# ADS-B In Tactical En Route Interval Management (IM) Operational Description

Federal Aviation Administration
Surveillance and Broadcast Servies

June 30, 2023

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# 1 INTRODUCTION

This document defines the operational description for en route Interval Management (IM) during the early phases 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 usable capacity, through the use of avionics and supporting ground automation, to reduce the variability of inter-aircraft times, and in so doing, improve the delivery accuracy of aircraft to common Timed-Based Flow Management (TBFM) Constraint Satisfaction Points (CSPs) such as Extended Meter Points (XMPs), Coupled Meter Points (CMPs), or Meter Fixes (MFs). IM operations generally consist of a controller instructing the flight crew of an IM-capable aircraft (the "IM Aircraft"[1]) to achieve and/or maintain a desired time or distance-based 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 developed 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 of IM 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) systems. 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,

[1] In some other documentation on Interval Management, the IM aircraft is referred to as the "Trail Aircraft", while the Lead Aircraft is referred to as the "Target Aircraft".

the 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/ FMDS as well as airlines equipping with TSO-compliant 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 en route 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 en route 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 level flight and during arrival operations in en route 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 both level cruise and arrival phases of flight to increase overall flow efficiency. 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, they enter its information into their FIM equipment, which then starts providing IM Speeds that are designed to get the aircraft into compliance with the clearance. During the initial deployment, IM clearances may be either of two defined clearance types: Cross or Maintain. For a Cross clearance, the spacing will be achieved by the time the aircraft reaches 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

During the initial deployment, ground automation is not expected to provide the full suite of functionality envisioned in DO-328B (RTCA, 2020b) to support controllers in identifying a full range of IM clearance information or satisfaction of initiation criteria.

Additionally, ACSS SafeRoute+ is expected to be the predominant avionics in the initial deployment of IM timeframe and is not expected to provide significantly different IM capability than provided for the AIRS Evaluation in 2022-2023. ACSS SafeRoute+ is a stepping stone for IM deployment, but has limitations that directly impact controller and flight crew applications of IM. Initially, the capability indicator on the ERAM display will not distinguish aircraft with DO-361A (RTCA, 2020a) 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 following assumptions with respect to the capabilities of the avionics and the availability of ground automation are therefore made for this document.

- ADS-B In capability indicators, including an IM capability on the ERAM displays is deployed throughout the NAS. Additional ground automation is not assumed to be available to support tactical IM, though controllers may use information available from the ground automation systems to determine when to apply IM to help achieve their objectives, identify the IM clearance parameters, and compose the IM clearance using information.

- Cross and Maintain are the only IM clearance types available.[2]
- 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 intervening waypoints. 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. More complex IM clearances that use intended flight path information (IFPI) and traffic reference points (TRPs) are not supported.

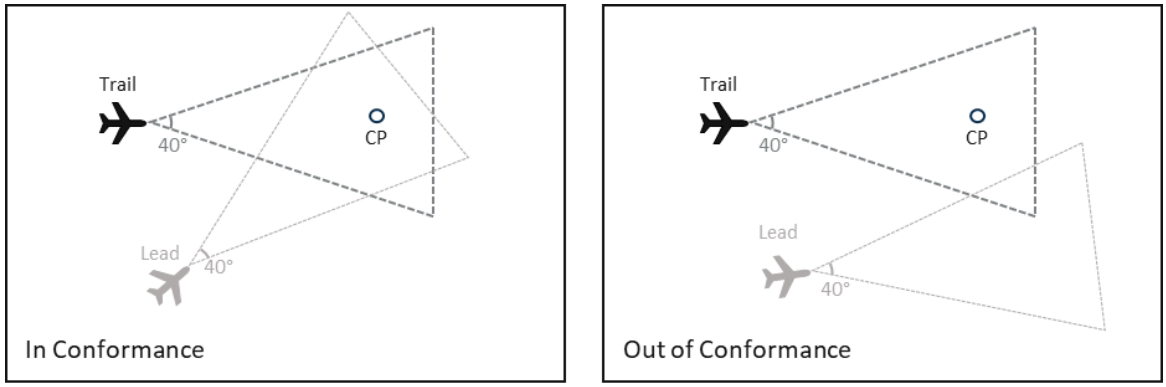


**Figure 2-1. ACSS Avionics Monitoring Before the CP (adapted from Comstock, 2020)**

- 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 (Figure 2-2), or the instantaneous tracks must have an intercept angle less than 90 degrees and intersect between the two aircraft positions (Figure 2-3).

[2] The community has made various changes to the terms used in DO-328B 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.

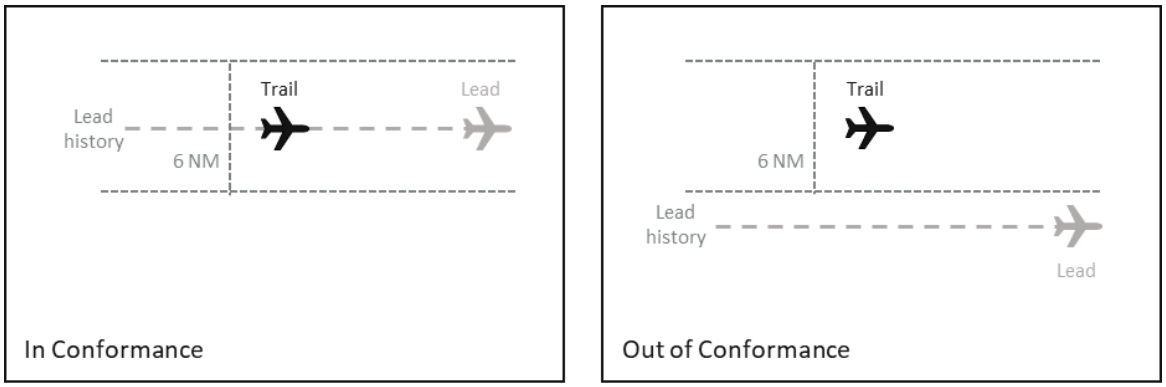


**Figure 2-2. ACSS Avionics Initiation Criteria for Maintain Clearance – Swimlane (adapted from Comstock, 2020)**

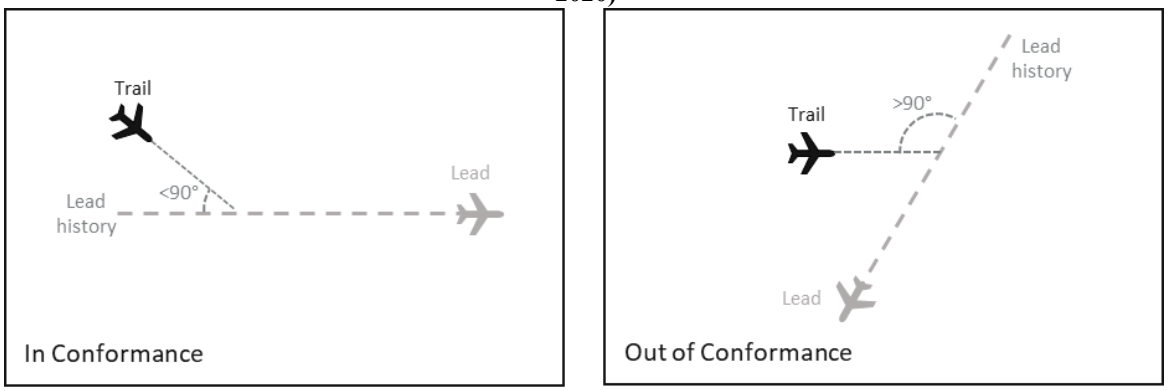


**Figure 2-3. ACSS Avionics Initiation Criteria for Maintain Clearance – Intercept Angle (adapted from Comstock, 2020)**

- IM special points (i.e., for SafeRoute+, the PCP and CP) must be defined as a named fix.
- A distance-based ASG must be in whole nautical miles (i.e., an integer value).
- Due to clearance limitations and avionics behavior, only time-based ASGs can be used with IM operations continuing onto the descent segment of an arrival.
- Controllers must be cognizant that they cannot rely on ground automation or avionics to flag operations that are likely infeasible from the start. Controllers will rely on their experience and judgment, and facilities may develop rules of thumb to ensure satisfactory initiation conditions.
- Data communications supporting IM are not expected to be available in the initial deployment timeframe.

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. en route airspace with suitably equipped aircraft. The operations may be performed in metering and non-metering environments using both time- and distance-based ASGs and applied within sector, across sectors, and across facilities (ARTCCs). IM may be used to support cruise and arrival (descent) spacing objectives, MIT restrictions, and time-based exit restrictions. The concepts rely on the deployment of the ADS-B In capability indicators to support the display of capability indicators to en route controllers on the ERAM displays. Figure 2-4 shows a nominal en route IM environment where controllers may apply distance-based IM clearances to meet MIT restrictions[3] and time-based IM clearances to meet arrival metering schedules. For arrival metering operations, aircraft numbers indicate the sequence at the meter fix (entering the terminal). Three separate meter arcs are shown as solid lines, with their respective freeze horizons shown as dashed lines (paired arcs and freeze horizons are shown using the same colors). As each arrival aircraft passes through each respective freeze horizon, it will either be issued a new IM clearance, or issued an amendment if there is an active IM clearance.

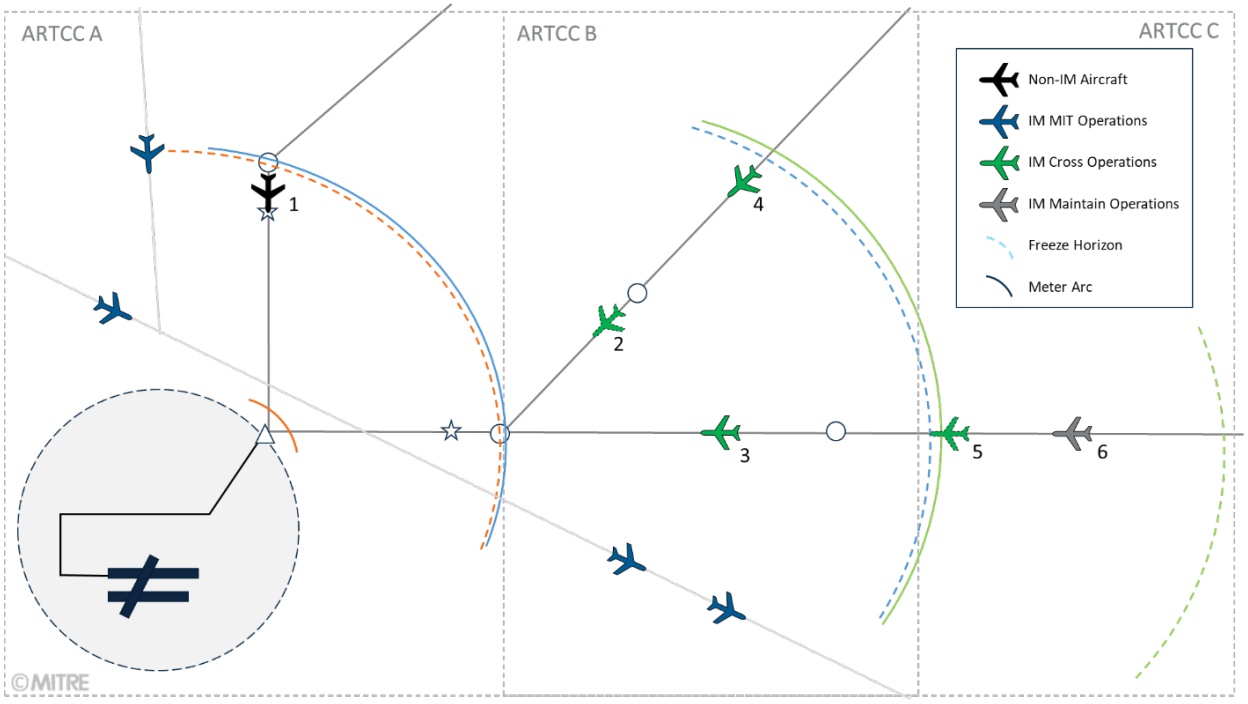


**Figure 2-4. En Route IM Operational Environment**

## 2.3 Concept Operations

IM is one method controllers may use to achieve their spacing objectives. For example, Figure 2-5 shows the tasks a controller will perform while managing aircraft to a MIT restriction. The circled task "Determine technique to meet MIT" is where the controller might identify IM as a suitable and desired technique to apply.

[3] IM MIT operations can be Cross or Maintain operations, and both are shown in this figure

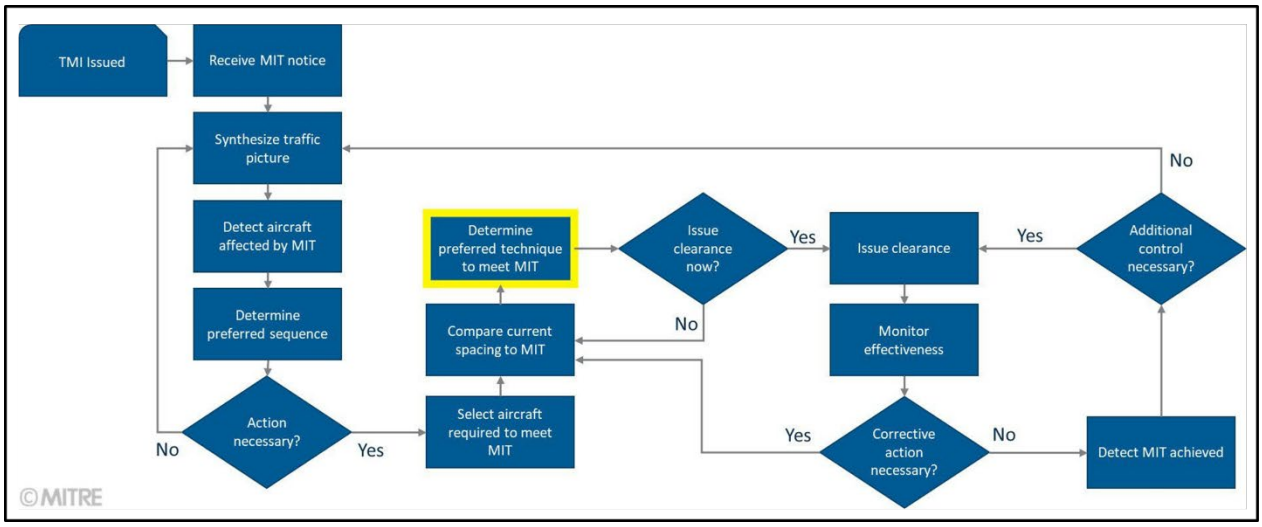


**Figure 2-5. Controller Task Flow for MIT Operation (adapted from Baker et al., 1999)**

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 (i.e., a Scheduled Time of Arrival [STA]) for each, such as in a traditional time-based metering operation. During the initial deployment, en route IM operations will only be available for aircraft pairs in which an IM Aircraft arrives behind a Lead Aircraft to the same en route CSP or, in a non-metering operation, a controller-determined sequence. 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 until the IM operation is cancelled.

All IM operations will be tactically initiated by controllers. Ground automation capable of proposing IM pairs and ASGs directly to the controller is not expected to be available. Aircraft included in Traffic Management Initiatives (TMIs) such as MIT restrictions will be ideal candidates for IM operations initiated by en route controllers as they, by definition, contain predefined points (i.e., the CP and/or PCP) and spacing goals that need to be met at those points (i.e., the ASG). Additionally, 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 operations in metering environments. The time-based ASGs in these circumstances should be based on the difference in TBFM STAs of the candidate IM Aircraft and Lead Aircraft at a given en route CSP. Time-based operations are suitable for the descent phase of flight associated with arrivals and IM operations initiated en route may continue into terminal airspace with proper controller-to-controller coordination.

During the initial deployment, it is expected that ATC may communicate the IM clearance to the flight crew of the IM Aircraft only via voice, not data link communications. The flight crew on the IM Aircraft enters the IM clearance information into the FIM equipment. If the FIM avionics determine the IM clearance is valid (e.g., the data in the Lead Aircraft's ADS-B Out message must be of sufficient quality), IM speeds are displayed to the flight crew, who then begin implementing them. Whether the ASG is distance- or time-based, the FIM equipment will propose IM speeds to the flight crew to actively manage the spacing with the Lead Aircraft and to

comply with the IM clearance. During the IM operation, ATC is still responsible for aircraft separation and must monitor the entire air traffic picture; however, speed commands for the IM Aircraft will be generated by the FIM equipment, not the controller, and the controller should not need to reroute or vector either aircraft in the pair to achieve the desired spacing. The IM operation continues until reaching a pre-determined location (PCP) or until canceled by ATC.

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 equipment functional behavior with respect to each type is described in detail in DO-328B (RTCA, 2020b)[4]. The two types available during the initial phase are:

- **Cross**. Used when a particular spacing value is desired at a specific location (i.e., the CP) for any route geometry. If desired, spacing can be maintained (after that location when the IM and Lead Aircraft are on the same route) until 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 a common route.

A TBFM rescheduling event may result in changes to the aircraft sequence or in differences in an IM operation's time-based ASG (caused by changes in the STA for the Lead and/or IM Aircraft). Controllers will need to be notified when an active IM clearance may no longer be valid due to changes in STAs or sequence. Depending on the change(s), 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. A schematic overview of IM operations is shown in Figure 2-6.

[4] As previously noted, DO-328B refers to these types as Achieve-by then Maintain (Cross) and Capture then Maintain (Maintain). The described behavior is applicable to both DO-361A avionics an SafeRoute+ avionics.

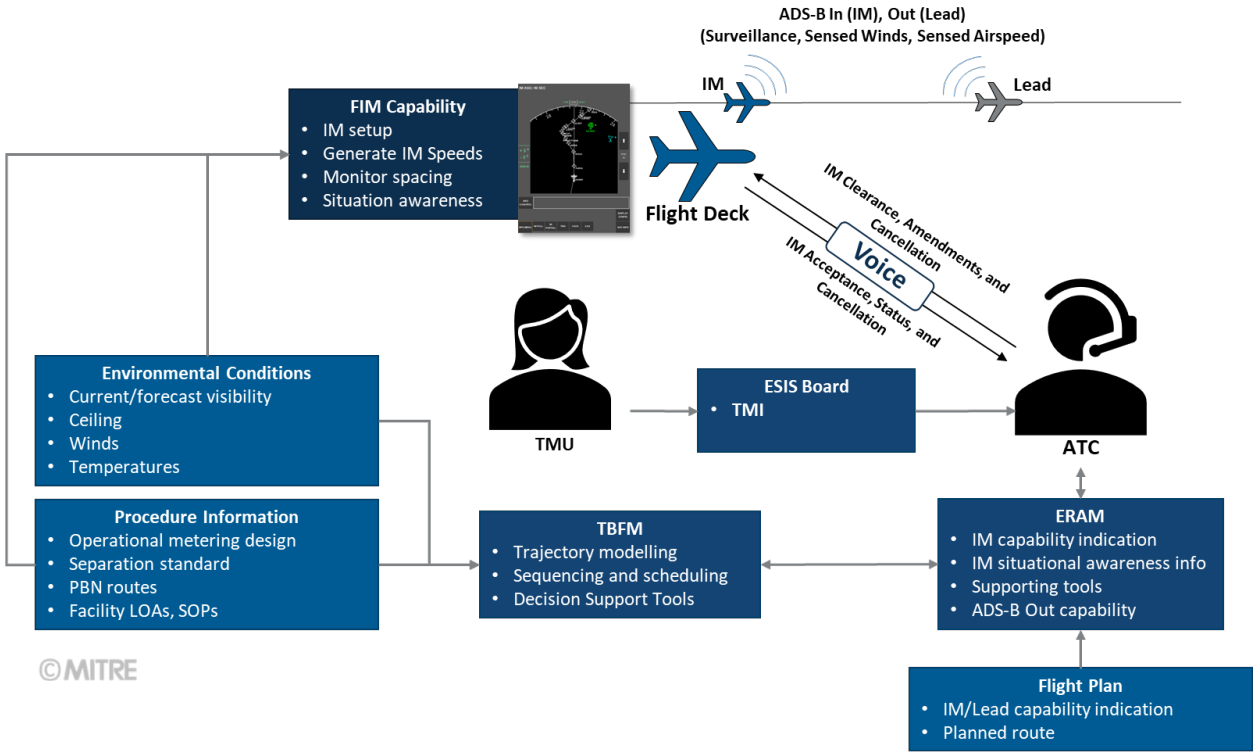


**Figure 2-6. IM Operations Overview**

## 2.4 Supporting Infrastructure

Implementation of the IM en route capability as described in this Operation Description will require the TBFM and ERAM automation systems. Additionally, controllers will be expected to use currently in-use methods such as the Enhanced Status Information System (ESIS) or instruction from the operational (area) supervisor to determine pertinent information in constructing IM clearances (e.g., MIT restrictions) to support their objectives. Although no other automation systems are expected to be identified as a dependency for the initial deployment of IM, additional engineering activities may define solutions that rely on, or modify, other systems. For example, continuation into terminal airspace of IM operations initiated en route may require changes to STARS or the TBFM or ERAM interfaces to STARS.

## 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. When applied with time-based arrivals, improved delivery accuracy of IM aircraft to the TRACON boundary may result in fewer controller interventions. 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. A broader discussion of applicable benefits can be found in Bone and Mendolia (2018).

Application of IM in MIT operations may reduce controller workload associated with overflight traffic; support assignment of preferred altitudes to more aircraft; support improved MIT accuracy and eventual reduction in MIT restrictions; and reduce controller vectoring, thereby reducing miles flown as indicated for arrivals.

Realized benefits of tactically applied IM in en route airspace will be dependent on the number of suitably equipped aircraft.

# 3 ROLES AND RESPONSIBILITIES

Responsibilities for participating controllers and flight crews based on those specified in DO-328B (RTCA, 2020b) and the scope of en route tactical IM defined 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<br>• Determining the IM Aircraft, the Lead Aircraft, the ASG, any applicable Special Points, and the IM clearance type<br>• Verifying that initiation criteria are met to ensure a reasonable expectation of a successful operation<br>• Communicating the IM clearance to the IM Aircraft<br>• Confirming IM clearance information is read back correctly by the flight crew of the IM Aircraft<br>• Ensuring separation between the IM Aircraft and all other aircraft, including the Lead Aircraft<br>• Monitoring for and detecting path and longitudinal deviations and providing instructions when necessary<br>• Amending the IM operation as needed<br>• Cancelling the IM operation if the goal is no longer applicable or is not being met<br>• Resuming non-IM operations whenever the IM operation is canceled | • Determining whether to accept or reject the IM clearance<br>• Confirming IM clearance information to the controller via readback and upon request<br>• Making the IM clearance information available to the FIM equipment<br>• Cross-cockpit verification of IM clearance entry<br>• Ensuring that IM Speeds do not conflict with the safe operation of the aircraft<br>• Informing the controller if they are unable to accept the IM clearance<br>• Implementing the IM Speed<br>• Monitoring the FIM equipment for any notifications and speed compliance alerts<br>• Reporting IM status at check-on for each new frequency<br>• Amending the IM operation as instructed by the controller<br>• Cancelling the IM operation as instructed by the controller<br>• Informing the controller if they are unable to continue the IM operation |

The Traffic Management Coordinator (TMC), Supervising Traffic Management Coordinator (STMC), and area supervisor may also have roles in determining time-based ASGs and coordinating that information with controllers. The TMC, STMC, and area supervisor may also support controllers when rescheduling, resequencing, or taking other actions that may cause changes to the TBFM schedule or sequence and subsequently to the IM clearance elements. In these cases, controllers may wish to cancel all active IM operations; however, if a controller is

interested in continuing an operation rather than canceling it, the TMC, STMC, or area supervisor can support the controller by helping to verify the pair and ASG.

# 4 PROCEDURE DESCRIPTION

The following sections describe the nominal flow of operations as well as potential off-nominal or abnormal modes of operation. As the phraseology may be reasonably expected to change based on the results of the AIRS Evaluation, specific phraseology is not included in the body of this document, rather, overall considerations and general characteristics are described in the AIRS Final Report for I-IM at ZAB.

## 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.
2. IM described in this document is limited to en route operations and does not include approach and other terminal applications of IM.
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 lead aircraft IFPI or TRPs; lead aircraft IFPI is still used by controllers in determining IM pairs and when initiation criteria are met but is not communicated as part of the clearance.
6. Ground automation capabilities assumed in DO-328B (RTCA, 2020b) are not expected in the initial deployment timeframe. 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 ADS-B In capability indicators are assumed to be deployed nationwide; however, these procedures are agnostic to other new automation capabilities to directly support tactical IM.
7. 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.
8. The community now uses the term "cancellation" rather than "termination".

The application of these procedures is predicated on controllers in the facility, as well as the aircraft operators, 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 TMC and ATC tasks and specifically identify information gaps related to IM operations. Each phase description is accompanied by a table that identifies the relevant tasks by participant, the information needs that are associated with the performance of each task, and then enumerates the existing sources of information for that task (i.e., sources that can provide the associated information and are currently in use or expected to be in use in the deployment timeframe), and information gaps that may be present for the task. The

avionics/flight deck support of flight crew tasking is assumed complete and is not specifically addressed.

### 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 on ERAM 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 considering factors such as initial spacing and operational goals. When TBFM metering is turned on, TBFM data may be used to help determine the Lead Aircraft in the sequence as well as a time-based ASG. When TBFM is not in use, this determination is made considering several factors, such as initial spacing and operational goals. For IM to be successful, aircraft need to be in an appropriate sequence with adequate spacing during the en route phase of flight 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 projected arrival times or controller-determined sequence at a shared fix on their flight plans.

IM operations may span or cross control areas (sectors) 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). Alternatively, controllers may be procedurally limited to initiating operations only when both the IM Aircraft and Lead Aircraft are in the same control area or may define operations such that they cancel at or prior to hand-off.

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

- The IM Aircraft and Lead Aircraft are within ADS-B In range of each other[5].
- The identified Lead Aircraft shows operative ADS-B Out capability.
- 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.
- The CP and PCP are named Navigational Aids (NAVAIDs) or waypoints.
- The aircraft are positioned to achieve the desired spacing using speed alone.
- The aircraft are in the cruise or descent phase of flight (i.e., neither aircraft is in the climb phase of flight).

[5] ADS-B In range can vary but the general rule of thumb is expected to be provided for controllers based on their airspace (e.g., the AIRS evaluation used 90 NM).

**Table 4-1. Pre-Initiation Tasks**

| Participant | Pre-Initiation Phase Tasks | Information Needs | Existing Sources | Potential Information Gaps |
|---|---|---|---|---|
| **TMC STMC** | Make MIT and other restrictions available to ATC | • MIT restriction(s)<br>• MIT point(s) | • TMU | |
| | Support as necessary ATC in identifying time-based ASGs | • Candidate IM Aircraft Identification (ID)<br>• Candidate Lead Aircraft ID<br>• Lead and IM Aircraft STAs<br>• Sequence | • TBFM<br>• Traffic Situation Display (TSD)<br>• TMU Sector Quick Look | • STAs suitable to derive timed-based ASG |
| **ATC** | Identify sequence and capabilities of aircraft | • Traffic picture<br>• Aircraft IM capability | • IM Capability Indicator<br>• Map Display<br>• Continuous Range Readout (CRR)<br>• Flight Plan (FP) Readout<br>• Meter Reference Point (MRP) List | |
| | Determine IM Operations are desirable | • TMI or other traffic management objectives<br>• Environmental conditions | • Map Display<br>• CRR<br>• Sector Quick Look<br>• ESIS<br>• Metering Plan<br>• Weather Display<br>• Ground Interval Management-Spacing (GIM-S) | |

| Participant | Pre-Initiation Phase Tasks | Information Needs | Existing Sources | Potential Information Gaps |
|---|---|---|---|---|
| | Determine IM clearance parameters | • Candidate IM Aircraft Identification (ID)<br>• Candidate Lead Aircraft ID<br>• Candidate IM Aircraft routing<br>• Candidate Lead Aircraft routing<br>• ASG<br>• Clearance type<br>• CP if applicable<br>• PCP | • Non-ADS-B Indicator[6]<br>• Map Display<br>• CRR<br>• MRP<br>• FP Readout<br>• Data (D)-Side En Route Decision Support Tool (EDST)<br>• ESIS<br>• Sector Quick Look | • ASG (time-based) |
| | Ensure initiation conditions are met | • Initiation criteria<br>• Candidate pair relative position and routing | • Map Display<br>• FP Readout<br>• CRR<br>• Delay Countdown Timer (DCT)<br>• GIM-S | • Initiation Criteria[7] |
| | Coordinate with Lead Aircraft controller | • Candidate Lead Aircraft ID<br>• Lead Aircraft Sector | • Non-ADS-B Indicator<br>• Sector Quick Look | |
| **Flight Crew** | None | | | |

[6] The Non-ADS-B Indicator refers to the coral "A" displayed when the flight is either not ADS-B equipped or is equipped but no ADS-B based surveillance data has been received for the flight (FAA, 2019).

[7] Although controllers will be trained on initiation criteria and with experience rely on their judgement and rules of thumb, there is no current plan to specifically identify the criteria or that the criteria are satisfied in the ground automation or with other tools.

### 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 the IM clearance to the controller, who confirms that the information read back matched what was issued. If the flight crew needs clarification on any elements of the clearance the flight crew contacts ATC to request additional information. The flight crew enters the clearance elements into the FIM equipment, performs a cross-cockpit verification of the entry, and executes the clearance, which triggers the equipment's IM Speed display (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 Gaps |
|---|---|---|---|---|
| **ATC** | Communicate IM clearance | • IM Aircraft ID<br>• IM Clearance Information | • Sources used for "Determine IM clearance parameters" | • IM Clearance Information (as a complete set[8]) |
| | Respond to Flight Crew Requests for clarification of clearance elements | • IM Aircraft ID<br>• IM Clearance Information | • Sources used for "Determine IM clearance parameters" | • IM Clearance Information (as a complete set) |
| | Record the IM clearance and status | • IM Aircraft ID<br>• IM Clearance Information<br>• IM Status | • Sources used for "Determine IM clearance parameters"<br>• Flight Crew Readback (Acceptance) | • IM Clearance Information (as a complete set) |
| **Flight Crew** | Reply to IM clearance | • IM Clearance Information | | |
| | Assess IM Capability | • Lead Aircraft ID<br>• FIM Equipment status<br>• Navigation Database currency | | |
| | Assess IM clearance parameters | • IM Clearance Information<br>• FIM Equipment status<br>• Ownship routing information<br>• Navigation Database currency | | |
| | Notify ATC if Unable | • Unable reason | | |
| | Make IM application parameters available to FIM equipment | • IM Clearance Information | | |

[8] Until such time as the controller records the IM Clearance Information, the full set of parameters (IM Aircraft ID, Lead Aircraft ID, ASG, Clearance Type, CP, and PCP) may not be available together for controller reference.

| Participant | Initiation Phase Tasks | Information Needs | Existing Sources | Potential Information Gaps |
|---|---|---|---|---|
| | Contact ATC for missing information / clarification | • IM Clearance Information<br>• FIM Equipment status<br>• Ownship routing information | | |
| | Confirm Feasibility of IM Operation | • FIM Equipment status<br>• Ownship Aircraft Performance Information<br>• Airspace speed restrictions<br>• Environmental conditions<br>• 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 a cockpit display.

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 gradually 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 sectors 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 Section 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.

**Table 4-3. Execution Tasks**

| Participant | Execution Phase Tasks | Information Needs | Existing Sources | Potential Information Gaps |
|---|---|---|---|---|
| **TMC STMC** | Coordinate changes to MIT and other restrictions | • MIT restriction(s)<br>• MIT point(s) | • TMU | |
| | Coordinate changes to the TBFM metering plan, schedule, or sequence as necessary with ATC | • TBFM Schedule and Sequence Changes | • TBFM<br>• TSD | |
| **ATC** | Monitor traffic conditions, separation, etc. | • Traffic picture | • Map Display<br>• CRR<br>• MRP List | |
| | Decide to continue/amend/cancel IM operation | • TMI or other traffic management objectives<br>• Traffic picture<br>• Environmental conditions<br>• IM Clearance Information<br>• IM Status<br>• IM Aircraft position<br>• IM Aircraft speed<br>• Lead Aircraft position<br>• Lead Aircraft speed<br>• IM Aircraft routing information<br>• Lead Aircraft routing information<br>• IM Clearance amendment information[9] | • Non-ADS-B Indicator<br>• TMU<br>• ESIS<br>• Map Display<br>• CRR<br>• MRP<br>• FP Readout<br>• Data (D)-Side En Route Decision Support Tool (EDST)<br>• Sector Quick Look<br>• Recorded IM Clearance Information<br>• IM Status<br>• Query Flight Crew | • Active IM Clearance Information (as a complete set)[10]<br>• IM Status<br>• IM Clearance amendment information |

[9] In this context, "IM Clearance amendment information" refers to IM clearance parameters (i.e., ASG, CP, or PCP) applicable to the current controller objective that differ from the active IM operation.

[10] Depending on the tools or mechanisms used to record IM Clearance Information and IM Status, coordination between controllers may not be sufficient for controllers that inherit active operations to have a complete set of information.

| Participant | Execution Phase Tasks | Information Needs | Existing Sources | Potential Information Gaps |
|---|---|---|---|---|
| | Communicate IM clearance amendment | • IM Aircraft ID<br>• IM Clearance Information | • ESIS<br>• Sector Quick Look | • IM Clearance Information (as a complete set) |
| | Record amendment / status | • IM Aircraft ID<br>• IM Clearance Information | • Sources used for "Determine IM clearance amendment"<br>• Flight Crew Readback (Acceptance) | • IM Clearance Information (as a complete set) |
| | Issue other instructions as required[11] | • Desired Aircraft Response/Behavior | | |
| | Coordinate IM clearance information with downstream/upstream controllers | • IM Aircraft ID<br>• Lead Aircraft ID<br>• IM Clearance Information<br>• IM Status | • ESIS<br>• Recorded IM Clearance Information/status | • IM Clearance Information (as a complete set)[12] |
| **Flight Crew** | Implement initial IM Speed | • IM Speed | | |
| | Determine if new IM Speeds are feasible/safe to implement | • FIM Equipment status<br>• Ownship Aircraft Performance Information<br>• Airspace speed restrictions<br>• Environmental conditions<br>• IM Speed | | |
| | Implement IM Speeds | • IM Speed | | |
| | Self-Report Active IM on Check-in | • IM Status<br>• Lead Aircraft ID | | |

[11] Other than speed instructions to the IM Aircraft or route changes to either aircraft in an IM pair, for which the controller should cancel IM prior to issuing the new speed instruction or route change.

[12] Flight crew self-reporting as described in this document (and defined for the AIRS evaluation) may support portions of this information exchange but only at the point where the IM Aircraft is transferred to the next sector/facility.

| Participant | Execution Phase Tasks | Information Needs | Existing Sources | Potential Information Gaps |
|---|---|---|---|---|
| | Monitor for PCP | • PCP<br>• Ownship position<br>• Ownship routing information | | |
| | Monitor FIM equipment for notifications | • FIM Equipment status<br>IM Status | | |
| | Respond to ATC IM queries | • IM Speed<br>• IM Status<br>• FIM Equipment status | | |
| | Notify ATC if unable | • Unable reason | | |
| | Implement other ATC instructions | • Instruction | | |

### 4.1.4 Cancellation Phase

Controllers may cancel an IM operation at any time.

Although the use of a PCP is optional, it is expected to be issued as part of an IM clearance. If a PCP is not issued, controllers must cancel the IM clearance via voice 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 cancels the IM operation at which point IM Speeds are no longer provided. The flight crew will then fly speeds issued 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.

Follow-on (after cancellation of IM) speed guidance may be given at the time of IM clearance communication. If this speed guidance 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 Gaps |
|---|---|---|---|---|
| **ATC** | Communicate Cancellation Instruction | • IM Aircraft ID<br>• IM Status | • TMU<br>• ESIS<br>• Map Display<br>• CRR | • IM Status[13] |
| | Record canceled status | • IM Aircraft ID<br>• Lead Aircraft ID<br>• IM Status<br>• IM Aircraft Position Relative to PCP | • Map Display<br>• CRR<br>• ESIS | • IM Status<br>• Lead Aircraft ID<br>• IM Aircraft Position Relative to PCP |
| | Issue speed / other instructions | • Speed instruction<br>• Routing instruction | • Map Display<br>• FP Readout<br>• Navigation Procedure<br>• SOP/LOA | |
| **Flight Crew** | Cancel at PCP and resume non-IM operations | • IM Status<br>• PCP<br>• Speed Instruction | | |
| | Cancel IM Operation in response to ATC instruction | • IM Status | | |
| | Fly appropriate non-IM Speed | • Speed instruction<br>• Routing instruction | | |

[13] Note that when cancellation occurs in the sector in which the operation was initiated, there may be no information gaps as the controller should maintain awareness of the operation in its entirety. However, when the cancellation occurs in a downstream controller's sector, their access to, and understanding of, information such as the status of the operation, the Lead Aircraft ID, and the PCP, will be subject to how well that information was coordinated across sectors.

## 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.

*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, they 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 FIM equipment 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[14], however, they may notice additional speed changes that may or may not seem appropriate as the avionics attempts to compensate for the changes to the Lead Aircraft's trajectory prior to the termination of the operation. 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 exactly 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. Once ATC becomes aware of CSMM, either through an ERAM generated CSMM alert[15] or the inability of the IM Aircraft flight crew to identify the Lead Aircraft, ATC must follow guidance

[14] The SafeRoute+ equipment uses "termination" rather than "cancellation".
[15] Note that during current-day operations, many facilities do not routinely turn on the CSMM alerting function.

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.

### 4.2.4 TBFM Rescheduling and Resequencing Events

A TBFM reschedule of previous frozen flights may result in changes to the sequence of aircraft or the differences in an IM pair's ASG derived from the new TBFM schedule. A manual swap, resequencing, or other coordinated event may also affect an active IM pair. In the event of a change to TBFM, the controller may choose to cancel, amend, or continue the IM operation(s). If controllers cancel IM due to TBFM changes to the schedule and/or sequence, they will continue to use normal metering tools and procedures to achieve their objectives and may resume using IM if/when they choose. If the controller chooses to continue IM, each IM pair should be verified to confirm the correct sequence (i.e., confirming the Lead aircraft) and ASG.

### 4.2.5 FIM Equipment Failures or Notifications

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.

### 4.2.6 Non-IM Related Aircraft Emergencies

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

ATC should cancel the IM operation, record the status change, and provide a new speed instruction and/or navigation clearance as needed.

# 5 SAMPLE SCENARIOS

These sample scenarios describe en route IM operations using both distance- and time-based ASGs. The scenarios are as follows.

1. Distance-based IM operations to satisfy MIT restrictions where active IM operations cross facility boundaries and must be coordinated across multiple facilities. Scenario 1B demonstrates the issuance of an IM clearance amendment by a controller downstream from the initiating sector/facility.
2. Distance-based IM operations to comply with MIT restrictions or other operational objectives within a single center's airspace that may involve multiple sectors within the same center. The scenario depicts operations with a defined PCP that automatically cancel prior to exit and provides considerations for operations where a controller must cancel the IM operation via voice communications prior to hand-off to the next facility.
3. A time-based IM operation during level flight to achieve a specified time-based spacing objective to meet restrictions at the facility boundary with oceanic airspace.
4. Time-based IM operations to support arrival traffic on delivery to the terminal area in accordance with metering or other objectives. These operations may continue into the terminal if adequate coordination is provided.

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.

- IM is a technique to help the controller to achieve desired spacing; the use of IM does not change controller responsibilities with respect to non-IM traffic. Controllers are required to monitor and maintain spacing and separation for all traffic under their control.
- Controllers are expected to comply with TMIs whether they use IM or some other technique.
- Additionally, as noted in Section 1.1, the IM Aircraft may also be referred to as the "Trail Aircraft", and "Trail Aircraft" is used throughout the scenario descriptions.

## 5.1 En Route Center-to-Center MIT Operations

### 5.1.1 Scenario 1A: Cross-Facility MIT IM

Scenario 1A describes the application of IM across sector and facility boundaries to achieve a specific MIT required by a TMI. Figure 5-1 illustrates the aircraft, routes, IM special points, and sectors and centers involved in the scenario. The TMI requires Center A to deliver aircraft headed to airport KABC 20 MIT over SRIUS to Center B.

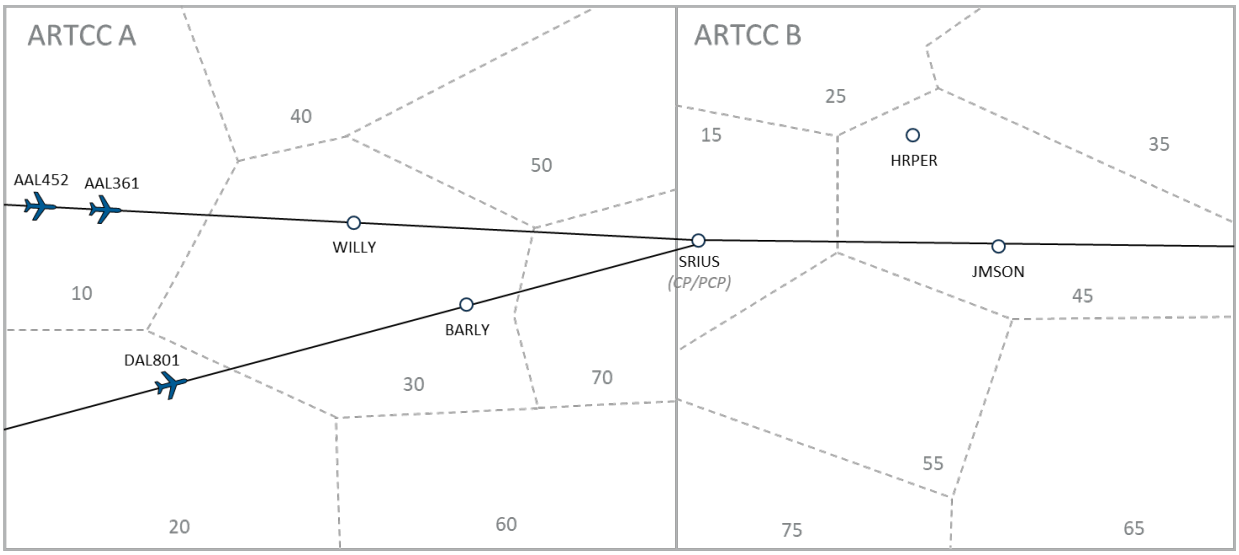


**Figure 5-1. En Route Scenario 1A – Cross-Facility**

Table 5-1 highlights some of the IM-related tasking for each of the participants in scenario 1A. Although not specifically listed, when using IM, controllers maintain responsibility for separation of all aircraft in their sector and must maintain awareness of the overall traffic environment; additionally, controllers are expected coordinate throughout as described in Section 4.1.

**Table 5-1. Scenario 1A Participants and Tasks**

| Participants | Tasks |
|---|---|
| **TMU** | ➢ Establishes and posts the parameters of the TMI to ESIS |
| **Center A ATC** | ➢ Initiate IM if appropriate<br>➢ Cancel IM early if necessary |
| **Center B ATC** | ➢ Accept IM pairs from Center A<br>➢ Monitor spacing and separation<br>➢ Cancel IM early if necessary<br>➢ 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<br>➢ Implement IM speeds<br>➢ Monitor FIM Equipment<br>➢ Self-Report Active IM on Check-in<br>➢ Notify ATC if unable to continue spacing operation<br>➢ 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 |
|---|---|---|
| **Nominal MIT** | 20 NM | TMI and timeframe will be posted on ESIS |
| **IM Special Points** | CP: SRIUS<br>PCP: SRIUS | |
| **Aircraft Pair 1** | IM Aircraft: AAL361<br>Lead Aircraft: DAL801 | Aircraft pair are on different routes and IM may be initiated when headed on direct route to SRIUS with a cross clearance |
| **Aircraft Pair 2** | IM Aircraft: AAL452<br>Lead Aircraft: AAL361 | Aircraft are on the same route and a maintain clearance may be used |

Controllers with control of lead aircraft need to be cognizant that any changes to the route or heading of the lead aircraft will impact an active IM operation. When aircraft are in different sectors, coordination is necessary between controllers. Any route or heading changes necessary for the lead aircraft must be coordinated with controller who has the trail aircraft. Both aircraft must be on a straight-line route to the CP. Controllers also need to be aware that an aircraft in an IM operation may be both a lead and a trail aircraft in separate IM operations. At or prior to initiation, and during execution, controllers with lead aircraft need to know the aircraft will be or is a lead in an IM operation. In this scenario, the IM operation for Aircraft Pair 1 is initiated when the aircraft are in different sectors in Center A.

In this scenario, there are two IM operations. The order the IM operations are initiated is at the discretion of the controller. The first trail aircraft in sequence does not have to be issued the first clearance. Additionally, the scenario depicts the Sector 10 controller initiating both clearances specifically to highlight the cross-sector coordination necessary when the candidate Lead Aircraft is in another sector. Based on controller workload or facility procedures, the first pair may not be initiated until both aircraft are in Sector 30.

#### 5.1.1.1 Pre-Initiation

A TMI is established for Center A to deliver aircraft arriving to airport KABC 20 MIT over SRIUS to Center B. The Center A TMU coordinates with the relevant controller areas by posting the TMI to the ESIS boards.

The Sector 10 controller recognizes that there are two IM capable aircraft in the flow affected by the TMI. To take advantage of IM in managing the MIT, the controller looks for and identifies an appropriate candidate lead aircraft (DAL801) in an adjacent sector (20) for AAL361. AAL361 may also serve as the lead aircraft for AAL452 arriving in Sector 10 on the same route and headed to KABC over SRIUS. The Sector 10 controller identifies the following IM clearances.

<u>Pair 1</u>

- Trail Aircraft = AAL361
- Lead Aircraft = DAL801
- ASG = 20 NM

- Clearance Type = Cross
- CP = SRIUS
- PCP = SRIUS

Pair 2

- Trail Aircraft = AAL452
- Lead Aircraft = AAL361
- ASG = 20 NM
- Clearance Type = Maintain
- PCP = SRIUS

The Sector 10 controller ensures that all applicable initiation criteria are satisfied prior to initiating the IM operations and contacts the Sector 20 controller with the candidate lead (DAL801) to coordinate the operation and ensure that the controller is aware that any changes to DAL801's route will need to be coordinated with the Sector 10 controller as they would require the Sector 10 controller to cancel 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 clearances to the IM Aircraft. The flight crew of the IM aircraft reads back the IM clearance to the controller, who confirms that the information read back matches what was issued.

The AAL361 and AAL452 flight crews assess their IM capability as well as the IM clearance elements. If necessary, the flight crews contact ATC for any missing clearance elements or to request any clarifications. The trail aircraft 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 Sector 10 controller records the active IM operations, including the participation of both IM and lead aircraft. Upon acceptance of the IM Aircraft by the AAL361 flight crew, the Sector 10 controller will ensure that the participation of the lead aircraft (DAL801) is properly recorded and coordinated with Sector 20.

#### 5.1.1.3 Execution

The AAL361 and AAL452 flight crews fly the IM Speeds.

The Sector 10 controller monitors the speed of AAL361 and AAL452 as well as the spacing and separation in the sector. As the flights and IM operations progress, controllers will hand-off lead and trail aircraft to downstream sectors and eventually to Center B. Regardless of whether the aircraft are in the same sector or not, all controllers working the trail (IM) aircraft need to ensure adequate spacing and separation. The Sector 20 controller (and subsequent controllers with lead aircraft DAL801) will need to coordinate with the controller with AAL361 if any control instructions are given that would change the route of DAL801. Similar coordination is necessary if a controller needs to reroute AAL361; cancelling AAL361's IM operation will require coordination with the controller managing DAL801 and rerouting AAL361 will require

coordination with AAL452's controller. Controllers may adjust the speed or vector other aircraft to accomplish the required spacing behind AAL452.

The IM Aircraft (AAL361 and AAL452) flight crews continue to monitor for, assess, and implement new IM Speeds as presented by the avionics and monitor for other IM-related notifications.

As the flights progress and are handed-off to the next sector/center, the AAL361 and AAL452 flight crews will check-in on the next frequency and communicate that they are actively spacing behind the designated lead aircraft (DAL801 and AAL361 respectively).

The Sector 15 controller in Center B accepts the hand-offs from Center A and continues to monitor the IM operations until the aircraft reach the PCP. Coordination of the active IM operations, including participating aircraft and clearance elements such as the ASG and PCP will enable Center B to effectively manage the operations to completion.

#### 5.1.1.4 Cancellation

When the IM aircraft reach SRIUS, the IM operations automatically cancel on the flight deck. The Sector 15 controller must ensure that the IM aircraft have an appropriate speed instruction after cessation of the IM operation. Additionally, the Sector 15 controller must ensure that status of IM operation is properly recorded, and any display indications are properly updated.

After cancellation, the AAL361 and AAL452 flight crews fly their respective ATC assigned speeds.

### 5.1.2 Scenario 1B: Cross-Facility MIT IM with Amendment

Scenario 1B demonstrates the issuance of an IM clearance amendment by a controller downstream from the initiating sector/facility. In this case, Center B accepts active IM clearances from Center A and, where appropriate, modifies the ASG and PCP to continue an operation in support of a TMI to deliver aircraft to Center C. MIT restrictions are reduced as aircraft traverse sectors and centers to distribute the workload to achieve the desired final MIT as aircraft eventually are delivered to the KABC TRACON. The first TMI requires Center A to deliver aircraft headed to airport KABC 20 MIT over SRIUS to Center B. Center B is required to deliver aircraft headed to KABC 15 MIT over OTTTO (located just prior to the facility boundary) to Center C, where controllers will continue to merge and sequence traffic destined to KABC. Figure 5-2 illustrates the aircraft, routes, IM special points, and sectors and centers involved in the scenario.

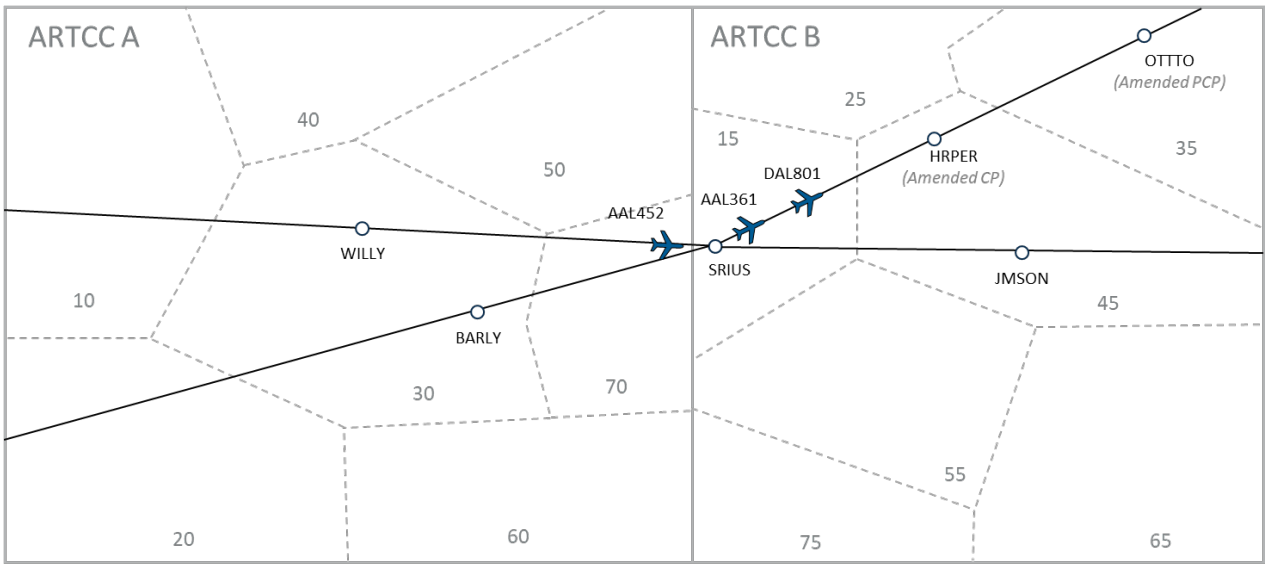


**Figure 5-2. En Route Scenario 1B – Cross-Facility with Amendment**

Table 5-3 summarizes the roles each of the participants in scenario 1B.

**Table 5-3. Scenario 1B Participants and Tasks**

| Participants | Tasks |
|---|---|
| **TMU** | ➢ Establishes and posts the parameters of the TMI to ESIS |
| **Center B ATC** | ➢ Accept IM pair from Center A<br>➢ Cancel IM early if necessary<br>➢ Amend IM clearances to support TMI<br>➢ 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<br>➢ Implement IM speeds<br>➢ Monitor FIM Equipment<br>➢ Self-Report Active IM on Check-in<br>➢ Amend IM clearance as instructed<br>➢ Notify ATC if unable to continue spacing operation<br>➢ 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 |
|---|---|---|
| **Nominal MIT** | 20 NM over SRIUS<br>15 NM over OTTTO | |

| Parameter | Scenario Details | Notes |
|---|---|---|
| **IM Special Points** | CP 1: SRIUS<br>PCP 1: SRIUS<br>PCP 2: OTTTO | Center B receives aircraft from Center A that are involved in IM operations intended to complete at SRIUS. The Center B controller may amend these operations to support their objectives and TMI regarding delivery of the same aircraft pairs to Center C. |
| **Aircraft Pair 1** | IM Aircraft: AAL361<br>Lead Aircraft: DAL801 | Aircraft are not on the same route until DAL801 reaches SRIUS. |
| **Aircraft Pair 2** | IM Aircraft: AAL452<br>Lead Aircraft: AAL361 | Aircraft are on the same route throughout the scenario. |

If the Center B controller decides to use IM to achieve the desired MIT for delivery to Center C, the controller may amend the existing IM clearance for a pair or issue a new clearance. A clearance amendment may change the clearance type, CP, PCP, or ASG. If a new lead is necessary, the controller must issue a new clearance. If the initial IM clearance automatically cancels when the IM aircraft reaches SRIUS, the controller may issue a new IM clearance, if desired.

This scenario starts in Center B with acceptance of KABC bound aircraft from Center A already involved in active IM operations.

#### 5.1.2.1 Pre-Initiation

A TMI is established for Center A to deliver aircraft arriving to airport KABC 20 MIT over SRIUS to Center B. Center B is required to deliver KABC bound aircraft to Center C 15 MIT. The Center B TMU coordinates with the relevant controller areas by posting the TMI to the ESIS boards indicating KABC traffic should be 15 MIT over OTTTO.

Through the applied coordination, the Sector 15 controller in Center B is recognizes that the aircraft received from Center A are involved in active IM operations defined to cancel at SRIUS. The controller also recognizes these same aircraft are subject to the KABC TMI and that IM may be used to achieve the 15 MIT over OTTTO. The controller identifies that the desired sequence and consequently the IM pairs are the same as previously established in Center A. Prior to the IM Aircraft reaching SRIUS and the currently active IM operations automatically canceling, the controller decides to amend the existing clearances to accommodate the 15 NM over OTTO. Alternatively, the controller may cancel (or wait until after the original PCP) the existing IM clearance and issue a new clearance.

<u>Amended Pair 1</u>

- Trail Aircraft = AAL361
- Lead Aircraft = DAL801
- ASG = **15 NM**
- Clearance Type = Maintain
- PCP = **OTTTO**

Amended Pair 2

- Trail Aircraft = AAL452
- Lead Aircraft = AAL361
- ASG = **15 NM**
- Clearance Type = Maintain
- PCP = **OTTTO**

The Sector 15 controller ensures that any initiation criteria applicable to the amended clearances are satisfied prior to issuing the amendments. The use of a Maintain clearance is possible with Pair 1 once the aircraft are on the same route (i.e., DAL801 reaches SRIUS).

#### 5.1.2.2 Initiation

Once the controller determines the clearance information and all initiating conditions are satisfied, the controller issues the clearance amendments to the IM Aircraft. The flight crew of the IM aircraft reads back the IM clearance to the controller, who confirms that the information read back matches what was issued.

The AAL361 and AAL452 flight crews assess the modified IM clearance elements. If necessary, the flight crews contact ATC to request any clarifications. The trail aircraft 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 Sector 15 controller records the modified IM operations.

#### 5.1.2.3 Execution

The IM aircraft crews fly the IM Speeds.

The Sector 15 controller monitors the speeds of the IM aircraft for and the spacing and separation of all aircraft in their sector.

The crews of the IM aircraft continue to monitor, assess, and implement the new IM speeds presented by the avionics and monitor for other IM-related notifications.

As the flights progress, Sector 15 initiates the hand-off to Sector 45 and ensures any coordination requirements are satisfied to inform Sector 45 of the active IM operations. The AAL361 and AAL452 flight crews will check-in on the next frequency and communicate that they are actively spacing behind the designated lead aircraft (DAL801 and AAL361 respectively). Subsequent hand-offs from Sector 45 to Sector 35 are similarly performed. Throughout, the Center B controllers monitor the speed of AAL361 and AAL452 and the spacing with their lead aircraft as well as other aircraft in the sector, adjusting the speed and/or routing of non-IM Aircraft as necessary.

The Sector 35 controller continues to monitor the IM operations until the IM aircraft reach the PCP.

#### 5.1.2.4 Cancellation

When the IM aircraft reach OTTTO, the IM operations automatically cancel on the flight deck. The Sector 35 controller must ensure that the IM aircraft have an appropriate speed instruction after cessation of the IM operation. Additionally, the Sector 35 controller must ensure that status of IM operation is properly recorded, and any display indications are properly updated.

After cancellation, the AAL361 and AAL452 flight crews fly their respective ATC assigned speeds.

## 5.2 En Route Within Center Miles-in-Trail Operations

### 5.2.1 Scenario 2: Within Center MIT IM with Automatic Cancellation

Scenario 2 demonstrates an IM operation that begins and ends in the same center, automatically cancelling at a PCP defined within the initiating center's airspace. A variation of the scenario is also presented where the controller cancels an IM operation prior to the PCP. Figure 5-3 illustrates the aircraft, routes, IM special points, and sectors and centers involved in the scenario.

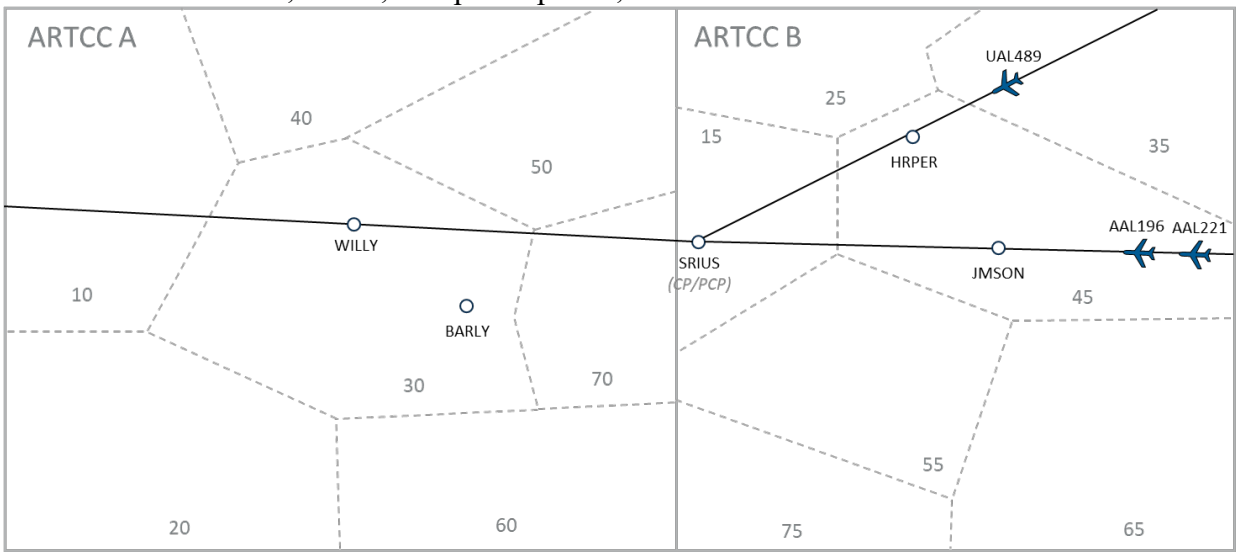


**Figure 5-3. En Route Scenario 2 – Within Center – Auto-cancel at PCP**

Table 5-5 summarizes the roles of each of the participants in scenario 2.

**Table 5-5. Scenario 2 Participants and Tasks**

| Participants | Tasks |
|---|---|
| **Center B ATC** | ➢ Initiate IM if appropriate<br>➢ Cancel IM early if necessary<br>➢ Ensure the IM clearance is appropriately canceled prior to leaving the center, and the IM Aircraft is provided the proper speed instruction |

| Participants | Tasks |
|---|---|
| **IM Aircraft Flight Crews** | ➢ Assess IM clearance on receipt<br>➢ Implement IM speeds<br>➢ Monitor FIM Equipment<br>➢ Self-Report Active IM on Check-in<br>➢ Notify ATC if unable to continue spacing operation<br>➢ Follow ATC instructions |

Table 5-6 lists the key IM related parameters for scenario 2.

**Table 5-6. Scenario 2 Key Parameters**

| Parameter | Scenario Details | Notes |
|---|---|---|
| **Nominal MIT** | 20 NM | |
| **IM Special Points** | CP: SRIUS<br>PCP: SRIUS | |
| **Aircraft Pair 1** | IM Aircraft: AAL196<br>Lead Aircraft: UAL489 | Aircraft pair are on different routes and IM may be initiated when headed on direct route to SRIUS with a cross clearance |
| **Aircraft Pair 2** | IM Aircraft: AAL221<br>Lead Aircraft: AAL196 | Aircraft are on the same route and a maintain clearance may be used |

There may be reasons for ATC to contain IM operations within their facility boundaries. In this case, the IM operation should be defined and executed such that operation is complete prior to hand-off of the lead aircraft and any display artifacts (e.g., 4th line entries) that might pass to the downstream controller are removed. In this scenario, the PCP is defined with Center B airspace such that operation automatically cancels prior to Center A.

As in scenario 1A (Section 5.1.1), this scenario includes initiation of IM with a lead aircraft (Pair 1) in another sector as well as the transverse of multiple sectors over the course of the IM operation. The same considerations regarding cross-sector controller coordination apply.

In this scenario, the initiating controller also issues the follow-on speed instruction for the flight crew to apply after cancellation of IM at the PCP.

#### 5.2.1.1 Pre-Initiation

In accordance with the LOA between centers, Center B is expected to deliver aircraft over SRIUS 20 MIT to Center A regardless of destination airport. This requirement is documented in Center B's SOPs and is common knowledge to the controllers.

The Sector 45 controller recognizes that there are two IM capable aircraft in the flow routed over SRIUS and subject to the 20 MIT restriction. To take advantage of IM in managing the MIT, the controller looks for and identifies an appropriate candidate lead aircraft (UAL489) in an adjacent sector (35) for AAL196. AAL196 may also serve as the lead aircraft for AAL221 arriving in

Sector 45 on the same route toward SRIUS. The Sector 45 controller identifies the following IM clearances.

Pair 1

- Trail Aircraft = AAL196
- Lead Aircraft = UAL489
- ASG = 20 NM
- Clearance Type = Cross
- CP = SRIUS
- PCP=SRIUS

Pair 2

- Trail Aircraft = AAL221
- Lead Aircraft = AAL196
- ASG = 20 NM
- Clearance Type = Maintain
- PCP = SRIUS

The Sector 45 controller ensures that all applicable initiation criteria are satisfied prior to initiating the IM operations and contacts the Sector 35 controller with the candidate lead (UAL489) to coordinate the operation and ensure that UAL489 will not be taken off route. The Sector 45 controller may confirm or request that UAL489 is on a direct course SRIUS if necessary.

#### 5.2.1.2 Initiation

Once the controller determines the clearance information and all initiating conditions are satisfied, the controller issues the clearances to the IM Aircraft. The flight crew of the IM aircraft reads back the IM clearance to the controller, who confirms that the information read back matches what was issued.

The AAL196 and AAL221 flight crews assess their IM capability as well as the IM clearance elements. If necessary, the flight crews contact ATC for any missing clearance elements or to request any clarifications. The trail aircraft 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 Sector 45 controller records the active IM operations, including the participation of both IM and lead aircraft. Upon acceptance of the IM aircraft by the AAL196 flight crew, the Sector 45 controller will ensure that the participation of the lead aircraft (UAL489) is properly recorded and coordinated with Sector 35.

#### 5.2.1.3 Execution

The AAL196 and AAL221 flight crews fly the IM Speeds.

The Sector 45 controller monitors the speed of AAL361 and AAL452 as well as the spacing and separation in the sector. As the flights and IM operations progress, controllers will hand-off lead and trail aircraft to downstream sectors. At various points in the operation the lead aircraft in an IM pair will be in the same or different sectors than the trail aircraft. Similar to Scenario 1 (Section 5.1.1) the controllers with the lead aircraft will need to coordinate with the controller with the trail aircraft if any control instructions are given that would change the route the lead. Controllers may adjust the speed or vector other aircraft not involved in an IM operation to accomplish the required spacing in their sector.

The IM Aircraft (AAL196 and AAL221) flight crews continue to monitor for, assess, and implement new IM Speeds as presented by the avionics and monitor for other IM-related notifications.

As the flights progress and are handed-off to the next sector/center, the AAL361 and AAL452 flight crews will check-in on the next frequency and communicate that they are actively spacing behind the designated lead aircraft.

The downstream controllers accept the hand-offs and continue to monitor the IM operations until the aircraft reach the PCP. Coordination of the active IM operations, including participating aircraft and clearance elements such as the ASG and PCP will each new controller to effectively manage the operations to completion.

#### 5.2.1.4 Cancellation

When the IM aircraft reach SRIUS, the IM operations automatically cancel on the flight deck. The Sector 15 controller must ensure that the IM aircraft have an appropriate speed instruction after the cancellation of the IM operation.

Depending on the reasons IM operations are constrained to Center B airspace and depending on the location of suitable PCPs relative to Center A boundary, it may be necessary for controllers to cancel the IM operation prior to Lead Aircraft hand-off to Center A and/or prior to the IM Aircraft reaching the PCP. In these circumstances, the Sector 15 controller will issue a cancellation instruction to the IM Aircraft at the appropriate time. Whether the IM operation automatically cancels at the PCP, or the controller cancels the operation, the Sector 15 controller will ensure status of IM operation is properly recorded, and any display indications are properly updated.

After cancellation, the AAL361 and AAL452 flight crews fly their respective ATC assigned speeds.

## 5.3 En Route Time-based Operations

### 5.3.1 Scenario 3: Time-based Exit Restriction

Scenario 3 demonstrates an IM operation when an IM aircraft is going to enter an oceanic sector and is required to be spaced behind a preceding aircraft by time. In this case, Center A is required to deliver aircraft into the oceanic sector 10 minutes (600 seconds) in trail. Additionally, this scenario includes a vector to account for initial spacing that is unlikely to be resolved with speed alone. Figure 5-4 illustrates the aircraft, routes, IM special points, and sectors and centers involved in the scenario.

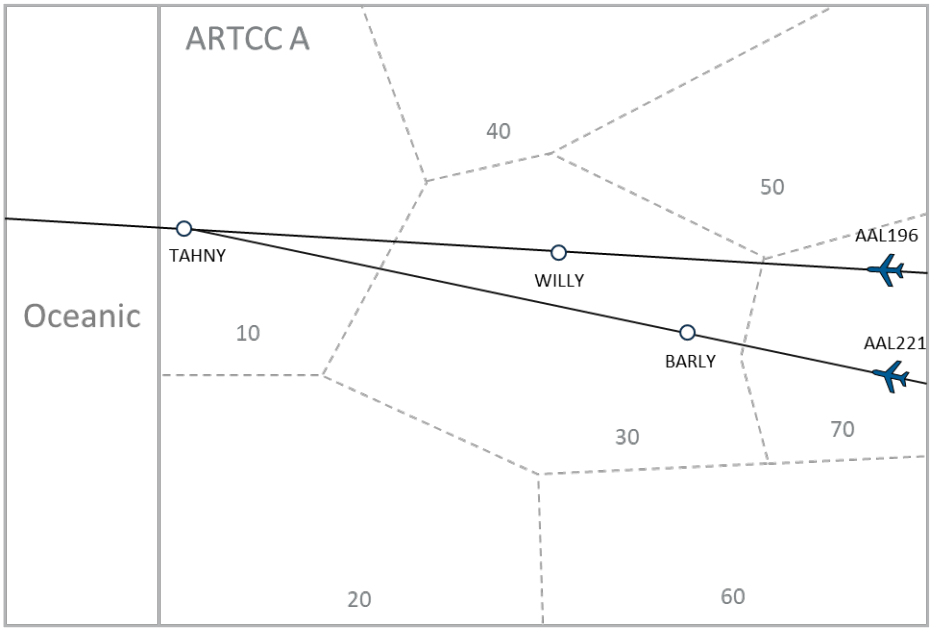


**Figure 5-4. En Route Scenario 3 – Time-based Exit Restriction**

Table 5-7 summarizes the roles of each of the participants in scenario 3.

**Table 5-7. Scenario 3 Participants and Tasks**

| Participants | Tasks |
|---|---|
| **TMU** | ➢ Enter the exit restriction (time) on ESIS, if applicable; otherwise, restriction may be part of the center SOP |
| **Center A ATC** | ➢ Initiate IM if and when appropriate<br>➢ Cancel IM early if necessary<br>➢ Ensure the IM clearance is appropriately canceled prior to leaving the center, and the IM Aircraft is provided the proper speed instruction |

| Participants | Tasks |
|---|---|
| **IM Aircraft Flight Crews** | ➢ Assess IM clearance on receipt<br>➢ Implement IM speeds<br>➢ Monitor FIM Equipment<br>➢ Self-Report Active IM on Check-in<br>➢ Notify ATC if unable to continue spacing operation<br>➢ Follow ATC instructions |

Table 5-8 lists the key IM related parameters for scenario 3.

**Table 5-8. Scenario 3 Key Parameters**

| Parameter | Scenario Details | Notes |
|---|---|---|
| **ASG** | 10 Minutes (600 seconds) | May be posted on ESIS or available in SOP |
| **IM Special Points** | CP: TAHNY<br>PCP: TAHNY | Last fix leaving en route airspace |
| **Aircraft Pair** | IM Aircraft: AAL221<br>Lead Aircraft: AAL196 | |

The SafeRoute+ avionics limits the ASG entry to three digits; the maximum time-based entry is 999 seconds (16 minutes 39 seconds).

IM clearances need to be canceled prior to entering oceanic airspace. If a convenient exit fix (e.g., TAHNY) is not available near the boundary, either the initiating controller may use the last fix in en route airspace in the trail aircraft's flight plan or may issue the clearance without the PCP, with the pre-coordinated understanding that the final controller in the initiating center must cancel the IM operation and provide an appropriate speed instruction. Regardless of the cancellation mechanism, the controller will ensure all IM status information is correctly updated.

#### 5.3.1.1 Pre-Initiation

A restriction is in place for aircraft entering oceanic airspace, 10 minutes in trail over last fix in enroute airspace. Time in trail is coordinated with affected sectors.

The Sector 70 controller recognizes the IM capable aircraft (AAL221) and identifies a candidate lead aircraft, both headed to oceanic airspace over TAHNY.

The Sector 70 controller defines the following IM clearance elements.

- Trail Aircraft = AAL221
- Lead Aircraft = AAL196
- ASG = 600 seconds
- Clearance Type = Cross
- CP = TAHNY
- PCP = TAHNY

The Sector 70 controller recognizes that the aircraft are currently spaced such that they are tied over TAHNY, and therefore it is unlikely that speed changes alone will be enough to meet the 600 second ASG. The Sector 70 controller vectors AAL221 off the route for a short time, then clears the aircraft direct to TAHNY and ensures that all additional applicable initiation criteria are satisfied prior to initiating the IM operations.

#### 5.3.1.2 Initiation

Once the controller determines the clearance information and all initiating conditions are satisfied the controller issues the IM clearance and records the necessary IM clearance information. In this case, anticipating the automatic canceling at the transition to oceanic airspace, and in accordance with Center A procedures, the initiating controller also includes the follow-on speed instruction when issuing the IM clearance. The flight crew of the IM aircraft reads back the IM clearance and speed instruction to the controller, who confirms that the information read back matches what was issued.

The AAL221 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.

#### 5.3.1.3 Execution

The AAL221 flight crew flies the IM Speeds.

The Sector 70 controller monitors the speed of the trail aircraft and spacing and separation with AAL196 and other aircraft in the sector.

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.

As the flights progress and are handed-off to the next sector, the AAL221 flight crews will check-in on the next frequency and communicate that they are actively spacing behind AAL196.

The downstream controllers accept the hand-offs and continue to monitor the IM operations until the aircraft reach the PCP.

#### 5.3.1.4 Cancellation

At the PCP (TAHNY) the IM operation will automatically cancel, and the flight crew will maintain the ATC assigned speed issued with the IM clearance. The Sector 10 controller will update the IM information to show the IM clearance is canceled.

## 5.4 Time-based Arrival Operations

### 5.4.1 Scenario 4: Time-based Arrivals

Scenario 4 describes the application of IM to arriving aircraft at a metered airport (KMRF). Time-based ASGs will be used to support the metering schedule at the MF located at the TRACON boundary. Figure 5-5 illustrates the aircraft, routes, IM special points, and ZAB sectors involved in the scenario.

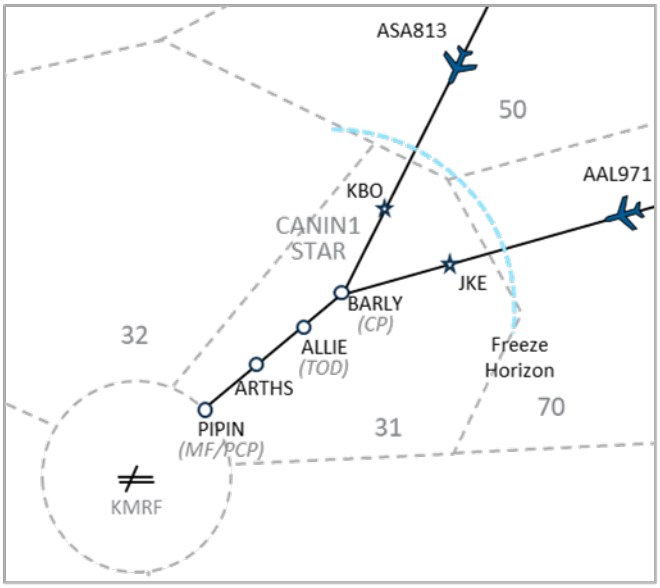


**Figure 5-5. En Route Scenario 4 – Time-based Arrivals**

Table 5-9 summarizes the roles of each of the participants in scenario 4.

**Table 5-9. Scenario 5 Participants and Tasks**

| Participants | Tasks |
|---|---|
| **TMU** | ➢ Support ATC, if necessary, in identifying time-based ASGs |
| **Sector 31** | ➢ If appropriate, initiate IM for aircraft on the CANIN1 arrival<br>➢ Cancel IM early if necessary<br>➢ Ensure the IM clearance is appropriately canceled, and the IM Aircraft is provided the proper speed instruction for the descent to KMRF |
| **IM Aircraft Flight Crews** | ➢ Assess IM clearance on receipt<br>➢ Implement IM speeds<br>➢ Monitor FIM Equipment<br>➢ Self-Report Active IM on Check-in<br>➢ Notify ATC if unable to continue spacing operation<br>➢ Follow ATC instructions |

Table 5-10 lists the key IM related parameters for scenario 4.

**Table 5-10. Scenario 4 Key Parameters**

| Parameter | Scenario Details | Notes |
|---|---|---|
| **ASG** | 80 seconds | May be derived from TBFM STAs or from another source that satisfies ATCs operational objective for spacing at PIPIN |
| **IM Special Points** | CP: BARLY<br>PCP: PIPIN | |
| **Aircraft Pair** | IM Aircraft: AAL971<br>Lead Aircraft: ASA813 | |

Although the scenario ends at PIPIN, these operations may continue into the TRACON if adequate coordination is provided and the appropriate LOAs are in place to authorize the operation. If continuation into the TRACON is not authorized, the en route arrival controller must ensure the operation is canceled prior to hand-off of the lead aircraft.

The use of a time-based spacing interval is appropriate for descent and allows for the spatial compression of aircraft as their groundspeeds reduce during descent to lower altitudes. Although the scenario depicted here is initiated in the sector containing the top of descent (TOD), a time-based IM operation may be used in level flight. Depending on the metering environment, time-based IM operations can be initiated earlier in the arrival with ASGs derived from the TBFM schedule or otherwise determined to support controller objectives. These ASGs may be updated (amended) as the aircraft progress on the arrival and schedules are frozen to the next meter reference point (MRP).

#### 5.4.1.1 Pre-Initiation

Aircraft landing KMRF are established on published routes and are routinely required to be spaced by arrival sector controllers. Spacing requirements may be an MIT restriction or a time restriction. The spacing requirement is provided by the TMU and coordinated with affected sectors. In this scenario, metering is in effect and the Center A controllers understand that time-based ASGs may be used to meet relative spacing objectives for suitably equipped aircraft arriving on the CANIN1 arrival into KMRF.

The Sector 31 controller recognizes that a KMRF bound flight (AAL971) is a candidate to use IM to achieve the desired spacing on the CANIN1 arrival. The Sector 31 controller confirms the appropriate Lead Aircraft in the sequence to KMRF (ASA813) and identifies the time-based spacing (80 seconds). The Sector 31 controller ensures both aircraft are direct to BARLY and on the CANIN1 arrival into KMRF. The controller defines the following IM clearance elements.

- Trail Aircraft = AAL971
- Lead Aircraft = ASA813
- ASG = 80 seconds
- Clearance Type = Cross
- CP = BARLY

- PCP = PIPIN

The Sector 31 controller ensures all applicable initiation criteria are satisfied prior to initiating the IM operation.

#### 5.4.1.2 Initiation

Once the Sector 31 controller determines the clearance information and all initiating conditions are satisfied the controller communicates the IM clearance to the AAL971 flight crew. The flight crew of the IM aircraft reads back the IM clearance to the controller, who confirms that the information read back matches what was issued.

The Sector 31 controller records IM Clearance information and status.

The AAL971 flight crew assesses 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 AAL971 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.

#### 5.4.1.3 Execution

The AAL971 flight crew flies the IM Speeds.

The Sector 31 controller monitors the speed of AAL971 and spacing with ASA813 and other aircraft in the sector. The Sector 31 controller may adjust the speed or vector the following aircraft to accomplish the required spacing behind AAL971.

Prior to AAL971 reaching ALLIE, the Sector 31 controller issues a descend via clearance for the CANIN1 with the exception to maintain IM spacing. The AAL971 flight crew will comply with the IM Speeds and the published altitudes. The Sector 31 controller monitors spacing, with the awareness that a natural compression will occur during the descent because a time-based clearance has been issued and at lower speeds the same time-based spacing will result in shorter distances.

#### 5.4.1.4 Cancellation

As the Lead Aircraft (ASA813) reaches the KMRF TRACON boundary and prior to hand-off, the Sector 31 controller cancels the IM clearance and instruct the AAL971 flight crew to fly published speeds for the CANIN1 arrival.

The Sector 31 controller updates the status of the IM operation to indicate it is canceled.

The AAL971 flight crew cancels the IM operation in the SafeRoute+ avionics.

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## *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 |
| CAVS | Cockpit Display of Traffic Information (CDTI)-Assisted Visual Separation |
| CDTI | Cockpit Display of Traffic Information |
| CMP | Coupled Meter Point |
| CP | Crossing Point |
| CRR | Continuous Range Readout |
| CSMM | Call Sign Mis-Match |
| CSP | Constraint Satisfaction Point |
| D-Side | Data Side |
| DCT | Delay Countdown Timer |
| EDST | En Route Decision Support Tool |
| ERAM | En Route Automation Modernization |
| ESIS | Enhanced Status Information System |
| FAA | Federal Aviation Administration |
| FDIO | Flight Data Input/Output |
| FMDS | Flow Management Data and Services |
| FIM | Flight Deck-Based Interval Management |
| FP | Flight Plan |
| GIM-S | Ground Interval Management-Spacing |
| ID | Identification |
| IFPI | Intended Flight Path Information |
| I-IM | Initial-Interval Management |
| IM | Interval Management |
| LOA | Letter of Agreement |
| MF | Meter Fix |
| MIT | Miles-in-Trail |
| MOPS | Minimum Operational Performance Standards |
| MRP | Meter Reference Point |
| NAS | National Airspace System |
| NAVAID | Navigational Aid |
| NM | Nautical Mile |
| PCP | Planned Cancellation Point |
| R-Side | Radar Side |
| RTCA | Radio Technical Commission for Aeronautics |

| | |
|---|---|
| SPR | Safety and Performance Requirements |
| 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 |
| TFDM | Terminal Flight Data Manager |
| TFMS | Traffic Flow Management System |
| 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 |