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A COMPUTER PROGRAM FUNCTIONAL DESIGN OF THE SIMULATION SUBSYSTEM OF AN AUTOMATED CENTRAL FLOW CONTROL SYSTEM

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16. Abstract

This report contains a functional design for the simulation subsystem of a future automation concept in support of the ATC Systems Command Center. The simulation subsystem performs airport airborne arrival delay predictions and computes flow control tables for the traffic management of excess airborne delays. Two flow control procedures are supported: Quota Flow and Fuel Advisory Departure procedures. This simulation subsystem works in conjunction with an input subsystem, a centralized data base of national air traffic schedules, a data and flight list retrieval subsystem and a report generator, all of which have been designed by the FAA and reported in separate documentation.

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PREFACE

This report has been written to document the software design of the simulation portion of an automated Central Flow Control System. The system is intended for the use of the Systems Command Center of the Federal Aviation Agency in the regulation of traffic flow into congested airports, i.e., those which will experience excess traffic delays due to temporary landing capacity reductions.

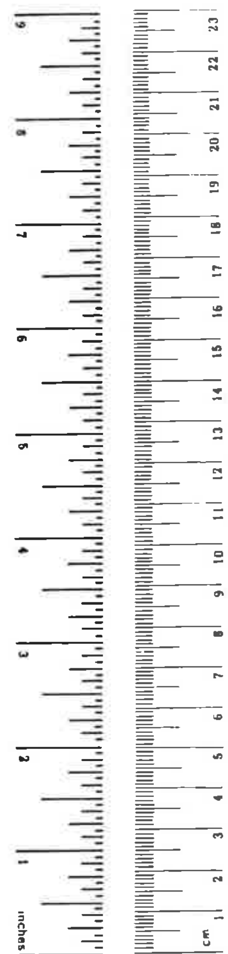
The design work reflected in this document was sponsored by the Federal Aviation Agency under Program Planning Agreement FA-T06, Carlo Broglio, Program Manager, ARD-102.

In addition to the listed authors, design credit is given to Hwei-Chen Hwang and Alexander Robb of Kentron Hawaii, Limited, ADP support contractor at TSC.

METRIC CONVERSION FACTORS

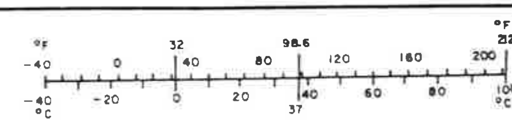
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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1. INTRODUCTION

The design which is presented in this report is addressed to the simulation portion of the Flow Control System under development by the Federal Aviation Agency. The simulation activities are those which are central to the generation of the following kinds of information:

1. The prediction of delays and stack conditions at a terminal (ARRD type simulation).

2. The generation of tier center flow control rates to alleviate congestion in the terminal area (QFLOW type simulation).

3. The generation of control delays to be applied on the ground and in the air to alleviate congestion (FAD type simulation).

Processing of the following character will be carried on in subsystems other than the Simulation Subsystem:

1. Data base creation.

2. Data base real time updating.

3. Interpretation of controller requests.

4. Retrieval of flights from the data base which are pertinent to the request.

5. Aquisition of control parameters necessary to simulation processing.

6. Formatting and outputting of simulation results.

7. Updating the data base with control delays resulting from a QFLOW or FAD type simulation.

The simulation has been designed to be interrupted after processing a flight block, a flight block being the entire demand for an airport or any subset thereof.

The design is taken to the level of specifying the processing activities which must be undertaken by each of the 56 modules (processing entities) in the design. Activities assigned to modules have been selected to maximize functional integrity and to limit size to about 50 high level instructions. While it is possible to code directly from the documentation contained herein, it is recommended that an intermediate document, such as a chapin chart be completed for each module to further define processing activities and attendant control logic.

2. OVERVIEW OF ARRIVAL DELAY PREDICTION SIMULATION (ARRD)

The object of the ARRD request is to produce a report concerning arrival traffic delays at any pacing airport (where all delays are assumed to be taken in the terminal area). This report is based on OAG flight schedules, real time NAS originated and ARO updates, hourly general aviation factors, a stack size specified for some time, and hourly landing rates at the destination airport. The report is produced for a 24 hour period or for any lesser time period specified in the request.

The report includes seven pieces of data relating to the traffic delays incurred in each hour:

1. Arrivals: The total number of aircraft expected to arrive at the destination airport during each hour of the report.

2. Active Flights: The total number of arrivals for which a departure message has been received.

3. Landings: The predicted number of aircraft landed during each hour of the report.

4. Peak Stack: The maximum number of aircraft which are projected to be holding in the terminal area for each hour of the report. A count of holding aircraft is made for every minute of the prediction period. The largest of these in each hour is the Peak Stack for that hour.

5. Average Stack size: The average of the stack counts made during an hour. It is the result of dividing the sum of the holding counts made during each minute of an hour by 60 or by the number of non zero counts made in an hour if the average during holding periods only is desired.

6. Peak Delay: The maximum delay projected for any aircraft holding during the hour. The entire projected delay for those aircraft arriving during the hour will be used for this peak statistic. For those aircraft which began their hold in previous hours, the entire delay minus any holding time prior to this hour will be used. For example, an aircfaft which is projected to have a 3 hour delay and arrives at 1230 would contribute a 3 hour delay to the 1200 hour statistics, a 2 1/2 hour delay to the 1300 hour, a 1 1/2 hour delay to the 1400 hour, and a 1/2 hour delay to the 1500 hour. Doing the same for other arriving flights, the largest projected delay occuring in each hour is then taken as the Peak Delay for that hour.

7. Average Delay: The average of projected delays attributed to aircfaft holding during each hour of the report. All the delays computed as in paragraph 6 above are summed for each hour. The sum is then divided by the number of flights contributing to those delays. The final result is used for this average.

In generating the above specified arrival delay statistics, the ARRD Subsystem commences processing on an arrival demand list (a list of flight records ordered by their ETA, estimated time of arival). It adds to this list a number of general aviation flights in comformance to controller specified general aviation counts. It prepares the flight list to accomodate controller specified stack conditions. It prepares a set of landing slots based on controller specified landing rates. It proceedes to assign flights to these slots gathering arrival delay data based on these assignments. Finally, after sequencing through all of the flights in the list, the data collected is summed and averaged to produce the hourly statistics.

In adjusting for general aviation counts, general aviation dummy flights will be evenly added in time to the known arrival flight list in quantities sufficient to produce the specified count when added to existing general aviation flights.

In order to collect the counts needed to determine the peak and average stack size, a set of sixty counters, corresponding to the minutes of the hour, will be provided for each hour of the day. Each flight processed will be assigned the earliest available landing time based upon the input landing rates. (Landing slots become unavailable when assigned to an arriving flight. Any landing slots prior to the last assigned slot become unavailable whether used or not.) In the event the flight must hold, i.e. the assigned landing time is later than the arrival time, every minute counter, which corresponds to the time span bounded by and inclusive of the ETA and the landing time will be incremented. After all flights in the list have been exhausted, the counters corresponding to respective hours will be summed and averaged. The maximum of these counts will be retained as the peak stack size for each hour.

In gathering the hourly delay data, the delays predicted for each flight will be compared to the peak delays already registered for the hours during which it will be delayed. Where previously recorded peak delays are exceeded, new peak values will be established. All delays associated with each flight will be added to the cumulative totals for the respective hours to provide an average delay per hour when divided by the number of delays added during each hour.

In order to cause the delay and hold predictions to reflect the exact stack size specified for a given instant of time, the program purges all statistics gathered in counters and accumulators associated with all later times and frees all landing slots later than the given stack time, making them all available for use. It then processes a set of dummy flights which have been added to the flight list to produce the specified stack size. These dummy flights have ETA's equal to the given stack adjustment time and will be assigned available landing times commencing at the stack adjustment time. The processing of the flight list is then automatically resumed with known flights after exhausting the dummy flights in the list.

The functional steps to be taken by the ARRD subsystem in the production of the arrival delay statistics are as follows:

1. In order to account for unscheduled general aviation traffic, intersperse evenly among the ETA ordered flights list, sufficient numbers of general aviation dummy flights to achieve the numbers specified as input parameters. Account will be taken of general aviation flights which already exist in the flight list.

2. It is necessary to provide for adjustment up or down from the computed stack size to the specified stack size at some time during the period of prediction. To do so, place in the input flight list (at a point between the flight record with ETA equal to or less than the stack adjustment time and the flight record with ETA greater than stack adjustment time) a number of dummy flights equal to the stack size with ETA's equal to the stack adjustment time.

3. Based upon the hourly landing capacities given for the current day establish a set of landing times equally spaced throughout each hour of the day.

4. Select the next later flight from the block of input flights ordered by time of arrival.

5. Associate with this flight the earliest available landing time.

6. Increment the arrival counter for the hour of arrival.

7. If this flight is active, increment the active counter for this arrival hour.

8. Increment the landing counter for the hour of landing.

9. Determine the peak delay for this flight by taking the difference between its arrival and landing times.

If this delay is greater than the peak delay for the hour of arrival reset the peak delay to the delay for this flight.

Add this delay to the cumulative total for the hour of arrival.

Increment the count of delay statistics taken for the hour of arrival.

10. If the flight's delay extends beyond the hour of arrival, determine the delays to be associated with ensuing hours by deducting from the flight's total delay, the delay taken prior to those hours.

If the delays are greater than the peak delays for these hours reset the peak delays.

Add the delays to the cumulative totals for these hours.

Increment the count of delay statistics taken for these hours.

11. Establish the contribution of this flight to holding conditions throughout the day by incrementing every minute counter which coincides with its period of hold.

12. Steps 4 through 11 are repeated until either the input block of flights has been exhausted or a stack adjustment time has been encountered.

If the input flight list has been exhausted do the following:

Determine the average delay for each hour by dividing the cumulative total delay for each hour by the count of delay statistics taken for each hour.

Determine the average stack size for each hour by totaling the counters associated with each minute of that hour and dividing by 60 to aquire the average stack size over the hour (or by the number of non zero counters to aquire the average stack size during holding periods of that hour only).

Determine the peak stack size for each hour by examining the counters associated with each minute of each hour and selecting the maximum of these counters as the peak stack size for that hour.

If a stack adjustment time is encountered, reset to zero all counters and accumulators for statistics gathering periods beyond the stack adjustment time. Make available for use all landing slots likewise assigned beyond the stack adjustment time.

13. Repeat steps 4 through 11 until the input flight list has been exhausted.

3. OVERVIEW OF QUOTA FLOW SIMULATION(QFLOW)

The objective of the QFLOW request is to compute tier center release rates and other subsidiary information which would be used to limit the delays in the terminal area to some controller specified level. This report is based on OAG flight schedules, real time NAS originated and ARO updates, hourly landing rates, hourly general aviation counts, a zone structure or structures which relate flight origins to tier centers, a stack size specified for some instant of time, the maximum delay desired in the terminal area and the earliest time at which the release rates about to be computed can be implemented. The release rates would be produced at sixty minute intervals over a 24 hour period or any lesser period specified in the request.

TIER CENTER RELEASE RATE TABLE

The report of tier center release rates contains two pieces of information for each tier center for each 60 min. interval:

1. Tier Center Release Rate: The number of aircraft to be released from a tier center during a sixty min. interval to achieve a controller specified maximum terminal area delay.

2. Tier Center Carry Over: The flights which will be holding in the tier center at the end of each 60 min. interval if the computed release rates are implemented.

For every tier center identified for a destination airport, two additional sets of information will be produced for the QFLOW simulations:

3. Origins: A set of origin centers which will funnel traffic through a particular tier center during each release interval of the report.

4. Origin Counts: The count of aircraft released during an interval and and associated with one of the origin centers.

To account for general aviation flights which have been created by the simulation in response to controller specified hourly general aviation counts, the following data item will be provided in the release rate table:

5. Dummy General Aviation Release Rates: The number of additional general aviation flights which should be released from the tier centers during each 60 min. interval. This release rate includes only the general aviation traffic created by the simulation. General

aviation traffic for which origin information is available will be included in the actual tier center release rates. No attempt is made to associate these dummy flights with particular tier centers. They will appear as an aggregate for all tier centers and will be associated with a particular release interval through a nominal flight time for dummy general aviation flights specified in the zone structure being used.

ZONE STRUCTURE

In order that tier center release rates be properly applied, it is necessary that operational personnel set up a zone structure which relates traffic origins (either airports or centers) with the tier centers (subzones) through which departed traffic will fly in reaching the destination. It is further required that the flight times from each tier center boundary crossing to the destination airport be included in the structure. There may be, in fact, several of these structures for an airport, to provide for changes in traffic routing over the course of the day. In addition, it will be necessary to include in the zone structure a nominal flight time for dummy general aviation traffic created by the simulation so that they may be placed in an approximately correct release interval.

RELEASE RATE TABLE COMPUTATION

To determine the tier center release rates which will be used to limit terminal area delays to some desired level, the subsystem, in effect, first sets up a list of landing slots based on specified arrival rates. It then proceeds to sequence through the flight list assigning the available landing slots and assigning to those flights, which would exceed the controller specified maximum delay, an arrival time equal to the assigned landing slot minus the maximum desired delay (without violating earliest notice time). After each flight assignment, the time interval in which this flight should be released from its tier center is determined by deducting from its arrival time the flying time from its tier center boundary crossing. A release rate counter associated with this time interval and tier center is then incremented. To determine the number of flights which should be held over in the tier center for each release interval, the time of arrival of each flight at its tier center boundary crossing is computed, (i.e. departure time plus its estimated time enroute to the terminal, minus the flight time from its tier center boundary). During the flights tier holding period, starting with the interval of the boundary arrival time, each interval carry over counter is incremented by 1 if it is not the boundary release interval. This, in effect, maintains the carry over counts. In addition, an origin counter associated with this flight's origin and its tier center is incremented for the appropriate interval to provide origin counts.

REMOVAL OF PREVIOUS FLOW CONTROLS

If this QFLOW computation is being conducted on a flight list which contains previous flow control assignments, it will be necessary to examine each flight to determine whether or not it is possible to remove its previous delay assignment to take advantage of any increase in landing capacity which may have come about since the last flow control computation.

This decision is based on the earliest notice time fixed by the current time and a specified communications lag, i.e. the earliest time the controls about to be computed may be implemented. It is further based upon the assumption that previous flow control assignments will be in effect up to earliest notice time. Each time a flight is taken from the input flight list to perform the release rate computation outlined above, its flow control departure time is compared to the earliest notice time (flights are not ground delayed in QFLOW but a QFLOW request may follow a FAD request in which case ground delay assignments could have been made).

If at earliest notice time, the flight would have taken none of its ground delay (planned time of departure is later than earliest notice time) departure time and arrival time are reset to planned times. If at earliest notice time, the flight would have taken part of its ground delay (controlled departure time is later than earliest notice time and planned departure time is earlier than earliest notice time) departure time is reset to the earliest notice time and its arrival time is reset to planned arrival time plus the delay taken on the ground. If at earliest notice time the flight has taken all of its delay (its controlled departure time is earlier than earliest notice time) the flight's arrival and departure times remain as previously controlled.

The subsystem then compares the flight's release time from the tier center boundary with the earliest notice time (longer range flights in FADP procedures and all flights in QFLOW procedures are subject to tier center delays). If the flight has left the tier center boundary (arrival time minus flight time to the tier center boundary is earlier than earliest notice time) its arrival time is considered unchangeable. If the flight has not yet reached its tier center boundary at earliest notice time and it had been assigned a tier center delay then its arrival time is reset to boundary arrival time plus boundary flight time. If the flight has been assigned a tier center delay and has taken part of it at the earliest notice time, its arrival time is reset to its boundary arrival time plus boundary flight time plus the delay taken at the tier center.

The process of delay removal may bring about a degree of disordering in the landing sequence established by the original planned time of arrival. This reordering will occur only when landing slots would go unused if the original landing sequence were adhered to. The flights which might land out of sequence to occupy unused slots (unassigned slots earlier than the last assigned slot) would be long haul flights which took none or only part of their tier center delays at earliest notice time and were flow controlled to arrive in the terminal area interspersed among flights which took all or part of their assigned ground delay at earliest notice time. This reordering is possible up to earliest notice time plus ete ground delay cutoff (a time enroute which serves as an upper bound on the flights which may receive ground delays) at which time the effects of unremovable ground delays will be dissipated. To assure a minumum amount of reordering, flights are considered for landing slots in their original ETA order. A list of unused slots is maintained and are assigned to those long haul flights which can take advantage of them.

MAINTAINANCE OF DUMMY FLIGHT ASSIGNMENTS

To provide proper translation between consecutive flow control runs, especially where ground delays have been proviously assigned, it will be necessary to maintain a record of dummy general aviation flow control assignments from run to run. (This is so because the general aviation distribution dictated in the first run by controller specified hourly general aviation counts do not hold in ensuing runs, i.e. flow control delays on the ground and in the tier centers distort the original arrival rate distribution. In addition, the real time updates which serve to provide hard information on previously dummied general aviation flights, will probably be lacking an hour before earliest notice time, assuming earliest notice time to be several minutes into the future and a time lag in the receipt and processing of departure messages.) They will be integrated with the ETA ordered flight list prior to QFLOW processing, relinquishing their position in the flight list to general aviation flights for which departure messages have been newly received and which are closest in flight times to themselves.

STACK ADJUSTMENT

As in the ARRD computation, a number of dummy flights, equal to the specified stack size and with ETA's equal to the specified stack time, will be added to the flight list to align the computed stack size with the specified stack size at stack time. To accomplish this adjustment, all assigned slots after stack time will be released for assignment to the dummy flights. These dummy flights will utilize more or less slots than had been previously assigned, and in this way compensate for the difference in computed and specified stack size. The dummy flights will not contribute directly to the release rate statistics (no tier center release times will be computed for dummy flights), but the release times calculated for flights arriving after stack time will be dependent upon the number of landing slots assigned to the dummy flights. Fewer slots will imply earlier release times for ensuing flights; more slots will imply later release times.

The functional steps to be taken by the QFLOW subsystem in the production of tier center release rate tables are as follows:

1. In order to account for unscheduled general aviation traffic, intersperse evenly among the ETA ordered flights list, sufficient numbers of general aviation dummy flights to achieve the numbers specified as input parameters. Account will be taken of general aviation flights which already exist in the flight list. If this is not the first flow control run of the day, supress the addition of general aviation flights in the foregoing manner up to earliest notice time, instead, integrate previously flow controlled general aviation dummy flights which were scheduled to depart or be released from their tier centers during this period of time. In performing this integration, relinquish positions in the flight list to general aviation flights for which departure messages have been newly received and which most nearly correspond in flight times to the previously added dummy flights.

2. It is necessary to provide for adjustment up or down from the computed stack size to the specified stack size at some time during the period of release rate computation. To do so, place in the input flight list (at a point between the flight record with ETA equal to or less than the stack adjustment time and the flight record with ETA greater than stack adjustment time) a number of dummy flights equal to the stack size with ETA's equal to the stack adjustment time.

3. Based on the hourly landing capacities given for the current QFLOW run, establish a set of landing times equally spaced throughout each hour of the day.

4. Select the next flight from the block of input flights ordered by time of arrival.

5. Remove from this flight any previously assigned flow control ground delay later than earliest notice time.

If planned time of departure is later than earliest notice time, reset departure and arrival times to planned times.

If controlled time of departure is later than earliest notice time and planned time of departure is earlier than earliest notice time reset departure time to earliest notice time and arrival time to planned time plus the delay taken on the ground.

6. Remove from this flight any flow control assigned air delay later than earliest notice time.

If the flights arrival time at the tier center boundary is later than earliest notice time reset time of arrival to boundary arrival time plus boundary flight time.

If the flights arrival time at the tier center boundary is earlier than earliest notice time and its release time from the tier center boundary is later than earliest notice time reset time of arrival to boundary arrival time plus boundary flight time plus delay taken in the tier center (earliest notice time minus arrival time at the tier center boundary).

7. If this flight's time of arrival is earlier than any unused landing slot, make that assignment, otherwise, assign the flight to the next available landing slot.

8. If the flight's arrival time is earlier than that which would preserve a specified maximum delay in the terminal area, set the flights flow controlled arrival time to that time (without violating earliest notice time)

9. Determine the release time from the tier center as the assigned arrival time minus the flight time from its tier center boundary.

10. Increment the release counter associated with the tier center and interval in which this release time falls.

11. Determine the tier center boundary arrival time as the departure time plus its ETE minus the flight time to the tier center boundary.

12. Increment the tier center hold over counters associated with intervals in which the flight will be holding prior to the release interval.

13. Increment the flights origin center counter which is associated with this release interval.

14. Steps 4 through 13 are repeated until either the input block of flights has been exhausted or a stack adjustment time is encountered.

If the input flight list has been exhausted, cease computation.

If a stack adjustment time is encountered, free for use by dummy stack flights all landing slots assigned after stack time and continue with step 4.

4. OVERVIEW OF FUEL ADVISORY DEPARTURE SIMULATION (FAD)

The objective of the FAD request is to compute control delays, tier center release rates and other subsidiary information which would be used to limit the delays in the terminal area to some controller specified level. In addition, arrival delay statistics would be computed to present the terminal area situation in the event these control delays and tier center release rates were implemented. This report is based on OAG flight schedules, real time NAS originated and ARO updates, hourly landing rates, hourly general aviation counts, a zone structure or structures which relate flight origins to tier centers, a stack size specified for some instant of time, the maximum delay desired in the destination area, controller specified ground delays for certain terminals, the earliest time at which the control delays and tier center release rates about to be computed can be implemented, and an ETE cutoff time which would serve to restrict ground delays to flights with shorter times enroute. The control delays would be produced at fifteen minute intervals, the tier center release rates and the arrival delay statistics at hourly intervals, all over a 24 hour period or any lesser period specified in the request. Since the tier center release rates and arrival delay statistics produced under FAD are generated and tabulated in the same way as is done under QFLOW and ARRD respectively, only limited discussion of these tabulations will be contained herein.

ENERGY CONSERVATION REPORT

The energy conservation report contains three pieces of information pertinent to flights which had planned to arrive in the terminal area during each 15 min. interval of the report:

1. Control Delay: The control delay to be assigned to aircraft whose planned times of arrival fall within the interval for which this control delay applies. It is intended that the control delay be applied on the ground for those flights within ETE cutoff or in the air over tier centers for the longer range flights. The control delay, while meant to be applied uniformly to all applicable aircraft in the interval, is actually the average of the all delays assigned to aircraft planning to arrive in that interval. For FADT simulations, controller specified ground delays for specific airports will be factored into the control delay, i.e. aircraft departing such airports would take additional delays only if the applicable control delay exceeds the delay imposed by conditions local to the departure airport.

2. Terminal Area Delay: The terminal area delay projected to be taken by all delayed flights with planned times of arrival which fall within the interval for which this terminal delay applies. (this delay is also the average of terminal delays assigned to aircraft planning to arrive in the interval)

Total Delay: The total delay projected for flights which were to arrive during each interval of the report.

ZONE STRUCTURE

In order that tier center release rates be properly applied, it is necessary that operational personnel set up a zone structure which relates traffic origins (either airports or centers) with the tier centers (subzones) through which departed traffic will fly in reaching the destination. It is further required that the flight times from each tier center boundary crossing to the destination airport be included in the structure. There may be, in fact, several of these structures for an airport, to provide for changes in traffic routing over the course of the day. In addition, it will be necessary to include in the zone structure a nominal flight time for dummy general aviation traffic created by the simulation so that they may be placed in an approximately correct release interval.

ENERGY CONSERVATION COMPUTATION

To determine the control delays which will be used to limit terminal area delays to some desired level, the subsystem, in effect, first sets up a list of landing slots based on specified arrival rates. It then proceeds to sequence through the flight list assigning the available landing slots and assigning to those flights, which would exceed the controller specified maximum delay, an arrival time equal to the assigned landing slot minus the maximum desired delay (without violating earliest notice time). If such a flight is within ETE cutoff time, its departure is delayed by an amount equal to its assigned arrival time minus its expected arrival time (only if earliest notice time is less than or equal to expected departure time). After each arrival time assignment, a cumulative total of control delays for the interval associated with the flight's planned time of arrival is increased by the amount of this flight's control delay (assigned arrival time minus planned arrival time). To derive the average control delay from this total, a count of flights contributing to this total is maintained. To determine the average terminal area delay a cumulative total of each control delayed flight's terminal area delay is maintained along with a count of flights contributing to it. After sequencing through the flight list, the cumulative totals for each interval are divided by respective counts to determine the average control delays to be applied to flights which were scheduled to arrive during these intervals and to determine the average terminal area delays which are projected to be experienced by the same aircraft. The total average delay for each interval is then determined as the sum of the ground delay and average terminal area delay for each interval of the report.

note: The computation of tier center release rates and arrival delay statistics would be carried on concurrently with the computation of control delays as the FAD subsystem sequences through the flight list.

The description of the release rate computation given for the QFLOW subsystem applies except the computation would be based on delayed departure times where they were applicable, i.e. arrival time at the tier center boundary would be computed as delayed departure time, plus ETE, minus flight time from the boundary to the terminal, for ground delayed flights. Ground delayed flights, therefore, would not contribute to the tier center hold over statistics but would contribute to tier center release rates, i.e. no hold over counters would be incremented for a ground delayed flight since boundary arrival time and boundary release times would be equal.

The description of the arrival delay statistics computation given for the ARRD subsystem applies to arrival delay computations in the FAD subsystem except that the terminal area arrival time used in the computation would be assigned arrival times where assignments were made.

REMCVAL OF PREVIOUS FLOW CONTROLS

If this FAD computation is being conducted on a flight list which contains previous flow control assignments, it will be necessary to examine each flight to determine whether or not it is possible to remove its previous delay assignment to take advantage of any increase in landing capacity which may have come about since the last flow control computation.

This decision is based on the earliest notice time fixed by the current time and a specified communications lag, i.e. the earliest time the controls about to be computed may be implemented. It is further based upon the assumption that previous flow control assignments will be in effect up to earliest notice time. Each time a flight is taken from the input flight list to perform the control delay computation outlined above, its control departure time (if one has been assigned) is compared to the earliest notice time.

If at earliest notice time, the flight would have taken none of its ground delay (planned time of departure is later than earliest notice time) departure time and arrival time are reset to planned times. If at earliest notice time, the flight would have taken part of its ground delay (controlled departure time is later than earliest notice time and planned departure time is earlier than earliest notice time) departure time is reset to the earliest notice time and its arrival time is reset to planned arrival time plus the delay taken on the ground. If at earliest notice time the flight has taken all of its delay (its controlled departure time is earlier than earliest notice time) the flight's arrival and departure times remain as previously controlled.

The subsystem then compares the flight's release time from the tier center boundary with the earliest notice time (longer range flights in FADP procedures and all flights in QFLOW procedures are subject to tier center delays). If the flight has left the tier center boundary (arrival time minus flight time to the tier center boundary is earlier than earliest notice time) its arrival time is considered unchangeable. If the flight has not yet reached its tier center boundary at earliest notice time and it had been assigned a tier center delay then its arrival time is reset to boundary arrival time plus boundary flight time. If the flight has been assigned a tier center delay and has taken part of it at the earliest notice time, its arrival time is reset to its boundary arrival time plus boundary flight time plus the delay taken at the tier center.

The process of delay removal may bring about a degree of disordering in the landing sequence established by the original planned time of arrival. This reordering will occur only when landing slots would go unused if the original landing sequence were adhered to. The flights which might land out of sequence to occupy unused slots (unassigned slots earlier than the last assigned slot) would be long haul flights which took none or only part of their tier center delays at earliest notice time and were flow controlled to arrive in the terminal area interspersed among flights which took all or part of their assigned ground delay at earliest notice time. This reordering is possible up to earliest notice time plus ete ground delay cutoff (a time enroute which serves as an upper bound on the flights which may receive ground delays) at which time the effects of unremovable ground delays will be dissipated. To assure a minumum amount of reordering, flights are considered for landing slots in their original ETA order. A list of unused slots is maintained and are assigned to those long haul flights which can take advantage of them.

MAINTAINANCE OF DUMMY FLIGHT ASSIGNMENTS

To provide proper translation between consecutive flow control runs, especially where ground delays have been proviously assigned, it will be necessary to maintain a record of dummy general aviation flow control assignments from run to run. (This is so because the general aviation distribution dictated in the first run by controller specified hourly general aviation counts do not hold in ensuing runs, i.e. flow control delays on the ground and in the tier centers distort the original general aviation arrival rate distribution. In addition, the real time updates which serve to provide hard information on previously dummied general aviation flights, will probably be lacking an hour before earliest notice time, assuming earliest notice time to be several minutes into the future and a time lag in the receipt and processing of departure messages.) They will be integrated with the ETA ordered flight list prior to FAD processing, relinquishing their position in the flight list to general aviation flights for which departure messages have been newly received and which are closest in flight times to themselves.

STACK ADJUSTMENT

As in the ARRD and QFLOW computations, a number of dummy flights, equal to the specified stack size and with ETA's equal to the specified stack time, will be added to the flight list to align the computed stack size with the specified stack size at stack time. To accomplish this adjustment, all assigned slots after stack time will be released for assignment to the dummy flights. These dummy flights will utilize more or less slots than had been previously assigned, and in this way compensate for the difference in computed and specified stack size. The dummy flights will not contribute directly to control delays (no control delays will be computed for dummy flights), but the control delays calculated for flights arriving after stack time will be dependent upon the number of landing slots assigned to the dummy flights. Fewer slots will imply earlier departure times or tier center release times for ensuing flights; more slots will imply later departure times or tier center release times.

The functional steps to be taken by the FAD subsystem in the production of the energy conservation report are as follows:

1. In order to account for unscheduled general aviation traffic, intersperse evenly among the ETA ordered flights list, sufficient numbers of general aviation dummy flights to achieve the numbers specified as input parameters. Account will be taken of general aviation flights which already exist in the flight list. If this is not the first flow control run of the day, suppress the addition of general aviation flights in the foregoing manner up to earliest notice time, instead, integrate previously flow controlled general aviation dummy flights which were scheduled to depart or be released from their tier centers during this period of time. In performing this integration,

relinquish positions in the flight list to general aviation flights for which departure messages have been newly received and which most nearly correspond in flight times to the previously added dummy flights.

2. It is necessary to provide for adjustment up or down from the computed stack size to the specified stack size at some time during the period of control delay computation. To do so, place in the input flight list (at a point between the flight record with ETA equal to or less than the stack adjustment time and the flight record with ETA greater than stack adjustment time) a number of dummy flights equal to the stack size with ETA's equal to the stack adjustment time.

3. Based on the hourly landing capacities given for the current FAD run, establish a set of landing times equally spaced throughout each hour of the day.

4. Select the next flight from the block of input flights ordered by time of arrival.

5. If there are controller specified delays for certain airports and that delay has not been factored into the flight list on previous runs:

Determine if this flight originates at one of these airports.

If so modify its departure and arrival times to correspond to the specified delay.

6. Remove from this flight any previously assigned flow control ground delay later than earliest notice time.

If planned time of departure is later than earliest notice time, reset departure and arrival times to planned times.

If controlled time of departure is later than earliest notice time and planned time of departure is earlier than earliest notice time reset departure time to earliest notice time and arrival time to planned time plus the delay taken on the ground.

7. Remove from this flight any previous flow control assigned air delay later than earliest notice time.

If the flights arrival time at the tier center boundary is later than earliest notice time reset time of arrival to boundary arrival time plus boundary flight time.

If the flights arrival time at the tier center boundary is earlier than earliest notice time and its release time from the tier center boundary is later than earliest notice time reset time of arrival to boundary arrival time plus boundary flight time plus delay taken in the tier center (earliest notice time minus arrival time at the tier center boundary).

8. If this flight's time of arrival is earlier than any unused landing slot, make that assignment, otherwise, assign the flight to the next available landing slot.

9. If the flight's arrival time is earlier than that which would preserve a specified maximum delay in the terminal area, set the flights flow controlled arrival time to that time (without violating earliest notice time).

10. If the flight's estimated time enroute is within ETE cutoff, delay its departure by an amount equal to its assigned arrival time minus its expected arrival time (only if earliest notice time is less than or equal to expected departure time).

11. Increase the cumulative total delay for the 15 min. report interval in which its planned arrival time falls by the amount of its control delay (assigned arrival time minus planned arrival time).

12. Increase the cumulative total of terminal delays for the same fifteen minute interval by the amount of its terminal delay (assigned landing time minus assigned arrival time).

13. Increment the count of flights contributing to these totals.

14. Steps 4 through 13 are repeated until either the input block of flights has been exhausted or a stack adjustment time is encountered.

If the input flight list has been exhausted, do the following :

Determine the average control delay for each 15 min. interval as the cumulative total for that interval divided by the count of flights contributing to that total.

Determine the average terminal delay for each 15 min. interval as the cumulative total for that interval divided by the count of flights contributing to that total.

Determine the total average delay for each 15 min. interval as the sum of the average control delay and average terminal delay for each interval.

15. If a stack adjustment time is encountered, free for use by dummy stack flights all landing slots assigned after stack time and continue with step 4.

5. OVERVIEW OF AUXILIARY PROCESSING TO SUPPORT SIMULATION

To prepare for the processing activities of any one of the major subsystems (ARRD, QFLOW or FAD) it will be necessary to perform several supporting functions, not necessarily in the order given. First, it will be necessary to translate user specified demand information (General aviation counts, Stack sizes and times, and Zone structures) into adjustments to the flight list developed from OAG schedules and real time updates. Second, it will be necessary to save and restore the interrupted state of the simulation between the processing of flight blocks. Third, it is necessary to retain information used or generated in one simulation which will be pertinent in a later simulation.

I TRANSLATION OF USER SPECIFIED DEMAND INFORMATION

A. ADDITION OF DUMMY GENERAL AVIATION FLIGHTS

General Considerations:

Since the flight plans of general aviation aircraft are not always known well in advance of departure and since this kind of traffic often constitutes a substantial portion of the total demand on an airport it is essential to supplement the data base with dummy general aviation aircraft for each type of simulation (ARRD, QFLOW, or FAD). This addition of dummy general aviation flights will be done in accordance with a set of anticipated hourly general aviation counts input by the controller at the start of the simulation. The counts will be taken to refer to the number of general aviation aircraft which were expected to arrive prior to the initiation of flow controls, even if the counts are modified after such initiation.

These hourly counts will include general aviation aircraft for which flight plans are known (a flight record exists in the data base). The concern of the subsystem, therefore, will be to add sufficient numbers of dummy general aviation aircraft to bring the total up to that which has been specified by the controller.

General aviation hourly counts may be changed from one flow control run to another and the numbers of known general aviation aircraft will also change from one run to another as real time updates are received. For these reasons it will be necessary to resupplement the flight list with dummy general aviation aircraft each time a flow control message is received. No dummy flight records will be retained in the data base between flow control runs.

If the current flow control run was preceeded by a flow control run in which controlled arrival times were applied, it will be necessary to consider each dummy flight for the application of flow controls consistent with those applied in the preceeding run. If new real general aviation flights are aquired since the last flow control run, they too must be considered for the application of flow controls consistent with those applied in the previous run.

Since the flight list is ordered and formed into hourly segments in terms of estimated arrival time rather than planned arrival time, it will be necessary to key on estimated arrival time in the distribution of dummy flights. The fact that general aviation counts are given in terms of planned arrival times makes necessary a transformation from the planned arrival interval, for which the count is given, to a corresponding controlled arrival interval into which the dummy flight distribution will be made. A set of flights with planned arrival times distributed over a one hour interval may have associated controlled arrival times distributed over several hours.

The foregoing assumes that dummy flights may be added once flow controls have been applied without adjustment to the previously applied controls. This is true under all circumstances if the general aviation counts have not been altered between flow control runs. It is true if the previous run was a FAD type even if the general aviation counts have been altered. It is not true if the previous run was a QFLOW type and alterations were made to the general aviation counts. The reason for this difference is the way in which FAD type controls and QFLOW type controls are applied. In FAD type control procedures, once a flight has accrued its required control delay, it is allowed to proceed to the terminal area. This makes reasonable the assumption that previously controlled flights will enter the terminal area at the assigned time, even though the level of demand on which these assignments were made was in error. In the QFLOW type control procedure, the number of aircraft entering the terminal area is limited to the calculated quota regardless of the delays accrued in the tier stacks. This renders invalid the foregoing assumption. For this reason, there should be no alteration of general aviation counts after the initiation of quota flow controls. This design, for reasons of program complexity, will not deal with this problem.

Adding Flow Control Times To Dummy And New General Aviation Flights:

Each time a new general aviation flight appears in the flight list or a dummy general aviation flight is added under the condition of previously applied flow controls, consideration must be given to the amount of delay, if any, which should be applied to these aircraft so that they receive the same control delays as previously delayed flights with similar planned times of arrival. The amount of delay to be applied will be determined by referencing a table created during the last run which lists the amount of control delay applied to the first flight in every 15 min. planned arrival time interval of the flow control period (where no flight appeared in that interval an interpolation will be performed between the closest intervals with flights).

The kind of control applied will be dependent upon the kind of control in effect in the previous run. If the previous run was a QFLOW type, air delays will be applied (a controlled arrival time will be assigned with the delay to be taken in the tier center). If the previous run was a FAD type and the flight was within ETE cutoff, a ground delay would be assigned (a controlled departure and arrival time would be applied). All dummy general aviation flights would fall within ETE cutoff (a standard 1 1/2 hour ETE is applied to all dummy flights). No new general aviation flights will receive ground delays since it will be assumed that their reported departure times properly reflect the ground delay conditions in effect since the previous FAD type run. Their reported departure and arrival times will be copied into the controlled departure and arrival fields of the flight record and appropriate planned times would be constructed.

Distributing Dummy General Aviation Flights Among Known Traffic:

The bounds for the controlled arrival time segment into which dummy flights are to be added is determined by referencing the table of planned arrival times and associated control delays mentioned in the previous paragraph. The controlled delays associated with the start and end of the planned arrival hour are added to the respective planned times to aquire these bounds. The segment is then scanned to determine the number of real general aviation flights in the segment. The difference between this number and the general aviation count for the hour to which this segment corresponds is the number of dummy general aviation flights to be distributed over this segment. The distribution of flights will be made by dividing the planned arrival hour into a number of intervals equal to the general aviation count for that hour and by determining corresponding intervals in the controlled arrival segment by referencing the delay table from the last run. Each of these intervals in the controlled arrival segment will be scanned in turn for real general aviation flights. If no real general aviation flight is found, a dummy flight will be effectively inserted with a controlled arrival time equal to the center of the interval and a planned arrival time derived from the table mentioned above. If one or more real general aviation flights are found in an interval a number of intervals will be skipped equal to the number found in that interval. If additional real general aviation flights are found in intervals being skipped an additional interval will be skipped for each such flight. The addition of flights to this segment will terminate when the number needed to achieve the controller specified general aviation count (the count for the corresponding hour minus the number of real general aviation flights) has been added. If a new real general aviation flight is found in an interval it may require the assignment of a controlled arrival time, in which case it will be misplaced in its current position in the flight list and will require, in effect, movement to a later place in the list, perhaps to an interval other than the one being scanned. If this is the case, it will be counted in the interval to which it has been moved.

B. PREPARATION FOR STACK ADJUSTMENT

To allow the controller to provide the simulation with current knowledge of the terminal area stack size and thereby improve prediction accuracy, a mechanism is provided in all the major processing subsystems to adjust the computed stack size to a controller specified stack size at some instant of time. To support this acitivity the preparation subsystem, in effect, will insert in the flight list a set of dummy flights equal in number to the specified stack size and with ETA's equal to the specified stack time.

C. ADDITION OF TIER CENTER IDENTITY TO FLIGHT RECORD

In order that tier center release rates may be properly computed by the QFLOW and FAD subsystems, it is necessary that operational personnel set up a zone structure which relates traffic origins (either airports or centers) with the tier centers (subzones) through which departed traffic wil fly in reaching the destination. It is further required that the flight times from each tier center boundary crossing to the destination airport be included in the structure. There may be, in fact, several of these structures for an airport to provide for changes in traffic routing over the course of the day. A function of this subsystem is to consult the appropriate structure for each flight and append to its flight record the proper tier center identification and the flight time from this tier center boundary to the terminal area.

II RETENTION AND RESTORATION OF THE INTERRUPTED STATE

Because all the major subsystems must be prepared to leave core after the processing of each flight data block, it will be necessary to store all information needed to restart the simulation with the next flight data block at the point at which it was interrupted. The information to be saved is as follows:

(a) All simulation state parameters needed to resume the construction of the data tables utilized in generating reports.

(b) All partially completed data tables utilized in the generation of reports.

(c) All flight records whose processing must await the receipt of the next flight data block.

Upon restart of the simulation this information will be restored by this subsystem.

III RETENTION OF INFORMATION PERTINENT TO THE NEXT SIMULATION RUN

To provide continuity between QFLOW and FAD type simulation runs it will be necessary to retain certain information from the previous simulation. This information is as follows:

(a) Type of simulation

(b) Landing capacities

(c) General aviation counts

(d) Departure delay table (indicates the origin airports which are delaying traffic because of problems local to them and the amount of delay anticipated)

(e) Desired delay in the terminal area

(f) Stack adjustment sizes and times

(g) Zone structures used and times of implementation

(h) Control delay table (contains the amount of control delay which was assigned the first flight in every 15 min. interval of the flow control period)

The preparation subsystem will make this information available to the major processing subsystems upon initiation of a new simulation.

6. MODULAR HIERARCHY STRUCTURE OF THE SIMULATION SUBSYSTEM

```
         DIR
         SIM
          I
 -------------------
 I        I        I
SET      PROC     CONC
UP       SIM      SIM
SIM
```

These segments are defined further in the following three hierarchy charts.

SIMULATION SET UP HIERARCHY

```
                    SET
                    UP
                    SIM
                     I
 ------------------------------------------
 I            I                          I
ASEM         RSTR                       ASEM
CON          INT                        EVNT
DATA         STAT                       LIST
  I            I                          I
----  -----------------   -----------------------------------
  I  I    I    I    I   I          I           I         I
ASEM RSTR RSTR RSTR RSTR GET       SCAN        DIST      NSRT
MODS STAT DATA LFOV PAT  CAT       CAT         DUM       STAK
     PARA TABL FLTS DELS SEG       SEG         GA        EVNT
                                     I           I         I
                               ------------  -------  -------
                               I    I    I   I    I    I    I
                              NSRT APLY REOR SCAN NSRT NSRT NSRT
                              ZONE DEL  DEL  INT  DUM  STAK DUM
                              INFO GA   GA   GA   GA   TIME FLTS
```

PROCESS SIMULATION HIERARCHY

```
                                     PROC
                                     SIM
                                      I
             --------------------------------------------------
             I                                                I
            PERF                                            PREP
            SIM                                             SIM
                                                            OUT
             I                                                I
 -------------------------                             --------------
 I                       I                              I      I    I
RETV                    PROC                          PREP   PREP PREP
NEXT                    EVEN                          ARRD   FAD  FLT
EVEN                                                  TABL   TABL REPT
                         I                              I
    ------------------------------------------      -------
    I    I          I            I           I       I    I
   RSET COMP       COMP         COMP        COMP    COMP COMP
   STAK DELS       FLT          ARRD        FLOW    ARRD ARRD
   ADJS ICUR       TIME         DEL         CNTL    DELS HOLD
         I          I            I           I
       ------    ---------    ------    -----------
       I    I    I      I    I    I    I    I    I
      COMP COMP COMP    COMP UPDT UPDT COMP COMP ADD
      DEL  DEP  LAND    FLOW A/C  A/C  QUOT FAD  FLT
      AIRB DEL  TIME    TIME DELS HOLD      DEL  REPT
                 I        I
                 -     -------
                 I     I    I
                GET   UPDT FILL
                UNUS  FLT  PAT
                SLOT  LIST DELS
```

CONCLUDE SIMULATION HIERARCHY

```
                                CONC
                                SIM
                                 I
                            ---------------
                            I             I
                           BUFF         BUFF
                           INT          CONT
                           DATA         DATA
                            I             I
                       -------------  --------
                       I    I     I   I     I
                      STR  STR  STR  STR  STR
                      STAT DATA LFOV PAT  MODS
                      PARA TABL FLTS DELS
```

Simulation Subsystem Hierarchy Legend

```
DIR SIM:          1. "Direct Simulation"
SET UP SIM:       1.1 "Set Up Simulation"
ASEM CON DATA:    1.1.1 "Assemble Control Data"
ASEM MODS:        1.1.1.1 "Assemble Modules"
RSTR INT STAT:    1.1.2 "Restore Interrupted State"
RSTR STAT PARA:   1.1.2.1 "Restore Simulation State Parameters"
RSTR DATA TABL:   1.1.2.2 "Restore Data Tables"
RSTR LFOV FLTS:   1.1.2.3 "Restore Leftover Flights"
RSTR PAT DELS:    1.1.2.4 "Restore Old PAT Control Delay Table"
ASEM EVNT LIST:   1.1.3 "Assemble Event List"
GET CAT SEG:      1.1.3.1 "Get CAT Segment of Flight List"
SCAN CAT SEG:     1.1.3.2 "Scan CAT Segment"
NSRT ZONE INFO:   1.1.3.2.1 "Insert Zone Information"
APLY DEL GA:      1.1.3.2.2 "Apply Flow Control Delay to New GA"
REOR DEL GA:      1.1.3.2.3 "Reorder Delayed New GA"
DIST DUM GA:      1.1.3.3 "Distribute Dummy GA's"
SCAN INT GA:      1.1.3.3.1 "Scan CAT Interval for Real GA's"
NSRT DUM GA:      1.1.3.3.2 "Insert Dummy GA Flight"
NSRT STAK EVNT:   1.1.3.4 "Insert Stack Event"
NSRT STAK TIME:   1.1.3.4.1 "Insert Stack Time Event"
NSRT DUM FLTS:    1.1.3.4.2 "Insert Dummy Flights"
PROC SIM:         1.2 "Process Simulation"
PERF SIM:         1.2.1 "Perform Simulation"
RETV NEXT EVEN:   1.2.1.1 "Retrieve Event"
PROC EVEN:        1.2.1.2 "Process Event"
RSET STAK ADJS:   1.2.1.2.1 "Reset For Stack Adjust"
COMP FLT TIME:    1.2.1.2.2 "Compute Flight Times"
COMP LAND TIME:   1.2.1.2.2.1 "Compute Landing Time"
GET UNUS SLOT:    1.2.1.2.2.1.1 "Get Unused Flow Landing Slots"
COMP FLOW TIME:   1.2.1.2.2.2 "Compute Flow Control Times"
UPDT FLT LIST:    1.2.1.2.2.2.1 "Update Controlled Flight List"
FILL PAT DELS:    1.2.1.2.2.2.2 "Fill In PAT Control Delay Table"
COMP ARRD DEL:    1.2.1.2.3 "Compute ARRD Delay Prediction"
UPDT A/C DELS:    1.2.1.2.3.1 "Update Aircraft Delays"
UPDT A/C HOLD:    1.2.1.2.3.2 "Update Aircraft Holding"
COMP DELS ICUR:   1.2.1.2.4 "Compute Delays Incurred"
COMP DEL AIRB:    1.2.1.2.4.1 "Compute Delay Incurred for Airborne Flight"
COMP DEP DEL:     1.2.1.2.4.2 "Compute Departure Delay Status"
COMP FLOW CNTL:   1.2.1.2.5 "Compute Flow Controls"
COMP QUOT:        1.2.1.2.5.1 "Compute Quotas"
COMP FAD DEL:     1.2.1.2.5.2 "Compute FAD Delay"
ADD FLT REPT:     1.2.1.2.5.3 "Add Flight To Report List"
PREP SIM OUT:     1.2.2 "Prepare Simulation Outputs"
PREP ARRD TABL:   1.2.2.1 "Prepare ARRD Table"
COMP ARRD DELS:   1.2.2.1.1 "Compute ARRD Delays"
COMP ARRD HOLD:   1.2.2.1.2 "Compute ARRD Holds"
PREP FAD TABL:    1.2.2.2 "Prepare FAD Table"
PREP FLT REPT:    1.2.2.3 "Prepare Flight Report List"
CONC SIM:         1.3 "Conclude Simulation"
BUFF INT DATA:    1.3.1 "Buffer Interrupted Data"
STR STAT PARA:    1.3.1.1 "Store Simulation State Parameters"
STR DATA TABL:    1.3.1.2 "Store Data Tables"
STR LFOV FLTS:    1.3.1.3 "Store Leftover Flights"
BUFF CONT DATA:   1.3.2 "Buffer Continue Data"
STR PAT DELS:     1.3.2.1 "Store New PAT Control Delay Table"
STR MODS:         1.3.2.2 "Store Modules"
```

7. MODULE SPECIFICATIONS OF SIMULATION SUBSYSTEM

Overview

This segment determines the type and status of the required simulation process and directs the setup, processing, and concluding function. It is the main program of the Simulation Subsystem (SS); it interfaces with the Executive Subsystem, receiving the appropriate inputs and returning the desired outputs.

Segment Function

This segment must start a new simulation upon command, must process the flight records in interrupted blocks of flights and when it has processed the last block of flights, must output the desired data tables for the Report Generation Subsystem. During the processing of a flow control simulation, updated flight data concerning the flow control assignments are returned to the executive. Between the passing of flight record blocks, the SS must save that data vital to proceeding with the interrupted simulation; between simulations, the SS must save that data vital to continuing with a new simulation. In the former case the saved data is returned to the SS by the executive along with the next block of flight records; in the latter case the continue simulation data is returned to the SS by the executive in order that continuity in flow controls and delay predictions be maintained during an operational day.

Process 1

Input:
- SMT Message Type
- SSF Status Flags
- SEC Executive Control Data
- SIB Interrupt Buffer
- SCB Continue Buffer
- SBF Block of Flight Records

Process:
- "Set Up Simulation"

Output:
- SCP Simulation State Control Parameters
- SDT Data Tables
- SEL Event List
- SLF Leftover Flight Buffers

Process 2

Input:
- SMT Message Type
- SSF Status Flag
- SCP Simulation State Control Parameters

SDT Data Tables
SEL Event List

Process:
"Process Simulation"

Output:
SAT ARRD Table
SQT Quota Table
SCT Conservation Table
SRF Reported Flights Table
SCL Controlled Flight List Buffer
SDT Data Tables

Process 3

Input:
SSF Status Flags
SCP Simulation State Control Parameters
SDT Data Tables
SLF Leftover Flight Buffers

Process:
"Conclude Simulation"

Output:
SIB Interrupt Buffer
SCB Continue Buffer

HIPO 1.1 "SET UP SIMULATION"

Overview

This segment will assemble the simulation control data, restore the state of an interrupted simulation process and assemble the Event list for the current simulation pass.

Segment Function

Determines and conducts the kind of set up or restoration required to perform the simulation. The assembly of control data is performed whenever the first block of flight records is to be processed.

Process 1

Input:
SSF New Simulation Flag

Process:
If this is the first block of flights to be processed, go to process 2; otherwise go to process 3.

Output:
none

Process 2

Input:

SCB Continue Buffer
SIM Type of Simulation
SEC Executive Control Data

Process:
"Assemble Control Data"

Output:
SCP Simulation State Control Parameters

Process 3

Input:
SIM Interrupt Buffer
SIM Continue Buffer
SSF New Simulation Flag
SMT Type of Simulation

Process:
"Restore Interrupted State"

Output:
SCP Simulation Control Parameters
SDT Data Tables
SLF Leftover Flight Buffers
SOD PAT Control Delay Table

Process 4

Input:
SCP Simulation State Control Parameters
SLF Leftover Flight Buffers
SOD PAT Control Delay Table
SIM Simulation Status Flags
SMT Type of Simulation
SIM Block of Flight Records

Process:
"Assemble Event List", (Return).

Output:
SEL Event List

HIPO 1.1.1 "ASSEMBLE CONTROL DATA"

Overview

This segment integrates the latest control data entries with previous control data chronology as necessary to perform or combine the required simulation. This function is called once at the start of a new simulation request.

Segment Function

Assemble the control parameter data from that passed by the executive sub-system. How much effort is involved in this segment will depend on how the control information is received from the executive sub-system.

Process 1
    Input:
        SCB Continue Buffer
        SMT Type of Simulation
        SEC Executive Control Data
    Process:
        "Assemble Modules"
    Output:
        SCP Simulation State Control Parameter

HIPO 1.1.1.1 "ASSEMBLE MODULES"

Segment Function

This segment refers to a series of modules whose function is to assemble the following control data:

1. landing capacities
2. GA counts
3. departure delay table
4. hold criterion
5. stack adjustment data
6. zone structure information

HIPO 1.1.2 "RESTORE INTERRUPTED STATE"

Overview

This segment restores the information which is necessary for continuing the simulation from its previously interrupted point.

Segment Function

Restores the simulation state parameters, various data tables, leftover flight buffers and PAT Control Delay Table.

Process 1
    Input:
        SMT Type of Simulation
        SIB Simulation State Data Set
    Process:
        "Restore Simulation State Parameters"
    Output:
        SCP Simulation Control Parameter
Process 2
    Input:
        SMT Type of Simulation
        SIB DaTa tables Data Set
    Process:

"Restore Data Tables"
Output:
SDT Data Tables
Process 3
Input:
SIB Leftover Flights Buffer Data Set
SSF New Simulation Flag
Process:
"Restore Leftover Flights"
Output:
SLF Leftover Flight Buffer
Process 4
Input:
SCB PAT Control Delay Table
Process:
"Restore PAT Control Delay Table"
Output:
SOD PAT Control Delay Table

HIPO 1.1.2.1 "RESTORE SIMULATION STATE PARAMETERS"

Segment Function
This segment resets all appropriate simulation internal control parameters to the previous simulation state prior to the interruption.

Prcess 1
Input:
SMT Type of Simulation
SIB Simulation State Data Set
Process:
Restore the necessary simulation state parameters.
Output:
SMT Type of Simulation
SLC Landing Capacity Data
SGA GA Entry Data
SSD DD Table Data
SFH Flow Hold Time
SSE Stack Entry Data
SZR Zone Record Data

HIPO 1.1.2.2 "RESTORE DATA TABLES"

Segment Function
Restores all incomplete data tables and lists to the pre-interrupted state. These tables will then be updated as appropriate in performing the simulation.

Process 1
    Input:
        SMT Type of Simulation
        SIB Data Tables Data Set
    Process:
        Restore the required data tables from Interrupt Buffer
    Output:
        SDT Data Tables

HIPO 1.1.2.3 "RESTORE LEFTOVER FLIGHTS"

Segment Function

This segment restores the unprocessed leftover flights from the incomplete last hour of the previously interrupted simulation as well as any leftover displaced new GA flights.

Process 1
    Input:
        SSF New Simulation Flag
        SIB Leftover Flights Buffer Data Set
    Process:
        If SSF New Simulation Flag is 0, restore the leftover flights and displaced new GA flights from SIB Leftover Flights Buffer.
    Output:
        SLF Leftover Hour Flights Buffer
        SLF Misplaced GA Flights Buffer

HIPO 1.1.2.4 "RESTORE PAT CONTROL DELAY TABLE"

Segment Function

This segment restores the table that lists the amount of control delay applied to the first flight in every 15 minutes Planned Arrival Time(PAT) interval of the flow control period. This table is obtained from the continue buffer associated with the last flow control simulation.

Process 1
    Input:
        SCB PAT Control Delay Table
    Process:
        Restore PAT Control Delay Table from the Continue Buffer.
    Output:

HIPO 1.1.3 "Assemble Event List"

Overview:

This segment assembles the next event list block to be processed by the simulation. It does this by merging the new block of flight record events (just passed to the simulation subsystem) with the following three other sources of events:

1. unprocessed flights from the previous interrupted simulation
2. GA dummy flights
3. stack adjustment events

Segment Function:

The event list is produced by assembling one hour of "planned arrival time" traffic at a time. The controlled arrival time segment of the flight list, which corresponds to a PAT hour, is scanned for real GA's. This scan in conjunction with the GA count for the hour is used to determine the number of GA dummies to distribute in the segment. If a stack adjustment event is required in this segment, it is inserted.

Process 1

Input:

SPH PAT Hour; numeric, epoch; next planned arrival time hour to be assembled

SOD PAT Control Delay Table; numeric, seconds; control delay for every 15 minute interval of last flow control run

Process:

Transform PAT hour to CAT segment time bounds as follows: add entry in PAT control delay table, corresponding to PAT hour, to the PAT hour giving lower bound; add entry in PAT control delay table, corresponding to next PAT hour, to the next PAT hour giving upper time bound.

Output:

STB Segment Lower Time Bound; numeric, epoch

STB Segment Upper Time Bound; numeric, epoch

Process 2

Input:

SSF End of flight Blocks Flag

STB Segment Upper Time Bound (from 1)

SBF Block of Flight Records

Process:

Determine whether or not the block of flights spans the upper time bound. If upper time bound is spanned or this is the last block of flights,go to process 3; otherwise go to process 9.

Output:

SSB Span Bounds Flag; numeric; if upper time bound is spanned this is a 1, otherwise a 0.

Process 3

Input:

STB Segment Lower Time Bound (from 1)
STB Segment Upper Time Bound (from 1)
SBF Block of Flight Records
SLF Leftover Flight Buffers; mixed; leftover hour flights and misplaced new GA flights

Process:

"Get CAT Segment of Flight List"

Output:

SCS CAT Segment of Flight List; mixed; those flights records whose ETA's are bounded by the CAT time bounds

Process 4

Input:

SMT Type of Simulation
SZR Zone Record Data
SOD PAT Control Delay Table
SCS CAT Segment of Flight List (from 3)

Process:

"Scan CAT Segment"

Output:

SRG Real GA Count; numeric, number of real GA's in the CAT segment
SCS CAT Segment of Flight List
SLF Misplaced GA Flight Buffer

Process 5

Input:

SRG Real GA Count (from 4)
SGA GA Counts
SPH PAT Hour
SOD PAT Control Delay Table
SCS CAT Segment (from 4)

Process:

"Distribute Dummy GA's in CAT Segment"

Output:

SCS CAT Segment

Proess 6

Input:

SSE Stack Flag; numeric; 0 is stack entry, 1 is no stack entry

Process:

If there is no stack entry, go to process 8

Process 7
Input:
STB Segment Lower Time Bound (from 1)
STB Segment Upper Time Bound (from 1)
SSE Stack Entry Data
SCS CAT Segment (from 5)
Process:
"Insert Stack Adjustment Event"
Output:
SCS CAT Segment

Process 8
Input:
SSB Span Bounds Flag (from 2)
SPH PAT Hour
Process:
If the span bounds flag is set, increment the PAT hour by 1 and go to process 1; otherwise go to process 9.
Output:
SPH PAT Hour

Process 9
Input:
SSF End of Flight Block Flag
SBF Block of Flights
Process:
If end of flight blocks flag is not set, put unprocessed flights which remain in flight block into the leftover hour flight buffer. (return)
Output:
SLF Leftover Hour Flight Buffer

HIPO 1.1.3.1 "GET CAT SEGMENT OF FLIGHT LIST"

Segment Function
This module collects those flights within the current block of flights that fall within the current CAT time bounds.

Process 1
Input:
STB Segment Lower Time Bound
STB Segment Upper Time Bound
SBF Block of Flight records
SLF Leftover Hour Flight Buffer
SLF Misplaced GA Flight Buffer
Process:

Those flights which fall within the CAT time bounds in each of the three flight lists (i.e. leftover, block, and misplaced) are merged into a single list, maintaining an ETA sort.

Output:

SCS CAT Segment of Flight List

HIPO 1.1.3.2 "SCAN CAT SEGMENT"

Overview

This module scans the selected CAT flight segment searching for real GA's, preprocessing new real GA's, and inserting zone information if necessary.

Segment Function

The number of real GA's in the segment is obtained. Previous flow control delays are applied to new real GA's and they reordered in the flight segment if necessary. If required, zone information is inserted in the flight records.

Process 1

Input:

SCS Number of Flights in CAT segment; numeric

Process:

Iterate on number of flights in the CAT segment. Exit when flights are exhausted.

Output:

SCS Scan Pointer; numeric (pointer to next flight record in CAT segment to be processed)

Process 2

Input:

SCS Scan Pointer
SCS CAT Segment
SRG Real GA Count
SOD PAT Control Delay Table type; numeric (0 = no table, 1 = FAD, and 2 = Quota Flow)

Process:

If this is a scheduled flight, go to process 7.
If this flight is an old real GA, increment GA count by one and go to process 7.
If this flight is a new real GA and PAT control delay table type is not Quota Flow, increment counter by one and go to process 7.

Output:

SRG Real GA Count; numeric

Process 3

Input:

SCS Scan Pointer
SCS CAT Segment
SOD PAT Control Delay Table

Process:

"Apply Previous Flow Control Delay to New GA"

Output:

SCS CAT Segment

Process 4

Input:

SCS Scan Pointer
SCS CAT Segment
STB Upper Time Bound
SRG Real GA Count

Process:

If the ETA for this flight is greater than or equal to the Upper Time Bound, transfer this flight to the misplaced GA flight buffer and go to process 1; otherwise increment GA Count by one.

OUTPUT:

SLF Misplaced GA Flight Buffer
SRG Real GA Count

Process 5

Input:

SCS Scan Pointer
SCS CAT Segment (from 3)

Process:

"Reorder Delayed New GA"

Output:

SCS Scan Pointer
SCS CAT Segment

Process 6

Input:

none

Process:

Go to process 2.

Output:

None

Process 7

Input:

SMT Type of Simulation

Process:

If type of simulation is ARRD, go to process 1.

Output:

none

Process 8

Input:

SCS Scan Pointer
SCS CAT Segment

SZR Zone Record Data
Process:
"Insert Zone Information"
Output:
SCS CAT Segment

HIPO 1.1.3.2.1 "INSERT ZONE INFORMATION"

Segment Function

This module assigns a subzone index and boundary time to a particular flight and puts this information into the flight record.

Process 1

Input:
- SCS Scan Pointer
- SCS CAT Segment
- SZR Zone Record Data

Process:
The departure airport is used to determine which subzone the flight is to be associated with. The subzone index and boundary time are then stored in the flight record.

Output:
SCS CAT Segment

HIPO 1.1.3.2.2 "APPLY FLOW CONTROL DELAY TO NEW GA"

Segment Functon

This module applies the previous flow control delay to the new GA flight by referencing the PAT control delay table. The flight should then look like an old real GA.

Process 1

Input:
- SCS Scan Pointer
- SCS CAT Segment
- SOD PAT Control Delay Table

Process:
The delay is picked up from that 15-minute interval in the delay table into which the planned arrival time of the new GA falls (where no flight delay appears in an interval, an interpolation will be performed between the closest intervals with flights). This delay is added to the planned arrival time and the result stored as the control arrival time as well as the new ETA for the flight.

Output:
SCS CAT Segment

HIPO 1.1.3.2.3 "REORDER DELAYED NEW GA"

Segment Function
This module repositions the delayed new GA in the sorted flight segment if it is necessary.

Process 1
Input:
SCS Scan Pointer
SCS CAT Segment
Process:
Using the ETA of the delayed new GA, put the flight in the proper place in the ETA sorted flight segment. If the flight is moved, reset the scan pointer to the next flight in the CAT segment; otherwise do nothing.
Output:
SCS Scan Pointer
SCS CAT Segment

HIPO 1.1.3.3 "DISTRIBUTE DUMMY GA's"

Overview
This module distributes the required number of dummy GA flights evenly in time over the CAT segment of flights; in doing so, it takes into account the real GA flights which already exist in the segment.

Segment Function
The PAT hour of interest is divided into as many intervals as the given GA count; the PAT control delay table is used to determine the corresponding intervals in the CAT segment. A GA dummy flight is placed into each interval in the CAT segment which does not have a real GA associated with it.

Process 1
Input
SRG Real GA Count; numeric
SGA GA Count; numeric
SPH PAT Hour
Process:
Set number of dummy GA flights to GA count for the PAT hour minus real GA count; if this number is less than or equal to zero, return.

Output:
SNG Number of Dummy GA's; numeric
SNG Number of Real GA's; numeric

Process 2
Input:
SPH PAT Hour
SGA GA Count; numeric
Process:
Iterate on the number of intervals, which number is equal to the given GA count for the PAT hour of interest. Exit when the intervals are exhausted.
Output:
SII Interval Index; numeric (the next time interval to be looked at)

Process 3
Input:
SGA GA Count; numeric
SII Interval Index (from 1)
SPH PAT Hour
SOD PAT Control Delay Table
Process:
Using the GA count to divide the PAT hour into as many equal time intervals, obtain the lower and upper bounds for that interval which corresponds to the interval index. Obtain the corresponding CAT bounds by adding to each PAT bound the delay found in that 15-minute interval of the delay table into which the particular PAT bound time falls.
Output:
SIT CAT Interval Lower Time Bound; numeric, epoch
SIT CAT Interval Upper Time Bound; numeric, epoch
SIT PAT Interval Center Time; numeric, epoch (This is the time at the center of the PAT time interval of interest.)

Process 4
Input:
SIT CAT Interval Lower Time Bound (from 3)
SIT CAT Interval Upper Time Bound (from 3)
SCS CAT Segment
Process:
"Scan CAT Interval for Real GA's"
Output:
SNG Interval Number of Real GA's; numeric (the number of real GA's in the interval just scanned)

Process 5
Input:
SNG Interval Number of Real GA's; numeric (from 4)
SNG Number of Real GA's; numeric
Process:

Increment the number of real GA's by the interval number of real GA's. If this latest number of real GA's is not zero, decrement this number by one, and go to process 2. If this number is zero, go to process 6.

Output:

SNG Number of Real GA's; numeric

Process 6

Input:

SOD PAT Control Delay Table Type
SIT CAT Interval Lower Time Bound
SIT CAT Interval Upper Time Bound
SIT PAT Interval Center Time
SCS CAT Segment

Process:

"Insert Dummy GA Flight"

Output:

SCS CAT Segment

Process 7

Input:

SNG Number of Dummy GA's; numeric

Process:

Decrement number of dummy GA' by one; if this latest number of dummy GA's is zero, return. If the number is not zero, go to process 2.

Output:

SNG Number of Dummy GA's; numeric

HIPO 1.1.3.3.1 "Scan CAT Interval for Real GA's"

Segment Function:

This module counts the real GA's in the CAT interval.

Process 1

Input:

SIT CAT Interval Lower Time Bound
SIT CAT Interval Upper Time Bound
SCS CAT Segment

Process:

Count the real GA's that appears in the CAT segment between the interval lower and upper time bounds.

Output:

SNG Interval Number of Real GA's

HIPO 1.1.3.3.2 "Insert Dummy GA Flight"

Segmet Function:

This module inserts into the CAT segment a dummy GA flight record with appropriate flow control delay and ETA in the middle of the CAT interval.

Process 1

Input:

SIT CAT Interval Lower Time Bound
SIT CAT Interval Upper Time Bound

Process:

Create a dummy GA flight record with ETA and CAT set to the center of the CAT interval.

Output:

SDG Dummy GA Flight Record

Process 2

Input:

SDT PAT Control Delay Table Type
SIT PAT Interval Center Time
SDG Dummy GA Flight Record (from 1)
SND Nominal Dummy GA Flight Time; numeric, seconds

Process:

The delay assigned to the dummy flight will be the difference between the CAT in the flight record and the PAT interval center time. The planned departure time is set to the CAT minus the sum of the nominal flight time and the delay; if the delay table is a FAD type, the control departure time is set to this planned departure time plus the delay.

Ouput:

SDG Dummy GA Flight Record

Process 3

Input:

SDG Dummy GA Flight Record (from 2)
SCS CAT Segment

Process:

Using the ETA of the dummy GA, put the flight record in the proper place in the ETA sorted flight segment.

Ouput:

SCS CAT Segment

HIPO 1.1.3.4 "Insert Stack Event"

Overview:

This module places stack adjustment events at the proper place in the CAT sorted flight segment.

Segment Function:

If required, there is inserted in the CAT segment a stack time event followed by as many dummy flights as the given stack size.

Process 1

Input:

STB Segment Lower Time Bound
STB Segment Upper Time Bound
SSE Stack Time

Process:

If the stack time falls within the CAT Time Bounds, go to process 2; otherwise return.

Output:

none

Process 2

Input:

SSE Stack Time
SCS CAT Segment

Process:

"insert Stack Time Event"

Output:

SCS CAT Segment
STE Time Event Pointers; numeric; points to time event in CAT segment

Process 3

Input:

SSE Stack Time
SSE Stack Size
SCS CAT Segment
STE Time Event Pointer (from 2)

Process:

"Insert Dummy Flights", (return)

Output:

SCS CAT Segment

HIPO 1.1.3.4.1 "Insert Stack Time Event"

Segment Function:

This module inserts in its proper place in the CAT segment a stack time event with the given stack adjustment.

Process 1

Input:

SSE Stack Time
SCS CAT Segment

Process:

The stack time event will have as its event time the given stack adjustment time, this event is placed in the CAT segment such that its event time is less than the ETA of any flight event that follows it.

Output:

SCS CAT Segment

STE Time Event Pointer

HIPO 1.1.3.4.2 "Insert Dummy Flights"

Segment Function:

This module inserts in the CAT segment as many dummy flights as the given stack size, each with an ETA equal to the given stack time.

Process 1

Input:

SSE Stack Time

Process:

Create a stack dummy flight event with ETA time equal to the stack time

Output:

SSD Stack Dummy Flight Event

Process 2

Input:

SSE Stack Size

SCS CAT Segment

STE Time Event Pointer

SSD Stack Dummy Flight Event

Process:

Insert in the CAT segment, immediately after the stack time event, as many stack dummy flight events as the given stack size.

Output:

SCS CAT Segment

HIPO 1.2 "PROCESS SIMULATION"

OVERVIEW

This module supervises the production of the simulation report data. Calls to appropriate subroutines are made in appropriate sequence to generate the required tables, (SIM ARRD Table , the quota tables, SIM Quota Table and SIM Quota Origin Table, and the FAD tables, SIM Conservation Table and SIM Reported Flight Table). All interface between the other functions of the system and the simulation functions are via this module. Input is all the data items impacting the simulation reports including schedule, stack, and capacity information. Output are data tables which contain the required information organized for report production.

SEGMENT FUNCTION

This module supervises simulation operations, i.e. start, stop, and routing of various data and variables to the proper simulation subparts.

PROCESS 1

INPUT:

SIM Event List : Numeric, mixed, Table; Merged flight list and stack events.
SIM ARRD Delay Data Table : Numeric
SIM ARRD Hold Data Table : Numeric
SIM Landing Capacities : Numeric ;
SIM ARRD TABLE : Numeric, Mixed, Table; Data from previous pass.
SIM Qouta Table: numeric, table; The release rate and carry over counts for each report interval.
SIM Qouta Origin Table: numeric, table; the origin center associations for the released tier traffic for each interval.
SIM Reported Flights Table: mixed, table; The flight report list of the FADF simulations.
SIM FAD Table: numeric, table; The raw data collected for the Conservation report of FAD.
SIM Conservation Table: numeric, table; The energy conservation flow control report data for the FADP simulations.
SIM Unused Flow Landing Slots: numeric, table; The data table used to assign landing slots to flow controlled flights out of the original order, when such is required to prevent unused landing capacity situations.
SMT Type of Simulation: numeric; (ARRD, FADP, etc.)

PROCESS

"Perform Simulation" Models traffic flow to predict delays and assign flow controls if necessary.

OUTPUT

SIM ARRD TABLE : Table as updated by simulation, to process 3.

SIM ARRD Delay Data Table : As updated by simulation, to process 3.

SIM ARRD Hold Data Table : As updated by simulation, to process 3.

SIM Qouta Table: numeric, table; The release rate and carry over counts for each report interval.

SIM Qouta Origin Table: numeric, table; the origin center associations for the released tier traffic for each interval.

SIM Reported Flights Table: mixed, table; The flight report list of the FADF simulations.

SIM FAD Table: numeric, table; The raw data collected for the Conservation report of FAD.

SIM Conservation Table: numeric, table; The energy conservation flow control report data for the FADP simulations.

SIM Unused Flow Landing Slots: numeric, table; The data table used to assign landing slots to flow controlled flights out of the original order, when such is required to prevent unused landing capacity situations.

PROCESS 2

INPUT

SSF End of flights block flag: Numeric

PROCESS

Decide if end of simulation for current flight block, if so then do process 3, otherwise exit the segment.

OUTPUT

None

PROCESS 3

INPUT

SMT : From process 1 input list.

SIM ARRD TABLE : Output from process 1

SIM ARRD Delay Data Table : Output from process 1

SIM ARRD Hold Data Table : Output from process 1

SIM Reported Flights Table: mixed, table; The flight report list of the FADF simulations.

SIM FAD Table: numeric, table; The raw data collected for the Conservation report of FAD.

PROCESS

"Prepare Simulation Output." For ARRD simulation, organizes data into table appropriate for ARRD report generation.

OUTPUT

SIM ARRD TABLE : Finished output of simulation for ARRD request.

SIM Reported Flights Table: mixed, table; The flight report list of the FADF simulations.

SIM Conservation Table: numeric, table; The energy conservation flow control report data for the FADP simulations.

HIPO 1.2.1 "Perform Simulation"

OVERVIEW

Iterates through time-sequenced simulation events, event by event. An event is an arrival (real or dummy) or a stack event (A/C leaves, enters, etc.) Processing for each event is scheduled and performed, and the data collected for output.

SEGMENT OVERVIEW

Models the traffic to obtain the delay statistics and any flow controls required.

PROCESS 1

INPUT

SIM Event List : Numeric, Mixed, Table; Merged flight list and Stack events, also input to process 2.

PROCESS

For each simulation, step through the retrieval and processing of each event until none left in list. Sequences execution of processes 2 and 3.

OUTPUT

NONE

PROCESS 2

INPUT

SIM Event List : Input from process 1 input list.

PROCESS

"Retrieve Event." Pick next activity off event list. Determine type of event, retrieve flight record if event was a flight, and adjust stack if event was stack type.

OUTPUT

SEL Event Data Set: numeric, table; Either a flight event or a stack event with their respective data sets.

PROCESS 3

INPUT

SMT Type of Simulation : Numeric
SIM ARRD Delay Data Table : Numeric, Elapsed Time, Table;
SIM ARRD Hold Data Table : Numeric ;
SIM Landing Capacities : Numeric ;
SIM ARRD TABLE : Numeric, Mixed, Table; ARRD report data without current data results filled in.
SIM Qouta Table: numeric, table; The release rate and carry over counts for each report interval.
SIM Qouta Origin Table: numeric, table; the origin center associations for the released tier traffic

for each interval.
SIM Reported Flights Table: mixed, table; The flight report list of the FADF simulations.
SIM FAD Table: numeric, table; The raw data collected for the Conservation report of FAD.
SIM Conservation Table: numeric, table; The energy conservation flow control report data for the FADP simulations.
SIM Unused Flow Landing Slots: numeric, table; The data table used to assign landing slots to flow controlled flights out of the original order, when such is required to prevent unused landing capacity situations.

PROCESS

"Process Event" Each event occurance occasions several direct consequences. Statistics on each event and consequences are gathered for reporting. Event and consequences also stored for inclusion in calculations for subsequent events.

OUTPUT

SIM ARRD TABLE : Updated for current event.
SIM ARRD Delay Data Table : Updated for current event
SIM ARRD Hold Data Table : Updated for current event.
SIM Qouta Table: numeric, table; The release rate and carry over counts for each report interval.
SIM Qouta Origin Table: numeric, table; the origin center associations for the released tier traffic for each interval.
SIM Reported Flights Table: mixed, table; The flight report list of the FADF simulations.
SIM FAD. Table: numeric, table; The raw data collected for the Conservation report of FAD.
SIM Conservation Table: numeric, table; The energy conservation flow control report data for the FADP simulations.
SIM Unused Flow Landing Slots: numeric, table; The data table used to assign landing slots to flow controlled flights out of the original order, when such is required to prevent unused landing capacity situations.

HIPO 1.2.1.1 "Retrieve Event"

Segment Functon

The function of this segment is to identify the next event in the event list by type and to pass the type identifiation and the parameter characterizing the event to the "Perform Simulation" segment. Only two classes of events will occur in the event list for each simulation, so that this segment is quite simple, it is provided as a seperate identificable unit for generality and to accomodate program expansion or elaboration. The two classes of events that may occur in the list during a simulaton are flight arrivals (of real or dummy flights) characterizied by their flight records and simulation data array initialization events, characterizied by their time occurrence. These occur at simulation start time and at the time of any stack adjustment.

Process 1

Input :

SIM Event list : A collection of event records. For flight arrival events, the event record is the SEL Event Type designation = 2, followed by the flight record in similar form in which it appears in the SBF Flight Record Data Set. For a data initialization event, the event record is the type designation = 1, followed by stack time and stack size, followed by nulls (so as to make all records of the same length)

Event pointer : Numeric pointer to current event record in event list.

Process :

Determine type of event and setup proper event data set.

Output :

SEL Event Data Set: numeric, table

HIPO 1.2.1.2 "Process Event"

Overview:

If the next event is a stack adjustment, this segment resets the simulation by initializing it at the given stack time. In effect, the continued simulation will then consume as many landing slots as the given stack size, updating the traffic statistics accordingly.

If the next event is a flight, this segment uses the ETA to compute the landing time and make the consequent arrival delay predictions. The remaining functions of this segment have to do with message type other than ARRD.

Segment Function:

A test is first made for the event type.

For a stack adjustment event, the "Reset for Stack Adjustment" segment is called initializing the data tables.

For a flight event, the ETA is extracted from the flight record and the active flight flag is set if there is an actual departure time. A check for ARRD type of simulation is made; if it is not ARRD type, the "Comput Delay Incurred" segment is required before the "Compute Flight Time" segment. Furthermore, a call to "Compute Flow Controls" should be made after the "Compute Arrival Delay Predictions" segment. The "Compute Flight Time" segment is called to obtain the next available landing time followed by a call to the "Compute Arrival Delay Predictions" segment which updates the delay and hold data tables with the current flight.

Process 1

Input :

SEL Event Type : numeric; 1 is stack adjustment and 2 is a flight

Process :

Check type of event : if stack event, go to process 2; if flight event, go to process 3.

Output : none

Process 2

Input :

SEL Event Time : numeric, epoch; this is stack adjustment time

SIM ARRD Table : numeric;contains ARRD prediction data by the hour

SIM ARRD Delay Data Table : numeric; contains delay by the hour

SIM ARRD Hold Data Table : numeric; contains hold data by the minute

Process :

"Reset for Stack Adjustment" and exit this segment.

Output :

SIM ARRD Table : (to 8)

SIM ARRD Delay Data Table : (to 8)

SIM ARRD Hold Data Table : (to 8)

Capacity Hour : numeric; this is the capacity hour index;(to 6)

Landing Slot : numeric; last landing slot considered used in the capacity hour;(to 6)

SER Extra Report Intervals : numeric; this is an offset to be applied when indexing the data tables; it is a result of a stack adjustment time being not on the hour;(to 6)

Process 3
    Input :
        Flight Record : mixed numeric and character
    Process :
        Extract ETA Value and set active flight flag if an actual departure time exists.
    Output :
        SEL ETA Value : numeric, epoch; (to 6 and 8)
        Active Flag : logical; false is not active, true is active; (to 8)

Process 4
    Input :
        SMT Type of Simulation : numeric, 1 for ARRD type.
    Process :
        Check type of simulation : if it is ARRD type, go to process 6; if it is not ARRD type, go to 5.
    Output : none

Process 5
    Input :
        SFN Earliest Notice Time : numeric, seconds
        SEL Subzone Boundary Time : numeric, seconds
        SEL Original Arrival Time : numeric, epoch
        SEL Original Departure Time : numeric, epoch
        SEL ETA value : numeric, epoch
        SEL Flow Arrival Time : numeric,epoch
        SEL Flow Departure Time : numeric, epoch
    Process :
        "Compute Delay Incurred"
    Output :
        SDI Delay Incurred : numeric, seconds

Process 6
    Input :
        SIM Landing Capacities : numeric; organized by the hour
        SEL ETA Value : (from 3)
        Capacity Hour : (from 2)
        Landing Slot : (from 2)
        Extra Report Intervals : (from 2)
    Process :
        "Compute Flight Times"
    Output :
        SEL Landing Time : numeric, epoch; this is the landing slot time;(to 8)
        SER Arrival Interval Index : numeric; (to 8)
        SER Landing Interval Index : numeric; (to 8) SER ETA Value

Process 7
    Input :
        SMT Type of Simulation

Process :
If the type of simulation is QFLOW go to process 10.
Output : none

Process 8
Input :
SIM ARRD Table : (from 2)
SIM ARRD Delay Data Table : (from 2)
SIM ARRD Hold Data Table : (from 2)
SEL ETA Value : (from 3)
Active Flag : (from 3)
SEL Landing Time : (from 6)
SER Landing Interval Index : (from 6)
SER Arrival Interval Index : (from 6)
Process :
"Compute Arrival Delay Predictions"
Output :
SIM ARRD Table :
AIM ARRD Delay Data Table :
SIM ARRD Hold Data Table :

Process 9
Input :
SMT Type of simulation : numeric, 1 is for ARRD.
Process :
Determine flow controls to be computed or not : if the SMT Type of Simulation is ARRD, exit from here; if the SMT Type of Simulation is not ARRD, go to process 10.
Output : none

Process 10
Input :
SEL Flow Arrival Time : numeric, epoch
SEL Flow Departure Time : numeric, epoch
SEL Land Time : numeric, seconds
SEL Estimated Arrival Time : numeric, epoch
SEL Estimated Departure Time : numeric, epoch
SEL Original Arrival Time: numeric, epoch
SEL Original Departure Time : numeric, epoch
SEL Subzone Boundary Time : numeric, seconds
SIM Quota Table
SIM Quota Original Table
SIM FAD Table
SIM Reported Flights Table
Process :
"Compute Flow Controls"
Output :
SIM Quota Table
SIM Quota Origin Table
SIM Report Flight Table
SIM FAD Table : numeric, table

HIPO 1.2.1.2.1 "RESET FOR STACK ADJUSTMENT"

SEGMENT FUNCTION

This segment prepares three ARRD data tables in accordance with a specified stack condition. It resets the report intervals following the stack adjustment event time to the null or zero condition. If the event occurs in the middle of an hour it closes the current event period at the event time and inserts a new interval for reporting the data from the event time to the end of the current hour. In resetting the tables, the beginning time of each report interval is stored with the interval in the data set of the SIM ARRD Table. The three tables involved in this function are the SIM ARRD Table, the SIM ARRD Delay Data Table and the SIM ARRD Hold Data Table. This segment also resets the landing capacity indicies to the last landing slot prior to the stack adjustment event time for all simulation type. This makes all landing slots after the adjustment event available for proper disposition of the reset stack and the subsequent arrivals.

PROCESS 1

INPUT:

SEL Event Time : Numeric, Epoch; the time of the stack reset event
SER Extra Report Intervals: Numeric; the number of extra interval required for stack adjustment events which were not on the hour.

PROCESS:

Increment the SER Extra Report Intervals by one if the stack adjust is not on the hour.

OUTPUT:

SER Extra Report Intervals: Numeric; the updated count. (TO 2)

PROCESS 2

INPUT:

SER Extra Report Intervals: (FROM 1)
SIM ARRD Table
SIM ARRD Delay Data Table
SIM ARRD Hold Data Table

PROCESS:

For the period starting with the stack adjust event interval (i.e. the Hour of stack adjust time plus the SER Extra Report Intervals) to the end of report intervals, zero all data fields in the three tables (SIM ARRD Table, SIM ARRD Delay Data Table and SIM ARRD Hold Data Table) and for each interval starting with the SEL Event Time insert the time value into SAT Time of Hour (an element of SIM ARRD Table). Increment the time value to the next hour value after each insertion.

OUTPUT:

SIM ARRD Table
SIM ARRD Delay Data Table
SIM ARRD Hold Data Table

PROCESS 3

INPUT:

SIM Landing Capacities: Numeric; landing capacities organized hour.
SEL Event Time: Numeric, hour; Epoch

PROCESS:

Set Capacity Hour to the hour of the stack adjust time and set Landing Slot to the number of landing slots in that hour prior to the stack adjust time.

OUTPUT:

Capacity Hour: Numeric; the hour index into the SIM Landing Capacities Table.
Landing Slot: Numeric; the count of used and unavailable landing slots in the indexed capacity hour.

HIPO 1.2.1.2.2 "Compute Flight Times"

Overview :

Given the ETA value, this segment computes the landing time using the airport hourly landing capacity. It also produces the arrival and landing interval indices. If the SMT type of simulation is not ARRD, this segment will then compute the flow control times using the adjusted ETA value.

Segment Function :

A call is made to the "Compute Landing Time" segment which produces a landing slot time and capacity hour index. The arrival and landing interval indices are then obtained from the ETA and capacity hour respectively. When SMT type of simulation is other than ARRD, set the ETA value and call the "Compute Flow Control Times" segment.

Process 1

Input :

SIM Landing Capacities : numeric; organized by hour

SEL ETA Value : numeric, epoch; expected time of arrival

Capacity Hour : numeric; this is current capacity hour index

Landing Slot : numeric; this is last landing slot used in the current capacity hour

Process :

"Compute Landing Time"

Output :

Capacity Hour : (see process 1 input); passed to process 2

Landing Slot : (see process 1 input)

SEL Land Time : numeric, epoch (to 2, 3 and 4)

Process 2

Input :

SER Extra Report Intervals : numeric; this is an offset to be applied when indexing the data tables; it is a result of a stack adjustment time being not on the hour

SEL ETA Value : (see process 1 input)

SEL Land Time : numeric, epoch (from 1)

Process

Truncate ETA value to the hour and add to this the SER Extra Report Intervals value to give the SER Arrival Interval Index. Add the SER Extra Report Intervals value to the Hour of SEL Land Time to give the SER Landing Interval Index.

Output :

SER Arrival Interval Index : numeric

SER Landing Interval Index : numeric

Process 3

Input :

SEL Original Arrival Time : numeric, epoch

SDI Delay Incurred : numeric, seconds

SMT Type of Simulation : numeric; '1' means ARRD type

SEL ETA value : numeric, epoch; expected time of arrival

Process : Check SMT type of simulation : if it is ARRD(=1) type of simulation, exist from this segment. if it is not ARRD type of simulation (i.e. SMT type of simulation is not equal to 1), compute the SEL ETA value by adding the SDI Delay Incurred to the Original Arrival Time and then go to process 4.

Output :

SEL ETA value : numeric, epoch; adjusted estimated time of arrival(to 4)

Process 4

Input :

SEE ETE Value: numeric, seconds
SEL Land Time : numeric, epoch
SDI Delay Incurred : numeric, seconds
SFH Hold Control Time : numeric, seconds
SEL Original Arrival Time : numeric, epoch
SEL Original Departure Time : numeric, epoch
SEL ETA Value : numeric, epoch (from 3)
SEL Boundary Arrival Time : numeric, seconds
SEL Boundary Release Time : numeric, seconds
SFN Earliest Notice Time : numeric, epoch

Process :

"Compute Flow Control Times" : If controls must be applied and the flight is not beyond control assignment, compute the flow control arrival time. If simulation is a PAD, compute the ground delay assignment.

Output

SEL Flow Departure Time : numeric, epoch
SEL Flow Arrival Time : numeric, epoch(to 5)
SEL Boundary Arrival Time : numeric, seconds (to 5)
SEL Boundary Release Time : numeric, seconds (to 5)

Process 5

SEL Original Arrival Time : numeric, epoch
SEL Actual Arrival Time : numeric, epoch
SEL Flow Arrival Time : numeric, epoch
SEL DD Arrival Time : numeric, epoch
SER Extra Report Intervals : numeric

Process :

Set SEL ETA value to the latest time of the 4 arrival time inputs and recompute the SER Arrival Interval Index.

Output : SEL ETA Value : numeric, epoch
SER Arrival Interval Index

HIPO 1.2.1.2.2.1 "Compute Landing Time"

Segment Function

This segment computes a landing slot time for the given ETA value. It also returns the current capacity hour index.

Process 1

Input :

SMT Type of Simulation : numeric; code equal to 1 for ARRD simulations

SFL Continued Flow Control : numeric, 0 or 1; this is a flag which indicates that the current simulation is a continuation of a previous flow control simulation (=1), otherwise it is set to 0.

SIM Unused Flow Landing Slots : numeric, table; this is a table containing any slots which were skipped over in finding a landing slot for a previously delayed flight. These skipped slots may be capable of being used by another flight. The use of these unused slots, assures that every effort will be made to avoid lost landing capacity during improved capacity conditions under flow control situations. It also means that the first come first serve order will be violated in filling these otherwise unused landing slots.

SEL Original Arrival Time : numeric, epoch

SEL ETA Value : numeric, epoch

Process :

If the SMT Type of Simulation is not equal to 1 and the SFL Continued Flow Control flag is equal to 1 , then "Get Unused Flow Landing Slot" and if a slot was found (i.e., SFL Unused Slot Found = 1), exit this segment, otherwise go to process 2.

Output :

SIM Unused Flow Landing Slots : numeric, table; updated as required.

SEL Land Time : numeric, epoch; output only if an unused slot was assigned.

SFL Unused Slot Found : numeric ; set to 1 if slot found, otherwise 0. This is actually a part of the SIM Unused Landing Slots table above, but is included to clarify process.

Process 2

Input :

SIM Landing Capacities : numeric; organized by hour

Capacity Hour : numeric; this is current capacity hour index

Landing Slot : numeric; this is last landing slot used in the current capacity hour

Process :

If the Landing Slot count is less than the Landing Capacity for the hour, increment it by 1 and compute the associated Landing Time; otherwise set the Landing Time to the hour of the next non-zero capacity hour, set the Capacity Hour to the hour of this Landing Time, and set the Landing Slot to 1.

Output :
Landing Time : numeric,epoch; this is the new landing slot time, passed to process 3
Capacity Hour : (see process 1 input)
Landing Slot : (see process 1 input)

Process 3
Input :
SMT Type of Simulation : numeric ; used in this process to skip saving unused slots if ARRD simulation (=1).
SCF Continued Flow Control : numeric ; also used to decide if saving of unused slots is necessary (i.e., saving slots is unnecessary on first flow control simulation of the day for an airport and this is conveyed by setting this flag = 0). If this flag is 1, save unused slots.
SIM Unused Flow Landing Slots : numeric, table
SEL ETA Value : numeric,epoch
Landing Time : (see process 1 output)
SFN Earliest Notice Time: numeric, epoch
Process :
If this Landing Time is greater than or equal to the SEL ETA Value, exit this segment, otherwise go back to process 2 if SMT Type of Simulation equals 1 or SCF Continued Flow Control equals 0 or Landing Time is equal to or earlier than SFN Earliest Notice Time. Otherwise, Increment by 1 the SFL Length of Unused Slots and append this Landing Time to the SFL Unused Slots Data Set (i.e., set SFL Unused Landing Time= Landing Time). Then go back to process 2.
Output :
SEL Land Time : numeric, epoch
SIM Unused Flow Landing Slots : numeric, table

HIPO 1.2.1.2.2.1.1 "Get Unused Flow Landing Slots"

Segment Function

This segment tries to find an appropriate landing slot for the flight from a list of unused landing slots. Unused landing slots exist when previous flow control ground delays have prevented a flight from arriving earlier than an airborne delayed flight and when significant increases in landing capacity has occured or substantial reductions in original arrival traffic has freed more landing slots. If no unused slots are listed or none can meet the flight's ETA Value, the function returns a flag indicating that no slot was found (i.e., the landing slot must be obtained from future landing capacity rather than past unused landing slots).

Before searching the unused slot list,the list is pruned of all slots which are known to be no longer usable. These slots are those landing times which are earlier than the current flight's original arrival time (this holds true because the flights are initially ordered by this original arrival time and the flow control assignments effectively preserve this order).

Process 1
- Input :
  - none
- Process :
  - Set SFL Unused Slot Found to zero.
- Output :
  - SFL Unused Slot Found: numeric, 0 or 1 ; when set to zero this flag indicates that no landing time was retrieved from the unused slots list.

Process 2
- Input :
  - SFL Length of Unused Slots : numeric; the number of unused slots in the SFL Unused Slot Data Set.
- Process :
  - If SFL Length of Unused Slots is equal to 0, exit segment,this function is complete.
- Output :
  - None

Process 3
- Input :
  - SIM Unused Flow Landing Slots : numeric, table; the data table where all of the unused slot information is preserved.
  - SEL Original Arrival Time: numeric, epoch
- Process :
  - Remove all SFL Unused Landing Times which are earlier than the SEL Original Arrival Time. Decrement by 1 the SFL Length of Unused Slots for each element removed.
- Output :
  - SIM Unused Flow Landing Slots : numeric, table; (to 4)

Process 4
- Input :
  - SIM Unused Flow Landing Slots: numeric, table; (from 3)
  - SEL ETA Value: numeric, epoch
- Process :
  - Search the remaining SEL Unused Slot Data Set for a SFL Unused Landind Time which is greater than or

equal to the SEL ETA Value. Exit segment if no match is found.

Output :

SFL Unused Landing Time: numeric, epoch; the time which satisfied the search criteria and which will be given the flight. (to 5).

Process 5

Input :

SFL Unused Landing Time: numeric, epoch; (from 4)
SFL Unused Slot Data Set: numeric, table; the list of unused landing times.
SFL Length of Unused Slots: numeric

Process :

Set SEL Landing Time = SFL Unused Landing Time, set SFL Unused Slot Found = 1, remove SFL Unused Landing Time from the SFL Unused Slot Data Set, decrement by 1 the value of SFL Length of Unused Slots and then exit this segment.

Output :

SEL Land Time: numeric, epoch
SFL Unused Slot Found: numeric; the value returned from this process is 1, indicating that a slot was found which matches the flight's ETA Value.
SFL Length of Unused Slots: numeric
SFL Unused Slots Data Set: numeric, table

HIPO 1.2.1.2.2.2 "Compute Flow Control Times"
Segment Function:

Given the Landing Time, the delay incurred, the flight record data, and earliest notice time, this segment computes the assigned arrival time, flow delay, control arrival time and control departure time as appropriate for the type of simulation.

Process 1

Input:

SEL Boundary Release Time: numeric, epoch
SFN Earliest Notice Time: numeric, epoch

Process:

Check new flow control assignment: if no new flow control assignment can be made(i.e. boundary release time less than the earliest notice time), go to process 10. Otherwise, process as follows.

Output: none

Process 2

Input:

SEL Land Time: numeric, epoch

SFH Hold Control Time: numeric, seconds

Process:

Set Assigned Arrival Time: obtained by subtracting the SFH Hold Control Time from the SEL Land Time.

Output:

Assigned Arrival Time: numeric, epoch (to 3)

Process 3

Input:

Assigned Arrival Time: numeric, epoch (from 2)

SEL Original Arrival Time: numeric, epoch

Process:

Set Flow Delay:Compute the flow delay time by subtracting SEL Original Arrival Time from Assigned Arrival Time.

Output:

Flow Delay: numeric, seconds (to 4,5,6,8)

Process 4

Input:

Flow Delay: numeric, seconds (from 3)

Process:

Check Flow Delay: if no flow delay(i.e. flow delay less than or equal to 0), set SEL Flow Arrival Time and SEL Flow Departure Time to null and go to process 10. Otherwise GO TO process 5.

Output:

SEL Flow Arrival Time: numeric, epoch

SEL Flow Departure Time: numeric, epoch

Process 5

Input:

SDI Delay Incurred: numeric, seconds

Flow Delay: numeric, seconds(from 3)

Process:

Adjust Flow Delay: if SDI Delay Incurred is greater than Flow Delay, set Flow Delay equal to SDI Delay Incurred.

Output:

Flow Delay: numeric, seconds

Process 6

Input:

Flow Delay: numeric, seconds (from 3 or 5)

SEL Original Arrival Time: numeric, epoch

Process: Compute SEL Flow Arrival Time and SEL Flow Departure Time: Let the SEL Flow Arrival Time equal to the sum of SEL Original Arrival and Flow Delay, also let the SEL Flow Departure Time be the SEL Original Departure Time.

Output:

SEL Flow Arrival Time: numeric, epoch

SEL Flow Departure Time: numeric, epoch

Process 7
    Input:
        SMT Type of Simulation: numeric,
    Process:
        Check SMT Type of Simulation: if it is a quota simulation(i.e. SMT type of Simulation greater than 4), then go to process 9, otherwise go to process 8.
    Output: none

Process 8
    Input:
        Flow Delay: numeric, seconds (from 3 or 5)
        SEL Original Departure Time: numeric, epoch
        SEL Original Arrival Time: numeric, epoch
        SEL Estimated Departure Time: numeric, epoch
        SFN Earliest Notice Time:numeric, epoch
        SEE ETE value: numeric, seconds; this is the flight range within which FAD ground delay assignments are permitted
    Process:
        Compute ground delay assignment if applicable: Set SEL Flow Departure Time equal to the sum of the SEL Original Departure Time and the Flow Delay, if the following two conditions are met; (1) the SEL Estimated Departure Time is greater than or equal to the SFN Earliest Notice Time, and (2) the difference between SEL Original Arrival Time and SEL Original Departure Time is less than or equal to SEE ETE value.
    Output:
        SEL Flow Departure Time: numeric, epoch

Process 9
    Input:
        SEL Flight Record
    Process:
        "Update Controlled Flight List"
    Output:
        SCL Controlled Flight List Buffer

Process 10
    Input:
        SEL Flight Record
    Process:
        "Fill In PAT Control Delay Table"
    Output:
        SDT PAT Control Delay Table

HIPO 1.2.1.2.2.2.1 "Update Control Flight List"

Segment Function:
This module adds to the controlled flight list buffer those flights which have been given new flow control assigments.

Process 1
Input:
SEL Flight Record
Process:
Add the flight record in the proper format to the controlled flight list buffer.
Output:
SCL Controlled Flight List Buffer

HIPO 1.2.1.2.2.2.2 "FILL IN PAT CONTROL DELAY TABLE"

Segment Function
This module picks the first flight to fall into a 15-minute planned arrival time interval and puts it into the corresponding place in the delay table.

Process 1
Input:
SBI Beginning Interval Time; numeric,epoch
(start time of next 15-minute interval)
SEL Planned Arrival Time; numeric, epoch
Process:
If the PAT of the flight is less than or equal to the beginning interval time, return.
Output:
none

Process 2
Input:
SBI Beginning Interval Time
SEL Planned Arrival Time
SEL Control Arrival Time
Process:
Put the control delay (CAT - PAT) of the flight into that place in the delay table which corresponds to the beginning interval time.
Output:
SDT PAT Control Delay Table; numeric

Process 3
Input:
SBI Beginning Interval Time
Process:
Increment the beginning interval time by 15 minutes.
Return.

Output: SBI Beginning Interval Time

HIPO 1.2.1.2.3 "COMPUTE ARRD DELAY PREDICTION"

OVERVIEW

As a flight arrives over the airport, data is collected about the delay. When a flight can not immediately land, the delay statistics are computed. After all events have been modeled for the simulation, the final statistics are computed for each interval and stored for output.

SEGMENT FUNCTION

The delay data and the hold data are recorded whenever a flight delay occurs. the arrival and landing statistics are kept in the SIM ARRD Table independent of delays.

PROCESS 1

INPUT:

SAT Time of Hour: Numeric, Epoch
SAT Arrival Count: Numeric

PROCESS:

Increment SAT Arrival Count: The arrival count is incremented for the arrival hour.

OUTPUT:

SAT Arrival Count: Numeric ; (TO 7)

PROCESS 2

INPUT:

SAT Time of Hour: Numeric, Epoch
Active Flag: Numeric ; To indicate whether the flight is already departed, during the time of simulation.
SAT Active Count: Numeric

PROCESS:

Increment Active Arrival Count if active: when the Active Flag is on, SAT Active Count is incremented.

OUTPUT:

SAT Active Count: Numeric ; (TO 7)

PROCESS 3

INPUT:

Land Hour: Numeric, epoch
SAT Flights Landed Count: Numeric

PROCESS:

Increment Landing Count: SAT Flights Landed Count is incremented for Land Hour.

OUTPUT:

SAT Flights Landed Count: Numeric ; (TO 7)

PROCESS 4

INPUT:

SEL ETA Value: Numeric, Epoch
SEL Land Time: Numeric, Epoch

PROCESS:

Decide if delay statistics required (i.e. SEL ETA Value is unequal to SEL Land Time)

OUTPUT:

Not applicable.

PROCESS 5

INPUT:

SEL ETA Value: Numeric, Epoch
SEL Land Time: Numeric, Epoch
SIM ARRD Delay Data Table: Numeric
SAT Peak Hold Delay: Numeric

PROCESS:

"Update Aircraft Delays": Update the number of delayed aircraft, the total delays and the peak hold delay.

OUTPUT:

Delay Data Table: Numeric
SAT Peak Hold Delay: Numeric ; Pass to process 7.

PROCESS 6

INPUT:

SEL ETA Value: Numeric, Epoch
SEL Land Time: Numeric, Epoch
Arrival Hour: Numeric, epoch
SIM ARRD Hold Data Table: Numeric
SRT Report Start Time: Numeric , epoch

PROCESS:

"Update Aircraft Holding" : Update the aircraft holding counts for every minute of holding during each hour.

OUTPUT:

SIM ARRD Hold Data Table: Numeric ; A table contains the hold counts for each minute of the hour.

PROCESS 7

INPUT:

SIM ARRD Table: Numeric
SAT Arrival Count: Numeric (from 1)
SAT Active Count: Numeric (from 2)
SAT Peak Hold Delay: Numeric (from 5)
SAT Flights Landed Count: numeric (from 3)

PROCESS:

Add Data to SIM ARRD Table: Store the arrival count, the active count, the flights landed count and the peak hold delay into SIM ARRD Table for each hour.

OUTPUT:

SIM ARRD Table: Numeric

HIPO 1.2.1.2.3.1 "UPDATE AIRCRAFT DELAYS"

SEGMENT FUNCTION

Compute aircraft delays from the difference between arrival times and landing times. Keep a count of the number of flights delayed each hour. compute the sum of all projected delays for each hour. (A delayed flight spanning several hours will contribute to the delays in each hour.)

PROCESS 1

INPUT:

SEL Land Time: numeric, epoch
SEL ETA Value: numeric, epoch

PROCESS:

Compute Destination Hold Delay: Subtract SEL ETA Value from SEL Land Time for each aircraft holding.

OUTPUT:

Destination Hold Delay: numeric, seconds (TO 2)

PROCESS 2

INPUT:

Destination Hold Delay: numeric, seconds (FROM 1)
SAD Sum of Delays: numeric, seconds; total for each hour of simulation

PROCESS:

Add Destination Hold Delay to the sum for each arrival hour. Count delay additions. (i.e., Increment by 1 the SAD Number of Delay Additions).

OUTPUT:

SAD Sum of Delays: numeric, seconds (TO 3)
SAD Number of Delay Additions: numeric (TO 3)

PROCESS 3

INPUT:

SAD Sum of Delays: numeric, seconds (FROM 2)
SAD Number of Delay Additions: numeric (FROM 2)
SEL Land time: numeric, epoch
SEL ETA Value: numeric, epoch

PROCESS:

For flights holding into the next hour (or longer), compute delay for the flight from the beginning of the hour to the landing time of the flight. Add this delay to the SAD Sum of Delays and increment by 1 the count of the SAD Number of Delay Additions for this interval.

OUTPUT:

SAD Sum of Delays: numeric, seconds
SAD Number of Delay Additions: numeric

HIPO 1.2.1.2.3.2 "UPDATE AIRCRAFT HOLDING"

SEGMENT FUNCTION

To locate the proper minute counters and increment the holding counts.

PROCESS 1

INPUT:

SEL ETA Value: Numeric, Epoch
SRT Report Start Time: Numeric, Epoch
SEL Land Time: Numeric, Epoch

PROCESS:

Determine the Holding Period for incrementing Holding Counters: Find the proper minute counter indexes for which the flight will be held during these minutes.

OUTPUT:

Minute Counter Index: Numeric; an index pointing to the minute counter where the number of holding is kept for that minute. (TO 2)

PROCESS 2

INPUT:

SAH Number Holding: Numeric
Minute Counter Index: Numeric; (FROM 1)

PROCESS:

Increment the Appropriate Minute Counters During the Holding Period: Increment the holding counts for those minute counters specified by the minute counter indexes.

OUTPUT:

SAH Number Holding: Numeric

HIPO 1.2.1.2.4 "Compute Delays Incurred"

Overview :

Given that controls are relaxed or eliminated prior to the previously projected time for controls to end, this routine computes for each flight the amount of delay which the flight has already taken. The various statistics, including estimated arrival time, are then updated accordingly. Where appropriate, departure delays are taken into account.

Segment Function :

Flights are classified as uncontrolled, controlled and on the ground, and controlled and in the air. Delay incurred is calculated for each case. In the event that the flight is controlled and airborne, the submodule "Compute Delays Incurred for Airborne Flights" is invoked. When incurred delays for applicable flow controls have been calculated, the routine checks for event type. If type 4, the routine uses the "Compute Departure Delay Status" submodule to account for possible additional delays incurred due to departure controlls at the origin air terminal. Finally, all statistics are compared to generate actual flight status, the "estimateds", which is entered into the SEL array.

Process 1 :

Input :

SEL ETA Value: numeric, epoch; System best estim. of flight arrival time .

SEL Boundary Time: Numeric; Elapsed time for flight to move from tier boundary to terminal arrival point (SEL Subzone Boundary Time). Also input to process 4.

SFN Earliest notice time: Numeric, epoch; Time of lifted controls Also input to processes 2,3, and 4.

Process:

Compute Boundary Release Time. (SEL Boundary Release time=SEL ETA Value-SEL Subzone Boundary Time).

Initialize Delay Incurred (SDI Delay Incurred=0).

If SEL Boundary Release time is less than SFN Earliest Notice time, set SDI Delays Incurred = SEL Flow Arrival time-SEL Original Arrival Time, exit; no delays incurred.

Output:

SDI Delays Incurred: Numeric; Amount of delay incurred. (SDI Delay Incurred). Input to process 6.

SEL Boundary release time: Numeric, epoch; Time flight is due to leave tier center .

Process 2

Input:

SEL Flow Arrival Time:Numeric, Epoch; Flow control imposed time of arrival at destination terminal arrival point .

SEL Original Departure time: Numeric, Epoch; Departure time originally planed by flight .

SFN Earliest notice time: (See Proc. 1 Input)

Process:

If flight not previously flow controlled (SEL Flow Arrival Time=0), Do Process 5. If SEL Original Departure time is greater than or equal to SFN Earliest Notice time, reset flow control times (SEL Flow Departure time=SEL Flow Arrival Time=0) and do process 5. If none of the above conditions is true, do process 3.

Outputs:

SEL Flow departure time: Numeric, Epoch; Time at which flow control procedures will permit flight to depart. Null if zero. Input to process 7.

SEL Flow Arrival Time: Numeric, Epoch; Projected arrival time under flow control procedures. .

Process 3

Inputs:

SEL Original Departure time: Numeric, epoch; See inputs process 2.

SFN Earliest Notice Time: Numeric, Epoch; See inputs, process 1.

SEL Flow Departure Time: Numeric, Epoch; Time at which control procedure will permit departure of flight in question. Also input to process 7.

Process:

If SFN Earliest Notice time is earlier than SEL Flow Departure time, (SFN Earliest Notice timeis less than or equal to SEL Flow Departure time), set SDI Delay Incurred=(SFN Earliest Notice time-SEL Original Departure time) and set SEL Flow Departure time = SFN Earliest Notice time and do process 5. Otherwise, do process 4.

Outputs:

SDI Delays Incurred: Numeric; Delay time already experienced by flight. Input to process 6.

SEL Flow Departure time: See input list; Control departure modified to indicate change caused by lifting controls. Input to process 7.

Process 4

Inputs:

SEL Subzone Boundary Time: See process 1 inputs

SFN Earliest Notice time: See process 1 inputs

SEL Original Departure time: See process 2 inputs

SEL Flow Departure time: See process 3 inputs

SEL Estimated Departure time:Numeric, Epoch;Best estimate of flight departure time given all factors

affecting same.
SEL Original Arrival time: Numeric, Epoch; Flight's original, intended time of arrival at destination. Also input to processes 6 & 7.

Process:

If flight is airborne, i.e. SEL Estimated Departure time is less than or equal to SFN Earliest Notice time, "Compute Delay Incurred for Airborne Flights" 1.2.1.2.4.1. In any case, do process 5.

Outputs:

SEL Boundary Arrival time: Numeric, Epoch; Time of arrival of flight at tier center stack or hold point.
SDI Delays Incurred: Numeric; Amount of time delayed by flight in question. Input to process 6.

Process 5

Inputs:

SEL Event type: Numeric; Identifies sort of simulation being performed.

Process:

Set SEL DD Departure time=SEL DD Arrival time=0.
If SEL Event Type is not equal to 4, do process 7.
If SEL Event Type = 4, Do process 6.

Outputs:

SEL DD Departure time: Numeric, Epoch; Time of departure caused by departure delay at flight's origin. Input to step 6.
SEL DD Arrival Time: Numeric, Epoch; Arrival time caused by departure delay.

Process 6

Inputs:

SEL Original Departure time: See inputs to process 2.
SEL Original Arrival time: See inputs to process 4.
SDI Delay Incurred: Numeric; Previously calculated incurred delay value. Output from process 1, 3, or 4, depending on stage of flight.
SDD Airport Data Set: AlphaNumeric, Array; Table of DD terminals by name together with the actual Departure Delay times.

Process:

"Compute Departure Delay Status" 1.2.1.2.4.2

Outputs:

SDI Delay Incurred: Numeric; Incurred delay value modified as necessary by departure delay status.
SEL DD Departure time: See output for process 5
SEL DD Arrival Time: See outputs for process 5.

Process 7

Inputs:

SEL Original Departure time: See inputs for process 2.

SEL Original Arrival time: See inputs for process 4.
SEL Flow Departure time: See inputs for process 3, Outputs for processes 2 & 3.
SEL Actual Departure time: Numeric, Epoch; If actual departure time of flight has been made available to the system, this is it.
SEL DD Departure time: See outputs processes 5 & 6.

Process

Calculate SEL Estimated Departure time;
SEL Estimated Departure time = Latest of the times (SEL Original Departure time,SEL DD Departure time,SEL Flow Departure time)
If (SEL Actual Departure time is not equal to 0), SEL Estimated Departure time = SEL Actual Departure time
Calculate SEL ETA Value;
SEL ETA Value = SEL Estimated Departure time + (SEL Original Arrival time - SEL Original Departure time)
EXIT

Outputs:

SEL Estimated Departure time: Numeric, Epoch; See input to process 4. This is final estimate of departure time by system.
SEL ETA Value: Numeric, Epoch; System best estimate of arrival time for flight in question. Includes incurred delays, and actual reported flight data, if any.

HIPO 1.2.1.2.4.1 "Compute Delay Incurred for Airborne Flight"

Overview :

This module is part of a subsection computing incurred delays after unexpected relaxation of flow controls. In particular, this routine covers the case where the aircraft has exhausted the assigned ground delay, if any, and is enroute.

Segment Function :

Time of arrival at tier boundary is calculated. If aircraft is not yet at tier, incurred delay is ground delay. If the aircraft has reached the tier center hold point, incurred delay is ground delay and whatever delay the flight has experienced at the tier center. Flights which have completed all flow control delays are not handled by this routine. Refer to 1.2.1.2.4 "Compute Delays Incurred."

Process 1

Inputs:

SEL Estimated Departure time: Numeric, Epoch; Current system estimate of flight departure time, all things considered.
SEL Original Departure time: Numeric, Epoch; Flight's planed time of departure. Also input to processes 2 & 3.
SEL Original Arrival time: Numeric, Epoch; Flight's planed arrival time.
SFL Subzone Boundary Time: Numeric; Elapsed time for flight to pass from tier hold point to destination hold point.

Process

Compute boundary arrival time:
(SEL Boundary Arrival time = SEL Estimated Departure time + SEL Original Arrival time - SEL Original Departure time - SEL Subzone Boundary Time)

Outputs:

SEL Boundary Arrival time: Numeric, Epoch; Time of arrival of flight at tier center hold point. Input to processes 2 & 3.

Process 2

Inputs:

SFN Earliest Notice time: Numeric, Epoch; Time of lifting of controls. Also input to process 3.
Flow Departure Time: Numeric, Epoch; Flow control procedure departure time for flight in question. Also input to process 3.
SEL Original departure time: See inputs, process 1.

Process

If SEL Boundary Arrival time is greater than or equal to SFN Earliest Notice time, Compute delay incurred as
SDI Delay Incurred = SEL Flow Departure time - SEL Original Departure time, and
EXIT.
Otherwise do process 3.

Outputs:

SDI Delay Incurred: Numeric; Delay time already experienced by flight in question.

Process 3

Inputs:

SFN Earliest Notice time: See inputs for process 2
SEL Flow Departure time: See inputs for process 2.
SEL Original Departure time: See inputs for process 1.
SEL Boundary Arrival time: See outputs for process 1.

Process:

Compute delay incurred as
SDI Delay Incurred = (SEL Flow Departure time - SEL Original Departure time) + (SFN Earliest Notice time - SEL Boundary Arrival time).

EXIT

Outputs:

SDI Delay Incurred: Numeric; Delay already experienced by flight in question.

HIPO 1.2.1.2.4.2 "Compute Departure Delay Status"

Overview

Routine functions as subpart of section calculating delays incurred after unexpected lifting of flow controls. If flight in question experienced a departure delay, and flow controls are removed, it may be that the departure delay exceeds the delay the flight would have incurred due to flow control. In that case, the delays incurred equal the departure delays.

Segment Function

Flight and origin airport are checked to determine if departure delays apply. If not, routine is done. If origin air terminal has departure delays, they are picked up as an internal variable. First, delay departure time and delay arrival time are calculated. Then delay incurred is set according to result of comparison with departure delays.

Process 1

Inputs:

NONE

Process:

Initialize departure delays, DD = 0.

Output:

DD: Numeric, seconds; Local variable to hold departure delay if any.

Process 2

Inputs:

SDD Airport Data Set: Character, table; Table of terminals with departure delays and the delay values.

SEL Departure Airport: Numeric; Code of flight origin air terminal.

Process:

Search departure delay airport list for SEL Departure Airport. If found, set DD equal to SDD Departure Delay for entry found.

Outputs:

DD: Numeric, seconds; Value of departure delays. Local variable. (TO 3)

Process 3

Inputs:

DD: Numeric,seconds; (FROM 2)

Process:

If DD = 0, EXIT.

If DD is not equal to 0, do process 4.

Outputs: NONE

Process 4

Inputs:

SEL Original Departure time: Numeric, Epoch; Flight's intended departure time.

SEL Original Arrival time: Numeric, Epoch; Flight's intended arrival time.

SDI Delay Incurred: Numeric, seconds; Amount of time the flight has been delayed due to flow controls up to earliest notice time.

DD: Numeric, seconds; Local variable value of departure delay. Input from process 1 or 2.

Process

SEL DD Departure time = SEL Original Departure time + DD.

SEL DD Arrival time = SEL Original Arrival time + DD.

If DD is greater than SDI Delay Incurred, SDI Delay Incurred = DD.

Outputs

SEL DD Departure time: Numeric, Epoch; Time of departure after departure delays exhausted.

SEL DD Arrival: Numeric, Epoch; Time of arrival of flight having taken a departure delay.

SDI Delay Incurred: Numeric, seconds; Value of delay incurred by flight.

HIPO 1.2.1.2.5 "Compute Flow Controls"

Overview:

Given flight event and its flow control assignments, hourly flow control quotas are calculated at the boundary crossings for each tier center. The quota data computed includes flights released, carried over, and, if applicable, boundary releases by origin center.

Depending on the type of simulation, an energy conservation report may be computed, or the flight record may be added to the Flight Report Data Set.

Segment Function:

A test may be made to see if the boundary release time is earlier than or equal to the earliest notice time. If it is, then the quotas are computed, and if appropriate, a call is made to "Compute FAD Delay" (for FADP simulations), or "Add Flight to Report Data List" (for FADF simulations)

Process 1
- Input:
  - SEL Flow Arrival Time: numeric, epoch
  - SEL Subzone Boundary Time: numeric, seconds; time to fly from zone boundary to destination airport.
  - SEL Estimated Departure Time: numeric, epoch
  - SEL Original Arrival Time: numeric, epoch
  - SEL Original Departure Time: numeric, epoch
  - SIM Quota Table
  - SIM Quota Origin Table
- Process:
  - "Compute Quotas" - adds the flight's flow control status to the quota tables.
- Output:
  - SEL Boundary Release Time: numeric, epoch
  - SEL Boundary Arrival Time: numeric, epoch
  - Estimated time enroute: numeric, seconds
  - SIM Quota Table
  - SIM Quota Origin Table

Process 2
- Input:
  - SEL Original Arrival Time: numeric, epoch
  - SEL ETA Value: numeric, seconds
  - SFN Earliest Notice Time: numeric, epoch
  - SEL Land Time: numeric, seconds
  - SIM Conservation Table
- Process:
  - "Compute FAD Delay" - Compute cumulaive control and destination delays.
- Output:
  - SFT Cumulative Destination Delay: numeric, seconds
  - SFT Cumulative Control Delay: numeric, seconds
  - Average control delay: numeric, seconds

Process 3
- Input:
  - SIM reported flights table
  - SEL Land Time: numeric, epoch
  - SEL Subzone Boundary Time: numeric, seconds
  - SEL Original Arrival Time: numeric, epoch
  - SEL ETA Value: numeric, epoch
  - SEL Estimated Departure Time: numeric, epoch
  - SEL original departure time: numeric, epoch
  - SEL Flow Departure Time: numeric, epoch
  - SEL Boundary Release Time: numeric, epoch
- Process:
  - "Add Flight to Report Data List" - Appends SEL flight event data to the indexed SRF Flight Report

Data Set.

Output:

Sim Reported Flights Table

HIPO 1.2.1.2.5.1 "Compute Quotas"

Segment Function:

Adds the flight's flow control status to the quota tables. This segment computes the boundary arrival and release times. It also produces the SQT Release Rate and the quota carry count. If appropriate, it increments the SQOT Originating Center Flight Count.

Process 1

Input:

SEL Flow Arrival Time: numeric, epoch
SEL Subzone Boundary Time: numeric, seconds; time to fly from zone boundary to destination airport.
SEL Estimated Departure Time: numeric, epoch
SEL Original Departure Time: numeric, epoch
SEL Original Arrival Time: numeric, epoch

Process:

Compute boundary arrival times and release times.
(SEL Boundary Release Time = SEL Flow Arrival Time SEL Subzone Boundary Time)
(SEL Boundary Arrival Time = SEL Estimated Departure Time + Estimated Time Enroute - SEL Subzone Boundary Time)

Output:

Estimated Time Enroute: numeric, seconds
SEL Boundary Arrival Time: numeric, epoch (to 2)
SEL Boundary Release Time: numeric, epoch (to 2 and 3)

Process 2

Input:

SIM Quota Table
SEL Boundary Arrival Time (from 1)
SEL Boundary Release Time (from 1)
SEL Subzone Index: numeric, integer

Process:

Increment by 1 for each flight the SQT Release Rate for the SEL Subzone Index and the hour of SEL Boundary Release Time. Starting with hour of SEL Release Time and ending with the hour of SEL Boundary Arrival Time for the subzone indexed, increment by 1 the quota carry count (i.e. SQT carry-over) if the SEL Boundary Release Time is later than the count hour.

Output:

SIM Quota Table

Process 3

Input:

SMT Type of Simulation
SEL Boundary Release Time (from 1)
SIM Quota Origin Table
SEL Subzone Index: numeric, integer

Process:

If the SMT Type of Simulation = 5 (QFLZ), then EXIT. For the hour of SEL Boundary Release Time and the subzone indexed, increment by 1 the SQOT Center Originating Flight Count for the appropriate origin center in the subzone. If no matching origin center in the SEL Subzone Data Set, add it to the SQOT entry data set and then increment the SQOT Originating Flight Count by 1.

Output:

SIM Quota Origin Table

HIPO 1.2.1.2.5.2 "Compute FAD Delay"

Segment Function:

Given flight event and its flow control assignments, energy conservation delays are computed. The FAD table interval number is also produced.

Process 1

Input:

SEL Original Arrival Time: numeric, epoch
SFN Earliest Notice Time: numeric, epoch

Process:

If SEL Original Arrival Time is earlier than SFN Earliest Notice Time, EXIT. Otherwise, compute SFT Interval Index from 1 + (SEL Original Arrival Time - SFN Earliest Notice Time)/900 and continue with processes 2 and 3.

Output:

Interval Index: numeric, integer (to 2 and 3)

Process 2

Input:

SEL ETA Value: numeric, epoch
SEL Land Time: numeric, epoch
Interval Index: numeric, integer (from 1)

Process:

Compute destination hold delay (= SEL Land Time - SEL ETA Value), and add it to the SFT Cumulative Destination Delay for interval. Increment by 1 SFT Interval Aircraft Count for indexed interval.

Output:
SFT Interval Aircraft Count: numeric
SFT Cumulative Destination Delay: numeric, seconds

Process 3
Input:
SEL Original Arrival Time: numeric, epoch
SEL ETA Value: numeric, epoch
Interval Index: numeric (from 1)
Process:
Compute Flow Control Delay (= SEL ETA Value - SEL Original Arrival Time) and add it to the SFT Cumulative Control Delay for interval.
Output:
SFT Cumulative Control Delay: numeric, seconds

HIPO 1.2.1.2.5.3 "Add Flight to Report List"

Segment Function
Given the flight record and its flow control assignments, this segment computes the total flight delay and estimated time enroute, and appends flight record data to the indexed hour's SRF Flight Report Data Set.

Process 1
Input:
SEL ETA Value: numeric, epoch
SRF Number of Hours: numeric, 0-24
SRF Number of Flight Reports: numeric
Process:
Compute hour index from SEL ETA Value. If no flights entered as yet that hour, then increment by 1 the SRF Number of Hours and set SRF Time of Hour (= hour of SEL ETA Value). Increment by 1 SRF Number of Flight Reports for indexed hour.
Output:
SRF Number of Hours: numeric
SRF Time of Hour: numeric, epoch
SRF Number of Flight Reports: numeric
Hour Index: numeric (to 2 and 3)

Process 2
Input:
SEL Flow Departure Time: numeric, epoch
SEL Land Time: numeric, epoch
SEL Original Arrival Time: numeric, epoch
SEL Original Departure Time: numeric, epoch
Hour Index: numeric (from 1)
Process:

For hour indexed, compute SRF Flow Control Departure Delay (= SEL Flow Departure Time - SEL Original Departure Time), SRF Total Flight Delay (= SEL Land Time - SEL Original Arrival Time), and SRF ETE of Flight (= SEL Original Arrival Time - SEL Original Departure Time).

Output:

SRF Flow Control Departure Delay: numeric, seconds
SRF Total Flight Delay: numeric, seconds
SRF ETE of Flight: numeric, seconds

Process 3

Input:

SEL Aircraft Identification: character
SEL Departure Airport: numeric; airport or center code.
SEL Estimated Departure Time: numeric, epoch
SEL Original Departure Time: numeric, epoch
SEL Estimated Time of Arrival: numeric, epoch
SEL Boundary Crossing Time: numeric, epoch

Process:

Copy the remaining SRF Flight Data Set from SEL flight record data for the indexed hour.

Output:

SRF Flight Report Data Set

HIPO 1.2.2 "Prepare Simulation Outputs"

Overview

This segment accepts data as presented in the SIM ARRD TABLE and other output tables as output from "Process Simulation" segment. This data is passed to the various table preparation segments for generation and updating of the report tables for final output. This segment is the logical point for bookkeeping required when one of several different reports must be assembled.

Segment Function

This segment accepts data generated by simulation, checks type of request, updates the appropriate raw data sets and prepares the final reportable data tables.

Process 1

Input:

SMT Type of Simulation: numeric, 1 for ARRD; 2 for FADP; 3 for FADF; 4 for FADT, 5 for QFLZ and 6 for QFLW.

Process:
Check for simulation type: if the SMT Type of Simulation is 1, 2, 3 or 4, go to process 2; otherwise, exit from this segment.
Output: none

Process 2
Input:
SMT Type of Simulation : Numeric, Flag, Integer.
SAD ARRD Delay Data Table : Numeric, Elapsed Time, Array;
SAD ARRD Hold Data Table : Numeric, No. of A/C, Array;
SIM ARRD TABLE : Numeric, Mixed, Array; Partially updated ARRD data table for current simulation pass
Process:
"Prepare ARRD Table": for final update of the SIM ARRD TABLE.
Output:
SIM ARRD TABLE : ; Fully updated ARRD data array. Ready for report generator.

Process 3
Input:
SMT Type of Simulation: numeric, 1 for ARRD; 2 for FADP; 3 for FADF etc.
Process:
Check for FAD type of simulation: if the SMT Type of Simulation is 2, go to process 4; if SMT Type of Simulation is 3, go to 5.
Output: none

Process 4
Input:
SIM FAD Table: Numeric, Table; The raw FAD control data.
SIM Conservation Table: numeric
Process:
"Prepare FAD Table": compute the SCT Average Control Delays, the SCT Average Destination Delays and the SCT Total Average Delays for each interval of the FAD Table.
Output:
SCT Average Control Delay: numeric, seconds
SCT Average Destination Delay: numeric, seconds
SCT Total Average Delay: numeric, seconds

Process 5
Input:
SIM Reported Flights Table: mixed numeric and character
SIM Airport decode Table: mixed numeric and character

Process:
"Prepare Flight Report List": decode the numeric airport code and sort each hour's list of flights by the SEL ETA Value.

Output:
SIM Report Flights Table: mixed numeric and character

HIPO 1.2.2.1 "PREPARE ARRD TABLE"

OVERVIEW

Compute the report period delay statistics for a given airport and arrange them for output by hour. Delay and hold data accumulated in the delay prediction process during simulation are used to compute an average hold delay for each period. The SAT average hold count and peak hold count are also derived from these data.

SEGMENT FUNCTION

Pass appropriate collected data to the segments which perform the computations, and assemble the processed delay information into the SIM ARRD TABLE.

PROCESS 1

INPUT:
SIM ARRD Delay Data Table : numeric, mixed; an hourly set of delay data produced under "Perform Simulation".

PROCESS:
"Compute ARRD Delays": Divide the sum of delays by the number of delayed aircraft.

OUTPUT:
SAT Average Hold Delay: numeric, seconds (to 3)

PROCESS 2

INPUT:
SIM ARRD Hold Data Table: numeric; hold count for each minute of the hour being processed.
SIM ARRD Table: numeric, table

PROCESS:
"Compute ARRD Holds": Divide the sum of the hold counts for the interval by the time difference between this interval and the next interval to obtain the SAT Average Hold Count. Determine and save the maximum count during the interval in SAT

Peak Hold Count.

OUTPUT:
SAT Average Hold Count: numeric (to 3)
SAT Peak Hold Count: numeric (to 3)

PROCESS 3
INPUT:
SIM ARRD Table: numeric, mixed
SAT Average Hold Delay: numeric, seconds (from 1)
SAT Average Hold Count: numeric (from 2)
SAT Peak Hold Count: numeric (from 2)

PROCESS:
Add data to ARRD Table: assemble data from processes 1 and 2 and arrange in a form such that only formatting and decoding are required to produce the actual report.

OUTPUT:
SIM ARRD Table: numeric, mixed

HIPO 1.2.2.1.1 "COMPUTE ARRD DELAYS"

SEGMENT FUNCTION
Compute the hourly SAT Average Hold Delay at a given airport.

PROCESS 1
INPUT:
SIM ARRD Delay Data Table: numeric, mixed; An hourly set of delay data produced under "Perform Simulation"

PROCESS:
Compute SAT Average Hold Delay: For each hour, divide the SAT Sum of Delays by the SAT Number of Delay Additions.

OUTPUT:
SAT Average Hold Delay: numeric, seconds

HIPO 1.2.2.1.2 "COMPUTE ARRD HOLDS"

SEGMENT FUNCTION
Compute the average hold count and find the maximum number of aircraft holding during each hour.

PROCESS 1

INPUT:

SIM ARRD Hold Data Table: numeric; Hold count for each minute of the hours being processed.
SIM ARRD Table: Numerig, Table

PROCESS:

Compute Average Hold Count: Step through the report intervals, compute for±each interval the interval span by finding the difference between the indexed interval's SAT Time of Hour and the next interval's SAT Time of Hour. Divide the sum of all hold counts of the interval by the interval span to obtain the hold average. (If an average is desired for just the holding periods, then divide by the number of non-zero hold counts.) After the completion of SAT Average Hold Counts , go to process 2.

OUTPUT:

SAT Average Hold Count: numeric

PROCESS 2

INPUT:

SIM ARRD Hold Data Table: Numeric, Table

PROCESS:

Compute SAT Peak Hold Count: For each interval, scan the SAH±Hold Minutes Data Set to find the maximum value of the number of aircraft holding. Store it in the SAT Peak Hold Count. the maximum value of the number of aircraft holding.

OUTPUT:

SAT Peak Hold Count: numeric

HIPO 1.2.2.2 "Prepare FAD Table"

Segment Function

Given the SIM Conservation Table and the SIM FAD Table, the SCT Average Control Delay, the SCT Average Destination Delay and the SCT Total Average Delay are computed for each interval of the FAD Table. For interval with a zero SFT Interval Aircraft Count, interpolate the value of SCT Average Control Delay and SCT Average Destination Delay from the nearest non-zero intervals.

Process 1

Input:

SFT Interval Aircraft Count: numeric, integer

Process:

Step through each interval and for each interval if the SFT Interval Aircraft Count is not zero, then do process 2. When all intervals have been stepped through, go to process 3.

Output: none

Process 2

Input:

SFT Interval Aircraft Count: numeric, integer (from 1)

SFT Cumulative Destination Delays: numeric, seconds

SFT Cumulative Control Delay: numeric,seconds

SIM Conservation Table: numeric

Process:

Compute SCT Average Control Delay, SCT Average Destination Delay and SCT Total Average Delay: divide the SFT Cumulative Control Delays and SFT Cumulative Destination Delays by SFT Interval Aircraft Count and store the results in SCT Average Control Delay and SCT Average Destination Delay respectively. Set the SCT Total Average Delay equal to the sum of SCT Average Control Delay and SCT Average Destination Delay. Then, return to process 1.

Output:

SCT Average Control Delay: numeric, seconds

SCT Average Destination Delay: numeric, seconds

SCT Total Average Delay: numeric, seconds

Process 3

Input:

SFT Interval Aircraft Count: numeric, integer

Process:

Step through intervals and for each interval if the SFT Interval Aircraft Count is zero, do process 4. Exit from this segment on completion of steps.

Output:

Zero interval Index: numeric, the interval with zero aircraft count

Process 4

Input:

SIM Conservation Table: numeric

Zero Interval Index: numeric, te interval of zero aircraft(from 3)

Process:

Estimate the SCT Average Control Delay and SCT Average Destination Delay by interpolating the value from the nearest non-zero intervals to the zero interval(i.e. the bordering intervals with non-zero interval counts). Compute the SCT Total Average Delay by adding SCT Average Control Delay to SCT

Average Destination Delay. After the above three data items have been properly stored, go to process 3.

Output:

SCT Average Control Delay: numeric, seconds; updated interval data for the Zero Interval Index
SCT Average Destination Delay: numeric, seconds; Updated interval data for the Zero Interval Index
SCT Total Average Delay: numeric, seconds; Updated interval data for the Zero Interval Index

HIPO 1.2.2.3 "Prepare Flight Report List"

Segment Function

Given the SIM Reported Flights Table Data Segment and the SIM Airport Decode Table, the SRF Departure Airport codes(numeric) are replaced by the 3 letter character codes. For report purpose, each hour's list of flights is also sorted by the SEL ETA Value.

Process 1

Input:

SIM Reported Flights Table: mixed numeric and character
SIM Airport Decode Table: mixed numeric and character

Process:

Decode the SRF Departure Airport Code: direct access the SIM Airport Decode Table using the numeric airport code to locate the proper 3 letter character code for each of the SRF Departure Airport codes in the flight record.

Output:

SIM Reported Flights Table: mixed numeric nad character(to 2)

Process 2

Input:

SIM Reported Flights Table: mixed numeric and charcter (from 1)

Process:

Sort each hour's list of flights by the SEL ETA Value.

Output:

SIM Reported flights Table: mixed numeric and character

HIPO 1.3 "CONCLUDE SIMULATION"

OVERVIEW

This segment saves that information which is required to maintain continuity between simulation passes. In this respect, there are two cases of interest:

1. between interrupted simulations; i.e. waiting for the next block of flights.
2. between new simulations; i.e. between simulation requests. Sufficient information is saved to recover from the possibility of the simulation sub-system being removed from the computer's memory.

SEGMENT FUNCTION

A test is made to see if the current block of flights is the last to be processed. If it is, then data are transferred to the Continue Buffer. Otherwise, they are moved to the Interrupt Buffer.

PROCESS 1
- INPUT:
  - SSF End of Flight Blocks Flag
- PROCESS:
  - If last block, skip to Process 3.
- OUTPUT:
  - None

PROCESS 2
- INPUT:
  - SCP Simulation State Control Parameters
  - SDT Data Tables
  - SLF Leftover Flight Buffers
- PROCESS:
  - "Buffer Interrupted Data" (Return)
- OUTPUT:
  - SIB Interrupt Buffer

PROCESS 3
- INPUT:
  - SCP Simulation State Control Parameters
  - SDT PAT Control Delay Table
- PROCESS:
  - "Buffer Continue Data" (Return)
- OUTPUT:
  - SCB Continue Buffer

HIPO 1.3.1 "BUFFER INTERRUPTED DATA"

OVERVIEW:

This segment maintains continuity between interrupted simulations. It has the responsibility for storing the necessary Simulation State Parameters, the incomplete Data Tables, and the unprocessed flight records.

SEGMENT FUNCTION:
Store Simulation State Control Parameters, Data Tables, and Leftover Flights from the interrupted simulation.

PROCESS 1
INPUT:
SCP Simulation State Control Parameters
PROCESS:
"Store Simulation State Parameters"
OUTPUT:
SIB Simulation State Data Set

PROCESS 2
INPUT:
SDT Data Tables
PROCESS:
"Store Data Tables"
OUTPUT:
SIB Data Tables Data Set

PROCESS 3
INPUT:
SLF Leftover Flight Buffers
PROCESS:
"Store Leftover Flights"
OUTPUT:
SIB Leftover Flights Buffer Data Set

HIPO 1.3.1.1 "STORE SIMULATION STATE PARAMETERS"

SEGMENT FUNCTION
This segment stores the critical simulation internal control parameters necessary for restarting the simulation with the next block of flights. This information is stored in the Interrupt Buffer.

PROCESS 1
INPUT:
SMT Type of Simulation
SLC Landing Capacities Data
SGA GA Entry Data
SDD DD Data Table
SFH Flow Hold Time

SSE Stack Entry Data
SZR Zone Record Data

PROCESS:
Store Simulation State Control Parameters in Interrupt Buffer

OUTPUT:
SIB Simulation State Data Set

HIPO 1.3.1.2 "STORE DATA TABLES"

SEGMENT FUNCTION

This segment stores the incomplete data tables in the Interrupt Buffer. These tables include: the Hold Data Table, the Delay Data Table, the current PAT Control Delay Table, etc.

PROCESS 1

INPUT:
SAD ARRD Delay Data Table
SAH ARRD Hold Data Table
SQT Quota Table
SFT FAD Table
SDT PAT Control Delay Table

PROCESS:
Store data tables in Interrupt Buffer

OUTPUT:
SIB ARRD Tables Data Set
SIB Quota Tables Data Set
SIB FAD Tables Data Set
SIB PAT Control Delay Table Data Set

HIPO 1.3.1.3 "STORE LEFTOVER FLIGHTS"

SEGMENT FUNCTION

This segment stores the unprocessed flight records for the incomplete last hour of flights of the current block of flights, as well as, any leftover displaced new GA flights.

PROCESS 1

INPUT:
SLF Leftover Hour Flights Buffer
SLF Misplaced GA Flights Buffer

PROCESS:
Store Leftover Flights in Interrupt Buffer

OUTPUT:
SIB Leftover Flights Buffer

HIPO 1.3.2 "BUFFER CONTINUE DATA"

OVERVIEW

This segment maintains continuity between simulation requests. It has the responsibility for storing PAT Control Delay Table and the simulation control data. This function is called once at the end of each simulation request.

SEGMENT FUNCTION

Store PAT Control Data and the Simulation State Parameters

PROCESS 1
- INPUT:
  - SDT PAT Control Delay Table
- PROCESS:
  - "Store PAT Control Delay Table"
- OUTPUT:
  - SCB PAT Control Delay Table Data Set

PROCESS 2
- INPUT:
  - SCP Simulation State Control Parameters
- PROCESS:
  - "Store"
- OUTPUT:
  - SCB Simulation State Data Set

HIPO 1.3.2.1 "STORE PAT CONTROL DELAY TABLE"

SEGMENT FUNCTION

This segment saves the PAT Control Delay Table for the next simulation request run. This information is put into the Continue Buffer.

PROCESS 1
- INPUT:
  - SDT PAT Control Delay Table
- PROCESS:
  - Store PAT Control Delay Table in Continue Buffer
- OUTPUT:
  - SCB PAT Control Delay Table

HIPO 1.3.2.2 "STORE"

SEGMENT FUNCTION

The function of this segment is to store the following control data in the Continue Buffer for use in the next simulation request:

1. type of simulation
2. landing capacities
3. GA counts
4. departure delay table
5. hold criterion
6. stack adjustment data
7. zone structure information

PROCESS 1

INPUT:

SMT Type of Simulation
SLC Landing Capacities Data
SGA GA Entry Data
SDD DD Data Table
SFH Flow Hold Time
SSE Stack Entry Data
SZR Zone Record Data

PROCESS:

Store Simulation State Control Parameters in Continue Buffer

OUTPUT:

SCB Simulation State Data Set

8. DATA INPUTS TO SIMULATION SUBSYSTEM

```
SIM BLOCK OF FLIGHT RECORDS DATA SEGMENT
    SBF Number of Flight Records
    SBF Flight Record Data Set
        SBF File Pointer
        SBF Aircraft Identification
        SBF Departure Airport
        SBF Original Departure Time
        SBF Original arrival Time
        SBF Actual Deparutre Time
        SBF Actual Arrival Time
        SBF Flow Departure Time
        SBF Flow Arrival Time
        SBF Flow Land Time
        SBF ETA Key
        SBF ETA Value
ENDSEGMENT SIM BLOCK OF FLIGHT RECORDS


SIM LANDING CAPACITIES DATA SEGMENT
    SLC First Hour of Capacities
    SLC Number of Landing Capacity Hours
    SLC Landing Capacity Hour Data Set
        SLC Landing Rate
ENDSEGMENT SIM LANDING CAPACITIES


SIM ZONE RECORD DATA SEGMENT
    SZR Zone Identification
    SZR Number of Subzones
    SZR Subzone Data Set
        SZR Subzone Heading
        SZR Subzone Boundary Time
        SZR Number of Subzone Origins
        SZR Subzone Origin Data Set
            SZR Origin Code
ENDSEGMENT ZONE RECORD


SIM 05 MESSAGE TYPE DATA SEGMENT
    SMT Type of Simulation
ENDSEGMENT SIM 05 MESSAGE TYPE


SIM 05 TRANSACTION TIME DATA SEGMENT
    STT Message Time
ENDSEGMENT SIM 05 TRANSACTION TIME


SIM 05 GA ENTRY DATA SEGMENT
```

```
    SGA General Aviation Flag
    SGA General Aviation Factor
ENDSEGMENT SIM 05 GA ENTRY

SIM 05 REPORT TIMES DATA SEGMENT
    SRT Report Start Hour
    SRT Report Stop Hour
ENDSEGMENT SIM 05 REPORT TIMES

SIM 05 STACK ENTRY DATA SEGMENT
    SSE Stack Flag
    SSE Stack Time
    SSE Stack Size
ENDSEGMENT SIM 05 STACK ENTRY

SIM 05 FLOW HOLD TIME DATA SEGMENT
    SFH Hold Control Time
ENDSEGMENT SIM 05 FLOW HOLD TIME

SIM 05 ETE ENTRY DATA SEGMENT
    SEE ETE Flag
    SEE ETE Value
ENDSEGMENT SIM 05 ETE ENTRY

SIM 05 DD TABLE DATA SEGMENT
    SDD Number of DD Airports
    SDD Airport Data Set
        SDD Airport Code
        SDD Departure Delay
ENDSEGMENT SIM 05 DD TABLE

SIM FLOW NOTICE TIME DATA SEGMENT
    SFN Earliest Notice Interval
ENDSEGMENT SIM FLOW NOTICE TIME

SIM STATUS FLAGS DATA SEGMENT
    SSF New Simulation Flag
    SSF End Of Flight Blocks Flag
ENDSEGMENT SIM STATUS FLAGS

SIM AIRPORT TO CENTER CONVERSION TABLE DATA SEGMENT
    SAC Length of Airport To Center TAble
    SAC Airport to Center Entry Data Set
        SAC Center Code
ENDSEGMENT SIM AIRPORT TO CENTER CONVERSION TABLE
```

```
SIM CONTINUE BUFFER DATA SEGMENT
    SCB Length of Continue Buffer
    SCB Continue Data Data Set
        SCB Transaction Time
        SCB GA Chronology Data Set
            SCB GA Entry
            SCB GA Entry Time
        SCB Number of Hold Entries
        SCB Number of Hold Entries
        SCB Hold Cronology Data Set
            SCB Hold Entry
            SCB Hold Entry Time
        SCB Number of Zone Entries
        SCB Zone Chronology Data Set
            SCB Zone Identification
            SCB Zone Entry Time
            SCB Number of Subzones
            SCB Subzone Data Set
                SCB Subzone heading
                SCB Subzone Boundary Time
                SCB Number of Subzone Origins
                SCB Subzone Origin Date Set
                    SCB Origin Code
        SCB PAT Control Delay Table Data Set
            SCB PAT Control Delay Table Entry Time
            SCB PAT Control Delay Table
ENDSEGMENT SIM CONTINUE BUFFER


SIM INTERRUPT BUFFER DATA SEGMENT
    SIB Length of Interrupt Buffer
    SIB Interrupt Data Data Set
        SIB  Length of Simulation State Parameters
        SIB Simulation State Data Set
        SIB Length of Delay Hold Buffer
        SIB Delay Hold Buffer Data Set
            SIB Enter Stack Time
            SIB Predicted Land Time
        SIB Leftover Flight Buffers Data Set
        SIB New PAT Control Delay Table Data Set
        SIB Data Tables Data Set
            SIB Delay Data Table length
            SIB Delay Data Table Data Set
        SIB Quota Data Table Length
        SIB Quota Data Table Data Set
            SIB Conservation Data Table Length
            SIB Conservation Data Table Data Set
            SIB Flight Report Data Table Length
            SIB Flight Peport Data Table Data Set
            SIB Number of Reordered Flights
            SIB Reordered Flight Data Set
ENDSEGMENT SIM INTERRUPT BUFFER
```

9. DEFINITION OF SIMULATION SUBSYSTEM DATA INPUTS

This data segment contains the control parameters as passed from the executive subsystem to the simulation subsystem.

These control parameters include:

Type of Simulation
Landing Capacities
GA Counts
DD Table
Flow Hold Time
Stack Information
Zone Structure Information

This list is not exhaustive.

ENDSEGMENT EXECUTIVE CONTROL DATA

SIM BLOCK OF FLIGHT RECORDS DATA SEGMENT

'This data is prepared by the Simulation Preparation Subsystem for use in the Simulation Subsystem. The data is extracted from the central data base and sorted in estimated time of arrival order (i.e., ETA Value sort by increasing time). If this is the first block of flights to be passed to the Simulation Subsystem, an associated flag (i.e., SSF New Simulation Flag) is set to so indicate. If it is the last block, SIM End of Flight Blocks Flag is set accordingly.'

SBF Number of Flight Records: Numeric

SBF Flight Record Data Set:

SBF File Pointer: Numeric; A pointer into the central data base where the flight was originally retrieved. This pointer will be used by the Simulation Update Subsystem to update the flow control status of this flight.

SBF Aircraft Identification: Character; A character string is assumed for the flights identify since it best accommodates the various alpha and/or number mixes possible in this field and the Simulation Subsystem does not utilize airline or flight numbers individually.

SBF Departure Airport: Numeric; An airport or center code.

SBF Original Departure Time: Numeric, Epic; The scheduled or first entered departure time.

SBF Original arrival Time: Numeric, Epic; The scheduled or first entered arrival time.

SBF Actual Deparutre Time: Numeric, Epic; The actual departure time as recorded by reciept of a departure message.

SBF Actual Arrival Time: Numeric, Epic; Computed based upon the actual departure time plus the estimated time enroute as derived from the Original Departure time and the Original Arrival Time. If in a later version an actual arrival message is received, the message data would be used.

SBF Flow Departure Time: Numeric, Epic; This is the value last entered on the centralized data base as a result of a previous flow control message.

SBF Flow Arrival Time: Numeric, Epic; The previous flow control assigmenment.

SBF Flow Land Time: Numeric, Epic; The previous landing time prediction.

SBF ETA Key: Numeric, 1 to 3; An indicator of the source of the ETA value. If 1, the original arrival time was used; if 2, the actual arrival time was used and if 3, the flow arrival time was used.

SBF ETA Value: Numeric, Epic; The time of arrival used for retrieval and sort processes. The ETA is determined by the latest of the three possible times stored with the flight record.

ENDSEGMENT SIM BLOCK OF FLIGHT RECORDS

SIM LANDING CAPACITIES DATA SEGMENT

'These capacities are prepared by the Simulation Preparation Subsystem for use by the Simulation Subsystem. The data is organized by hourly values. The first value is for the arrival hour of the first scheduled flight of the first Block of Flight Records. The remaining values are for the following hours in sequence.'

SLC First Hour of Capacities: Numeric, Epic; This is the hour of the first value of landing capacitiees in the set.

SLC Number of Landing Capacity Hours: Numeric

SLC Landing Capacity Hour Data Set:

SLC Landing Rate: Numeric; The number of landings predicted for the hour.

ENDSEGMENT SIM LANDING CAPACITIES

SIM ZONE RECORD DATA SEGMENT

'This zone record is drawn from the adapted data base. It is identified by airport and by zone number. It is passed to the Simulation Subsystem for use in associating individual flights with subzones (e.g., Tier Center, Destination Center) The subzones are used to key the data columns of the Quota Reports (i.e., QFLZ and QFLW). A subzone is selected for a flight based upon matching the flights origin airport or center code with a code in the subzone's origin list. This table is not passed in an ARRD message.'

SZR Zone Identification: Numeric, 0 to 5; A zero value indicates no zone entered in the simulation message. This value otherwise is the specific zone number requested for the flow controlled airport.

SZR Number of Subzones: Numeric

SZR Subzone Data Set:

SZR Subzone Heading: Character; The title of this subzone data (i.e., Quota report column heading)

SZR Subzone Boundary Time: Numeric, Seconds; This is the average flight time rom the Tier Center boundary to the destination airport. Only one tier center can be associated with a subzone.

SZR Number of Subzone Origins: Numeric

SZR Subzone Origin Data Set:

SZR Origin Code: Numeric; An airport or center code. In a zone record, only one origin association can be made within all subzones. (i.e., multiple entries in or across subzones, of the same origin code is meaningless). It can occur inadvertently by entry of an airport contained in a center which is also entered. In any case the first detected subzone association will be used.

ENDSEGMENT ZONE RECORD

SIM 05 MESSAGE TYPE DATA SEGMENT

'Data passed to the Simulation Subsystem to identify the type of simulation requested in the message.'

SMT Type of Simulation: Numeric, 1 to 6; Where type is 1 for ARRD, 2 for FADP, 3 for FADF, 4 for FADT, 5 for QFLZ and 6 for QFLW.

ENDSEGMENT SIM 05 MESSAGE TYPE

SIM 05 TRANSACTION TIME DATA SEGMENT

'This is the time associated with the original Simulation message entry. It is used throughout the Simulation Subsystem to uniquely identify data of a complete simulation (i.e., independent of interrupted simulation processing).'

STT Message Time: Numeric, Epic

ENDSEGMENT SIM 05 TRANSACTION TIME

SIM 05 GA ENTRY DATA SEGMENT

'This is the entry prepared by the Input Processor Subsystem, and passed by the Simulation Preparation Subsystem to the Simulation Subsystem for use in creating dummy general aviation traffic.'

SGA General Aviation Flag: Numeric, 0 or 1; This flag is 1 if a GA factor is passed. Otherwise it is zero.

SGA General Aviation Factor: Numeric, Percentage; The percent of scheduled air carrier hourly traffic to be used as general aviation dummy traffic. This dummy traffic will be uniformly spread throughout the hour and individual flights will be superceded by real world general aviation flight entries as received.

ENDSEGMENT SIM 05 GA ENTRY

SIM 05 REPORT TIMES DATA SEGMENT

'This data is passed to the Simulation Subsystem as prepared by the Input Processor Subsystem and passed by the Simulation Preparation Subsystem. It is used to set the report start and end hours for the data tables created by the Simulation Subsystem to pass to the Output Subsystem.'

SRT Report Start Hour: Numeric, Epic; The hour of first data to report.

SRT Report Stop Hour: Numeric, Epic; The hour terminating the report data. Report data is not included for this hour.

ENDSEGMENT SIM 05 REPORT TIMES

SIM 05 STACK ENTRY DATA SEGMENT

'Data passed to the Simulation Subsystem by the Simulation Preparation Subsystem after processing by the Input Processor Subsystem. This data is optional in all simulation messages, but input should be required when prediction accuracy is desired.'

SSE Stack Flag: Numeric, 0 to 1; This flag is 1 when a stack entry is passed. Otherwise it is zero.

SSE Stack Time: Numeric, Epic; This time is either the explicit stack time entered with the message or the defaulted report start time entered with the message.

SSE Stack Size: Numeric; The number of flights estimated as holding over the destination airport at the stack time.

ENDSEGMENT SIM 05 STACK ENTRY

SIM 05 FLOW HOLD TIME DATA SEGMENT

'This data is entered with all simulation messages except ARRD's. It is passed to the Simulation Subsystem by the Simulation Preparation Subsystem after receipt from the Input Processor Subsystem. It is used in computing flow controls to limit the holding delays over the destination airport to the given value if possible.'

SFH Hold Control Time: Numeric, Seconds

ENDSEGMENT SIM 05 FLOW HOLD TIME

SIM 05 ETE ENTRY DATA SEGMENT

'This data is prepared by the Input Processor Subsystem and passed by the Simulation Preparation Subsystem to the Simulation Subsystem. It is used in FAD simulations for ground hold flow control decisions. Those flights within this ETE will be subject to ground holds. In FADT the ETE is an optional entry. If no ETE is entered the default will be to set ETE to 72000 seconds. (i.e., essentially infinite).'

SEE ETE Flag: Numeric, 0 or 1; If the flag is 1, an ETE value was entered. Otherwise the flag is zero and the ETE Value is 72000 seconds.

SEE ETE Value: Numeric, Seconds; This value is the flight range within which FAD ground delay assignments are permitted.

ENDSEGMENT SIM 05 ETE ENTRY

SIM 05 DD TABLE DATA SEGMENT

'This table is assembled from a message by the Input Processor Subsystem. It is passed on by the Simulation Preparation Subsystem for use by the Simulation Subsystem. It is organized by airport and has a data set for each airport, containing a delay value. This Table is only used in a FADT message.'

SDD Number of DD Airports: Numeric

SDD Airport Data Set:

SDD Airport Code: Numeric:

SDD Departure Delay: Numeric, Seconds; This value will be applied in adjusting all deparutre times by adding the given delay to the original departure time of each flight leaving the airport. If an actual departure time is found, the flights departure time will not be altered.

ENDSEGMENT SIM 05 DD TABLE

SIM FLOW NOTICE TIME DATA SEGMENT

'This contains the earliest notice interval for use by the Simulation Subsystem in determining when flow controls can first be implemented or revised. This data is obtained from the adapted airport data and only one value exists for an airport. This data is not passed in an ARRD message.'

SFN Earliest Notice Interval: Numeric, Seconds

ENDSEGMENT SIM FLOW NOTICE TIME

SIM STATUS FLAGS DATA SEGMENT

'This contains two flags associated with passing the Block of Flight Records to the Simulation Subsystem from the Simulation Preparation Subsystem.'

SSF New Simulation Flag: Numeric, 0 or 1; If the block of flight records is the first to be passed to the Simulation Subsystem, set this flag to 1. Otherwise set it to zero.

SSF End Of Flight Blocks Flag: Numeric, 0 or 1; If the block of flight records is the last to be passed to the Simulation Subsystem, set this flag to 1. Otherwise zero.

ENDSEGMENT SIM STATUS FLAGS

SIM AIRPORT TO CENTER CONVERSION TABLE DATA SEGMENT

'This table prepared during system build, is used by the Simulation Subsystem to identify the center code from an airport code. The table should also include a foreign area code or the first center encountered by an arriving flight. This association is used in Quota flow control subzone identification. This table is not passed in an ARRD message.'

SAC Length of Airport To Center Table: Numeric

SAC Airport to Center Entry Data Set:

SAC Center Code: Numeric; This value should be retrievable by hash code techniques using the hashed airport code as the table entry key and a subsequent serial search as necessary.

ENDSEGMENT SIM AIRPORT TO CENTER CONVERSION TABLE

SIM CONTINUE BUFFER DATA SEGMENT

'This Buffer, created by the Simulation Subsystem, is pased back and forth between the Executive Subsystem and the Simulation Subsystem with each activation of the Simulation Subsystem. It conveys continuity data between runs. The Buffer is keyed by airport (i.e. each airport has its own buffer). It is organized in mixed Tables of data in a form which need only be known within the Simulation Subsystem. Outside of this Subsystem, only the length of the Buffer is relevant to its storage and retrieval.'

SCB Length of Continue Buffer: Numeric; This is the length in relevant units to the implementation (i.e.

words of bytes).

SCB Continue Data Data Set:

SCB Transaction Time : Numeric, Epic; The transaction time of last Buffer update.

SCB Number of GA Entries: Numeric

SCB GA Chronology Data Set:

SCB GA Entry: Numeric, Percent

SCB GA Entry Time: Numeric, Epic; This is the time associated with the above GA Entry. The Entries are in order of GA Entry Time, the first being the earliest.

SCB Number of Hold Entries: Numeric

SCB Hold Cronology Data Set:

SCB Hold Entry: Numeric, Seconds; The flow control delay criteria for the destination airborne desired delay.

SCB Hold Entry Time: Numeric, Epic; The time associated with the above Hold Entry. The Entries are in order of Hold Entry Time, the first being the earliest.

SCB Number of Zone Entries: Numeric

SCB Zone Chronology Data Set:

SCB Zone Identification: Numeric; The Zone number used in the transaction message.

SCB Zone Entry Time: Numeric, Epic; The transaction time of the message containing this zone specification.

SCB Number of Subzones: Numeric

SCB Subzone Data Set:

SCB Subzone heading: Character; The title of this subzone data (i.e. Quota Report column heading).

SCB Subzone Boundary Time: Numeric, Seconds; This is the average flight time from the tier center boundary to the destination airport. Only one tier center can be associated with a subzone.

SCB Number of Subzone Origins: Numeric

SCB Subzone Origin Date Set:

SCB Origin Code: Numeric; An airport or center code.

SCB PAT Control Delay Table Data Set
SCB PAT Control Delay Table Entry Time
Transaction time of simulation which produced this table.
SCB PAT Control Delay Table
(see internal definition)

ENDSEGMENT SIM CONTINUE BUFFER

SIM INTERRUPT BUFFER DATA SEGMENT

'This Buffer, created by the Simulation Subsystem is passed back and forth between the Executive Subsystem and the Simulation Subsystem. It is created and updated only when a Simulation Subsystem message is processed in multiple buffers of flight records, namely in between each block passage. This buffer saves the essential Simulation status when interrupted awaiting more flight records and restores this status upon receipt of the next block of flight records. The Buffer is organized in mixed tables of data in a form which need only be known within the Simulation Subsystem. Outside of the Subsystem, only the length of the Buffer is relevant to its storage and retrieval.

SIB Length of Interrupt Buffer: Numeric; This is the length in relavent units to the implementation (e.g., words or bytes).

SIB Interrupt Data Data Set:

SIB Length of Simulation State Parameters: Numeric

SIB Simulation State Data Set:

'This subset of data has not been definitized yet. It is envisioned to contain single parameters and tables in support of the Simulation internal control.'

SIB Length of Delay Hold Buffer: Numeric

SIB Delay Hold Buffer Data Set:

SIB Enter Stack Time: Numeric, Epic; The entry time of being stacked over the destination airport.

SIB Predicted Land Time: Numeric, Epic

SIB Leftover Flight Buffers Data Set
(see internal definition)
SIB New PAT Control Delay Table Data Set
(see internal definition)
SIB Data Tables Data Set:

SIB Delay Data Table length: Numeric

SIB Delay Data Table Data Set:

'Table to be defined later '

SIB Quota Data Table Length: Numeric

SIB Quota Data Table Data Set:

'Table to be defined later.'

SIB Conservation Data Table Length: Numeric

SIB Conservation Data Table Data Set:

'Table to be defined later'

SIB Flight Report Data Table Length: Numeric

SIB Flight Report Data Table Data Set:

'Table to be defined later'

SIB Number of Reordered Flights: Numeric

SIB Reordered Flight Data Set:

'This has the same format as the Simulation Subsystem's internal flight record. This data set will be entered later The order of these flight records is by ETA.

ENDSEGMENT SIM INTERRUPT BUFFER COED

10. DATA OUTPUTS FROM SIMULATION SUBSYSTEM

```
    SAT Number of Hours
    SAT Hourly Data Set
        SAT Time of Hour
        SAT Arrival Count
        Sat Active Count
        SAT Flights Landed Count
        SAT Average Hold Count
        SAT Average Hold Delay
        SAT Peak Hold Count
        SAT Peak Hold Delay
ENDSEGMENT SIM ARRD TABLE


SIM QUOTA TABLE DATA SEGMENT
    SQT Number of Hours
    SQT Hourly Data Set
        SQT Time of Hour
        SQT Number of Subzones
        SQT Subzone Data Set
            SQT Heading
            SQT Boundary Time
            SQT Release Rate
            SQT Carry Overs
ENDSEGMENT SIM QUOTA TABLE


SIM QUOTA ORIGIN TABLE DATA SEGMENT
    SQOT Number of Hours
    SQOT Hourly Data Set
        SQOT Time of Hour
        SQOT Number of Subzones
        SQOT Subzone Data Set
            SQOT Number of Entries
            SQOT Entry Data Set
                SQOT Center Code
                SQOT Center Originating Flight Count
ENDSEGMENT SIM QUOTA ORIGIN TABLE


SIM CONSERVATION TABLE DATA SEGMENT
    SCT Number of Intervals
    SCT Interval Data Set
        SCT Time of Interval
        SCT Average Control Dalay
        SCT Average Destination Delay
        SCT Total Average Delay
ENDSEGMENT SIM CONSERVATION TABLE


SIM REPORTED FLIGHTS TABLE DATA SEGMENT
    SRF Number of Hours
    SRF Hourly Data Set
```

```
        SRF Time of Hour
        SRF Number of Flight Reports
        SRF Flight Report Data Set
            SRF Aircraft Identification
            SRF Departure Airport
            SRF Estimated Departure Time
            SRF Original Departure Time
            SRF Flow Control Departure Delay
            SRF Total Flight Delay
            SRF ETE of Flight
            SRF Estimeted Time of Arrival
            SRF Boundary Crossing Time
ENDSEGMENT SIM REPORTED FLIGHTS TABLE


SIM CONTROLLED FLIGHT LIST BUFFER DATA SEGMENT
    SCL Number of Flight Update Records
    SCL Flight Update Record Data Set
        SCL File Pointer
        SCL Aircraft Identification
        SCL Flow Departure Time
        SCL Flow Arrival Time
        SCL Flow Land Time
        SCL ETA Key
        SCL ETA Value
ENDSEGMENT SIM UPDATED FLIGHTS TABLE


SIM CONTINUE BUFFER DATA SEGMENT
    SCB Length of Continue Buffer
    SCB Continue Data Data Set
        SCB Transaction Time
        SCB Number of GA Entries
        SCB GA Chronology Data Set
            SCB GA Entry
            SCB GA Entry Time
        SCB Number of Hold Entries
        SCB Hold Cronology Data Set
            SCB Hold Entry
            SCB Hold Entry Time
        SCB Number of Zone Entries
        SCB Zone Chronology Data Set
            SCB Zone Identification
            SCB Zone Entry Time
            SCB Number of Subzones
            SCB Subzone Data Set
                SCB Subzone heading
                SCB Subzone Boundary Time
                SCB Number of Subzone Origins
                SCB Subzone Origin Date Set
                    SCB Origin Code
        SCB PAT Control Delay Table Data Set
            SCB PAT Control Delay Table Entry Time
```

```
            SCB PAT Control Delay Table
ENDSEGMENT SIM CONTINUE BUFFER


SIM INTERRUPT BUFFER DATA SEGMENT
    SIB Length of Interrupt Buffer
    SIB Interrupt Data Data Set
        SIB  Length of Simulation State Parameters
        SIB Simulation State Data Set
        SIB Length of Delay Hold Buffer
        SIB Delay Hold Buffer Data Set
            SIB Enter Stack Time
            SIB Predicted Land Time
        SIB Leftover Flight Buffers Data Set
        SIB New PAT Control Delay Table Data Set
        SIB  Flow Arrival Time
        SIB Flow Land Time
        SIB ETA Key
        SIB ETA Value
        SIB Subzone Indentifier
        SIB DD Departure Time
        SIB DD Arrival Time
        SIB Boundary Crossing Time
        SIB Flight Status Code
        SIB Control Status Code
        SIB Flight Ground Holding Link
        SIB Flight Subzone Holding Link
        SIB Flight Destination Holding Link
        SIB Data Tables Data Set
            SIB Delay Data Table length
            SIB Delay Data Table Data Set
            SIB Quota Data Table Length
            SIB Quota Data Table Data Set
            SIB Conservation Data Table Length
            SIB Conservation Data Table Data Set
            SIB Flight Report Data Table Length
            SIB Flight Report Data Table Data Set
        SIB Number of Reordered Flights
        SIB Reordered Flight Data Set
ENDSEGMENT SIM INTERRUPT BUFFER
```

11. DEFINITIONS OF SIMULATION SUBSYSTEM DATA OUTPUTS

'This table, prepared by the Simulation Subsystem, is passed to the Output Subsystem to produce the Report of Arrival Delay Predictions. It is organized by hour. Within each hour there is a set of data corresponding to the columns of data in the report. No headings are contained in this table.'

SAT Number of Hours: Numeric, 0 to 24

SAT Hourly Data Set:

SAT Time of Hour: Numeric, Epic

SAT Arrival Count: Numeric; New arrivals within hour

Sat Active Count: Numeric; Count of those flights which are or where active up to the time of message entry.

SAT Flights Landed Count: Numeric; Predicted landing slots used during the hour.

SAT Average Hold Count: Numeric; The average value of the number of flights holding during the hour.

SAT Average Hold Delay: Numeric, Seconds; The average of delays encountered by the flights holding during this hour.

SAT Peak Hold Count: Numeric; The highest number of flights held during any instant during the hour.

SAT Peak Hold Delay: Numeric, Seconds; The maximum predicted delay of the flights holding during this hour.

ENDSEGMENT SIM ARRD TABLE

SIM QUOTA TABLE DATA SEGMENT

'This table, prepared by the Simulation Subsystem, is passed to the Output Subsystem to produce the report of Quotas for flow control release use. It is organized by hour. Within each hour are groups of data. Each group contains a heading, a release rate and a carry over hold count.'

SQT Number of Hours: Numeric, 0 to 24

SQT Hourly Data Set:

SQT Time of Hour: Numeric, Epic

SQT Number of Subzones: Numeric

SQT Subzone Data Set:

SQT Heading: Character; The subzone title.

SQT Boundary Time: Numeric, Seconds; The average flight time from the boundary of a tier center to the destination airport.

SQT Release Rate: Numeric; The quantity of flights to be uniformly released from the tier center boundary.

SQT Carry Overs: Numeric; The number of flights to be retained until the next interval.

ENDSEGMENT SIM QUOTA TABLE

SIM QUOTA ORIGIN TABLE DATA SEGMENT

'This table, prepared by the Simulation Subsystem, is passed to the Output Subsystem to produce the report of origin center traffic for the Quota Report. It is organized by hour. Within each hour are groups of data. Each group contains a list of center codes with the appropriate traffic counts. No headings are contained in this table.'

SQOT Number of Hours: Numeric, 0 to 24

SQOT Hourly Data Set:

SQOT Time of Hour: Numeric, Epic

SQOT Number of Subzones: Numeric

SQOT Subzone Data Set:

SQOT Number of Entries: Numeric

SQOT Entry Data Set:

SQOT Center Code: Numeric

SQOT Center Originating Flight Count: Numeric

ENDSEGMENT SIM QUOTA ORIGIN TABLE

SIM CONSERVATION TABLE DATA SEGMENT

'This table, prepared by the Simulation Subsystem, is passed to the Output Subsystem to produce the report of flow control delay assignments in support of FAD ground delays. The table is organized by 15 minute time intervals. Each interval contains a set of data corresponding to the columns of data in the report. No headings are contained in this table.'

SCT Number of Intervals: Numeric, 0 to 96; Each interval represents 15 minutes.

SCT Interval Data Set:

SCT Time of Interval: Numeric, Epic; This time is associated with the original time of arrival of flights scheduled during this interval.

SCT Average Control Delay: Numeric, Seconds; The average of control delays to be assigned flights originally scheduled for this arrival interval.

SCT Average Destination Delay: Numeric Seconds; The average delay experienced by aircraft originally scheduled to arrive at the destination airport during this interval.

SCT Total Average Delay: Numeric, Seconds; The sum of SCT Average Control Delay and SCT Average Destination Delay for this interval.

ENDSEGMENT SIM CONSERVATION TABLE

SIM REPORTED FLIGHTS TABLE DATA SEGMENT

'This table, prepared by the Simulation Subsystem is passed to the Output Subsystem to produce the individual flight flow control assignment report. It is organized by hour. Within each hour there is a list of flight reports. Each flight report contains a standard set of data. No headings are contained in this table.'

SRF Number of Hours: Numeric, 0 to 24

SRF Hourly Data Set:

SRF Time of Hour: Numeric, Epic

SRF Number of Flight Reports: Numeric

SRF Flight Report Data Set:

SRF Aircraft Identification: Character

SRF Departure Airport: Numeric; An airport or center code.

SRF Estimated Departure Time: Numeric, Epic; Contains the best estimate of departure time, considering schedules, flow controls and actual departure times as applicable.

SRF Original Departure Time: Numeric, Epic; The scheduled or first record of departure time.

SRF Flow Control Departure Delay: Numeric, Seconds; The ground delay assigned to the flight.

SRF Total Flight Delay: Numeric, Seconds; The total delay predicted for the flight.

SRF ETE of Flight: Numeric, Seconds; This is the ETE conputed using the original departure and arrival times.

SRF Estimated Time of Arrival: Numeric, Epic; This is based upon consideration of flow controls, actual departure time plus ETE time or scheduled arrival time as applicable for the flight.

SRF Boundary Crossing Time: Numeric, Epic: This time is the estimated time of affival minus the flight time from tier center boundary. If no zone structure is defied, this data field is set to -1.

ENDSEGMENT SIM REPORTED FLIGHTS TABLE

SIM CONTROLLED FLIGHT LIST BUFFER DATA SEGMENT

'This table, prepared by the Simulation Subsystem, is passed to the Simulation Update Subsystem for use in updating the central data base with respect to flow control assignments. The Table is organized by flight update record in order of estimated time of arrival. Each flight update record contains a standard set of data.'

SCL Number of Flight Update Records: Numeric

SCL Flight Update Record Data Set:

SCL File Pointer: Numeric; An index into the central data base where the flight was formerly retrieved.

SCL Aircraft Identification: Character

SCL Flow Departure Time: Numeric, Epic; The flow control assigned departure time may or may not involve ground delays. If no ground delays, this field equals the uncontrolled departure time.

SCL Flow Arrival Time: Numeric, Epic; The assigned airborne arrival time over the airport (i.e. this is the time of stack entry over the airport).

SCL Flow Land Time: Numeric, Epic; This is the predicted landing time for the flight.

SCL ETA Key: Numeric, 1,2 or 3; This key =1 if original time used, =2 if actual time estimate used or =3 if flow controlled arrival time is to be used for sorts etc.

SCL ETA Value: Numeric, Epic: The best estimated arrival time from considering the schedule, actual or flow control times.

ENDSEGMENT SIM UPDATED FLIGHTS TABLE

SIM CONTINUE BUFFER DATA SEGMENT

'This Buffer, created by the Simulation Subsystem, is pased back and forth between the Executive Subsystem and the Simulation Subsystem with each activation of the Simulation Subsystem. It conveys continuity data between runs. The Buffer is keyed by airport (i.e. each airport has its own buffer). It is organized in mixed Tables of data in a form which need only be known within the Simulation Subsystem. Outside of this Subsystem, only the length of the Buffer is relevant to its storage and retrieval.'

SCB Length of Continue Buffer: Numeric; This is the length in relevant units to the implementation (i.e. words of bytes).

SCB Continue Data Data Set:

SCB Transaction Time : Numeric, Epic; The transaction time of last Buffer update.

SCB Number of GA Entries: Numeric

SCB GA Chronology Data Set:

SCB GA Entry: Numeric, Percent

SCB GA Entry Time: Numeric, Epic; This is the time associated with the above GA Entry. The Entries are in order of GA Entry Time, the first being the earliest.

SCB Number of Hold Entries: Numeric

SCB Hold Cronology Data Set:
SCB Hold Entry: Numeric, Seconds; The flow control delay criteria for the destination airborne desired delay.

SCB Hold Entry Time: Numeric, Epic; The time associated with the above Hold Entry. The Entries are in order of Hold Entry Time, the first being the earliest.

SCB Number of Zone Entries: Numeric

SCB Zone Chronology Data Set:

SCB Zone Identification: Numeric; The Zone number used in the transaction message.

SCB Zone Entry Time: Numeric, Epic; The transaction time of the message containing this zone specification.

SCB Number of Subzones: Numeric

SCB Subzone Data Set:

SCB Subzone heading: Character; The title of this subzone data (i.e. Quota Report column heading).

SCB Subzone Boundary Time: Numeric, Seconds; This is the average flight time from the tier center boundary to the destination airport. Only one tier center can be associated with a subzone.

SCB Number of Subzone Origins: Numeric

SCB Subzone Origin Date Set:

SCB Origin Code: Numeric; An airport or center code.

SCB PAT Control Delay Table Data Set
SCB PAT Control Delay Table Entry Time
Transaction time of simulation which produced this table.
SCB PAT Control Delay Table
(see internal definition)

ENDSEGMENT SIM CONTINUE BUFFER

SIM INTERRUPT BUFFER DATA SEGMENT

'This Buffer, created by the Simulation Subsystem is passed back and forth between the Executive Subsystem and the Simulation Subsystem. It is created and updated only when a Simulation Subsystem message is processed in multiple buffers of flight records, namely in between each block passage. This buffer saves the essential Simulation status when interrupted awaiting more flight records and restores this status upon receipt of the next block of flight records. The Buffer is organized in mixed tables of data in a form which need only be known within the Simulation Subsystem. Outside of the Subsystem, only the length of the Buffer is relevant to its storage and retrieval.

SIB Length of Interrupt Buffer: Numeric; This is the length in relavent units to the implementation (e.g., words or bytes).

SIB Interrupt Data Data Set:

SIB Length of Simulation State Parameters: Numeric

SIB Simulation State Data Set:

'This subset of data has not been definitized yet. It is envisioned to contain single parameters and tables in support of the Simulation internal control.

SIB Length of Delay Hold Buffer: Numeric

SIB Delay Hold Buffer Data Set:

SIB Enter Stack Time: Numeric, Epic; The entry time of being stacked over the destination airport.

SIB Predicted Land Time: Numeric, Epic

SIB Leftover Flight Buffers Data Set
(see internal definition)
SIB New PAT Control Delay Table Data Set
(see internal definition)

SIB Data Tables Data Set:

SIB Delay Data Table length: Numeric

SIB Delay Data Table Data Set:

'Table to be defined later '

SIB Quota Data Table Length: Numeric

SIB Quota Data Table Data Set:

'Table to be defined later.'

SIB Conservation Data Table Length: Numeric

SIB Conservation Data Table Data Set:

'Table to be defined later'

SIB Flight Report Data Table Length: Numeric

SIB Flight Report Data Table Data Set:

'Table to be defined later'

SIB Number of Reordered Flights: Numeric

SIB Reordered Flight Data Set:

'This has the same format as the Simulation Subsystem's internal flight record. This data set will be entered later The order of these flight records is by ETA.

ENDSEGMENT SIM INTERRUPT BUFFER COED

12. DATA INTERNAL TO SIMULATION SUBSYSTEM

```
SIM CONTROL PARAMETERS DATA SEGMENT
    SCP Control Parameter Data Set
        SMT Message Type Data
        SLC Landing Capacities Data
        SGA GA Entry Data
        SDD DD Table Data
        SFH Flow Hold Time Data
        SSE Stack Entry Data
        SZR Zone Record Data
ENDSEGMENT CONTROL PARAMETERS

SIM DATA TABLES DATA SEGMENT
    SDT Data Tables Data Set
        SDT ARRD Table
        SDT Quota Flow Table
        SDT FAD Table
        SDT New PAT Control Delay Table
ENDSEGMENT DATA TABLES

SIM LEFTOVER FLIGHT BUFFERS DATA SEGMENT
    SLF Leftover Hour Flight Buffer Data Set
        SLF Number of Leftover Flights
        SLF Flight Record Data Set
    SLF Misplaced GA Flight Buffer Data Set
        SLF Number of Misplaced Flights
        SLF Flight Record Data Set
ENDSEGMENT LEFTOVER FLIGHT BUFFERS

SIM OLD PAT CONTROL DELAY TABLE DATA SEGMENT
    SOD Old PAT Control Delay Table Data Set
        SOD PAT Control Delay Table Type
        SOD Time of First 15-minute Interval
        SOD Number of 15-minute Intervals
        SOD Control Delay Data Set
            SOD Control Delay
ENDSEGMENT OLD PAT CONTROL DELAY TABLE

SIM PLANNED ARRIVAL TIME HOUR DATA SEGMENT
    SPH PAT Hour
ENDSEGMENT PLANNED ARRIVAL TIME HOUR

SIM CAT SEGMENT TIME BOUNDS DATA SEGMENT
    STB Segment Lower Time Bound
    STB Segment Upper Time Bound
ENDSEGMENT CAT SEGMENT TIME BOUNDS

SIM SPAN BOUND FLAG DATA SEGMENT
    SSB Span Bound Flag
ENDSEGMENT SPAN BOUND FLAG
```

```
SIM CAT SEGMENT OF FLIGHT LIST DATA SEGMENT
    SCS CAT Segment Data Set
        SCS Number of Flights in Segment
        SCS Scan Pointer
        SCS Flight Record Data Set
ENDSEGMENT CAT SEGMENT OF FLIGHT LIST

SIM REAL GA COUNT DATA SEGMENT
    SRG Real GA Count
ENDSEGMENT REAL GA COUNT

SIM NUMBER OF GA's DATA SEGMENT
    SNG Number of Dummy GA's
    SNG Number of Real GA's
    SNG Interval Number of Real GA's
ENDSEGMENT NUMBER OF GA's

SIM INTERVAL INDEX DATA SEGMENT
    SII Interval Index
ENDSEGMENT INTERVAL INDEX

SIM INTERVAL TIMES DATA SEGMENT
    SIT CAT Interval Lower Time Bound
    SIT CAT Interval Upper Time Bound
    SIT PAT Interval Center Time
ENDSEGMENT INTERVAL TIMES

SIM DUMMY GA FLIGHT RECORD DATA SEGMENT
    SDG Dummy GA Flight Record Data Set
ENDSEGMENT DUMMY GA FLIGHT RECORD

SIM NOMINAL DUMMY GA FLIGHT TIME DATA SEGMENT
    SND Nominal Dummy GA Flight Time
ENDSEGMENT NOMINAL DUMMY GA FLIGHT TIME

SIM TIME EVENT POINTER DATA SEGMENT
    STE Time Event Pointer
ENDSEGMENT TIME EVENT POINTER

SIM STACK DUMMY FLIGHT EVENT DATA SEGMENT
    SSD Stack Dummy Flight Record Data Set
ENDSEGMENT STACK DUMMY FLIGHT EVENT
SIM Event List DATA SEGMENT
    SEL Length of Event List
    SEL Event Data Set
        SEL Event Type
        SEL Event Time
        SEL Stack Size
        SEL Aircraft Identification
        SEL Departure Airport
        SEL Original Departure Time
        SEL Original Arrival Time
        SEL Actual Departure Time
```

```
        SEL Actual Arrival Time
        SEL Flow Departure Time
        SEL  Flow Arrival Time
        SEL Land Time
        SEL ETA Key
        SEL ETA Value
        SEL Estimated Departure Time
        SEL DD Arrival Time
        SEL DD Departure Time
        SEL Subzone Index
        SEL Subzone Boundary Time
        SEL Boundary Arrival  Time
        SEL Boundary Release Time
ENDSEGMENT SIM Event List
SIM Airport Decode Table DATA SEGMENT
    SDT Length on Airport Decode Table
    SDT Airport Decode Data Set
        SDT Airport Character Code
ENDSEGMENT SIM Airport Decode Table
SIM Flow Notice Time DATA SEGMENT
    SFN Earliest Notice Interval
    SFN Original Message Time
    SFN Earliest Notice Time
ENDSEGMENT SIM Flow Notice Time
SIM Simulation Airport Code DATA SEGMENT
    SAP Airport Code
ENDSEGMENT SIM Simulation Airport Code
SIM Unused Flow Landing Slots DATA SEGMENT
    SFL Continued Flow Control
    SFL Unused Slot Found
    SFL Length of Unused Slots
    SFL Unused Slots Data Set
        SFL Unused Landing Time
ENDSEGMENT SIM Unused Flow Landing Slots
SIM Extra Report Intervals DATA SEGMENT
    SER Extra Report Intervals
    SER FAD Extra Report Intervals
    SER Arrival Interval Index
    SER Landing Interval Index
ENDSEGMENT SIM Extra Report Intervals
SIM FAD Table DATA SEGMENT
    SFT Number of Intervals
    SFT Interval Data Set
        SFT Interval Aircraft Count
        SFT Cumulative Destination Delays
        SFT Cumulative Control Delays
ENDSEGMENT SIM FAD Table
SIM Delay Incurred DATA SEGMENT
    SDI Delay Incurred
ENDSEGMENT SIM Delay Incurred
SIM CONTROLLED FLIGHT LIST BUFFER DATA SEGMENT
    SCL Controlled Flight List Buffer Data
        SCL Number of Controlled Flights
```

SCL Flight Record Data Set
ENDSEGMENT CONTROLLED FLIGHT LIST BUFFER
SIM BEGINNING INTERVAL TIME DATA SEGMENT
SBI Beginning Interval Time
ENDSEGMENT BEGINNING INTERVAL TIME

13. DEFINITIONS OF DATA INTERNAL TO SIMULATION SUBSYSTEM

This data segment contains the control parameters as passed from the executive subsystem to the simulation subsystem.
The control parameters would include:
Type of Simulaton
Landing Capacities
GA Counts
DD Table
Flow Hold Time
Stack Information
Zone Structure Information
this list should not be considered exhaustive.
ENDSEGMENT Executive Control Data

SIM Control Parameters Data Segment
This data segment is merely a collective reference to the control parameter data sets previously defined. It would also include any local control parameters necessary for resetting the simulation to the pre-interrupted state.
SCP Control Parameter Data Sets
SMT Message Type Data
SLC Landing Capacies Data
SGA GA Entry Data
SDD DD Table Data
SFH Flow Hold Time Data
SSE Stack Entry Data
SZR Zone Record Data
ENDSEGMENT Control Prarmeters

SIM Data Table Data Segment
This data segment is a collective reference to the various data tables required in exercising the simulation and which have to be saved across interruption of the simulation.
SDT Data Tables Data Set
SDT ARRD Tables
SDT Quota Flow Table
SDT FAD Tables
SDT New PAT Control Delay Table
During a flow control run this would be the control delay table being developed. (definition is the same as the old control delay table)
ENDSEGMENT Data Tables

SIM Leftover Flight Buffers Data Segment
This data segment contains those flights which cannot immediately be processed by the simulation.
SLF Leftover Hour Flight Buffer Data Set

SER Extra Report Intervals: numeric; the number of extra (sub hourly) report intervals in the ARRD report.

SER FAD Extra Report Intervals: numeric; this is not fully implemented in the current design. If a pre-stack size report is implemented, this parameter will be used to add the necessary report intervals.

SER Arrival Interval Index: numeric; the parameter used to direct data to the appropriate report interval

SER Landing Interval Index: numeric; the parameter used to direct data to the appropriate report interval

ENDSEGMENT SIM Extra Report Intervals

SIM FAD Table DATA SEGMENT

'This table is used to compile the individual flight contributions to the FAD Energy Conservation Report. The data collected in these tables is converted to the report form after all the flights in the simulation have been processed.'

SFT Number of Intervals: numeric; the number of report lines starting with the stack time interval, through the last flight's time of arrival interval.

SFT Interval Data Set:

SFT Interval Aircraft Count: numeric; the number of aircraft originally arriving during this interval. Each interval covers a 15 minute period.

SFT Cumulative Destination Delays: numeric,seconds; this is the sum of all the destination delays of the flights originally arriving this interval.

SFT Cumulative Control Delays: numeric, seconds; This is the sum of all the control delays of the flights originally arriving this interval.

ENDSEGMENT SIM FAD Table

SIM Delay Incurred DATA SEGMENT

'This is the parameter used to compute the revised flow control assignments. It identifies the unrecoverable delays already (or unavoidably) incurred due to previous flow control delays.'

SDI Delay Incurred: numeric, seconds

ENDSEGMENT SIM Delay Incurred

SIM Controlled Flight List Buffer Data Segment

After processing a block offlights, this data segment will contain those flights whose control flight times have been changed. The executive subsystem pick up the contents of this buffer for updating the flight data base.

SCL Controlled Flight List Buffer Data Set

SCL Number of Controlled Flights; numeric
this is the length of the buffer.

SCL Flight Recrd Data Set
Actual Flight Records

ENDSEGMENT Controlled Flight List Buffer

SIM Beginning Interval Time Data Segment

This is the start time of the next 15 minute interval entry place in the current PAT control delay table.

SBI Beginning Interval Time; numeric, epoch

ENDSEGMENT Beginning Interval Time