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of Transportation

# Memorandum

**Research and  
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Subject: Version 2.0 of the System Requirements for Task 3 of the Collaborative  
Decision-Making Program

From: Ken Howard/Volpe Center (617) 494-2697

To: CDM Workgroup

Attached is Version 2.0 of the System Requirements Document for Task 3 of the Collaborative Decision-Making (CDM) Program. Version 2.0 is a significant rewrite of the previous version (1.2). The document has been re-organized and has many functional changes reflecting the evolution of the system over the past 8 months.

The changes are primarily in the message exchange portion of the document; that is, the section that describes what messages an airline must send, how they must be sent, and how ATMS must process them. The portion of the requirements describing the slot allocation is largely unchanged from the previous version (1.2).

We strongly recommend that all parties who are building the CDM Task 3 software carefully reread these requirements. This is a good time to re-validate that our development is converging on a consistent functionality and that there are no expectations that will be unmet. Any comments, corrections, or questions should be sent to the author.

The major changes in the document are as follows:

- The document has been organized to separate airline requirements from ATMS requirements.
- Requirements have been added for diversion and cancellation processing.

# SYSTEM REQUIREMENTS DOCUMENT FOR TASK 3 OF THE COLLABORATIVE DECISION-MAKING PROGRAM

## 1. Introduction

### 1.1 Overview

This document describes the system requirements for Task 3 of the ATMS Collaborative Decision-Making (CDM) Ground Delay Program (GDP) Enhancements Program. Task 3 consists of modifying airline and FAA data processing systems to provide several significant new functions:

- send data directly from airlines to FAA concerning delays, cancellations, and other schedule changes
- send data from FAA to airlines concerning the aggregate traffic demand at airports
- assign arrival slots during ground delay programs according to OAG schedule
- apply compression to allow airlines to fully utilize their arrival slots

The advantage that this software offers to the FAA and the airlines is to reduce the number of ground delays issued and to preserve key aspects of the airlines' scheduling when a program is run. This can be accomplished for several reasons.

- FAA modeling (and therefore Monitor/Alert) will be based on current information on delays and cancellations rather than on the stale and less accurate information that is now used.
- The airlines will no longer be penalized if they submit early information on delays and cancellations to the FAA.
- The order of flights in the OAG schedule will be preserved during ground delay programs.

The CDM GDP Enhancements Program includes other tasks that will be documented at a later date. These tasks include:

- incorporating airline operational schedules
- simplifying the substitution process
- controlling by time of arrival
- exchanging additional data

### 1.2 Organization of this Document

This document has been organized into separate sections for the different major components of the CDM GDP system to facilitate its use by the different organizations involved in CDM. However, it is strongly recommended that anyone participating in the CDM GDP system development read the entire document to gain an understanding of the entire CDM system. For example, an airline developer needs to understand the ATMS requirements for accepting and rejecting messages described in section 3 to ensure that the messages will be properly generated.

This document is divided into four main sections:

- Section 1. - Introduction

- Section 2. - Airline Requirements
- Section 3. - ATMS Requirements
- Section 4. - FSM Requirements

### 1.3 Definitions

There are terms used throughout this document with a very specific meaning. These are defined as follows:

- **Advanced Traffic Management System (ATMS)** is the prototype FAA system for processing CDM flight data messages along with other flight data to maintain a national flight data base. ATMS provides that data to the FAA traffic management specialists. ATMS is the R&D counterpart to ETMS.
- **Aggregate Demand List (ADL)** is a set of data that provides a picture of the total predicted arrival demand at an airport.
- **Airline** is used generically to refer to any organization that regularly operates a schedule of flights in the NAS and is participating in the CDM GDP Enhancements program
- **Compression** is an algorithm used when computing a ground delay program that creates a “bridge” across a gap in a substitution sequence by moving other flights up in time.
- **Enhanced Traffic Management System (ETMS)** is the operational FAA traffic management system.
- **Flight** refers to a single occurrence of a single leg of a flight (e.g., United flight 123 from BOS to ORD on January 30, 1996).
- **Flight Data Message** refers to the airline messages that create, modify, or cancel flights.
- **Flight Data System** is used generically to refer to an airline’s data processing system for maintaining operational flight schedule data.
- **Flight Database** is the ATMS hub site database containing national flight data which is used for FAA traffic management.
- **Flight Schedule Monitor (FSM)** is the prototype software developed by FAA for viewing flight data and running traffic management programs associated with managing arrivals at an airport.
- **Ground Delay Program (GDP)** is a set of departure and arrival times assigned by FAA to flights to manage an airport arrival overload.
- **National Airspace System (NAS)** is the FAA’s air traffic control system.
- **NAS Data** is automated data from the NAS including flight plans, amendments, cancellations, departures, arrivals, track (position) updates, and center boundary crossings.
- **Substitution** is an action whereby an airline moves a flight from one assigned arrival slot into another arrival slot. A substitution may involve moving a flight into a cancelled flight’s slot, moving a flight into a previously vacated slot, or exchanging two flights’ arrival slots.

### 1.4 Associated Documents

Other documents related to the CDM program are as follows:

- **ADL Data Format** specifies the ADL report format and contents.

- **CDM Message Formats** specifies the message formats and protocols for flight data exchange between airlines and FAA.

## 2. Airline Requirements

### 2.1 Overview

Airlines currently make many decisions on how they will operate their flights of which the FAA is unaware. In particular, during a bad weather situation at an airport, an airline may be aware of delays and/or cancellations that affect the arrival situation at that airport. Airlines have in the past been discouraged from sending delays and cancellations to FAA as they may lose arrival slots or receive additional delays once a GDP is run. Under CDM Task 3, the GDP software and policy are being modified to remove these penalties. As a consequence, also as part of Task 3, airline Flight Data Systems are being modified to send flight data messages directly to ATMS notifying FAA of the latest and best data that the airlines have for the flights. Section 2.2 specifies the requirements for the airline generation of flight data messages.

Simplifying the substitution process is beyond the scope of Task 3. The airlines will continue to use the current operational SI process, as stated in Section 2.3.

### 2.2 Flight Data Message Generation

Airlines will generate three types of flight data messages.

- **Create** message - Either creates a new flight or reinstates a flight that had previously been cancelled.
- **Modify** message - Provides new data for a flight.
- **Cancel** message - Cancels a flight.

The requirements for generating these messages are as follows.

#### 2.2.1 Communications

Two mechanisms are currently being provided for airlines to use for sending flight data messages to ATMS: the pre-existing ARINC network and the new private AOCNet. In the future, the Internet may also be used for transmitting flight data messages.

**Req. 2.2.1-1** An airline shall feed flight data messages to ATMS in one of the two following manners:

- a) via ARINC to an ARINC address designated by FAA
- b) via AOCNet to an IP address designated by FAA

**Req. 2.2.1-2** An airline shall provide a default address (ARINC or IP) for ATMS to use when generating message replies and error messages.

**Req. 2.2.1-3** An airline shall follow the message formats and protocols specified in the document *CDM Message Formats*.

#### 2.2.2 Message Formatting

Some general requirements about the contents of the messages are specified here. Requirements specific to each message type are specified in sections 2.2.3 - 2.2.5. Detailed formats for the messages are documented separately, as stated in requirement 2.2.2-4:

- Req. 2.2.2-1** The airlines shall provide all dates and times in Universal Time Coordinates (formerly GMT).
- Req. 2.2.2-2** For the purposes of uniquely identifying a flight, the airlines shall provide on each flight message the following fields: the flight ID, original departure date/time, origin airport, and destination airport.
- Req. 2.2.2-3** The original departure date time shall be the month, date, hour, and minute on which the flight leg was originally planned to leave the gate at its departure airport; that is,
  - a) for a flight in OAG, the original departure date/time shall be the gate departure time for that flight leg as specified in the OAG schedule
  - b) for a flight not in OAG, the original departure date/time shall be the gate departure time for that flight leg as specified in the message which first created the flight in the ATMS flight database

Additional data fields and message types will be specified in the future; however, they are not required to complete CDM Task 3.

- Req. 2.2.2-4** Airline flight data messages shall be formatted according to the specifications found in the document *CDM Message Formats*.

### 2.2.3 Create Message

Airlines will send create messages to ATMS to ensure that all flights that will be operating are in the ATMS database. Create messages will be sent to add a new flight or to re-instate a flight that has previously been cancelled.

- Req. 2.2.3-1** An airline shall send a create message to ATMS whenever any of the following conditions is met:
  - a) a new flight is created in its Flight Data System
  - b) a previously cancelled flight has been reinstated in its Flight Data System (i.e., the airline is now planning to operate the flight)
  - c) a flight on the ground is diverted to a new destination (see section 2.2.6 for diversion processing)
- Req. 2.2.3-2** An airline create message shall specify the following information for the flight being created:
  - a) flight ID
  - b) original departure date/time
  - c) departure airport
  - d) arrival airport
  - e) gate departure date/time
  - f) runway departure date/time (optional)
  - g) arrival airport
  - h) gate arrival date/time
  - i) runway arrival date/time (optional)

j) aircraft type

**Req. 2.2.3-3** The airlines shall always provide gate times when a flight is first created. The airline shall also provide runway times whenever available.

## 2.2.4 Modify Message

Airlines will send modify messages to ATMS to ensure that ATMS has the latest data for its flights.

**Req. 2.2.4-1** An airline shall send a modify message to ATMS whenever any of the following conditions is met:

- a) the call sign changes
- b) the equipment type changes
- c) the destination changes for an airborne flight
- d) the gate departure time changes by more than 15 minutes from the last value sent to ATMS
- e) the gate arrival time changes by more than 15 minutes from the last value sent to ATMS
- f) the runway departure time changes by more than 15 minutes from the last value sent to ATMS
- g) the runway arrival time changes by more than 15 minutes from the last value sent to ATMS

**Req. 2.2.4-2** An airline modify message shall specify the following information for the flight being modified:

- a) flight ID
- b) original departure date/time
- c) departure airport
- d) arrival airport
- e) modified flight data (can be multiple fields)

## 2.2.5 Cancel Message

Airlines will send cancel messages to ATMS to ensure that FAA is aware of any flights that are not going to operate. (NOTE: Once a flight is cancelled it can only be re-instated with a create message.)

**Req. 2.2.5-1** An airline shall send a cancel message to ATMS whenever any of the following conditions is met:

- a) a flight is not going to operate
- b) a flight on the ground has been diverted to another airport (see section 2.2.6 for diversion processing)

**Req. 2.2.5-2** An airline cancel message shall specify the following information for the flight being cancelled:

- a) flight ID
- b) original departure date/time

- c) departure airport
- d) arrival airport

### 2.2.6 Exception Cases

Although the general message requirements above implicitly cover the exception cases (diversions and cancellations), they should be restated explicitly to ensure proper message generation. The message requirements for these cases are in some cases dictated by the data requirements of FSM and by the processing required to combine the airline data with NAS data.

- Req. 2.2.6-1** An airline shall divert a flight on the ground to a new destination by sending a cancel message for the old flight (i.e., old destination) and a create message for the new flight (i.e., new destination).
- Req. 2.2.6-2** An airline shall divert a flight in the air to a different destination by sending a modify message with the revised destination.
- Req. 2.2.6-3** An airline shall indicate that a flight has returned to the gate by either:
  - a) sending a modify message with the new flight data if the airline is still planning to operate the flight to the same destination
  - b) sending a cancel message if the airline is not planning to operate the flight
  - c) sending a cancel and create message if the airline is planning to operate the flight to a new destination (i.e., process it as a diversion for a flight on the ground)

We have not stated an explicit requirement for a flight that departs and then returns to its originating station. This case should be handled as an airborne diversion (requirement 2.2.6-2).

Examples of exception case processing can be found in the memo *Message Processing for Exception Cases*.

## 2.3 Substitution Messages

Task 3 does not include any modifications to the substitution processing that occurs after a GDP is issued, so the old rules and message formats must still be followed.

- Req. 2.3-1** Following the issuance of a GDP by FAA, an airline shall substitute flights by using the existing ETMS message formats and processing rules.

## 3. ATMS Requirements

### 3.1 Overview

The main function of ATMS is to provide traffic management specialists with the best possible prediction of traffic demands to allow the specialists to anticipate and avoid traffic congestion and delays. ATMS currently receives flight data from two primary sources. OAG provides airline schedules for far look-ahead planning; flights from the OAG schedules are loaded into the ATMS databases twelve hours prior to their departure time. NAS provides real-time data about flights as they operate; NAS data typically begins to enter the ATMS databases about one hour prior to departure. These two data sources leave a gap during a critical time when much traffic management planning is done. Under CDM Task 3, this gap will be filled by data sent directly from airlines to ATMS via flight data messages. The requirements for processing the flight data messages are specified in Section 3.2.

ATMS will incorporate the airline flight data into its databases along with the OAG and NAS data, and provide the enhanced data through its normal outputs to the FAA traffic management specialists. ATMS will also be enhanced to provide ADL files to both traffic management specialists and airline personnel for viewing through FSM. Section 3.3 gives the requirements for generating CDM-related outputs

## 3.2 Flight Data Message Processing

When a flight data message is received, the main processing job for each message will normally be to:

- Create message: insert that flight into the Flight Database.
- Modify message: change the flight data in the Flight Database;
- Cancel message: mark that flight in the Flight Database as cancelled.

The requirements for processing these messages are as follows.

### 3.2.1 Communications

Two mechanisms are currently being provided for airlines to use for sending flight data messages to ATMS: the pre-existing ARINC network and the new private AOCNet. In the future, the Internet may also be used for transmitting flight data messages. ATMS will keep CDM communications separate from any communications with the operational system.

**Req. 3.2.1-1** ATMS shall provide two destinations for airline flight data messages

- a) an ARINC address on the existing ARINC network
- b) an IP address on the new AOCNet

**Req. 3. 2.1-2** ATMS shall send replies and error messages to the return address associated with the message, or in lieu of any return address, a default address provided by the airline.

**Req. 3. 2.1-3** ATMS shall follow the message formats and protocols specified in the document *CDM Message Formats*.

**Req. 3. 2.1-4** ATMS shall keep the CDM communications paths separate from the operational ETMS.

### 3.2.2 Packet Handling

ATMS will by default acknowledge every message that it receives. To reduce the amount of data going back to the airline, an airline may optionally specify that no reply is wanted if no errors are found.

**Req. 3. 2.2-1** ATMS shall positively acknowledge every message packet that is received unless indicated otherwise by the sending airline.

**Req. 3. 2.2-2** ATMS shall allow the airline to suppress an acknowledgment when no errors are found in a message packet.

**Req. 3. 2.2-3** ATMS shall always send a reply when an error is encountered in a packet.

**Req. 3. 2.2-4** ATMS shall indicate in a packet reply whether each message in the packet was processed successfully or not.

**Req. 3. 2.2-5** ATMS shall send an explanatory error message for each message in a packet that is not processed successfully.

**Req. 3. 2.2-6** ATMS shall send any reply within one minute of receiving a message packet.



The format of the acknowledgment and error messages is specified in the document *CDM Message Formats*.

### 3.2.3 Syntax Checking

The formats of the flight data messages are specified in the document *CDM Message Formats*. Prior to performing any processing of the data, ATMS will check the syntax of the messages according to those specifications. ATMS will reject messages that have syntax errors and not use them for updating the ATMS Flight Databases.

**Req. 3.2.3-1** ATMS shall verify the syntax of each message prior to processing the data in the message and shall reject any message which is found to have incorrect syntax.

### 3.2.4 Message Timing

At any given time, the ATMS Flight Database maintains data only for flights scheduled to depart in the next twelve hours. Airlines, however, know about changes to their flight operations, in some cases, weeks or months ahead of time. In order to ease the job of implementation for the airlines, ATMS will accept airline flight data messages at any time and enter them into the Flight Database when appropriate. Because the departure date on the messages is limited to month and date, the airlines are practically limited from sending in flight messages more than one year prior to a flight's departure time. To reduce the possibility of errors, we suggest that the time period be limited to 11 months following the current month (this prohibits receiving messages for March 1998 during March 1997 and perhaps confusing them).

**Req. 3.2.4-1** ATMS shall use any flight message showing an original or estimated gate departure time within 12 hours of the current time to immediately update the Flight Database.

**Req. 3.2.4-2** ATMS shall store any flight message showing an original and estimated gate departure beyond 12 hours from the current time and within 11 months from the current month and re-process it when the departure time is within the 12 hour window of the current time.

**Req. 3.2.4-3** ATMS shall process the stored messages in the order that they were originally received.

**Req. 3.2.4-4** When a stored message is re-processed, ATMS shall not generate a reply to the airline if the message is processed correctly.

**Req. 3.2.4-5** When a stored message is re-processed, ATMS shall generate a reply to the airline's default address if an error occurs when processing the message.

### 3.2.5 Create Message Processing

A create message is normally used to create a new entry in the ATMS Flight Database. However, it may be difficult for an airline to always know whether a flight exists in the ATMS Flight Database prior to generating a message. In particular, an airline may think that a flight is missing from the ATMS database and send a create only to have it rejected by ATMS because the flight already exists from OAG data. To reduce unnecessary message rejections, ATMS will accept a create message for a flight that is already in the Flight Database as long as it is the first airline message received for that flight.

Create messages are also used to re-instate flights that have already been cancelled by an airline. A create message is the only airline message that can re-instate a cancelled flight.

The determination of whether a flight specified in a create message already exists in the Flight Database can be ambiguous. For example, if a flight exists that departs the same airport at the same time but has a

different destination than the create message, it is not clear whether it is the same flight. To properly define the requirements we must define two types of matches:

- **perfect match** is used when the flight in the message matches an entry in the database in flight ID, origin, destination, and approximate time of operation
- **partial match** is used when the flight in the message matches an entry in the database in origin or destination (but not both), and approximate time of operation

A message that has neither type of match is considered to have no matching entry.

For create messages, a partial match is generally rejected, as it is likely that there has been some kind of error. The only case that is accepted is when only OAG data exists for the flight; in this case, it is most likely that the OAG data is in error and the airline data is correct. In other cases, the airline data either conflicts with previous airline data or NAS data and is therefore considered an error.

The next set of requirements explains how create messages will be handled.

- Req. 3.2.5-1** ATMS shall accept a create message for any flight that does not match a flight in the Flight Database and add the flight to the Flight Database.
- Req. 3.2.5-2** ATMS shall accept a create message and update the flight data for a perfect match in the Flight Database if that flight meets one of the following criteria:
  - a) that flight has previously been cancelled by the airline and has not yet been reinstated, or
  - b) the create message is the first message that has been received from the airline for this flight
- Req. 3.2.5-3** ATMS shall accept a create message and update the flight data for a partial match in the Flight Database if only OAG data has previously been received for the flight.
- Req. 3.2.5-4** ATMS shall reject any create message that does not meet the conditions stated in requirements 3.2.5-1 to 3.2.5-3.

### 3.2.6 Modify Message Processing

A modify message is normally used to update data for a flight that already exists in the Flight Database. However, the same difficulty exists for the airline as with the create message; namely, the airline may not know for certain that the flight exists in the ATMS database. To reduce the amount of message rejections, ATMS will accept a modify message for a flight that is not already in the database as long as sufficient data is provided to create the flight entry. However, ATMS will not allow a modify message to re-instate a cancelled flight.

The decision of whether a modify message matches an existing Flight Database entry presents the same problems as with the create message. The terms *perfect match* and *partial match* are again used to clarify the requirements; see the definition of these terms in section 3.2.5. The same general principle is used for the modify message as for the create message; that is, when a modify message partially matches an entry created from OAG data, ATMS corrects the entry with the airline data, but ATMS rejects a modify message that partially matches an entry which has previous airline or NAS data.

There are a number of conditions that can cause a modify message to be rejected. If none of these is met, ATMS will use the data to update the database.

The following requirements specify how modify messages will be processed.

**Req. 3.2.6-1** ATMS shall reject a modify message for a partial match in the Flight Database if any of the following conditions is met:

- a) airline data has previously been received for this flight
- b) NAS data has previously been received for this flight
- c) an EDCT has been previously received for the flight

**Req. 3.2.6-2** ATMS shall reject a modify message for a perfect match in the Flight Database if any of the following conditions is met:

- a) the flight has been previously cancelled by the airline and has not been re-instated
- b) the flight is on the ground and the origin or destination is being modified
- c) the flight is in the air and the origin is being modified
- d) the flight is completed and the origin or destination is being modified
- e) the flight is in the air or completed and the estimated gate or runway time of departure is being modified
- f) the flight has been completed and the estimated gate or runway time of arrival is being modified
- g) the controlled departure time, controlled arrival time, or assigned arrival slot is being modified

NOTE: An exception to condition f) is being allowed until the actual time of arrival field is implemented. Until such time, ATMS will allow the arrival time to be modified up to one hour after the flight is completed.

**Req. 3.2.6-3** ATMS shall accept a modify message for a flight that already exists in the Flight Database and update the data for that flight as long as the conditions specified in requirement 3.2.6-1 and 3.2.6-2 are not met.

**Req. 3.2.6-4** ATMS shall accept a modify message for a flight that does **not** exist in the Flight Database if the following data fields are provided in the message:

- flight ID
- departure date
- departure airport
- arrival airport
- gate departure date/time
- arrival airport
- gate arrival date/time
- aircraft type

### 3.2.7 Cancel Messages

A cancel message is normally used to indicate that a flight that already exists in the Flight Database is not going to be operating. Additionally, to ensure that diversions are properly represented in FSM, a cancel message is used as part of a diversion of a flight on the ground (the flight is cancelled and re-created).

The decision of whether a cancel message matches an existing Flight Database entry presents the same problems as with the create and modify. The terms *perfect match* and *partial match* are used to clarify the requirements. See the definition of these terms in section 3.2.5. Cancel messages with partial matches are always rejected.

There are a number of conditions under which a cancel message is rejected. If none of these is met, the matching flight in the database is marked as cancelled.

The following requirements specify how cancel messages will be processed.

**Req. 3.2.7-1** ATMS shall reject a cancel message that matches no entry in the Flight Database.

**Req. 3.2.7-2** ATMS shall reject a cancel message that has a partial match in the Flight Database.

**Req. 3.2.7-3** ATMS shall reject a cancel message that has a perfect match in the Flight Database if any of the following conditions is met:

- a) the flight has already been cancelled by the airline.
- b) the flight has already departed.
- c) the flight has received an EDCT.

**Req. 3.2.7-4** ATMS shall update the Flight Database for any cancel message that does not meet any of the criteria in requirements 3.2.7-1 to 3.2.7-3.

### 3.2.8 Flight Database Maintenance

ATMS receives flight data from OAG and NAS as well as from the airlines. ATMS combines incoming data in the Flight Database to provide the best possible data to the traffic management specialist and airline user. The definition of “best” data is difficult. A general precedence has been adopted for resolving data conflicts:

- NAS data has precedence over airline data
- Airline data has precedence over OAG data

There are several exceptions to these rules in the current requirements:

- Airline predicted departure and arrival times have precedence over NAS flight plan times.
- Airline cancellation data has precedence over NAS flight plan data.

Additionally, runway departure and arrival times provided by the airlines are given precedence over times modeled by ATMS.

This section does not pretend to state the entire requirements for ATMS Flight Database maintenance but only those relevant to the CDM message processing. It is assumed that current ETMS processing is followed except where specified below. Some of these requirements are redundant with the individual message processing requirements but are included here to fully clarify the processing requirements.

#### Cancellations

Following are the requirements for determining whether a flight is cancelled given conflicting NAS and airline data:

**Req. 3.2.8-1** If a NAS flight plan cancel message is received and airline flight data messages have previously been received for the flight and the airline has not cancelled the flight, ATMS shall not cancel the flight.

**Req. 3.2.8-2** If a NAS flight plan is received for a flight that has been cancelled by an airline,

ATMS shall consider the flight to still be cancelled.

- Req. 3.2.8-3** If either a NAS flight plan cancellation or airline cancel message is received for a flight that has only OAG data, ATMS shall consider the flight cancelled.

In addition to NAS cancellations, a flight may be manually cancelled by a traffic management specialist through an ASD command. The command causes an “RS” message to be generated. This is a rare occurrence, and typically occurs when a specialist has been in communication with an airline. For this reason, the RS will override the airline flight data messages.

- Req. 3.2.8-4** If an RS message is received for a flight for which airline flight data messages have been received, ATMS shall consider the flight cancelled.

ATMS cancels flights which have not departed well past their planned departure time and for which no updates have been received. The time out logic shall remain unchanged from ETMS, but ATMS will allow an airline message to update the departure time for a “timed-out” flight, and if the new time is valid, will re-instate the flight. (Note that if a timed-out flight departs, current ATMS logic will also re-instate the flight.)

- Req. 3.2.8-5** If a flight for which airline messages have been received has not departed within one hour of its estimated runway departure time, ATMS shall consider the flight cancelled.

- Req. 3.2.8-6** If a valid airline flight data message is received for a flight which has previously been timed out and if the message provides a new departure time for the flight that is in the future, ATMS shall re-instate the flight.

#### Data Field Updates

The data field updates again rely on the distinction between perfect and partial matches. Refer to section 3.2.5 for the definition of these terms. In essence, when a NAS flight plan is a perfect match with previously received airline data, there are no issues. When a NAS flight plan has a different origin or destination than previously received airline data, it is processed as if the flight has been diverted. This might occur in a situation where an airline diverts a flight close to departure time and ATMS receives the flight plan before the airline cancel and create message. This processing is intended to create the same result in the database as if the cancel and create messages were received before the flight plan.

Following are the requirements for updating flight data fields in the Flight Database:

- Req. 3.2.8-7** ATMS shall not allow an airline, through a modify or cancel message, to change certain fields that have been received in a NAS flight plan. The fields that may not be changed are:
- a) call sign
  - b) departure airport,
  - c) arrival airport, and
  - d) aircraft type.
- Req. 3.2.8-8** When a NAS flight plan is a perfect match with a flight that has been created or modified by an airline message, ATMS will only use the aircraft type to update the database (NOTE: The flight plan times will be saved but not used to update the estimated runway times of departure and arrival).
- Req. 3.2.8-9** When a NAS flight plan is received that is a partial match with a flight that has been created or modified by an airline message, ATMS shall process the flight plan as if it is a diversion; that is, ATMS shall:

- a) cancel the flight with the airline data
- b) create a new flight entry from the flight plan data

ATMS maintains a best estimated runway departure and arrival time for each flight. These times are used for projecting traffic demands at an airport and displaying those demands to the traffic management specialist and airline user through FSM. These times will be maintained according to the following requirement:

**Req. 3.2.8-10** ATMS shall maintain best estimated runway departure and arrival times according to the following precedence (from high to low)

- a) actual time from NAS
- b) latest runway times provided by airline
- c) time from latest EDCT file
- d) time modeled from latest airline gate times
- e) time modeled from latest NAS flight plan times
- f) time modeled from OAG gate times

In addition to departure and arrival times, ATMS models times at intermediate points along a flight's route such as sector entry and exit points. ATMS must resolve the airline-provided runway times with the intermediate event times as stated in the following requirement:

**Req. 3.2.8-11** When ATMS uses airline provided runway departure and arrival times, ATMS shall update the intermediate event times to maintain temporal consistency with the runway times.

### 3.2.9 EDCTs and Subs

Task 3 does not include any modifications to the substitution processing that occurs after a GDP is issued, so the old rules and message formats must still be followed. However, additional data – assigned arrival slot and slot class -- is available in an FSM-generated GDP. ATMS will maintain this data throughout the EDCT and SI processing.

**Req. 3.2.9-1** ATMS shall in general process EDCTs in the same manner as ETMS.

**Req. 3.2.9-2** When processing an EDCT program, ATMS shall store assigned arrival slot and slot class along with the other EDCT data.

**Req. 3.2.9-3** ATMS shall in general process SIs in the same manner as ETMS.

**Req. 3.2.9-4** When processing an SI message, ATMS shall maintain assigned arrival slot and slot class data so that when a flight is moved into another flight's arrival slot, it assumes the assigned arrival slot and slot class of the flight that previously owned the slot.

### 3.3 Demand Data

The new flight data whose processing is described in section 3.2 must be incorporated into outputs for the traffic management specialist and airline user to view. The primary tool for viewing the data is FSM, described in section 4. FSM gets its data by requesting ADL files from ATMS. The ADL file is based on a new type of REQ report that incorporates the new CDM data. The CDM data also affects other ATMS outputs; that is, the data outputs that ETMS provides. The general approach has been to:

- Make no changes to existing output formats.
- Use airline data to improve accuracy of data fields where possible.

- Make all new CDM data available through a new report type.

The requirements for these outputs are specified below.

### 3.3.1 Existing Outputs

As CDM Task 3 is a prototype, it will not include any changes to the existing ETMS outputs except as the data accuracy can be improved through the processing described in section 3.2.

**Req. 3.3.1-1** ATMS shall maintain all existing ETMS data output formats.

**Req. 3.3.1-2** ATMS shall use CDM data to update data values in existing ETMS data output formats as indicated by the data processing requirements specified in section 3.2.

### 3.3.2 CDM Report

ATMS shall provide a new report type similar to the current REQ LIST report that makes new data fields particular to CDM available to the user. The detailed formatting of the report and report requests are described in a separate document *ADL Data Format*.

**Req. 3.3.2-1** ATMS shall provide a new report type for CDM data (REQ CDM).

**Req. 3.3.2-2** In a CDM report, ATMS shall display all flight times as 6-digits containing two digits each for date, hour, and minute.

**Req. 3.3.2-3** In a CDM report, ATMS shall include cancelled flights and an indication of why they were cancelled.

**Req. 3.3.2-4** In a CDM report, ATMS shall provide the current ETMS report data fields.

**Req. 3.3.2-5** In a CDM report, ATMS shall provide new fields for the new data elements provided by the airline flight data messages.

**Req. 3.3.2-6** In a CDM report, ATMS shall provide new fields for the new data elements provided by an FSM-generated GDP.

**Req. 3.3.2-7** In a CDM report, ATMS shall indicate when an ETD or ETA is a value provided by the airline.

**Req. 3.3.2-8** In a CDM report, ATMS shall make available the estimated runway departure and arrival time from when the flight was first created in the database.

### 3.3.3 ADL Distribution

To support operational use of FSM, ATMS must provide a capability of distributing a fixed format CDM report to all user sites that are using FSM to monitor a particular airport. The reports must be synchronized so that various users who are collaborating in a decision-making process are looking at the same data at the same time. Furthermore, the data must be filtered in a manner so that airlines do not see sensitive information from their competitors, yet the full functionality of FSM is still supported. This section defines the requirements for the ADL distribution.

The detailed format of the ADL report file is described in the document *ADL Data Format*. The messages for ADL data registry and retrieval are defined in the document *CDM Message Formats*.

**Req. 3.3.3-1** ATMS shall allow any authorized user to register for ADL data for a given airport.

**Req. 3.3.3-2** ATMS shall distribute fixed format ADL files to all registered users at a fixed time interval.

- Req. 3.3.3-3** ATMS shall ensure that ADL files sent to all users contain the same data except as restricted by requirement 3.3.3-4
- Req. 3.3.3-4** ATMS shall filter ADL files sent to airline so that an airline can see call signs only for its own flights or for flights belonging to an associated sub-carrier.
- Req. 3.3.3-5** When filtering call signs (requirement 3.3.3-4), ATMS shall replace unauthorized call signs with dummy call signs in a manner that ensures that all airlines will get the same results when running the FSM compression and substitution algorithms.

## 4. FSM Requirements

### 4.1 Background

When significant arrival delays are predicted at an airport, generally due to a reduction in the airport acceptance rate, a traffic management specialist may run a ground delay program for that airport. Currently, when a specialist decides to run a ground delay program at an airport, he or she prepares a list of flights that ETMS predicts to arrive at that airport during the time interval when the ground delay program is to be in effect. That list of flights is then passed to the Groverjack program, which then assigns those flights to the available landing slots.

The functions of producing the flight list and assigning flights to slots will be taken over by the Flight Schedule Monitor (FSM). Assigning flights to slots, which is performed in a single step by Groverjack, shall be performed in two steps by FSM. First, ration by schedule is used to determine which slots are assigned to each airline. Second, the slots belonging to each airline are filled with that airline's flights.

### 4.2 Preparing the List of Flights for Rationing by Schedule

Preparing the list of flights that serve as input to the rationing by schedule algorithm has several complications. Flights that were originally scheduled to be in the program time interval may now be expected to arrive before or after the program, or these flights may have been canceled. Flights originally scheduled to arrive before the program may now be arriving in the program. Also, flights that were not scheduled at any time may now be expected to arrive during the program. These complications must be dealt with so that slots are assigned without penalizing airlines submitting accurate information on delays and cancellations.

The following definitions are needed.

- Definition: A flight is a *scheduled flight* if it
- a) was in the most recent update of the OAG airline schedule database or
  - b) was created by a create message submitted by an airline.

Any other flight is an *unscheduled flight*.

- Definition: A flight is a *Class I* flight if it
- a) was in the most recent update of the OAG airline schedule database or
  - b) was created by a create message submitted by an airline at least forty-eight hours before its originally scheduled runway departure time.

Any other flight is a *Class II* flight.

- Definition: The *original scheduled arrival time* for a scheduled flight is the runway arrival time that the flight had when it first entered the ATMS Flight Database. (If a runway



arrival time is not provided, ATMS will estimate the runway arrival time from the gate arrival time provided in the OAG or the create message.)

Definition: The *original predicted arrival time* for an unscheduled flight is the runway arrival time derived from the NAS flight plan when the flight was first created in the ATMS Flight Database. (ATMS will estimate the original runway time from the original gate arrival time provided in the NAS flight plan.)

Definition: The *current predicted arrival time* for a flight is the most recent runway arrival time that the ATMS Flight Database shows. (This arrival time is provided by, or modeled on the basis of, a create message, modify message, NAS flight plan, or NAS flight plan amendment.)

When a specialist wants to compute a ground delay program at an airport for an interval of time, FSM must give the specialist the capability to produce the list of flights that will be used by the ration by schedule algorithm. The following requirements specify which flights will be included in this flight list.

**Req. 4.2-1** FSM shall provide the specialist with a command that, when executed, prepares a list of flights to be used by the ration by schedule algorithm.

**Req. 4.2-2** The ration by schedule flight list shall include the following categories of flights:

- a) scheduled flights that have an original scheduled arrival time in the program time interval and that are currently predicted to arrive during or after the program time interval
- b) scheduled flights that have an original scheduled arrival time in the program time interval and that have been cancelled
- c) scheduled flights that have an original scheduled arrival time before the program time interval and that have a current predicted arrival time in the program time interval
- d) unscheduled flights with a current predicted arrival time during the program time interval

**Req. 4.2-3** The ration by schedule flight list shall **not** include the following categories of flights:

- a) flights that have an original scheduled arrival time during the program time interval and that have a current predicted arrival time before the program time interval
- b) flights that have neither an original scheduled arrival time during the program time interval nor a current predicted arrival time during the program time interval

**Req. 4.2-4** FSM shall sort the flights in the ration by schedule flight list in ascending order by arrival time; if two flights have the same arrival time, then they shall be ordered randomly. The arrival times used for these flights shall be:

- a) original scheduled arrival times for all scheduled flights and
- b) original predicted arrival times for all unscheduled flights

### 4.3 Assigning Slots to Airlines

Once the list of flights described above has been prepared, the next step is to apply the ration by schedule algorithm to that list to produce the list of EDCTs. After slots are assigned to exempt flights, a first-come,

first-served algorithm is used to assign the remaining flights to the remaining slots. All flights on the list that are not assigned a slot are pushed into the time after the interval ends. If there is no flight available for a slot, then that slot goes unassigned. This leads to the following requirements.

- Req. 4.3-1** FSM shall, after assigning slots to exempt flights, assign arrival slots to flights in the order they appear in the flight list produced according to requirements 3.39. to 3.40. The result is a list of slots; for each slot is shown the airline that owns that slot. If a slot could not be assigned to an airline, this list shows that the slot is open.
- Req. 4.3-2** The algorithm that FSM uses to assign EDCTs to flights shall be equivalent to the Groverjack algorithm.

While this algorithm assigns flights to slots, this is only a tentative assignment; the real significance of this algorithm is not that it assigns flights to slots but rather than it assigns slots to airlines. That is, the real output of this algorithm is a list that shows the slots and the airline to which each slot is assigned.

It should be noted that, in assigning slots to airlines, FSM treats flights in the OAG and flights that are created by airlines exactly the same, even if flights are created by an airline at the last minute. It is in the process of substitution that flights created at the last minute are treated differently; it is at this time that the distinction between Class I and Class II flights is used.

#### 4.3.1 Assigning Flights to Slots

Once the list of slots that are assigned to each airline has been drawn up, the next step is to assign flights to these slots. There are at least three methods that can be used to do this.

- The *scheduled flight method* assigns scheduled flights to slots.
- The *actual flight method* takes into account cancellations and delays in assigning flights to slots but does not transfer slots among airlines.
- The *actual flight method plus compression* is the same as the actual flight method except that it determines which slots cannot be used and attempts to fill them.

The advantage of the scheduled flight method is that it does not interfere with the assignment of flights to slots that is produced in the previous step; this is the tentative assignment of flights to slots referred to above. The disadvantage of this method is that it can result in an unrealistic ground delay program since it might assign a slot to a canceled flight or to a flight that has been delayed and cannot fill that slot. The actual flight method avoids this disadvantage and perhaps decreases the amount of substitution that airlines will do, but by doing so it must move flights from their originally assigned slots; this method does not change the slots that are assigned to each airline, but it does change the flights that are assigned to the slots. The actual flight plus compression has the advantage of potentially making a more efficient use of slots; it has the disadvantage of reducing the control that an airline has over the slots that are originally assigned to it.

During the experimental phase the FAA and airlines might want to experiment with all three ways of assigning flights to slots, so the software needs to be able to support all three methods.

The actual flight method and the actual flight method plus compression both use the assumption that during a ground delay program an airline wants a flight to be moved earlier in time as long as two conditions hold.

- The earlier time does not violate the minimum notice requirement. That each, each airline specifies that it wants to receive a departure time at least  $n$  minutes before that departure time. For example, an airline might require that it receive a departure time at least 30 minutes before that time so that it has time to prepare the flight for take-off.

- The earlier time is not before the earliest runway departure time or the earliest runway arrival time specified by the airline. By default, the earliest allowed times are the scheduled (or proposed) times since an airline normally would not want a flight moved up earlier than its scheduled time. If desired, an airline can change these times. For example, if an aircraft has a mechanical problem, the earliest time that it can depart might be moved back.

It is required that FSM allow an airline to change these times.

**Req. 4.3.1-1** FSM shall allow each airline to specify the minimum notice that the airline shall receive for an EDCT. This minimum notice is the same for all flights at all airports.

**Req. 4.3.1-2** FSM shall allow an airline to specify for each flight the earliest runway departure time and the earliest runway arrival time.

After slots have been assigned to each airline, the actual flight method uses the following algorithm to assign flights to each airline's slots.

- FSM shall draw up a list of slots assigned to that airline. These slots shall be ordered in ascending chronological order.
- FSM shall draw up a list of the flights of that airline that are currently predicted to arrive at the controlled airport.
- FSM shall start with the first slot assigned to that airline. It will assign the first flight on the list of flights to that slot unless this results in a violation of the minimum notice time, the earliest runway departure time, or the earliest runway arrival time. Proceeding in this way, each slot shall be filled with the earliest flight on the flight list that has not yet been assigned to a slot and that does not violate the minimum notice time and the earliest departure and arrival times.
- If no flight can be assigned to a slot, that slot shall be designated as an open slot that belongs to that airline.

The algorithm used by the actual flight method plus compression will be spelled out elsewhere.

The following requirements govern how FSM shall assign flights to slots.

**Req. 4.3.1-3** FSM shall give the traffic management specialist the option of assigning flights to slots by using the scheduled flight method, the actual flight method, or the actual flight method plus compression.

#### **4.4 Issuing a Ground Delay Program**

Once the ground delay program has been defined, it must be sent to each airline.

**Req. 4.4-1** Once FSM has completed the process of assigning flights to slots, it shall prepare for each airline a report that shows the following data on each flight that is in the ground delay program

- a) Call sign
- b) Departure airport
- c) Scheduled or proposed departure time
- d) EDCT
- e) Controlled time of arrival
- f) Assigned arrival slot

g) Slot class

Once these EDCTs have been calculated, no further changes are needed to the software. That is, the subsequent processing shall be performed by existing ATMS software. The following are among the events that might happen.

- The traffic management specialist will use Autosend to issue the EDCTs, i.e., to send to the airlines the report prepared under requirement 3.48.
- The airlines submit substitution messages to reorder their flights.
- EDCTs are sent to towers.

#### ***4.5 Revising a Ground Delay Program***

It is sometimes necessary for the traffic management specialist to revise a ground delay program by changing the length of the program or changing the acceptance rate for all or part of the program. If a program is revised, then the procedure described above that assigns slots to airlines is followed. The algorithm for assigning flights to slots will be documented elsewhere.