Indication • Flight Scratchpad	• Current ASG[7] • New ASG (if needed)
	Communicate IM clearance amendment	• IM Aircraft ID • IM Clearance Information	• Terminal IDS • Sector Quick Look	• ASG
	Record amendment / status	• IM Aircraft ID • IM Clearance Information	• Flight Crew Readback (Acceptance) • Executing ADS-B In Operation Indication • Flight Scratchpad	• ASG
	Issue other instructions as required[8]	• Desired Aircraft Response/Behavior		

[7] If not recorded in the Flight Scratchpad or otherwise known.
[8] Refers to instructions other than speed instructions to the IM Aircraft or route changes to either aircraft in an IM pair. The controller should cancel IM prior to issuing the new speed instruction or route change.

Participant	Execution Phase Tasks	Information Needs	Existing Sources	Potential Information Gap
	Coordinate IM clearance information with downstream/upstream controllers	• IM Aircraft ID • Lead Aircraft ID • IM Clearance Information • IM Status	• Terminal IDS • Executing ADS-B In Operation Indication • Flight Scratchpad	
Flight Crew	Determine if new IM Speeds are feasible/safe to implement	• FIM Equipment status • Ownship Aircraft Performance Information • Airspace speed restrictions • Environmental conditions • IM Speed		
	Implement IM Speeds	• IM Speed		
	Self-Report Active IM on Check-in	• IM Status • Lead Aircraft ID		
	Monitor for PCP	• PCP • Ownship position • Ownship routing information		
	Monitor FIM equipment for alerts and notifications	• FIM Equipment status IM Status		
	Notify ATC if unable	• Unable reason (optional)		

4.1.4 Cancellation Phase

Controllers may cancel an IM operation at any time.

For those IM operations that are expected to continue to the Final Approach Fix (FAF), a default PCP is available in the avionics allowing the controller to forgo PCP communication,

If a PCP is not issued and the IM operation is not expected to continue to the FAF, controllers must cancel the IM clearance via an instruction or by the issuance of another speed instruction to the IM Aircraft. If the IM Aircraft is given a speed instruction from ATC, the flight crew terminates the IM operation in the FIM equipment at which point IM Speeds, and other IM information, are no longer provided. The flight crew will then fly speeds as instructed by ATC.

For IM clearances that include a PCP, the FIM equipment automatically cancels the IM operation when the IM Aircraft reaches the PCP. After cancellation, the FIM equipment no longer displays IM Speeds. To avoid any potential confusion concerning flight crew action after cancellation, the controller must issue specific control instructions for the flight crew to follow.

If speed guidance for after IM cancellation is not otherwise coordinated (e.g., by SOP), the issuing controller must coordinate the expected aircraft behavior with the downstream controller.

Once an IM operation is canceled, the controller may revert to non-IM Operations for the IM Aircraft or issue another IM clearance. The controller should record that the canceled IM operation is no longer active and ensure any associated display elements are removed.

Table 4-4. Cancellation Tasks

Participant	Cancellation Phase Tasks	Information Needs	Existing Sources	Potential Information Gap
ATC	Communicate Cancellation Instruction	• IM Aircraft ID • IM Status	• TMU • Terminal IDS • Radar Scope • Executing ADS-B In Operation Indication • Flight Scratchpad	
	Record canceled status	• IM Aircraft ID • Lead Aircraft ID • IM Status • IM Aircraft Position Relative to PCP	• Radar Scope • Terminal IDS • Executing ADS-B In Operation Indication • Flight Scratchpad	• PCP[9]
	Issue speed / other instructions	• Speed instruction • Routing instruction	• Radar Scope • Navigation Procedure	
Flight Crew	Cancel at PCP and resume non-IM operations	• IM Status • PCP • Speed Instruction		
	Cancel IM Operation in response to ATC instruction	• IM Status		
	Fly appropriate non-IM Speed	• Speed instruction • Routing instruction		

[9] If a PCP has not been issued or has not been recorded by an upstream controller, the current controller may not know when an IM operation is expected to end. Facility procedures should be established to ensure communication and awareness of IM cancellation expectations; whether that is for the issuing and recording of a PCP, the issuing of PCPs that are standardized and known by all controllers, PCPs as part of a defined procedure, or non-issue of a PCP with the expectation that controllers manually cancel the operation.

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, position overload, or traffic.

Note: ATC altitude instructions alone do not create off-nominal conditions for IM operations, nor do ATC speed instructions to the Lead Aircraft.

4.2.1 ATC-initiated Heading Instructions

If ATC needs to provide a heading instruction to either aircraft at any time during the conduct of IM, it will do so. ATC-initiated heading instructions to either the IM Aircraft or Lead Aircraft will affect the conduct of IM. If ATC issues a heading instruction to the Lead Aircraft, they should also cancel the IM operation by advising the flight crew of the IM Aircraft.

It is possible for the Lead Aircraft to take a heading off its route without the IM Aircraft's flight crew being notified to cancel IM. Once the IM Application detects that the IM Aircraft and the Lead Aircraft are no longer on the same route or direct to the same fix, it will notify the flight crew, cancel, and discontinue the display of IM Speeds. The IM Aircraft flight crew is not expected to detect this event on a display, such as a traffic display, prior to the termination message[10]. At this point, the flight crew notifies ATC they are unable to continue the IM operation. The IM Aircraft flight crew is expected to continue flying their current speed until ATC issues a new speed or they encounter a procedurally required speed.

If the IM Aircraft is taken off route or receives a vector from ATC, the flight crew flies that heading and cancels the IM operation at which point IM Speeds are no longer provided. The IM Aircraft flight crew is expected to continue flying their current speed until ATC issues a new speed or they encounter a procedurally required speed.

4.2.2 Unacceptable IM Speeds

If operational constraints (e.g., turbulence) result in the flight crew being unable to follow the IM Speed, they will maintain their last implemented IM Speed unless a different speed is required for safety and notify the controller as described in DO-328B (RTCA, 2020b).

4.2.3 Call Sign Mis-Match

Call Sign Mis-Match (CSMM) occurs when the ADS-B Out broadcasted flight ID does not match the call sign in the filed flight plan. The impact of CSMM during IM operations would be the inability of the flight crew to identify the Lead Aircraft within their avionics or the potential of the flight crew designating the incorrect aircraft as the Lead Aircraft. Once ATC becomes aware of CSMM, either through an ERAM generated CSMM alert or the inability of the IM Aircraft flight crew to identify the Lead Aircraft, ATC must follow guidance contained in *FAA JO 7110.65 para. 5-2-26 a. ADS-B Alerts* (FAA, 2021b) and reject the use of the CSMM aircraft as the Lead Aircraft in an IM operation.

[10] The SafeRoute+ equipment uses "termination" rather than "cancellation"

4.2.4 FIM Equipment Failures or Notifications and Alerts

DO-328B (RTCA, 2021b) describes a number of circumstances where the FIM equipment may detect a problem and notify the flight crew that the IM operation should be canceled. If they are unable to continue the IM operation, the flight crew should maintain the last implemented IM Speed and notify ATC they are unable to continue spacing, optionally including a reason. ATC should cancel the IM operation, record the status change, and provide a new speed instruction and/or navigation clearance as needed.

4.2.5 Non-IM Related Aircraft Emergency

The flight crew should follow appropriate emergency procedures. If they are unable to continue the IM operation, the flight crew should maintain the last implemented IM Speed and notify ATC. ATC should cancel the IM operation, record the status change, and provide a new speed instruction and/or navigation clearance as needed.

If an IM Aircraft experiences a loss of radio communications during an active IM operation, the flight crew is expected to cancel the IM operation, fly the last implemented IM speed until a different speed is required for safety or by procedure, and comply with standard lost communication procedures.

4.3 Procedural Considerations for IM transitioning to CAS on Approach

All IM operation procedures remain applicable until the IM operation's cancelation, regardless of whether or not it transitions to a CAS-A operation. One modification is for one option for a transition to CAS-A where the IM ASG may be based on an assumed transition to CAS-A if IM continues to the final approach. As with other IM operations, considerations should be given to whether the reduced IM ASG will be sufficient for the entire course of the IM operation prior to transitioning to CAS-A (when close to the runway / in the traffic pattern).

The IM clearance, and the associated identification of the Lead Aircraft in that communication, is expected to be sufficient for the identification of the Lead Aircraft for CAS-A and separate identification communication procedures are unnecessary. However, the Lead Aircraft identification can be included in the CAS-A instruction.

In an IM to CAS-A transition operation, the IM PCP is not normally reached and a cancellation of IM occurs as the Trail Aircraft is issued a CAS-A instruction during a vector off of the downwind or when joining final for a CAS-A operation. At this point, IM is cancelled, and the flight crew ends the IM operation within the ADS-B In avionics and initiates the CAS-A operation. IM information is removed, and CAS-A information is now provided to the flight crew to start the CAS-A operation.

5 SAMPLE SCENARIOS

These sample scenarios describe terminal IM operations using time-based ASGs. The scenarios are as follows.

1. IM operations for the Feeder Controller. These include an operation using the same ASG for all pairs within an arrival stream heading to downwind terminating before handoff to the Final Controller and an operation with pair-specific ASGs terminating at the FAF.
2. IM operations initiated on final approach. These include both independent and dependent runway configuration.
3. IM operations transitioning to a CAS-A.

Although these scenarios are depicted as nominal operations through the planned completion, any controller actively managing the IM Aircraft may cancel the IM operation if the flight crew reports unable, the controller's objectives change, another technique is preferred or necessary, or continuation of the IM operation is not desired for any other reason. The following apply across all the scenarios:

- The IM Aircraft will nominally be referred to as the Trail Aircraft.

5.1 IM Operations for the Feeder Controller

Multiple different scenarios are envisioned to support the Feeder controller. Note that any of these operations could be set-up En Route, prior to the Feeder controller receiving the aircraft, with sufficient coordination with the preceding ARTCC. This would afford the Feeder controller the full benefit of these scenarios while moving the pre-initiation and initiation tasks to a time in the operation where they may be more suitable, taking advantage of reduced workloads in cruise and additional En Route automation tools (such as TBFM). See ADS-B In Tactical En Route IM Operational Description (FAA 2022) for a description of tactical En Route IM operations.

5.1.1 Scenario 1A: Terminal Downwind Feeder IM Operation

Scenario 1A describes the application of IM by a single Feeder controller ending at the Feeder/Final position boundary (see Figure 2-5). The goal of the Feeder controller is to provide aircraft spacing to final that is consistent and appropriate for the level of traffic. This goal assists the Final controller by allowing the Final controller to focus on base-turns to final and fine-tuning the spacing of aircraft established on the final approach course, rather than adjusting speeds and spacing on the downwind. Figure 5-1 illustrates the aircraft, routes and positions involved in the scenario. Based on operational factors affecting compression on final, the spacing goal at the Feeder/Final boundary is 5 NM. The distance-based goal is converted to a time-based ASG based on the desired distance and observed aircraft ground speeds at the position boundary.

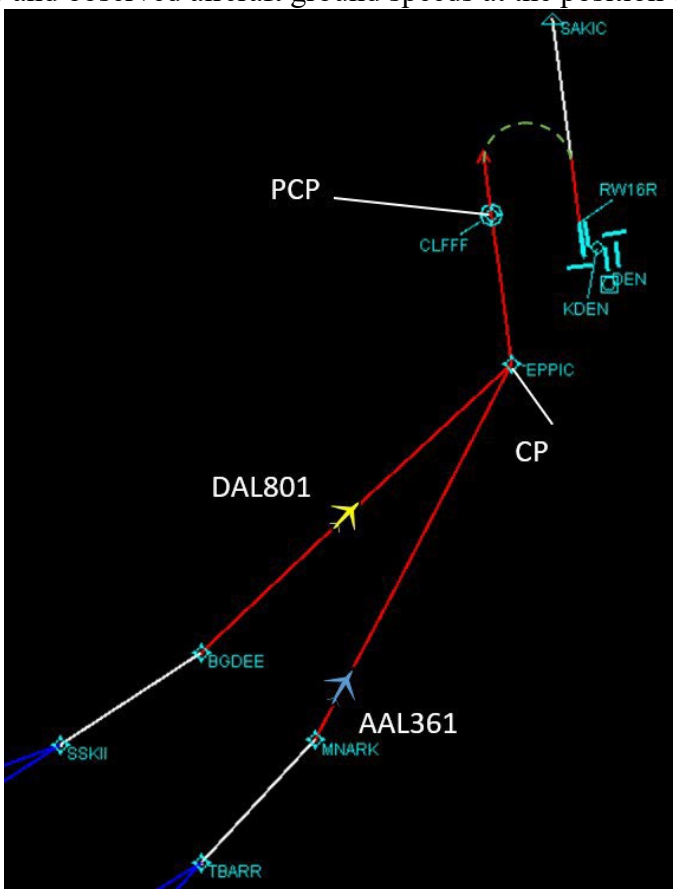

Figure 5-1. Scenario 1A – IM to Downwind

Use of IM in this and similar scenarios may only be suitable where route length until cancellation is sufficient to accommodate controller formulation and communication of the clearance, flight crew entry, the amount of initial spacing error, and facility procedures regarding the removal of IM display features prior to track control by the Final Controller.

Table 5-1 summarizes the participants and tasks in scenario 1A.

Table 5-1. Scenario 1A Participants and Tasks

Participant	Tasks
CIC	➢ Determine time-based ASG based on spacing goal and current ground speeds ➢ Monitor winds aloft, which affect ground speeds and advise Feeder controller of new time-based ASG, if appropriate
Feeder Controller	➢ Assess traffic ➢ Initiate IM if appropriate ➢ Monitor spacing and separation ➢ Cancel IM early if necessary ➢ Ensure the IM clearance is appropriately canceled, and the IM Aircraft is provided the proper speed instruction
IM Aircraft Flight Crews	➢ Assess IM clearance on receipt ➢ Implement IM speeds ➢ Monitor FIM Equipment ➢ Notify ATC if unable to continue IM ➢ Follow ATC instructions

Table 5-2 lists the key IM related parameters for scenario 1A.

Table 5-2. Scenario 1A Key Parameters

Parameter	Scenario Details	Notes
ASG (estimated for use by all aircraft on this arrival)	82 Seconds	Based on 5 NM spacing goal and 220 knot ground speed 5.0*NNNNNNN*/(220 kkkkkkkkkkkkkkkkkkkkk/3600kkkkkkkkkkkkk) = 82SSSSkkkkkkkkkkkkkkkkkkkSSSSkkkkk
IM Special Points	CP: EPPIC PCP: Defaulted	The PCP will not be communicated and instead the IM operation will be manually canceled prior to CLFFF

Aircraft Pair	IM Aircraft: AAL361 Lead Aircraft: DAL801	Aircraft pair are on different routes and IM may be initiated when headed on direct route to EPPIC with a cross clearance
Position Length	40 NM	The position is sufficiently large to allow IM speed commands to be effective

The Feeder controller needs to be cognizant that any changes to the route or heading of the Lead Aircraft will impact the active IM operation. In this scenario, the IM operation occurs entirely within the Feeder controller's airspace.

5.1.1.1 Pre-Initiation

The area CIC, in consultation with the Final controller and tower CIC, determines that spacing of 2.5 – 3.0 NM is needed over the runway threshold. To achieve this spacing, it is further determined that due to compression, 5.0 NM is optimal spacing for aircraft pairs entering the Final controller's airspace. The area CIC observes that typical ground speeds at the Feeder/Final boundary are 220 knots and uses a reference (lookup) table to ascertain a time-based ASG of 82 seconds. The CIC then advises the Feeder controller of the ASG, but continues to periodically monitor winds aloft and/or aircraft ground speeds for possible adjustments to the ASG.

The Feeder controller recognizes that AAL361 is IM capable and DAL801 is a suitable Lead Aircraft. The current spacing between the aircraft is approximately 8 NM, which should allow AAL361 to close the gap behind DAL801 while in the Feeder position airspace.

IM Pair

- Trail Aircraft = AAL361
- Lead Aircraft = DAL801
- ASG = 82 Seconds
- Clearance Type = Cross
- CP = EPPIC
- PCP = Defaulted

The Feeder controller ensures that all applicable initiation criteria are satisfied prior to initiating the IM operation.

5.1.1.2 Initiation

Once the controller determines the clearance information and all initiating conditions are satisfied, the controller issues the clearance to the IM Aircraft.

The AAL361 flight crew assess their IM capability as well as the IM clearance elements. If necessary, the flight crew contacts ATC for any missing clearance elements or to request any clarifications. The Trail Aircraft flight crew inputs the IM clearance parameters into the avionics, perform cross-cockpit verification of the data entry, and confirm the acceptability of the IM operation. ATC records any required IM clearance information.

5.1.1.3 Execution

The IM Aircraft (AAL361) flight crew continues to monitor for, assess, and implement new IM Speeds as presented by the avionics and monitor for other IM-related notifications.

The Feeder controller monitors the speed of AAL361 as well as the spacing and separation in the position.

5.1.1.4 Cancellation

Prior to hand off to the Final position, the Feeder controller cancels the IM operation. Since the IM operation achieved the desired spacing of 5 NM, the controller assigns a speed to AAL361 to maintain the spacing. Since DAL801 had previously been assigned 190 kts, the same speed is issued to AAL361. The Feeder controller hand-off both aircraft to Final.

After cancellation, the AAL361 flight crew flies their respective ATC assigned speeds.

5.1.2 Scenario 1B: Straight-in IM Initiated by Feeder, ending at the FAF Single Flow

Scenario 1B describes an operation initiated by the Feeder controller and terminated at the FAF. As illustrated in Figure 5-2, the operation is to cross the facility to achieve single runway spacing for an arrival flow to a dedicated runway. Both the Feeder and the Final controller have the same intended sequence and requires AAL246 to achieve the spacing of 110 seconds behind SWA963 by the FAF (TINKM). As the scenario progresses, the Final controller amends the spacing down to 95 seconds prior to TINKM.

Note that in some environments, procedure design may not be sufficient for the continuation of IM operations to be suitable. Depending on the operations at a given facility and the responsibilities and duties of controllers managing traffic to the final approach, IM operations canceled by the final controller may increase final controller workload and, therefore, not be operationally acceptable. Additionally, automation support to record and transfer lead identification and ASG may be necessary for operations to transition from feeder to final airspace.

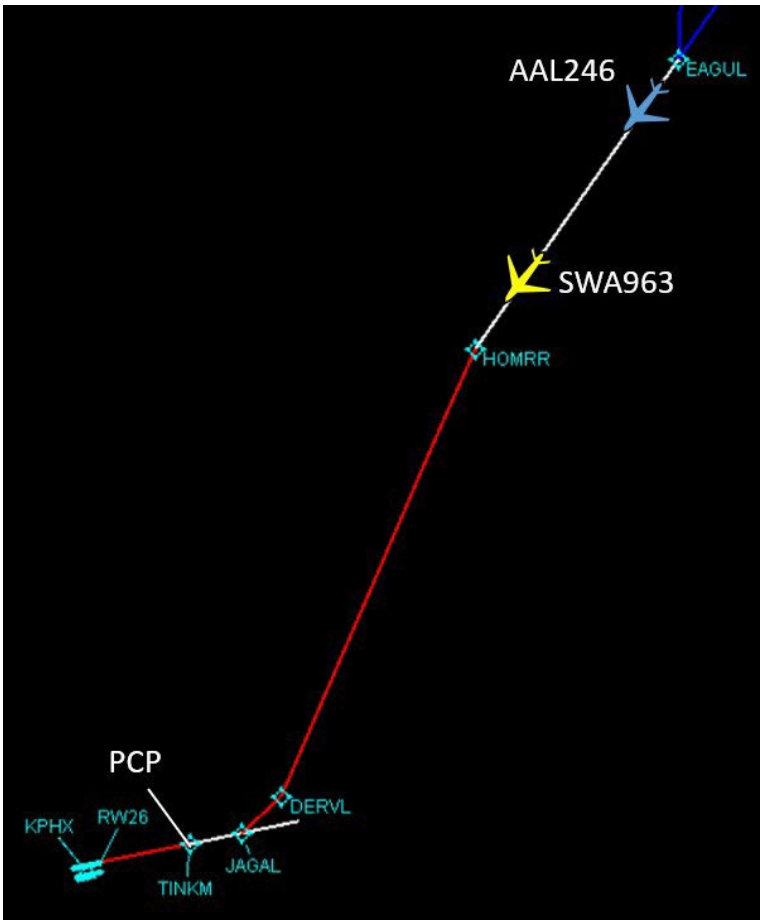

Figure 5-2. Scenario 1B – Feeder to FAF Same Route

Table 5-3 summarizes the participants and tasks in scenario 1B.

Table 5-3. Scenario 1B Participants and Tasks

Participant	Tasks
Feeder Controller	➢ Assess traffic ➢ Determine ASG ➢ Initiate IM if appropriate ➢ Monitor spacing and separation ➢ Cancel IM early if necessary
Final Controller	➢ Receive active IM pair ➢ Ensure the IM clearance is appropriately canceled, and the IM Aircraft is provided the proper speed instruction ➢ Amend or Cancel IM early if necessary
IM Aircraft Flight Crews	➢ Assess IM clearance on receipt ➢ Implement IM speeds ➢ Monitor FIM Equipment ➢ Notify ATC if unable to continue IM

Participant	Tasks
	➢ Follow ATC instructions

Table 5-4 lists the key IM related parameters for scenario 1B.

Table 5-4. Scenario 1B Key Parameters

Parameter	Scenario Details	Notes
ASG (estimated for this specific aircraft pair)	110 sec	ASG will be amended after initiation
IM Special Points	CP: N/A PCP: FAF	A default PCP could be used, but was determined to be inappropriate for the desired operation and thus the PCP is communicated.
Aircraft Pair	IM Aircraft: AAL246 Lead Aircraft: SWA963	Aircraft pair are on the same routes and IM may be initiated and a Maintain Clearance may be used

5.1.2.1 Pre-Initiation

In this scenario, a Feeder controller identifies an opportunity for an IM operation after an IM capable aircraft transitions into their airspace. The Feeder controller uses a checklist to aid in identifying the requirements for the IM operation. The Feeder Controller recognizes a possible Maintain operation with Aircraft SWA963 and AAL246 on the same route to initiate in their airspace and continue to the FAF. The ASG for this operation is determined for each Aircraft Pair by the Feeder Controller, using a reference table applicable at the FAF. From the reference table and the prevailing headwinds at the FAF, the Feeder Controller determines the ASG to be 110 sec.

<u>IM Pair</u>

- Trail Aircraft = AAL246
- Lead Aircraft = SWA963
- ASG = 110 Sec
- Clearance Type = Maintain
- PCP = FAF

The Feeder controller ensures that all applicable initiation criteria are satisfied prior to initiating the IM operations.

5.1.2.2 Initiation

Once the controller determines the clearance information and all initiating conditions are satisfied, the controller issues the clearances to the flight crew of AAL246.

The flight crew of AAL246 asses their IM capability as well as the IM clearance elements. If necessary, the IM flight crew should contact ATC for missing clearance elements or to request clarifications. The IM flight crews input the IM clearance parameters into the avionics, perform cross-cockpit verification of the data entry, and confirm the acceptability of the IM operation.

The Feeder controller records the active IM operations, including the participation of both IM and SWA963. The Feeder Controller also shares the ASG and IM Pair information on the Scratchpad for the downstream controller's awareness.

5.1.2.3 Execution

The IM flight crew continue to monitor for, assess, and implement new IM Speeds as presented by the avionics and monitor for other IM-related notifications.

The Feeder controller monitors the speed of AAL246 as well as the spacing and separation in the position. As the flights and IM operations progress, the Feeder controller will handoff the Lead and AAL246 to the Final controller. Regardless of whether the Lead aircraft has been handed-off or not, the Feeder controllers working the trail (IM) aircraft need to ensure adequate spacing and separation until handoff to Final.

At or prior to the handed-off of the Trail Aircraft, the Final controller will observe in automation that the IM operation is occurring to the FAF. In addition, the AAL246 flight crew will check-in with the Final Controller and communicate that they are actively spacing behind the designated Lead Aircraft.

The Final controller accepts the handoffs from the Feeder controller, takes responsibility for separation, and continues to monitor the IM operation until the aircraft reach the PCP at the FAF. As the operation progresses, the Final controller determines that they would like the aircraft pair needs to tighten up to accommodate surrounding traffic and communicates a new ASG of 95 seconds to AAL246, updating the Scratchpad after issuing the amendment.

5.1.2.4 Cancellation

When AAL246 reaches the FAF, the IM operation automatically cancel on the flight deck. The Final controller must ensure that the change in status of IM operation is properly recorded, and any display indications are properly updated.

As the cancellation is at the FAF, after cancellation the flight crew begins their transition to their Final Approach Speed.

5.1.3 Scenario 1C: Straight-in IM Initiated by Feeder, ending at the FAF (Cross)

Scenario 1C describes an operation initiated by the Feeder controller and terminated at the Final Approach Fix with an intervening merge. As illustrated in Figure 5-3, the operation is to cross the facility to achieve single runway spacing. Figure 5-3 illustrates the example aircraft, routes, IM

special points. Prior to the initiation on IM, the Feeder controller ensures both aircraft are direct to the CP (SKOLL), in this case issuing a vector to the IM Aircraft (AAL801). The CIC has determined that an appropriate runway spacing for this pair is 76 seconds and has ensured that this ASG also provides sufficient spacing at the CP.

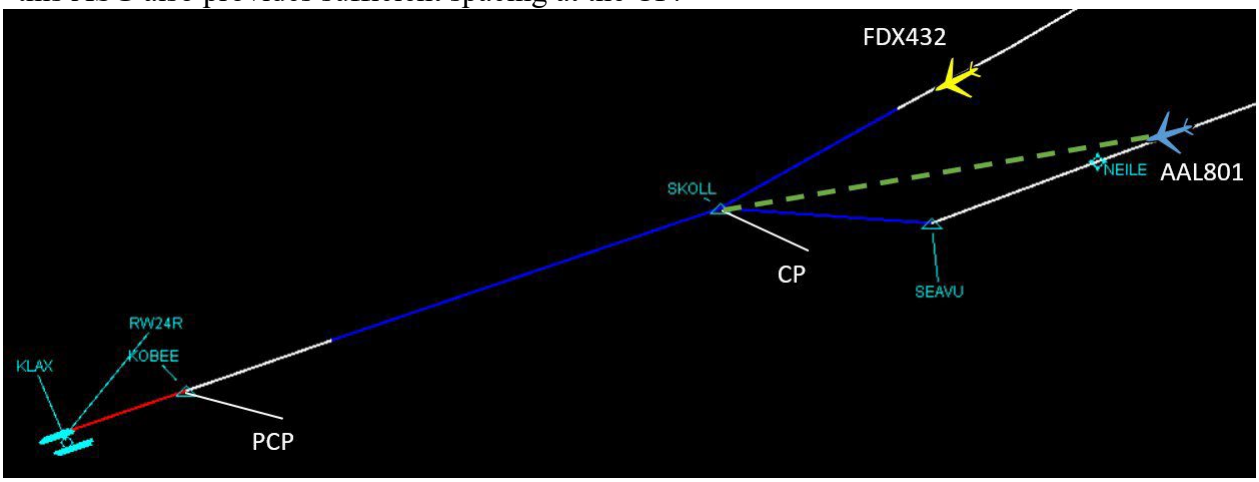

Figure 5-3. Scenario 1C – Feeder to FAF Cross

Table 5-5 summarizes the participants and tasks in scenario 1C.

Table 5-5. Scenario 1C Participants and Tasks

Participant	Tasks
Feeder Controller	➢ Assess traffic ➢ Initiate IM if appropriate ➢ Monitor spacing and separation ➢ Cancel IM early if necessary
CIC	➢ Determine time-based ASG based on the desired distance spacing and current winds at the FAF ➢ Monitor winds aloft, which affect ground speeds and advise Feeder controller of new time-based ASG, if appropriate
Final Controller	➢ Receive active IM pair ➢ Ensure the IM clearance is appropriately canceled, and the IM Aircraft is provided the proper speed instruction
IM Aircraft Flight Crews	➢ Assess IM clearance on receipt ➢ Implement IM speeds ➢ Monitor FIM Equipment ➢ Notify ATC if unable to continue IM ➢ Follow ATC instructions

Table 5-6 lists the key IM related parameters for scenario 1C.

Table 5-6. Scenario 1C Key Parameters

Parameter	Scenario Details	Notes
ASG (estimated for this specific aircraft pair)	76 sec	
IM Special Points	CP: SKOLL PCP: FAF (KOBEE)	
Aircraft Pair	IM Aircraft: AAL801 Lead Aircraft: FDX432	Aircraft pair are on different routes and IM may be initiated when headed on direct route to SKOLL with a cross clearance

The Feeder Controller with control of FDX432 needs to be cognizant that the operation must not initiate until AAL801 is on a direct route to the CP. Any changes to the route or heading of AAL801 will be accomplished prior to the initiation of AAL801 will impact the IM operation. In this scenario, the IM operation for the Aircraft Pair 1 is initiated after AAL801 is on a direct route to the CP.

5.1.3.1 Pre-Initiation

In this scenario, a Feeder controller identifies an opportunity for an IM operation after an IM capable aircraft transitions into their airspace. The Feeder controller uses a checklist to aid in identifying the requirements for the IM operation. The Feeder Controller recognizes a possible cross operation with FDX432 and AAL801 on separate routes. The operation would initiate prior to a common merge at SKOLL and continue to the FAF. The CIC has already determined an appropriate ASG for the IM pair at the FAF using a reference table. The ASG of 76 sec is shared with Feeder controller to use in the IM operation.

IM Pair

- Trail Aircraft = AAL801
- Lead Aircraft = FDX432
- ASG = 76 Sec
- Clearance Type = CROSS
- CP = SKOLL
- PCP=FAF (KOBEE)

The Feeder controller ensures that all applicable initiation criteria are satisfied prior to initiating the IM operations. In order to satisfy the requirement that both aircraft are direct to the CP prior to initiation, the Feeder issues the appropriate navigational clearance to AAL801, which the flight crew accepts.

5.1.3.2 Initiation

AAL801 having now turned direct to SKOLL, the Feeder issues the IM Clearance. The IM flight crew assess their IM capability as well as the IM clearance elements. If necessary, the flight crew must contact ATC for missing clearance elements or request clarifications. The IM flight crew input the IM clearance parameters into the avionics, perform cross-cockpit verification of the data entry, and confirm the acceptability of the IM operation.

The Feeder controller records the active IM operations, including the ASG and the participation of both AAL801 and FDX432 on the scratchpad.

5.1.3.3 Execution

The IM flight crew continue to monitor for, assess, and implement new IM Speeds as presented by the avionics and monitor for other IM-related notifications.

The Feeder controller monitors the speed of AAL801 as well as the spacing and separation in the position. As the flights and IM operations progress, the Feeder will hand-off Lead and Trail Aircraft to the Final controller.

As the flights progress and are handed-off to the next position, the Final controller will identify the ongoing IM operation in automation. In addition, the IM flight crew may check-in with the Final Controller and communicate that they are actively spacing behind the designated Lead Aircraft.

The Final controller accepts the hand-off from the Feeder controller and continues to monitor the IM operations until the aircraft reach the PCP at the FAF. Coordination of the active IM operations, including participating aircraft and clearance elements such as the ASG will enable the Final controller to manage the operations to completion.

5.1.3.4 Cancellation

When AAL801 reach the FAF, the IM operations automatically cancel on the flight deck. The Final controller must ensure that the change in status of IM operation is properly recorded, and any display indications are properly updated.

As the cancellation is at the FAF, after cancellation the flight crew begins their transition to their Final Approach Speed.

5.2 IM Operations Initiated on Final Approach

5.2.1 Scenario 2A: Independent Runway Spacing

Scenario 2A demonstrates an IM operation where both the IM Aircraft and the Lead Aircraft are landing in sequence to a runway operating independent of departure or other runway usage constraints. In this case, the airport is operating under IFR and the controller is ensuring a separation of 2.5 NM. Figure 5-4 illustrates the aircraft, approach, and IM special points involved in the scenario as well other traffic not involved with the IM operation.

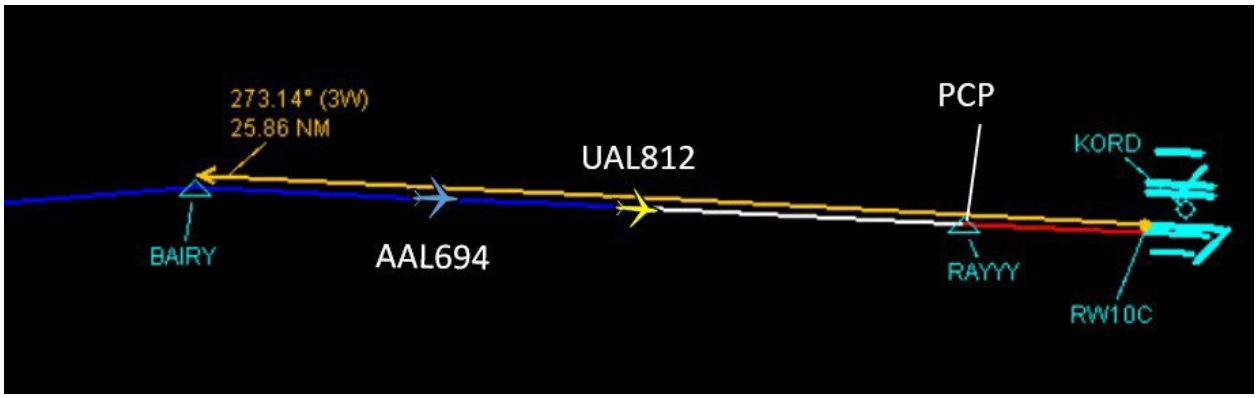

Figure 5-4. Terminal Scenario 2A – Single-runway Final Approach

Table 5-7 summarizes the participants and tasks in scenario 2A.

Table 5-7. Scenario 2A Participants and Tasks

Participant	Tasks
ATC	➢ Assess traffic ➢ Initiate IM if appropriate ➢ Monitor spacing and separation ➢ Cancel IM early if necessary
IM Aircraft Flight Crews	➢ Assess IM clearance on receipt ➢ Implement IM speeds ➢ Monitor FIM Equipment ➢ Notify ATC if unable to continue IM ➢ Follow ATC instructions

Table 5-8 lists the key IM related parameters for scenario 2A.

Table 5-8. Scenario 2A Key Parameters

Parameter	Scenario Details	Notes
ASG (estimated for this specific aircraft pair)	80 seconds	Reference table needed to assist in ASG determination.
IM Special Points	PCP: Defaulted	Operational assessments must be made before a facility determine that the default PCP is acceptable.
Aircraft Pair	IM Aircraft: AAL694	

	Lead Aircraft: UAL812	

The ASG for this operation will need to be determined based on the prevailing wind conditions and the specific spacing needs of the chosen aircraft pair.

5.2.1.1 Pre-Initiation

The TRACON has determined that IM operations can be used given current operating conditions and the receiving ATCT(s) have been notified.

The Final controller has received hand-off of an IM capable aircraft (AAL694). They identify a candidate lead (UAL812), which is the aircraft immediately preceding AAL694 in the controller's intended runway sequence. The controller identifies that IM is suitable and that the likely spacing correction is achievable given the length of the approach (generally, 0.3 NM of spacing correction can be achieved for every 4 NM of approach).

The controller decides an IM operation is preferred and determine the IM clearance elements that will need to be communicated.

- Trail Aircraft = AAL694
- Lead Aircraft = UAL812
- ASG = 80 seconds (based on current operating conditions, and controller spacing needs for AAL694)
- Clearance Type = Maintain

The controller maneuvers each aircraft towards final and clears them for approach. While communicating the approach procedure to AAL694, they inform the flight crew to expect an IM operation following UAL812.[11]

5.2.1.2 Initiation

Once both aircraft are established on the final approach course and all initiating conditions are satisfied the controller issues the IM clearance.

The AAL694 flight crew assess their IM capability as well as the IM clearance elements. If necessary, the flight crew contacts ATC for any missing clearance elements or to request any clarifications. The flight crew inputs the IM clearance parameters into the avionics, performs a cross-cockpit verification of the data entry, and confirms the acceptability of the IM operation.

Upon receipt of the readback from the AAL694 flight crew, the controller records the necessary IM clearance information, in this case denoting that AAL694 is performing IM.

[11] The exact phraseology to communicate the expectation of an IM clearance is yet to be determined. IM Aircraft "Expect Spacing behind" Lead Aircraft is likely given similar phraseology used in AIRS.

5.2.1.3 Execution

The crew of the Trail Aircraft continues to monitor, assess, and implement the new IM speeds presented by the avionics and monitors for other IM-related notifications.

The Final controller monitors the speed of the Trail Aircraft and spacing and separation with UAL812 and other aircraft on the approach flow.

The Final controller may hand off to the Tower while the IM operation is still executing. As the Tower is aware that aircraft may be performing IM, no further coordination is needed.

5.2.1.4 Cancellation

At the avionics determined default PCP the IM operation will automatically cancel, and the flight crew will continue with their final approach, slowing to their planned final approach speed.

5.3 IM Operations Transitioning to CAS-A Operations

The following points are applicable to both IM to CAS-A scenarios.

- IM could have started earlier in TRACON or en route (not shown in figures).
- IM is used to precondition and accurately deliver aircraft prior to a transition to CAS-A.
- Radar separation standard is assumed to be 2.5 NM when on final and 10 miles from the runway.
    - 3 miles when greater than 10 miles from the runway.
- The Lead Aircraft used for the IM operation is the same Lead Aircraft for the CAS-A operation.
- For any options that transition from IM to CAS-A, the controller issues instructions for that transition.
- If aircraft are performing CAS-A, controller CAS-A instructions are not expected to be issued until Trail Aircraft is on intercept to final or established on final.
- The need for and timing of a CAS-A "expect" instruction for an IM to CAS-A transition is dependent on facility needs and procedures. The CAS-A "expect" instruction would not cancel an IM operation, as the CAS-A clearance does. If the CAS-A operation is using the same Lead Aircraft as the IM operation, the expect instruction may not be useful. If the CAS-A operation is to be performed on a different Lead Aircraft, the IM operation should be explicitly canceled prior to the issuing of the CAS-A "expect" instruction so that new lead can be acquired.
- It is expected that the controller will, when desirable, issue a speed to the Trail Aircraft conducting CAS-A on final (as is done at most busy facilities during busy operations and there is another aircraft behind the Trail Aircraft).

5.3.1 Scenario 3A: IM through downwind with IM-based ASG. Vector off downwind for CAS-A.

Scenario 3A describes the use of IM to maintain spacing to the downwind behind the Lead Aircraft. The ASG is specified for IM operations without assuming a transition to CAS-A will occur with high probability. Before the Lead Aircraft is turned off of the downwind segment, IM is canceled by the controller. When the Trail Aircraft is in a position for the reduced spacing for

CAS-A, the controller vectors the Trail Aircraft off the defined route onto final behind the Lead Aircraft and issues a CAS-A instruction and an approach clearance. Figure 5-5 illustrates the traffic pattern, location where the two operations are conducted, and the transition point.

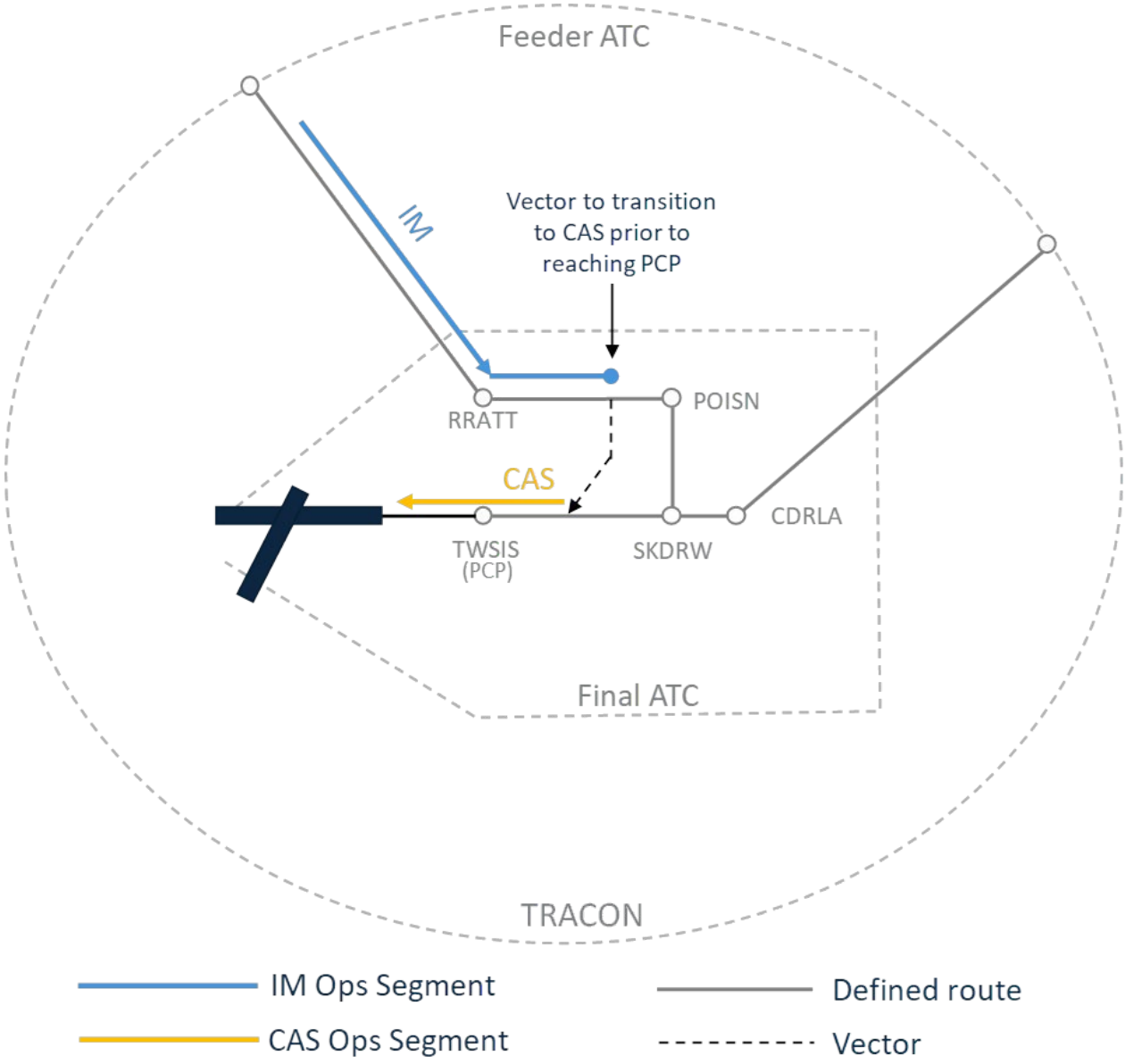

Figure 5-5. Scenario 3A – IM then CAS-A

Table 5-11 summarizes the participants and tasks for this scenario.

Table 5-9. Scenario 3A Participants and Tasks

Participant	Tasks
TMU	➢ Plans and schedules for IM arrivals (even though a transition to CAS-A is likely and desirable)
Final ATC	➢ Accept IM pair from Feeder ATC ➢ Monitor spacing and separation during IM ➢ Cancel IM early if necessary ➢ Issue CAS-A instruction and approach clearance ➢ Monitor CAS-A operations, as needed ➢ Hand off CAS-A pair to Local ATC
Local ATC	➢ Monitor CAS-A operations, as needed ➢ Ensure runway is clear ➢ Clear aircraft to land
Trail Aircraft Flight Crew	➢ Implement IM speeds ➢ Monitor FIM Equipment ➢ Notify ATC if unable to continue IM ➢ Cancel IM as instructed ➢ Assess CAS-A instruction on receipt ➢ Enter CAS-A clearance information and initiate equipment ➢ Conduct CAS-A ➢ Monitor FIM Equipment (now being used for CAS) ➢ Notify ATC if unable to continue CAS-A ➢ Conduct approach procedure ➢ Ensure Lead Aircraft clears the runway ➢ Land aircraft if runway is clear

Table 5-12 lists the key parameters for this scenario.

Table 5-10. Scenario 3A Key Parameters

Parameter	Scenario Details	Notes
Approaches	Instrument	
IM ASG	75 seconds	The ASG is specified for IM operations without assuming a transition to CAS-A will occur with high probability. This ASG time will result in a final spacing of approximately 3.4 NM (0.4 NM outside the separation standard of 3.0 NM).
IM Clearance Type	Maintain (or in the maintain stage)	IM clearance could have been initiated as a Cross or Maintain clearance. However, the

		Trail Aircraft is in the Maintain stage at this point.
IM Special Points	CP: NA PCP: TWSIS (FAF)	The CP has either been sequenced or was not part of the IM clearance type. The PCP is defined as the FAF but is not expected to be reached during IM operations as the transition to CAS-A will have occurred.

All expectations for nominal and off-nominal IM operations described in previous sections are applicable for the IM operations leading up to the transition for CAS-A. Non-IM aircraft are flying the defined route depicted in Figure 5-6. Any IM aircraft are vectored off the downwind to achieve the tighter spacing between the lead and Trail Aircraft that is enabled by CAS-A. In this scenario, IM operations have been on-going and are in the maintain stage of the operation. The IM operation will be terminated before the Lead is vectored to final. The CAS-A operation starts after the final controller vectors the Trail Aircraft to intercept the final approach course and issues the CAS-A instruction for the flight crew to conduct CAS-A against the same aircraft that was the Lead Aircraft for the IM operation. If the transition to CAS-A does not occur, the Trail Aircraft stops IM at the PCP / FAF as planned.

5.3.1.1 Pre-Initiation

An IM operation has been in effect for some period. Scheduling based on standard separation is being used and the aircraft pair is scheduled as such. However, if a transition to CAS-A is desirable, the final controller will vector the Trail Aircraft off the defined route to initiate a CAS-A operation and to achieve a further reduction in spacing than was planned for with IM. Prior to initiating the vector for CAS-A, normal IM operations are conducted between the trail and Lead Aircraft. When canceling IM, the controller may inform the Trail Aircraft to expect CAS on the same Lead Aircraft.

5.3.1.2 Initiation

At the point where the Lead Aircraft is on final (and prior to the Trail Aircraft reaching POISN), the final controller monitors for the opportunity to vector the Trail Aircraft into position behind the Lead Aircraft with the reduced spacing enabled by CAS-A. Once the Trail Aircraft is in the appropriate position, the aircraft is vectored off the downwind and provided the CAS-A instruction to the Trail Aircraft flight crew to follow the same Lead Aircraft and to apply CAS-A.

5.3.1.3 Execution

After receiving the CAS-A instruction, the flight crew initiates the CAS-A operation, keeping the same Lead Aircraft. During CAS-A, the flight crew monitors the spacing behind the Lead Aircraft and may use speed adjustments as needed to manage the spacing. They will inform ATC of speed if a speed assignment was also given with the CAS clearance.

The final and local controllers monitor the spacing between the aircraft for any significant issues and allow the flight crew of the IM Aircraft to apply CAS-A from the Lead Aircraft.

5.3.1.4 Cancellation

CAS-A nominally ends when the Lead Aircraft lands. At this point, CAS-A is complete, and a normal landing is executed. The local controller ensures the runway is clear prior to clearing the Trail Aircraft to land. The Trail Aircraft flight crew also ensures the runway is clear and lands the aircraft.

If CAS-A has to end abnormally due to a controller or flight crew issue, the controller will provide alternative instructions to establish another form of separation. The same contingency procedure used in today's operations apply.

5.3.2 Scenario 3B: IM through base with CAS-planned ASG. CAS-A initiation on final.

Scenario 3B is much like Scenario 3A with the key difference being that both the Lead and Trail Aircraft are flying straight in from Feeder to Final, as opposed to being turned off of a downwind segment.

This scenario describes the use of IM to maintain spacing until the Trail Aircraft joins the final approach course where the CAS-A operation starts. The IM ASG is specified assuming a transition to CAS-A will occur. If the transition to CAS-A does not occur (expected to be a rare event), the controller will need to consider the spacing between the aircraft and potentially cancel IM. The transition to CAS-A will occur well before going below current day radar separation standards (e.g., 3 NM on the extended final) and is no different from current day transitions to pilot-applied visual separation operations. As the Lead Aircraft joins final, the Trail Aircraft is still conducting IM and flying the defined route. When the Trail Aircraft is on final behind the Lead Aircraft, the controller issues the CAS-A instruction (thereby terminating IM) and an approach clearance (if not already done). Figure 5-6 illustrates the traffic pattern, location where the two operations are conducted, and the transition point.

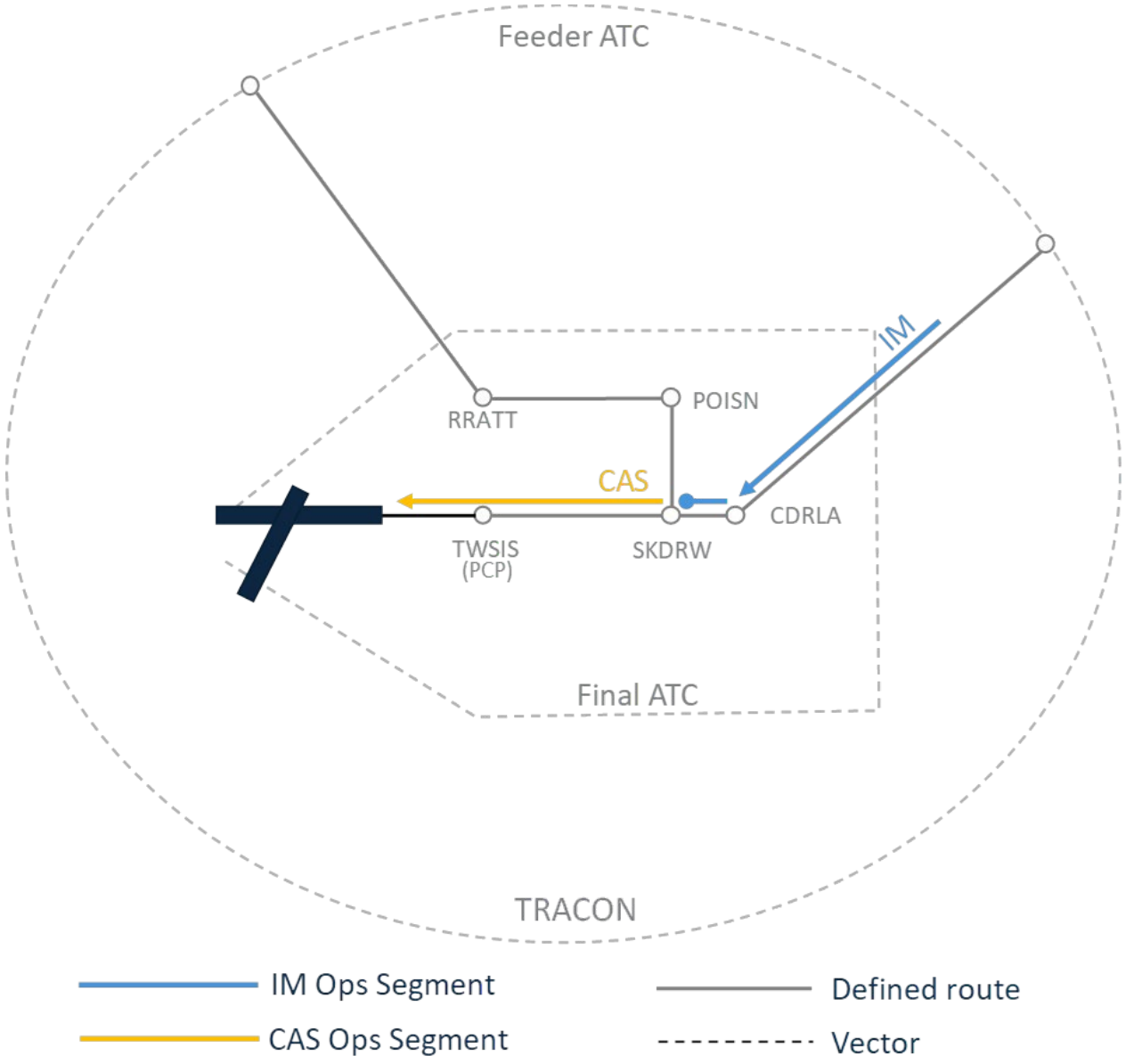

Figure 5-6. Scenario 3B – IM into CAS-A

Table 5-11 summarizes the participants and tasks for this scenario.

Table 5-11. Scenario 3B Roles and Responsibilities

Participant	Tasks
TMU	➢ Plan and schedule for IM and CAS-A arrivals
Final ATC	➢ Accept IM pair from Feeder ATC ➢ Monitor spacing and separation during IM ➢ Cancel IM early if necessary

Participant	Tasks
	➢ Issue CAS-A instruction and approach clearance ➢ Monitor CAS-A operations, as needed ➢ Hand off CAS-A pair to Local ATC
Local ATC	➢ Monitor CAS-A operations, as needed ➢ Ensure runway is clear ➢ Clear aircraft to land
Trail Aircraft Flight Crew	➢ Implement IM speeds ➢ Monitor FIM Equipment ➢ Notify ATC if unable to continue IM ➢ Assess CAS-A instruction on receipt ➢ Cancel IM upon accepting CAS-A instruction ➢ Enter CAS-A clearance information and initiate equipment ➢ Conduct CAS-A ➢ Monitor FIM Equipment (now being used for CAS) ➢ Notify ATC if unable to continue CAS-A ➢ Conduct approach procedure ➢ Ensure Lead Aircraft clears the runway ➢ Land aircraft if runway is clear

Table 5-12 lists the key parameters for this scenario.

Table 5-12. Scenario 3B Key Parameters

Parameter	Scenario Details	Notes
Approaches	Instrument	
IM ASG	65 seconds	The ASG is specified for IM operations but only based on assuming a transition to CAS-A will occur. This ASG time will result in a final spacing of approximately 2.7 NM (and is expected to compress below radar separation standard of 2.5NM after the final approach fix).
IM Clearance Type	Maintain (or in the maintain stage)	IM clearance could have been initiated as a Cross or Maintain clearance. However, the Trail Aircraft is in the Maintain stage at this point.
IM Special Points	CP: NA	The CP has either been sequenced or was not part of the IM clearance type.

	PCP: TWSIS (FAF)	The PCP is defined as the FAF but is not planned to be reached during IM operations as the transition to CAS-A will have occurred.

All expectations for nominal and off-nominal IM operations described in previous sections are applicable for the IM operations leading up to the transition for CAS-A. All aircraft are planned to the defined route depicted in Figure 5-6. IM operations have been on-going and are in the maintain stage of the operation. No communications need to occur for the IM operation as it is already in effect and the CAS-A instruction terminates the IM operation. The CAS-A operation starts after the Trail Aircraft is on the final approach course. If the transition to CAS-A does not occur, the controller determines the appropriate actions.

5.3.2.1 Pre-Initiation

An IM operation has been in effect for some period with an expectation of a transition to CAS-A on the final approach course. Prior to initiating CAS-A, normal IM operations are conducted between the trail and Lead Aircraft.

5.3.2.2 Initiation

At the point where the Lead Aircraft is on final and the Trail Aircraft is joining final, the final controller provides the CAS-A instruction to the Trail Aircraft flight crew to follow the Lead Aircraft and to apply CAS-A.

5.3.2.3 Execution

After receiving the CAS-A instruction, the flight crew of the Trail Aircraft cancels the IM operation and initiates the CAS-A operation while keeping the same Lead Aircraft. During CAS-A, the flight crew monitors the spacing behind the Lead Aircraft and may use speed adjustments as needed to manage the spacing. They will inform ATC of speed if a speed assignment was also given with the CAS clearance.

The final and local controllers monitor the spacing between the aircraft for any significant issues and allow the flight crew of the IM aircraft to apply CAS-A from the Lead Aircraft.

5.3.2.4 Cancellation

CAS-A nominally ends when the Lead Aircraft lands. At this point, CAS-A is complete, and a normal landing is executed. The local controller ensures the runway is clear prior to clearing the Trail Aircraft to land. The Trail Aircraft flight crew also ensures the runway is clear and lands the aircraft.

If the transition to CAS-A does not occur (expected to be a rare event due to an issue like flight deck equipment failure), the controller will need to consider the spacing between the aircraft and potentially cancel IM to establish another form of separation as the spacing after the final approach fix may be too small for non-CAS-A operations (unless tower-applied visual separation can be utilized).

If CAS-A had to end abnormally due to a controller of flight crew issue, the controller will provide alternative instructions to establish another form of separation. The same contingency procedure used in today's operations apply.

6 REFERENCE DOCUMENTS

FAA (2021a). ADS-B In Operational Use Case, En Route and Oceanic Services Second Level Engineering (SLE), En Route Automation Modernization (ERAM), Version 1.0, (AIMS 222207), Released March 31, 2021.

FAA (2021b). Order JO 7110.65 *Air Traffic Control*.

FAA, American Airlines, Aviation Communication & Surveillance Systems, LLC, NextGen Project (2022). ADS-B In Retrofit Spacing (AIRS) Initial-Interval Management (I-IM) Operation Description, Version 2.0, Released June 1, 2022.

Peterson, T.N., Penhallegon, W.J, & Moertl, P. (2012). *Mid-Term Interval Management – Spacing for Arrivals (MTR120203).* McLean, VA: The MITRE Corporation.

RTCA (2020a). Minimum Operational Performance Standards (MOPS) for Flight Deck IM (FIM) (DO-361A). Washington, DC: RTCA.

RTCA (2020b). Safety, performance, and interoperability requirements document for Airborne Spacing – Flight Deck Interval Management (ASPA-FIM) (DO-328B). Washington, DC: RTCA.

RTCA (2014). Safety and Performance Requirements Document for CDTI Assisted Visual Separation (CAVS) (DO-354). Washington, DC: RTCA.

Appendix A. Acronyms

Acronym	Definition
AAL	American Airlines
ACSS	Aviation Communication & Surveillance Systems
ADS-B	Automatic Dependent Surveillance – Broadcast
AGD	ADS-B Guidance Display
AIRS	ADS-B In Retrofit Spacing
ARTCC	Air Route Traffic Control Center
ASG	Assigned Spacing Goal
ASPA-IM	Airborne Spacing – Interval Management
ATC	Air Traffic Control
CAS	Cockpit Display of Traffic Information (CDTI)-Assisted Separation
CAS-A	CAS on Approach
CAVS	Cockpit Display of Traffic Information (CDTI)-Assisted Visual Separation
CDTI	Cockpit Display of Traffic Information
CMP	Coupled Meter Point
CP	Crossing Point
CSMM	Call Sign Mis-Match
CSP	Constraint Satisfaction Point
D-Side	Data Side
EDST	En Route Decision Support Tool
ERAM	En Route Automation Modernization
FAA	Federal Aviation Administration
FIM	Flight Deck-Based Interval Management
FP	Flight Plan
ID	Identification
IDS	Integrated Display System
IFPI	Intended Flight Path Information
I-IM	Initial-Interval Management
IM	Interval Management
LOA	Letter of Agreement
MF	Meter Fix
MIT	Miles-in-Trail
MRP	Meter Reference Point
NAS	National Airspace System
NAVAID	Navigational Aid
NM	Nautical Mile
PCP	Planned Cancellation Point
RTCA	Radio Technical Commission for Aeronautics
SOP	Standard Operating Procedures
STA	Scheduled Time of Arrival
STAR	Standard Terminal Arrival Route
STARS	Standard Terminal Automation Replacement System
STMC	Supervising Traffic Management Coordinator
TBFM	Timed-Based Flow Management

TMC	Traffic Management Coordinator
TMI	Traffic Management Initiative
TMU	Traffic Management Unit
TRP	Traffic Reference Point
TRACON	Terminal Area Control
TSD	Traffic Situation Display
XMP	Extended Meter Point