GE Aviation

Emirates FLOW – Final Report

Executive Summary
Revision – 1.0

15 December 2013

1. Executive Summary

In April of 2012, Emirates Airlines partnered with GE Aviation to explore an air traffic flow management solution to the increasing traffic congestion occurring at Dubai International Airport (DXB), UAE. The objective of the 18 month program, now drawing to conclusion, was to test the deployment of a simple yet potentially effective tool marketed as Attila that enabled airlines to self-regulate traffic flow in an effort to avoid current and potential future conflicts. A successful outcome would prove, to Emirates, the concept that an airline acting in their own best interests, could perform actions independent of Air Traffic Control (ATC) that would provide a positive benefit to both their own fleet as well as the system as a whole.

This final report provides an empirical assessment of the operational performance experienced by Emirates while under the direction of the Attila software as well as outline some of the challenges and opportunities that lie ahead. In an effort to align the report with clear and quantifiable results, effectiveness of the tool and success of the initial objectives are measured using 3 key areas initially defined by the Emirates/GE program team at the onset of the project. These objectives are outlined below and described in detail in Part B:

- Improvement in Emirates On Time Performance through improvements to A0/A14
- Improvement in Dwell time reduction (total Dwell time savings) through the reduction in the time an aircraft spends from the corner post to the runway
- Reduced fuel usage as a consequence of the above

This Part provides an overview of the methods used to measure the raw outputs collected during the Passive and Active phases of the project in order to determine the influence Attila had in these areas during the two periods.

Findings

Analysis of the Attila data indicates that there has been an improvement in all 3 key areas described above.

KEY METRIC	RESULT
A0 Improvement (Passive to Active) - DXB	14.82 %
A14 Improvement (Passive to Active) - DXB	12.04 %
Dwell Time Reduction - DXB	2.98 Minutes
Fuel Reduction	25,055 Kg / Day

Table 1 Data Analysis Results

Part B is further divided into individual subparts aligned with each of the 9 program objectives and provides a detailed description of the objective, assumptions, measurements, limitations, and results of the data analysis performed.

Complete listings of the 9 objectives set forth are outlined below:

- Improved on time performance for arrival and departure (Hub Protection)
- Reduced fuel usage
- Increased capacity and throughput
- Reduced block times
- Improved air/ground crew scheduling
- Better gate utilization
- Better aircraft utilization
- Crew confidence in arrival sequencing which will mitigate need for extra/holding fuel
- Increased cargo and/or takeoff performance because of reduced extra fuel

Part C of the Emirates FLOW Final Report provides a technical overview and analysis of the ATH Attila™ software and operational objectives. The overview is conducted by addressing the FLOW program goals as defined by Emirates, and the deployment process – both from a systematic and operational perspective. The performance analysis is an objective attempt to qualify the system in terms of system availability, system performance (i.e. alignment with goals), challenges and mitigations facing the FLOW program and finally technical opportunities outside the scope of the FLOW trial.

GE Aviation

Emirates FLOW – Final Report (PART B)

Data Analysis
Revision – Original

15 December 2013

1. Introduction

Part B of the Emirates FLOW – Final Report provides and empirical assessment of Emirates operational performance while under the direction of the Attila software.

This purpose of this section is to define, measure and analyze the performance objectives defined by Emirates at the onset of the FLOW trial. These objectives were as follows:

- Improved on time performance for arrival and departure (Hub Protection)
- Reduced fuel usage
- Increased capacity and throughput
- Reduced block times
- Improved air/ground crew scheduling
- Better gate utilization
- Better aircraft utilization
- Crew confidence in arrival sequencing which will mitigate need for extra/holding fuel
- Increased cargo and/or takeoff performance because of reduced extra fuel

The foundation of the measuring the performance is the baseline data collected during the 'Passive Operations' period and the same data captured during the 'Active Operations' (Go-Live) period.

The assessment is conducted in three parts:

1. **Data Overview** – Recognizing that the Attila data outputs are used to create baselines, identify effective goals and targets, monitor progress and evaluate impacts, an overview of the data source and quality is provided.
2. **Performance Objectives** – This section provides an assessment of Attila's performance against each of the aforementioned trial objectives. A qualification of the objective is stated followed by the methodology and data sources used to conduct the measurement. Finally, a summary of the results is provided.
3. **Forecast Improvements** – The final part of this assessment provides the results of recommended configuration changes to assist in extracting maximum value from the Attila program in operations beyond the FLOW trial.

2. Data Overview

2.1. Introduction

This section provides an overview of the data used to evaluate the objectives and how the evaluation was conducted. The objective of the overview and analysis is to provide a completely transparent assessment methodology in order to arrive at valid conclusions and an acceptance of the results,

Each objective is summarized in an opening problem statement followed by the measurements conducted, assumptions surrounding the process as well as limitations of the data,

It is recognized that the source and integrity of the data evaluated is a key component in the accuracy of the outcomes. In all cases, base data was used to complete the calculation in lieu of outputs from the Attila tool. Moving forward it is recommended that the team mutually agree and jointly determine the full and accurate data used for evaluation so as to prevent disparity in the output received from the calculations performed by the independent teams.

2.2. Purpose

The purpose of the data exploration was to evaluate the effects of the Attila Software on Emirates Operations at Dubai International Airport, UAE.

The primary objective was to determine the impact of the Attila Software as well as the overall effectiveness in achieving the stated objectives of (1) increasing the predictability of Emirates operations, (2) reducing fuel usage and (3) increasing capacity and throughput.

Specifically, to determine whether the goal seek calculations performed by Attila on Emirates aircraft inbound to Dubai International (DXB) and the resultant RTA's successfully executed had a definitive, measurable and positive impact on Emirates operational conditions. These activities occurred during the baseline (passive) period from April 1, 2013-June 24, 2013 and the operational (active) period measured from June 25, 2013-October 31, 213.

The objectives below are aligned with the performance metrics established at the onset of the program. Additional objectives described at the onset by the Emirates/GE program team are also described in this section but were not measured directly due to either a lack of data or a lack of measurable definitions surrounding the objectives. It is anticipated that these objectives will receive better definition and treatment as Emirates continues to refine the respective goal functions and boundary conditions surrounding their use of the tool.

2.3. Objectives

2.3.1. On Time Performance (HUB Protection):

Objective: Determine the impact of the RTA's on UAE On-Time Performance.

Measurement: Comparison of Passive and Active Period A0 and A14 performance.

2.3.2. Fuel Usage

Objective: Determine the impact of the RTA's on net fuel consumption.

Measurement: Estimate of fuel consumed across the fleet based on all available methods.

2.3.3. Capacity and Throughput

Objective: Determine the impact of the RTA's on UAE capacity and throughput.

Measurement: Depict the measurable shift in the overall distribution of aircraft arriving at the corner-post resulting in a predictable flow to the runway.

2.3.4. Block Time:

Objective: Determine the impact of the RTA's on UAE Block Time.

Measurement: Measure the reduced dwell time.

2.3.5. Air/Ground Crew Scheduling:

Objective: Determine the impact of the RTA's on UAE Air/Ground Crew Scheduling.

Measurement: No direct measurement available at this time.

2.3.6. Gate Utilization:

Objective: Determine the impact of the RTA's on UAE Gate Utilization.

Measurement: No direct measurement available at this time.

2.3.7. Aircraft Utilization:

Objective: Determine the impact of the RTA's on UAE Aircraft Utilization.

Measurement: No direct measurement available at this time.

2.3.8. Hold/Contingency Fuel:

Objective: Determine the impact of the RTA's on UAE Hold/Contingency fuel.

Measurement: No direct measurement available at this time.

2.3.9. Takeoff/Performance:

Objective: Determine the impact of the RTA's on UAE Takeoff/Performance:

Measurement: No direct measurement available at this time.

2.4. Data Availability

The initial data set consisted of 126,660 records generated as outputs from the Attila software during the combined Passive and Active phases of the project. A copy of the actual data used during this evaluation is available to eligible users upon request.

Data Treatment

The initial 126,660 flight records were evaluated using multiple subsets of the total in order to properly evaluate the interdependencies of the groups and phases. The Passive Phase included a total of 85 operational days, the active Phase 138 operational days and the OFF period 35 operational days. All data was captured by the multiple sources previously outlined in the Go Live report. Of these records, 53,043 consisted of Emirates (UAE) specific flights and 73,617 other operators into DXB. The Attila software collects data from multiple sources and consequently has the ability to generate a sizeable amount of data. Due to the size and nature of the data needed for the evaluation, the ATX file was selected as the primary source to use for evaluation. All of the data evaluated resides on the EGIT servers established and maintained in Dubai, UAE. In order to measure the system effects of Attila, the following unique characteristics were parsed from the original data and evaluated:

- **Dwell Time (O3)-(KEK):** Time from when an aircraft arrived over it's actual respective corner-post (KEK) until over the runway.
- **Total Flight Time (O3)-(O2):** Total flight time as measured by takeoff to touchdown.
- **Attila Touchdown Prediction (UQR)-(USR):** Effectively an Estimated Time of Arrival, this is the time Attila predicts an aircraft will arrive over the runway if the aircraft follows and meets the desired RTA.
- **On Time Performance (O3)-(USR):** An evaluation of the scheduled arrival time as projected by the airline against the actual arrival time.

3. Program Objectives

This assessment is conducted against the performance objectives established by Emirates/GE program team at the onset of the FLOW trial.

3.1. Goal Measurement

Due to the nature of the measurements and data available, the assessment was further divided into 3 categories in order to effectively evaluate the performance objectives. These categories consist of

(1) **Short Term Objective Goals** whose outcomes can be calculated with clarity,

(2) **Long term Objective Goals** whose outcomes require additional time and information in order to properly evaluate,

(3) **Long term Subjective Goals** that require additional definition and data in order to evaluate (some of this data residing within Emirates). These categories are as follows:

3.1.1. OBJECTIVE Goals: Short Term

- Improved on time performance for arrival and departure (Hub Protection)
- Reduced fuel usage
- Increased capacity and throughput

3.1.2. OBJECTIVE Goals: Long Term

- Reduced block times
- Increased cargo and/or takeoff performance because of reduced extra fuel

3.1.3. SUBJECTIVE Goals: Long Term

- Improved air/ground crew scheduling
- Better gate utilization
- Better aircraft utilization
- Crew confidence in arrival sequencing which will mitigate need for extra/holding fuel

The program objectives, the metrics used to measure Attila's performance against those objectives, and the associated sub-section where additional material may be found is provided table 3-1 below:

Goal	Metric(s)	Type	Period	Section
Improved on time performance for arrival and departure (Hub Protection)	A0 and A14 improvement	Objective	Short Term	3.1
Reduced fuel usage	Net Fuel Impact: • Fuel Consumed to meet RTAs • Fuel Recovered (Dwell Flight Time Savings)	Objective	Short Term	3.2

Goal	Metric(s)	Type	Period	Section
Increased capacity and throughput	Arrival Fix Demand / Distribution	Objective	Short Term	3.3
Reduced block times	Flight Time reduction (OFF to ON)	Objective	Long Term	3.4
Improved air/ground crew scheduling	ETA Prediction Flight Time Reduction Variance (by Flight Time) Pre to Post Attila	Objective	Long Term	3.5
Increased cargo and/or takeoff performance because of reduced extra fuel	Qualitative Data Discussion	Subjective	Long Term	3.5
Better gate utilization	Qualitative Data Discussion	Subjective	Long Term	3.5
Better aircraft utilization	Qualitative Data Discussion	Subjective	Long Term	3.5
Crew confidence in arrival sequencing which will mitigate need for extra/holding fuel	Qualitative Data Discussion	Subjective	Long Term	3.5

Table 1

3.2. On Time Performance

3.2.1. Introduction

Due to the location and nature of Emirates operations On-Time Performance (HUB Protection) was identified as a key performance indicator and a desired result of Attila system implementation.

Due to the directive nature of the Attila systems and related goal seeking capabilities, the Emirates Attila software has the ability to target any number of arrival times in order to align optimization with those desired by the user. Depending on the goal function settings selected by the operator; other objectives might receive a reduced priority over more desired outcomes such as reduced fuel consumption. In the case of the initial Attila installation at Emirates, on-time performance was placed as a priority over fuel conservation placing an expectation that fuel will be sacrificed in order to achieve optimum on time performance. Although one of the objectives of the FLOW trial was to understand the net fuel impact to Emirates OMDB operations, it should be noted that negative impacts on fuel are a direct result of the selections made by prioritizing On Time Performance. Ultimately, these settings can be readily changed to favor other goals.

3.2.2. Problem Statement:

Determine whether the RTA's calculated by Attila and followed by Emirates aircraft had a positive effect on On-Time Performance during the Active period as compared to the Passive period resulting in an improvement in A0 and A14 as measured across the Emirates arrival data.

3.2.3. Assumptions:

Measurement and comparison of A0 and A14 provides the most credible evidence as to whether RTA commands followed by Emirates aircraft resulted in a definitive and measurable impact of the on time performance of the fleet.

3.2.4. Measurement

The estimated fuel impact to Emirates is determined using the following process.

1. **Baseline** – The Passive period from 1 April-31 October 2013 was established as the baseline period for collecting data used in the A0 and A14 evaluation.

   Outliers due to poor data quality and other anomalies were removed from the baseline data in order to provide more accurate assessment and comparison.

   The UAE fleet was assessed for accuracy in meeting the targeted goal of Scheduled Arrival, denoted (USR) by Attila.

Erroneous data was eliminated by removing any records that did not contain both a valid Scheduled Arrival time (USR) and valid actual Land time (O3).

3.2.4.1. Data

The following data was used in the calculation of the A0/A14 analysis:

O3 Actual Time of Arrival Data	OOOI Database
Scheduled Arrival Data	LIDO Flight Planning System

3.2.5. Limitations of the Analysis:

Many factors can attribute to both positive and negative on-time performance to include improved ATC processes, internal OTP programs, and flow management tools. Due to the complexity of the problem and lack of data, this analysis did not attempt to ascertain the effects of these programs running in parallel—only to compare the state prior to and after Attila implementation.

Additional limitation of the analysis lies in the missing of one or both of the Actual Arrival IO3) or Scheduled arrival (USR) data parameters for individual flights. These limitations were resolved by the removal of records that did not contain both parameters for evaluation.

3.2.6. Analysis Results:

Table 2 displays an overview of the analysis results specific to On-Time Performance for Emirates Airlines into Dubai (DXB).

HUB PROTECTION METRICS	RESULT
Actual Arrival to Schedule (Δ)	
▪ Pre-Attila	-3.39 Minutes (Late)
▪ Post-Attila	+4.84 Minutes (Early)
Reduced Arrival Variance	4.3 Minutes (σ)
A0 Improvement (Passive to Active)	14.82 %
A14 Improvement (Passive to Active)	12.04 %
Dwell Time Reduction	2.98 Minutes

Table 2 Hub Protection Summary

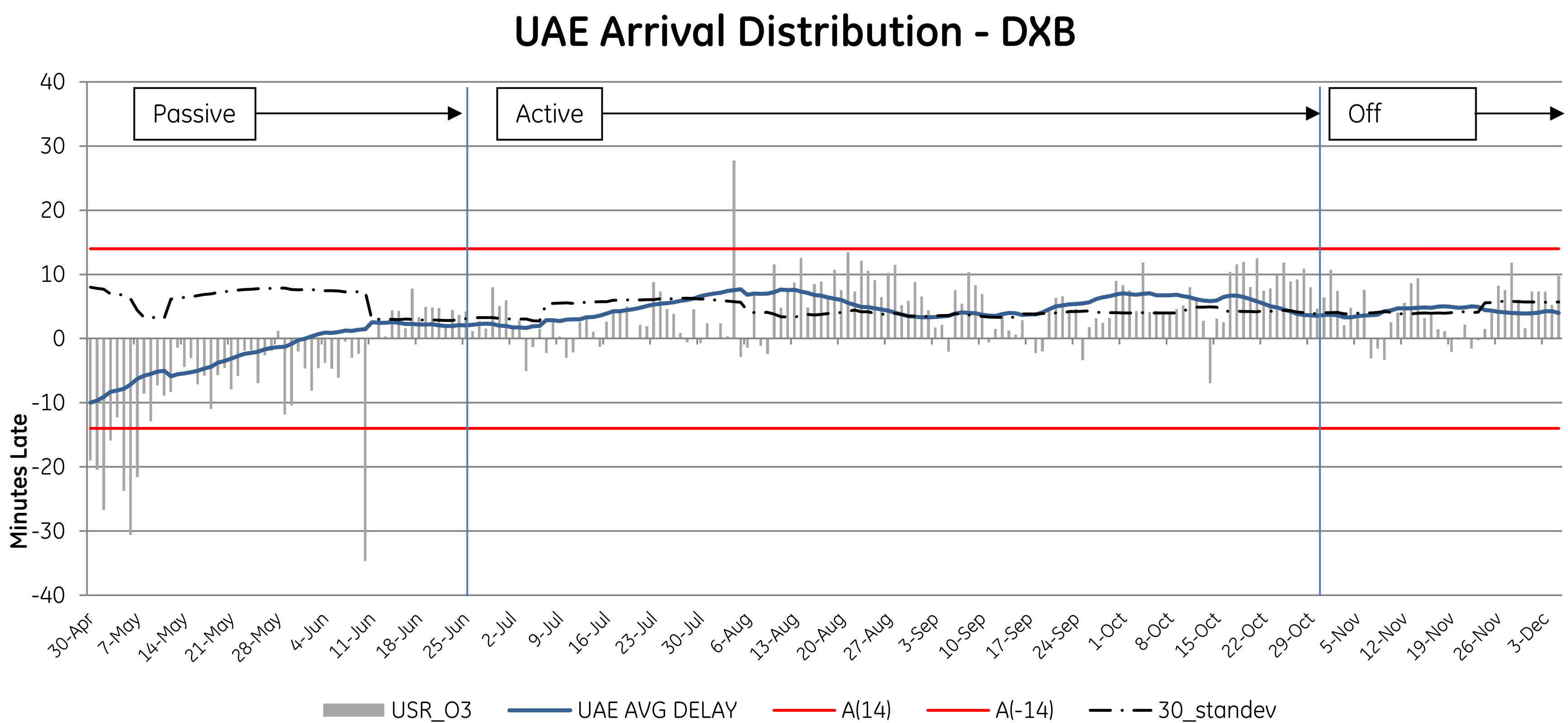
UAE ARRIVAL DISTRIBUTION – DUBAI (DXB)

APR 01 '13 – OCT 31 '13

For the period of April 1st, 2013 through October 31st, 2013, the average daily arrival delta (Δ) from schedule has decreased from 3.39 minutes late to 4.48 minutes early. Further to that the variance in arrival times (measured as a function of standard deviation) has decreased 4.3 minutes.

Of note is the trend from November 1st through December 5th, when Attila was not transmitting any messages (effectively turned off), which saw the average delay and standard deviation climb again to 3.54 minutes and 5.94 minutes respectively.

Table 3 Arrival Distribution



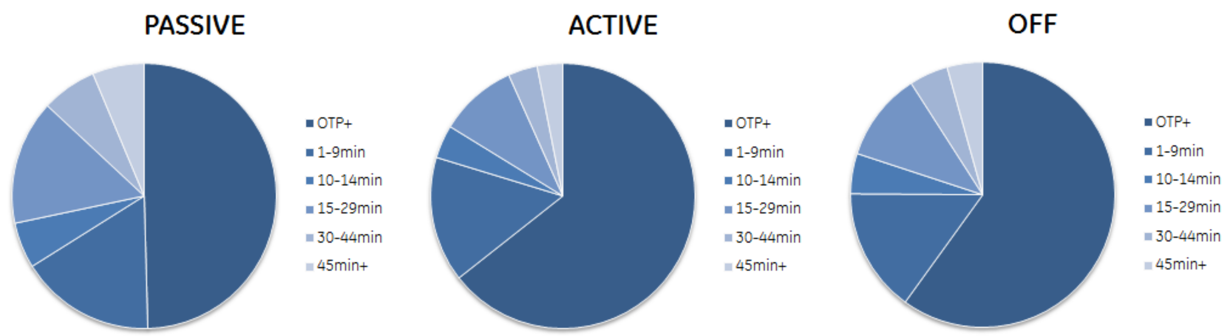
OTP Summary (Pre-Attila)	OTP Summary (Post-Attila)	OTP Summary (Off)
Arrival Average -3.39 Minutes	**Arrival Average** 4.84 Minutes	**Arrival Average** 3.54 Minutes
Standard Deviation 8.54	**Standard Deviation** 4.68	**Standard Deviation** 5.94

UAE DELAY DISTRIBUTION (DXB ARRIVALS)

APR 01 '13 – OCT 31 '13

The following table demonstrates the movement of delays from (At threshold)

Table 4 Delay Distribution



OTP	A0	1-9min	10-14min	15-29min	30-44min	45+min
PASSIVE	49.58%	16.53%	5.60%	15.21%	6.73%	6.35%
A14		71.71%				
ACTIVE	64.40%	15.30%	4.05%	9.54%	3.58%	3.13%
A14		83.75%				
OFF	59.99%	15.14%	4.91%	10.86%	4.76%	4.36%
A14		80.04%				

UAE DWELL TIME (DXB ARRIVALS)

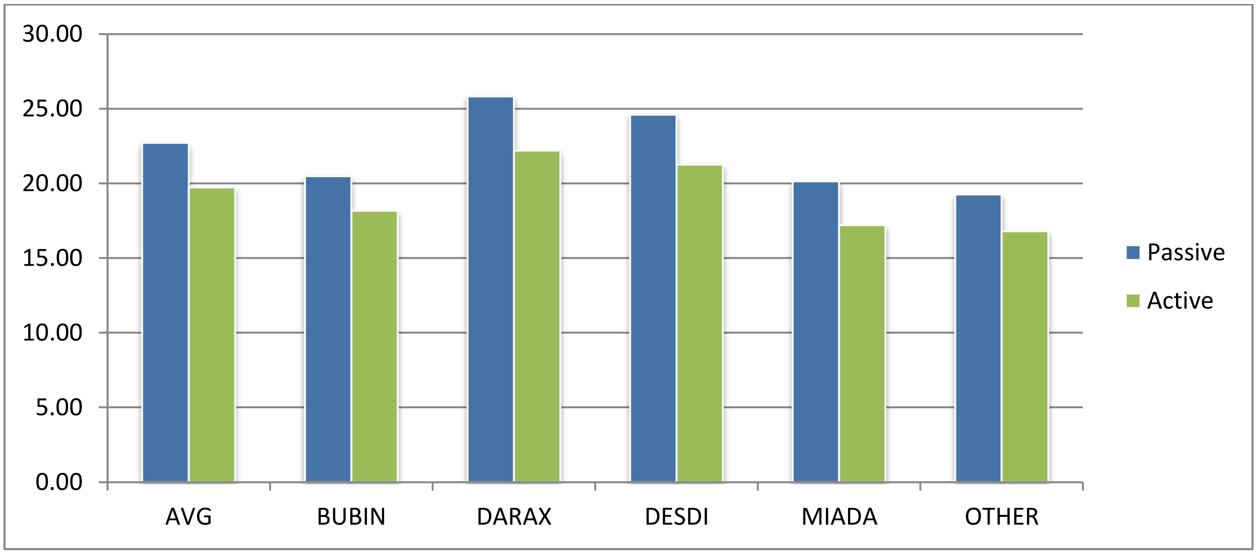
APR 01 '13 – OCT 31 '13

Recognizing that Attila has the greatest impact on delay reduction by decreasing the time spent in dwell, the following chart demonstrates a weighted average (see Table 3 for arrival fix distributions) dwell reduction time of 2.98 minutes.

Fix	**Passive** Distribution	**Active** Distribution
BUBIN	35.52%	40.31%
DARAX	2.80%	3.89%
DESDI	52.67%	48.57%
MIADA	2.77%	2.03%

OTHER	6.24%	5.21%

Table 4 - Arrival Fix Distributions



Dwell Summary (Pre-Attila)

Average Dwell Time 22.72 Minutes

Standard Deviation 3.31

Dwell Summary (Post-Attila)

Average Dwell Time 19.74 Minutes

Standard Deviation 1.85

OTP Flight Examples

APR 01 '13 – OCT 31 '13

Table 6 provides a sampling of flights that were outside of A14 during Attila's passive phase and the improvement that occurred to the same flights during Active operations.

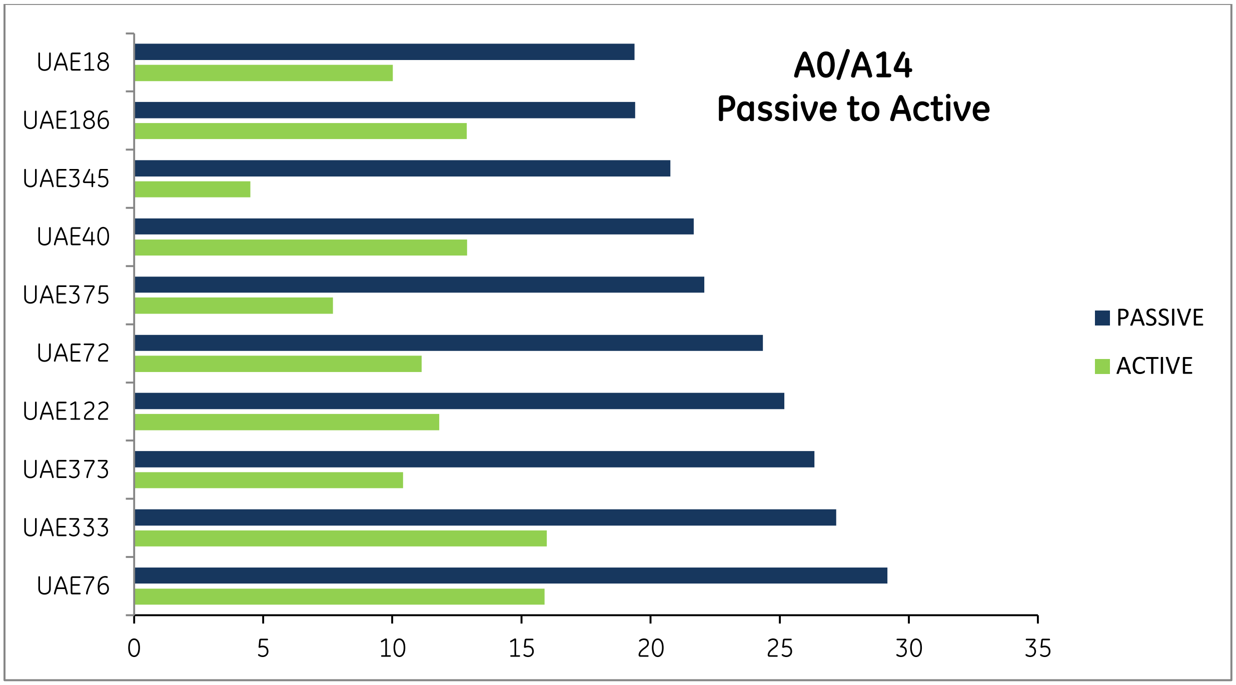


Table 6 A0/A14 Passive to Active

3.3. Fuel Usage

3.3.1. Introduction

Due to the directive nature of the Attila systems and related goal function settings, the Emirates Attila software has the potential to cause individual aircraft that follow RTA directives be placed in sub-optimum fuel efficiency flight profiles. Depending on the goal function settings selected by the operator; these states of reduced fuel efficiency might receive a reduced priority over other more desired outcomes such as on-time performance. In the case of the Attila installation at Emirates, on-time performance was placed as a priority over fuel conservation placing an expectation that fuel will be sacrificed in order to achieve optimum on time performance. A primary objective of the FLOW trial was to understand the net fuel impact to Emirates OMDB operations. It should be noted that negative impacts on fuel are a direct result of the selections made by an operator and can be readily changed to favor other goals such as fuel savings.

Mature Attila implementations also have the potential to offset and/or eliminate increases in fuel usage as confidence in the system grows. This further drives reductions in additional fuel boarded by crews, and/or flight plan arrival & approach fuel pads.

3.3.2. Problem Statement:

Determine whether the RTA's calculated by Attila and followed by Emirates aircraft resulted in a net fuel decrease across the fleet during the measurement period.

3.3.3. Assumptions:

Attila directly impacts fuel usage in 3 ways:

1. **RTA Movements forward** – An RTA request to increase speed tends to result in a negative fuel impact.
2. **RTA Movements backward** – An RTA request to decrease speed tends to result in a negative fuel impact when the slowdown is such that the benefits achieved with a reduced fuel-flow are negated by a longer flight time.
3. **Flight Time Savings** – Flight time saved by Attila as a result of sequencing the flow to the arrival fix tends to result in a net positive fuel impact.

3.3.4. Measurement

The estimated fuel impact to Emirates is determined using the following process:

2. **Baseline** – An operational baseline is defined using both aircraft and operational assumptions.
   a. Aircraft assumptions take into account fleet specific configuration (flap and gear setting), speeds, weights, and fuel flows.
   b. Operational assumptions include Flight Levels (FL), vertical profiles, and distances flown.

   The output at this stage is a fleet specific fuel burn over a fixed distance.
3. **RTA Impact** – A speed change from baseline is calculated for each aircraft type in order to meet the average RTA movement forward and backward sent by Attila.

   By calculating the fuel burn at the new speed over the same distance we are able to output an average fuel delta from the baseline amount.
4. **Hold/Dwell Impact** – A fuel flow (kg/min) is calculated for flight time savings using both aircraft and operational assumptions.

   A fleet average hold/dwell fuel flow (kg/min) is output at this stage.
5. **Net Impact** – The additional fuel burn generated by moving aircraft forward and backward (RTA Impact) is subtracted from the totally amount of fuel saved (Hold/dwell impact)

3.3.4.1. Data

The following data was used in the calculation of the NET fuel impact analysis:

Aircraft Performance Data	PIANO Database	Piano's database contains more than 400 commercial aircraft representing a huge variety of existing types as well as projected developments. Each aircraft has been calibrated according to the best data available to Lissys from both private and public sources.
Flight Data	Attila Files	RTA Movement Distribution (forward, neutral, and backward) RTA Compliance (%) Flight Time Savings
	DANS Data	Flight Time Savings
Fleet Data	Emirates	Fleet composition

3.3.5. Limitations of the Analysis:

Throughout the FLOW program, Emirates and GE/ATH have had ongoing dialogue centered on the Attila's NET fuel impact to Emirates. As of the time of writing a discrepancy still exists between the assumptions and conclusions used by GE/ATH and those of Emirates. Although both sides agree on the methodology of the NET fuel calculations, the most significant discrepancy relates to the aircraft fuel burn rates themselves.

3.3.6. Analysis Results

For the purposes of this report, a summary of the fuel impact analysis, representing combinations of both Emirates and GE/ATH assumptions, can be found in table 5 below. Four scenarios are depicted as follows:

1. GE Fuel Flow figures and DANS calculated delay savings
2. GE Fuel Flow figures and Attila calculated delay savings
3. Emirates Fuel flow figures and DANS calculated delay savings
4. Emirates Fuel flow figures and Attila calculated delay savings

Table 6 Net Fuel Impact Scenarios

	1	2	3	4
Average fuel burn Δ from baseline (RTA FWD)[1]	33 Kg		185 Kg	
Average fuel burn Δ from baseline (RTA BCK)[2]	16 Kg		53 Kg	
Avg. Flights moved forward/Day[3]	49.5			
Avg. Flights moved Backward (per day)[3]	51.8			
Average Hold/Dwell Fuel Flow (Kg/min.)[4]	155		64	
Total daily Flight time saved (min.)	83.9[5]	593[6]	83.9[5]	593[6]
Net Daily Fuel Impact	**10, 591 Kg Saved**	**89,712 Kg Saved**	**6,680 Kg Consumed**	**25,055 Kg Saved**

[1] Average RTA FWD = 1.13 Minutes
[2] Average RTA FWD = 0.93 Minutes
[3] For the purposes of conservatism, it's assumed that all flights will try to meet their assigned RTA. Actual compliance rates were not used.
[4] Weighted average based on Emirates fleet composition
[5] Dwell flight time savings based on DANS data of .64 minutes/flight.
[6] Dwell flight time savings based on Attila data of 2.98 minutes/flight

A complete fuel work-up example with detailed assumptions and notes can be found in Appendix **D.**

3.4. Capacity and Throughput

3.4.1. Introduction

Recognizing that the ultimate limitation to an airport's capacity and throughput is the physical runway infrastructure, Attila aims to provide a constant, and even demand to the runway. When the flow at the arrival fix is unadjusted and allowed to arrive 'as-is', traffic becomes clustered resulting in tactical control techniques used by ATC to provide sequencing and separation. These tactical techniques introduce considerable variance in the delivery of aircraft to the runway resulting in less than optimal capacity and throughput.

3.4.2. Problem Statement:

The RTA's calculated by Attila and followed by Emirates aircraft produced a measurable shift in the overall distribution of aircraft arriving at the corner-post resulting in a predictable flow to the runway.

3.4.3. Assumptions:

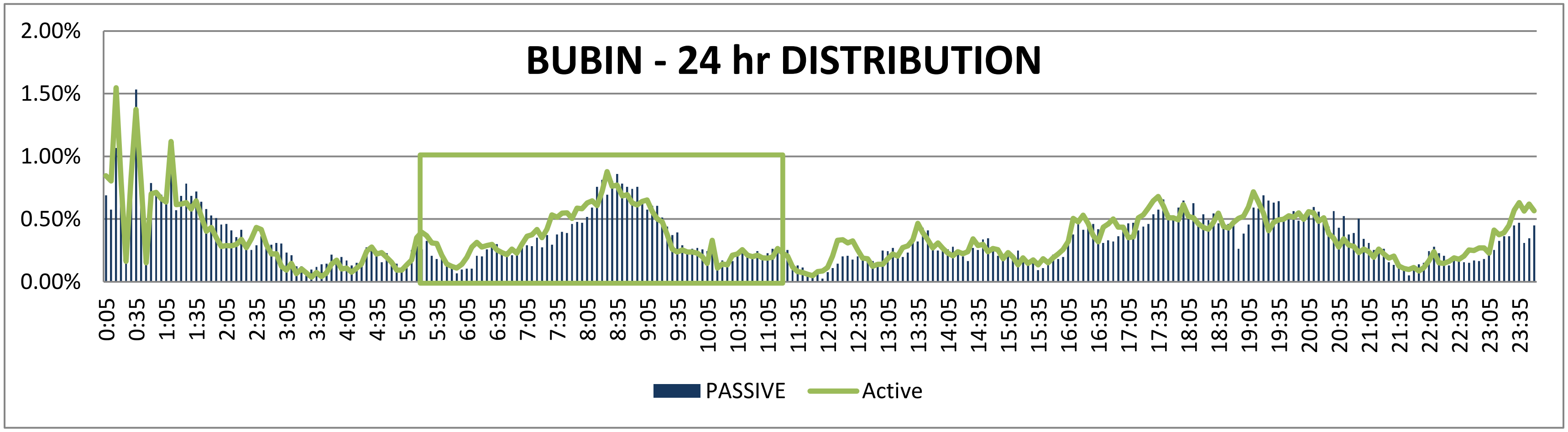
Measurement of the average aircraft count crossing each of the 4 DXB terminal area arrivals fixes, in 5 minute increments, will allow for the comparison of the pre and post Attila distributions.

3.4.4. Measurement:

3.4.5. Conclusions:

Attila is actively de-peaking arrivals and moving the demand into the shoulder areas of the heavy bank periods as evidenced in the BUBIN example below.

Table 8 Corner-post Distribution



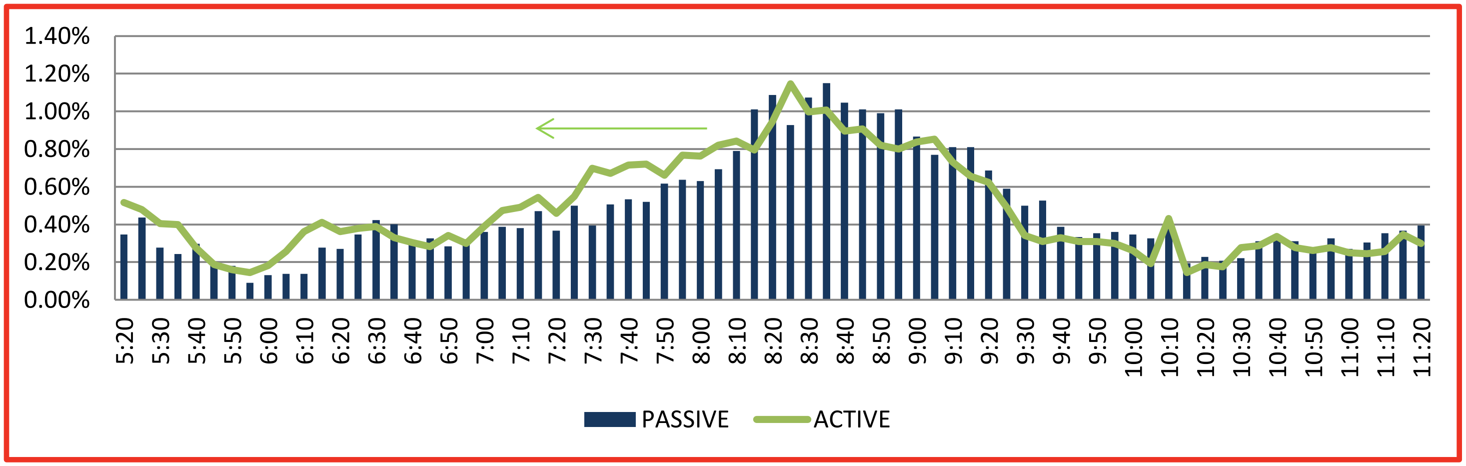


Table 9 Corner-post Distribution (DESDI)

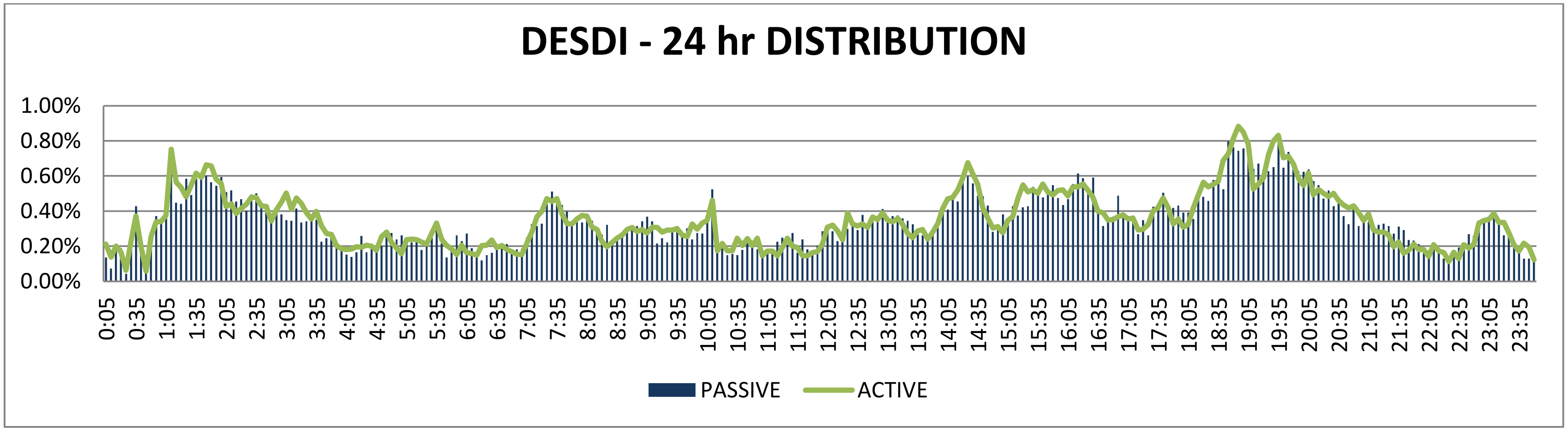


Table 10 Corner-post Distribution (MIADA)

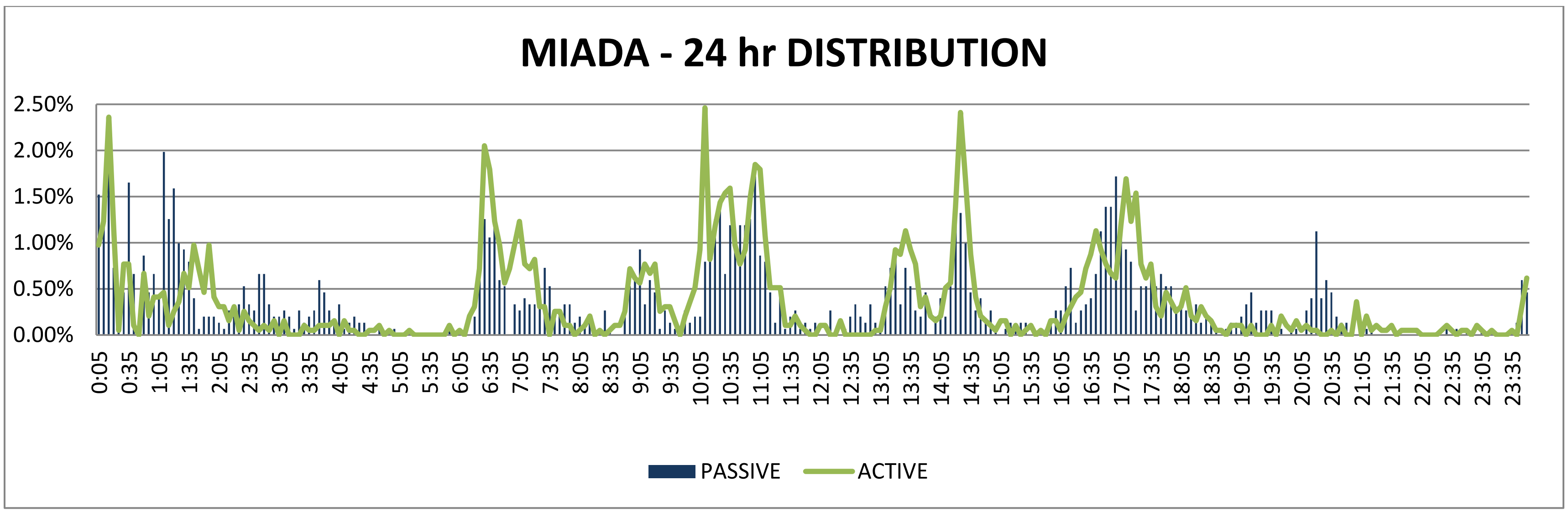
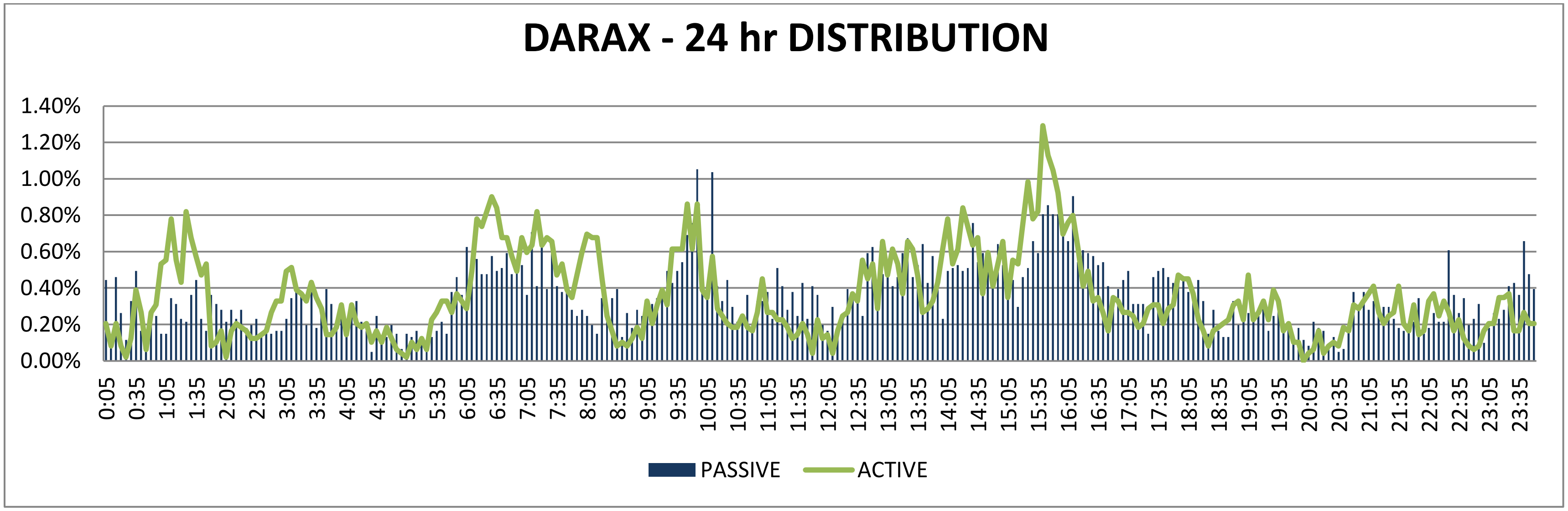


Table 11 Corner-post Distribution (DARAX)



3.5. Qualitative and Long-Term Goals

As a consequence of the outcome of the goals discussed above, there are further positive impacts associated with the implementation of Attila into Emirate's Dubai operations. These include:

- Reduced Block Times
- Air/Ground Crew Scheduling
- Gate utilization
- Aircraft Utilization
- Hold / Contingency Fuel
- Take-Off Performance

While tangible, these goals will require a longer 'in-service' period for Attila to produce the sustained results needed to influence the planning and operational culture of the airline.

3.5.1. Reduced Block Times

Attila has the greatest capacity to impact block time during the in-flight portion of any given operation. More specifically, the dwell time from the corner-post to the runway is most affected. From the purview of airline scheduling departments, the variance in this phase of flight is usually accounted for in the published schedules by adding time pads for ATC variance. There is an opportunity therefore, over a pro-longed period of time, and supported by historical data, to reduce those pads as Attila reduces the total arrival variance. Early indications, as supported in section 3.2.6 above, that Attila is having a very real impact in reducing this variance.

Block Time Reduction Metrics	RESULT
Reduced Arrival Variance	4.3 Minutes (σ)
Dwell Time Reduction	2.98 Minutes

Table 11 Block time improvement Indicators

3.5.2. Air/Ground Crew Scheduling

To improve the efficiency of Air Crew and Ground Crew assets (i.e. personnel and/or equipment), predictability and reliability must be established within the operation. Attila contributes to an increase in both of those qualities by ensuring that more flights adhere to the published schedule (OTP), reducing the variance around the arrival times, and accurately predicting when the aircraft will arrive (ETA Prediction).

1. **On-Time Performance (OTP)** – Since the implementation of Attila, A0 performance has improved 14.82%, while A14 has improved 12.04%. See section 3.2.6 above.

2. **Variance reduction** – Since the implementation of Attila, variance (measured as a function of standard deviation) at the landing threshold has been reduced by 29% from 8.54 min to 4.68 minutes. See section 3.2.6 above.

3.5.3. Gate Utilization

Ground Operations today establish a minimum period a gate must be unoccupied between flights to take into account variability from early arrivals or late departures. The reduction in arrival variance into DXB provided by Attila thereby reduces the amount of gate rest time needed between operations.

1. **Variance reduction** – Since the implementation of Attila, variance (measured as a function of standard deviation) at the landing threshold has been reduced by 29% from 8.54 min to 4.68 minutes. See section 3.2.6 above.

3.5.4. Aircraft Utilization

As a result of decreased variance in the block-times due to Attila's impact in the terminal area, slack can be removed from the published schedules once a consistent trend is observed in the historical data. The terminal area impact Attila is having is best measured by the reduction in dwell time. See section 3.2.6 above.

1. **Dwell reduction** – Since the implementation of Attila, the average dwell reduction is 2.98 minutes. See section 3.2.6 above.

3.5.5. Hold/Contingency Fuel

Experience has demonstrated that without proper statistics, an average of 2 to 3 times the amount of discretionary fuel was carried compared to the amount determined from statistical information. A confidence factor covering 99% of the flights will demonstrate that in most cases, no additional fuel above regulated contingency fuel is required. Flight statistics help increase the flight crew's confidence level of the flight planning system and will reduce their tendency of ad hoc fuel.[1]

As terminal operations standardize and operational variance decreases in the terminal environment, flight crews and dispatchers will be less inclined to add contingency fuel. Also, as sustained fuel improvements materialize and the fuel burns continues to decline, fuel pads in the flight planning software, used for ATC contingency purposes and arrival and approach operations, can be reduced.

Finally reducing the total boarded fuel (as a result of decreasing discretionary fuel and/or decreasing the flight plan fuel pads) results in a reduction in total trip fuel burn. It's estimated that the fuel penalty to carry the additional fuel is between 4% and 5% per flight hour.

[1] International Airline Transport Association (IATA). Guidance Material and Best Practices for Fuel and Environmental Management. Statistical and Discretionary Fuel. 1st Ed. 2004; 2.2 pp. 10.

3.5.6. **Takeoff Performance**

Reduction of fuel, as discussed above, may directly equate to an increase in available payload, an improvement in take-off performance, or the reduced costs associated with reduced thrust and/or de-rate operations.

4. Forecast Improvements

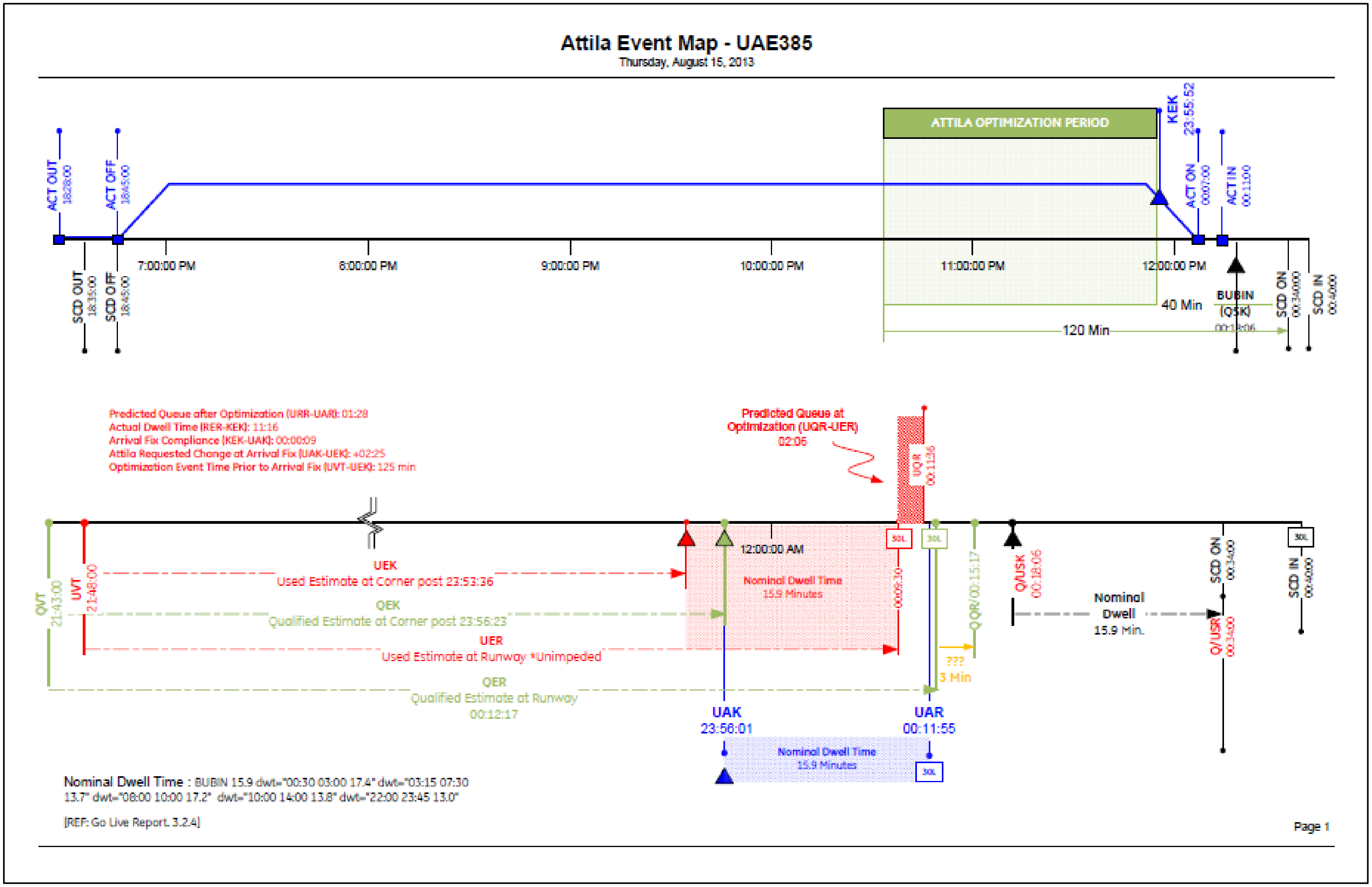
In order to evaluate potential changes to the goal function suite, a set of simulation tests was run. Data used was recorded data of May 31 to June 5, 2013. The following specific items were being tested:

- Enhanced Time in Queue component
  - Via a parameter setting this component will now not only consider the impact to the queue of the flights within the given optimization cycle, but will look at the impact of the queue looking downstream from this set of flights.
- Testing enabling the Queued Advisory component
  - Set via parameter in goal function file.
- Adjusting the Schedule component
  - Analysis of feedback and results showed some early flights were being slowed down unnecessarily. Adjusted the slope and zero point on the early side of the GF.
- Testing expanding the Velocity limits
  - Expanding the limits to +/- 16 knots from 11.
- Testing modifying the Time in Queue component weighting
  - Set via parameter in goal function file.
- Testing running with schedule component turned off
  - Set via parameter in goal function file.
- Testing various combination of changes

Simulation Results

		% change in savings values from baseline result							
							Move Request		
Run	Description	Flight time savings (Tsav)	Delay time savings (Dsav)	Fuel Savings	A0 improvement	A14 improvement	Speed Up	No Change	Slow Down
A	Baseline - current GF setting	-	-	-	-	-	-	-	-
B	Enhanced Q GF	14.4%	-2.8%	10.6%	-2.7%	-6.5%	10.9%	-11.7%	-4.6%
C	Expanded Vel GF (to +/- 16)	-0.5%	11.1%	-3.9%	7.2%	11.8%	2.8%	-6.0%	1.6%
D	Enhanced Q GF + Expanded Vel GF	12.8%	8.2%	9.8%	1.5%	11.8%	13.6%	-37.9%	13.1%
E	Modified Q GF values	-4.4%	-10.7%	2.3%	-11.7%	-12.9%	-7.8%	-5.2%	17.0%
F	Modified Q GF Values + Enhanced Q GF	-10.8%	-31.7%	1.5%	-26.3%	-22.0%	-16.2%	-14.1%	34.3%
G	Mod sched GF	13.0%	2.3%	10.3%	1.7%	-5.9%	6.6%	8.1%	-14.7%
H	Enable Q advisory GF component	11.2%	-4.5%	8.8%	-3.2%	-6.5%	13.9%	-23.4%	2.0%
I	No schedule component	-25.0%	-51.8%	-6.0%	-49.6%	-43.0%	-58.3%	66.1%	21.6%
J	G + B	13.3%	0.1%	11.1%	1.2%	18.3%	16.7%	-29.4%	2.6%
K	G + B + C	7.8%	4.6%	6.4%	0.5%	17.7%	15.7%	-39.9%	12.1%
L	G + B+ C + H	24.7%	6.3%	15.8%	-3.7%	5.4%	22.2%	-18.5%	-13.7%
M	G + B + H	18.2%	-6.9%	10.5%	-7.4%	-9.7%	15.9%	-3.6%	-17.6%

Appendix A. ATX MAP



Appendix B. Fuel Data Set

Section 1

Fleet	Operational Assumptions				Baseline Fuel Profile (kg)				
					CRZ				HLD/DWELL
	CONFIG.	Weight (kg)	FL	Fleet %	Cost Index	Speed (Mach)	Distance (nm)	Fuel Burn (kg)	Fuel Flow (kg/min)
A332	CLEAN	238,001	320	11.2%	0	0.78	1,000	13,760	98.6
A345	CLEAN	380,001	320	5.9%	0	0.803	1,000	21,848	163.4
A388	CLEAN	569,001	320	18.0%	0	0.828	1,000	31,644	237.9
B744	CLEAN	362,874	320	1.5%	0	0.8255	1,000	23,645	177.8
B772	CLEAN	343,370	320	13.7%	0	0.815	1,000	19,336	137.2
B773	CLEAN	340,195	320	51.2%	0	0.814	1,000	19,298	137.1

Notes:

-All performance figures using the PIANO database
-FL320 used to be conservative (Typical FL's inbound to Arrival fix = FL370/390)
-Used a fix distance (1000nm) to calculate impact of slow down/speed up along same distance.
-Cruise speeds using ECON speeds flown at optimal range speed given altitude and weight
-HLD/DWELL Fuel Flow based on min. drag @ FL180 and weight assumes initial cruise weight (listed) minus the cruise fuel burn – so we're taking into account that the airplane is considerably lighter in hold.

Section 2

Fleet	Mach Δ from ECON (Mach)		RTA Movement (min)		RTA Fuel Profiles					
					CRZ (RTA BCK)			CRZ (RTA FWD)		
	BCK	FWD	BCK	FWD	Dist (nm)	Fuel Burn(kg)	Baseline Δ (kg)	Dist (nm)	Fuel Burn(kg)	Baseline Δ (kg)
A332	0.005	0.0075	0:00:56	-0:01:08	1,000	13,763	3	1,000	13,768	8
A345	0.005	0.008			1,000	21,877	28	1,000	21,899	50
A388	0.005	0.0085			1,000	31,667	24	1,000	31,662	18
B744	0.0065	0.0065			1,000	23,669	24	1,000	23,670	25
B772	0.006	0.008			1,000	19,349	13	1,000	19,375	39
B773	0.006	0.008			1,000	19,312	14	1,000	19,336	39
						Average Fuel Δ =	16		**Average Fuel Δ =**	33

Notes:

-MACH Δ from ECON = The amount of speed reduction required from baseline cruise, to achieve the average RTA Slow down or Speed up (Column I & J)
-RTA Moment = The average movement (FWD/BCK) requested by Attila (Based on 01SEP13-30SEP13)
-RTA Fuel Profiles = The difference from cruise fuel burn based on an RTA FWD or RTA BCK
-AVG Fuel Δ = A fleet average weighted by fleet composition (Cells J12-J17)

Section 3

Daily RTA Sent (AVG)			Daily RTA Attainment			Flights			Fuel Δ From Baseline	
FWD	NONE	BCK	FWD	NONE	BCK	FWD	NONE	BCK	FWD	BCK
49.5	41.8	51.8	47.20%	49.50%	40.30%	23.364	20.691	20.8754	1617.7	807.4

Daily Fuel Δ (kg)	2,425.2
Data Period (kg)	72,754.9

Notes:

-Daily RTA's Sent (E.g. An average of 49.5 RTAs were sent requesting flights to move FWD, and an average of 51.8 RTA's were sent requesting flights to move BCK.
-Daily RTA Attainment = The actual number of flights that crossed the Arrival fix within +/- 1 min of the requested RTA
-Flights = The actual number of flights that Sped up / Slowed down to meet RTA.*
-For the purposes of this calculation we assume all flights that received an RTA tried to slow down or speed up - Resulting in a more conservative fuel impact.

Section 4

Daily Flight Time Saved (Min.)	Adjusted Daily Flight Time Saved	Daily HLD/DWELL Savings (kg)
140	83.90	13,016.27

Notes:

-Daily flight time saved = Represents the DANS data (0.64 seconds saved/EK Arrival) multiplied by the average daily arrival count for all EK flights (~219)
-Adjusted Daily flight Time saved = Flight Time Savings minus 'Pre-Corner post Savings' (Flt Time saved as a result of RTA speed-up)*
-For the purposes of this calculation we assume all flights that received an RTA FWD actually increased their speed - This results in more flight time saved prior to the corner post and less time assumed saved in HLD/DWELL.

Section 5

-NET Fuel Impact (Daily & Data Period) = Fuel Used to achieve RTA (FWD & BCK) minus the Fuel Saved due to reduced Flight Time (HLD/DWELL)
-e.g. This sheet indicates we save an estimated 10,591 Kg of fuel daily.

NET Fuel Impact	
Daily	**(10,591.11)**
Data Period	**(317,733.20)**

GE Aviation

Emirates FLOW – Final Report (PART C)

Technical Operations
Revision - Original

13 December 2013

Acronyms and Abbreviations

The acronyms and abbreviations listed in Table 1.1 are used throughout this document and are defined here for convenience.

Table 1.1: Acronyms and Abbreviations

TERM	DEFINITION
ACARS	Aircraft Communication and Reporting System
AMAN	Arrival Manager
AOC	Airline Operations Center
ASDI	Aircraft Situation Display to Industry
AT3	AUTOTRAC III Radar
ATH	The ATH Group
ATM	Air Traffic Management
CFMU	Central Flow Management Unit
DANS	Dubai Air Navigation Services
DWC	Dubai World Central
DXB	Dubai International Airport
EGDS	Emirates Ground Datalink System
EGIT	Emirates Group Information Technology
EK	Emirates Airline
FLOW	Operational Flow Management Project
OOOI	Out-Off-On-In
RTA	Required Time of Arrival
SDRL	Subcontractor Data Requirements List
SOW	Statement of Work
SZC	Sheikh Zayed Center

1. Introduction

Part C of the Emirates FLOW Final Report provides a technical overview and analysis of the ATH Attila™ software and operational objectives. The overview is conducted by addressing the FLOW program goals as defined by Emirates, and the deployment process – both from a systematic and operational perspective. The performance analysis is an objective attempt to qualify the system in terms of system availability, system performance (i.e. alignment with goals), challenges and mitigations facing the FLOW program and finally technical opportunities outside the scope of the FLOW trial. There is no attempt to quantify operational benefits to Emirates Airlines in this Part.

Table 2 Attila™ System Performance Overview

	JUN-JUL		JUL-AUG		AUG-SEP		SEP-OCT	
Average Daily Operation	24 Hours		24 Hours		24 Hours		24 Hours	
Average Daily RTA's Sent	145		159		126		169	
Compliance Rate[1]	**1min**	**2min**	**1min**	**2min**	**1min**	**2min**	**1min**	**2min**
	50.7%	75.9%	49.5%	73.2%	46.6%	72.6%	46.4%	72.6%

[1]Compliance rate refers to the number of aircraft operations that arrived at the arrival corner post within 1 minute and 2 minutes of the received RTA.

Note:

For the purposes of report publication the data period reflected in Table 3 above represents the FLOW trial active period from 25JUN13 through 31OCT13.

2. Technical Overview

2.1. FLOW Program Goals

Emirates Airline has a need for improved traffic flow for its fleet at DXB, with the preferred solution being via time sequencing of aircraft through their Airline Operations Center (AOC). Improved aircraft sequencing will benefit Emirates Airlines in multiple ways:

- Improved on time performance for arrival and departure (Hub Protection)
- Reduced fuel usage
- Increased capacity and throughput
- Reduced block times
- Improved air/ground crew scheduling
- Better gate utilization
- Better aircraft utilization
- Crew confidence in arrival sequencing which will mitigate need for extra/holding fuel
- Increased cargo and/or takeoff performance because of reduced extra fuel

2.2. Deployment Process

The FLOW program consists of project planning, identifying and interfacing various sources of airline data, installing Attila™ in Emirates AOC, base-lining the system by running Attila™ in "passive mode" where RTA messages are generated but not sent to the aircraft, and flight data collection and analysis to determine actual real-world savings provided by Attila™ at DXB during active operation.

A more detailed list of project tasks includes:

- Project planning
- Historical radar track analysis to characterize arrivals into DXB
- Tailoring of Attila™ to the unique host systems and input/output data available from Emirates systems and other data sources
- Installing two-copies of Attila™ on Emirates host servers (active and test)
- Operation of Attila™ in passive mode to gather baseline data
- Familiarization of Attila™ operation to Emirates' dispatch and flight crews
- Communication of Attila™ operation to various local and regional air navigation service providers
- Operating Attila™ in active mode and collecting resulting operational benefits over the duration of the project
- Modifying Attila™ to provide dispatch interaction
- Determining if arrival manager systems (AMAN) at DXB and SZC can benefit from receiving Attila™ sequence data and modifying Attila™ appropriately

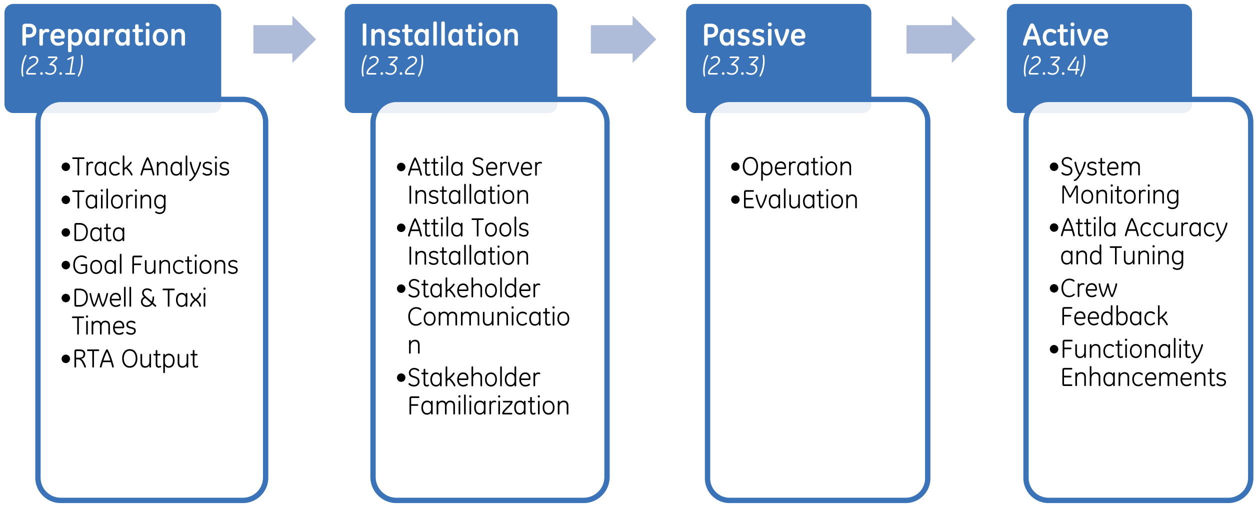


Figure 2-1 FLOW Deployment Phases

2.2.1. Preparation

2.2.1.1. Historical radar track analysis

Dubai Air Navigation Services (DANS) provided historical radar data for the period December 2011 – April 2012. The Attila™ simulator was modified to take the recorded radar trajectories and extend them back to their point of departure, and then remove holds and major vectoring in order to generate trajectory data for use in simulating traffic as it would be seen by Attila™. This was used in a detailed analysis of the DXB traffic and in running simulations for setting the Attila™ goal function suite. From this data, statistical data on airport dwell and holding times were determined. The dwell data were broken down by arrival fix and arrival direction.

2.2.1.2. Tailoring of Attila™ for Emirates

The baseline Attila™ software has been modified to operate in the Emirates environment. Changes have been made to:

- Interface with available data sources
- Add representative models of the aircraft in the Emirates fleet
- Adjust goal (cost) functions for Emirates schedule and operations
- Model airport dwell times (time from corner-posts to touchdown) and taxi times
- Output RTA messages to Emirates Ground Datalink System (EGDS).

2.2.1.3. Available Data Sources

In the baseline version of Attila™, information regarding aircraft flight plans and current position are received from the FAA's Aircraft Situation Display to Industry (ASDI) interface. For

Emirates at Dubai, Attila™ has been interfaced to a number of data sources to assemble the "picture" of traffic arriving at DXB. See Appendix B for a complete list of Data Sources.

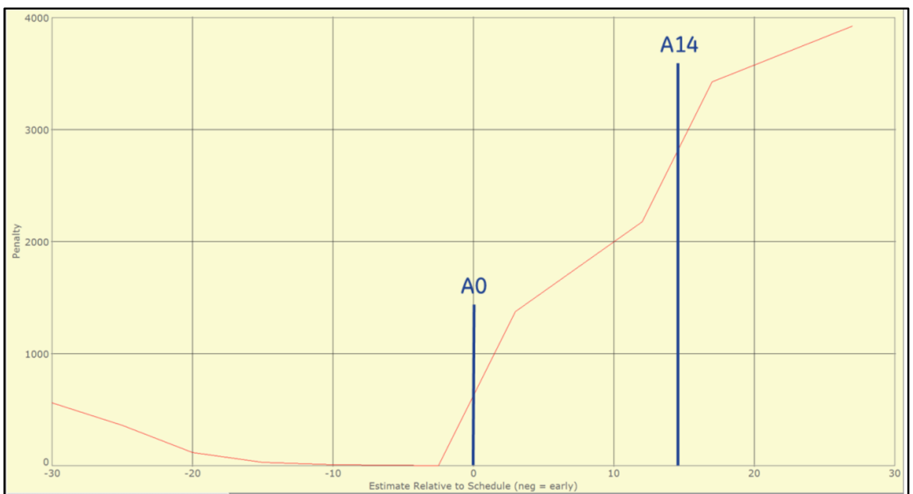
2.2.1.4. Aircraft Performance Limits

Attila™ uses aircraft performance limits in its trajectory generation and cost calculations. The parameters in Appendix C were received from EK performance engineering and incorporated in the Attila™ software. Note: The "Attila™ Allowable Mach Range" is further limited by the cost penalty associated with the Speed and Mach Goal Functions. This results in requested speed variations to be limited to a narrow range about the optimum speed.

2.2.1.5. Goal Functions

Attila™ is a goal seeking optimization tool which seeks the minimum overall cost using different goal function components. For Emirates, the following goal functions are used:

1. **Schedule** The schedule goal function penalizes deviation from the planned schedule. Originally, the schedule goal function included penalties for arriving early, as shown below (figure 2-2), however this was modified after observing system operation during the heavy late night bank. In order to not slow down an early flight into the bank, thereby making a bad problem worse, the penalty on early arrivals was removed, as shown in Figure 2-3.



Schedule component – focus is on AO and A14 arrival.
Increased penalty for very early flights.

Figure 2-2 Schedule Goal Function

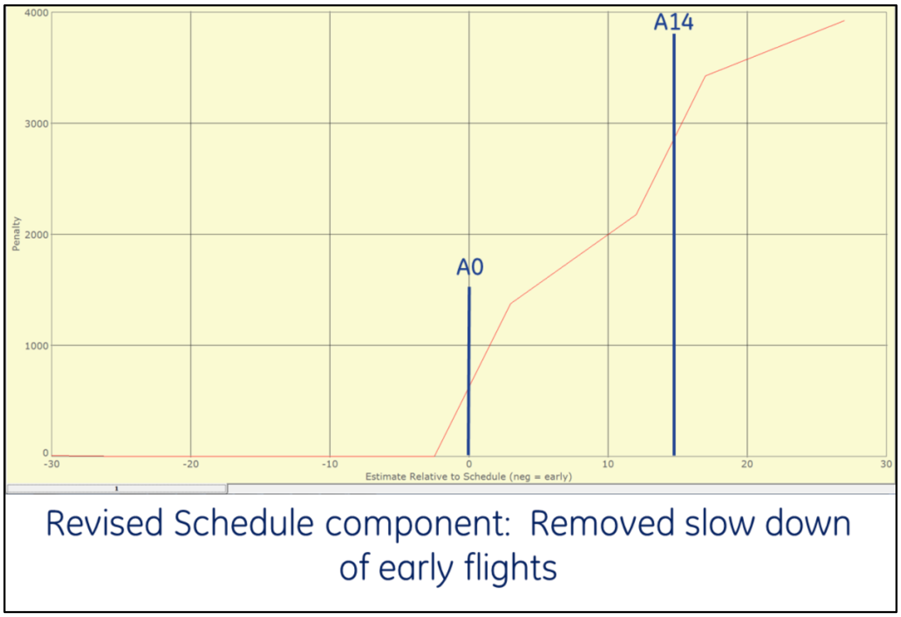
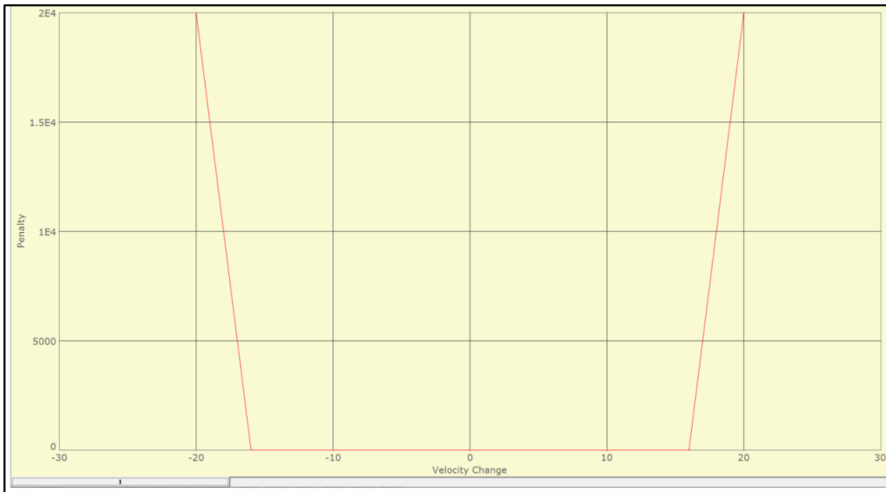


Figure 2-3: Effect of Removing Penalty on Early Arrivals

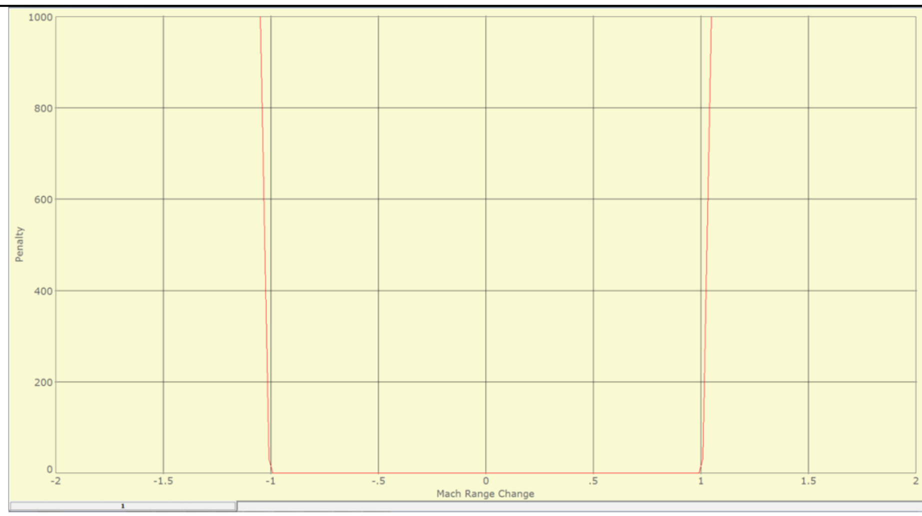
2. **Velocity** The velocity goal function introduces high penalties for large speed changes (**Error! Reference source not found.**). This ensures compliance with ATC limitations on allowed speed changes without providing notification to ATC. The limit is set at 16 knots, though initial operation may start with a more conservative limit of 12 knots.



Velocity GF – A limiting component with steep penalty wall at 16 knots

Figure 2-4 Velocity Goal Function

3. **MACH** The Mach goal function introduces high penalties for speed changes (**Error! Reference source not found.**) that put the aircraft outside of the allowable Mach range. This ensures that requested changes are within the aircraft normal operating range.



Mach GF – Limiting component that constrains changes to within the defined Mach range for a flight

Figure 2-5 Mach Goal Function

4. **Time in Queue** The time in queue goal function penalizes the predicted time in queue (**Error! Reference source not found.**).

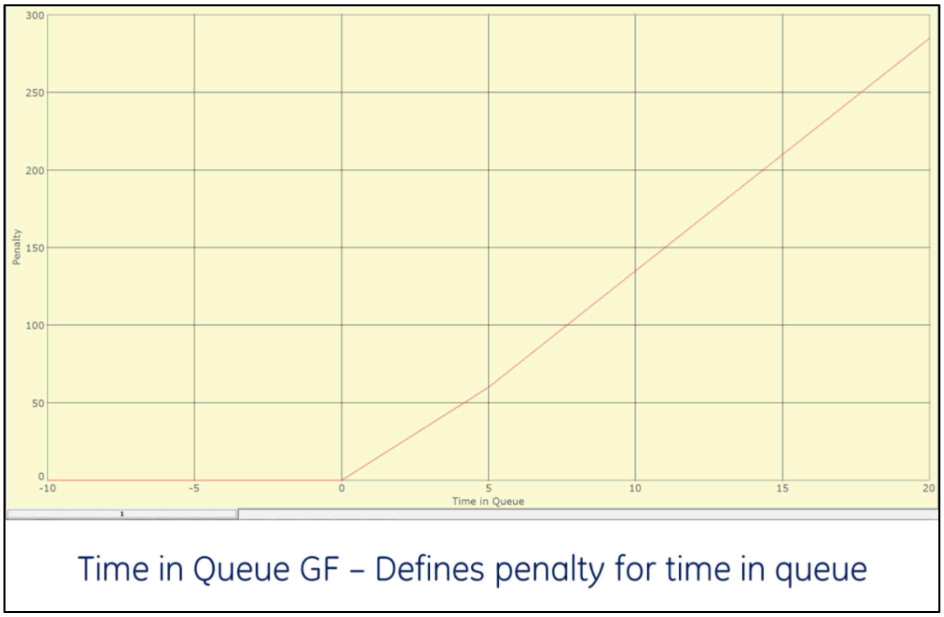


Figure 2-6 Time-in-Queue Goal Function

2.2.1.6. Goal Functions – Simulation Results

The Attila™ simulator is used to rerun flight data with different goal functions and other environmental parameters to determine the optimum settings for the Emirates application. Representative results (Figure 2-7) show the impact of changing the schedule goal function presented earlier. The simple removal of the early flight penalty leads to a rather substantial change in the aircraft movement requested by Attila™.

Based on experience with other installations, future goal function tailoring can be expected to further tailor system operation to Emirates' business needs.

Tests run using recorded data (Feb. 5 & 6) to evaluate requested movement

Baseline GF

Date	Forward	Unchanged	Slowed Down
2013/02/05	42.0%	14.8%	43.2%
2013/02/06	58.9%	10.4%	30.7%

Revised GF

Date	Forward	Unchanged	Slowed Down
2013/02/05	51.9%	24.7%	23.4%
2013/02/06	56.2%	25.9%	17.9%

Figure 2-7: Simulation Results

2.2.1.7. Dwell Times

Dwell time is defined as the time from an arrival fix to landing. Through analysis of the data collected to date, the default dwell times found in Appendix D have been determined.

2.2.1.8. Taxi Times

Attila™ uses taxi times to determine the time from touchdown to arrival at the gate. The baseline Attila™ was modified to extract this information for a flight from the associated FSUM file.

Since Attila™ receives both ON and IN OOOI messages from the CORE system and archives this data, it would be possible to analyze the data to either confirm or update the FSUM taxi times based on the historical data. This is a recommended future analysis task in support of Emirates' "Hub Matrix" project, which has the goal of tighter integration between Emirates' flight and ground operations.

2.2.1.9. RTA Output Messages

The baseline Attila™ was modified to output RTA messages in a format suitable to support free-text ACARS messages to the EK aircraft via EGDS.

Once the Attila™ optimization process is complete, Attila™ generates a corner-post time for each qualified EK flight arriving at DXB. Attila™ will send the corner-post target time along with flight id, corner-post id, and time tag to the EK ACARS application via a MQ interface. EK will use the data in the message to generate the actual ACARS message and send it to the designated aircraft.

2.2.2. Attila™ Installation

Attila™ was installed on both Test and Production servers located within the Emirates Group Technology Center site. Attila™ tools (Appendix F) were installed on several office personal computers and in the Network Operations Center.

Attila™ installation details are provided in in Appendix G.

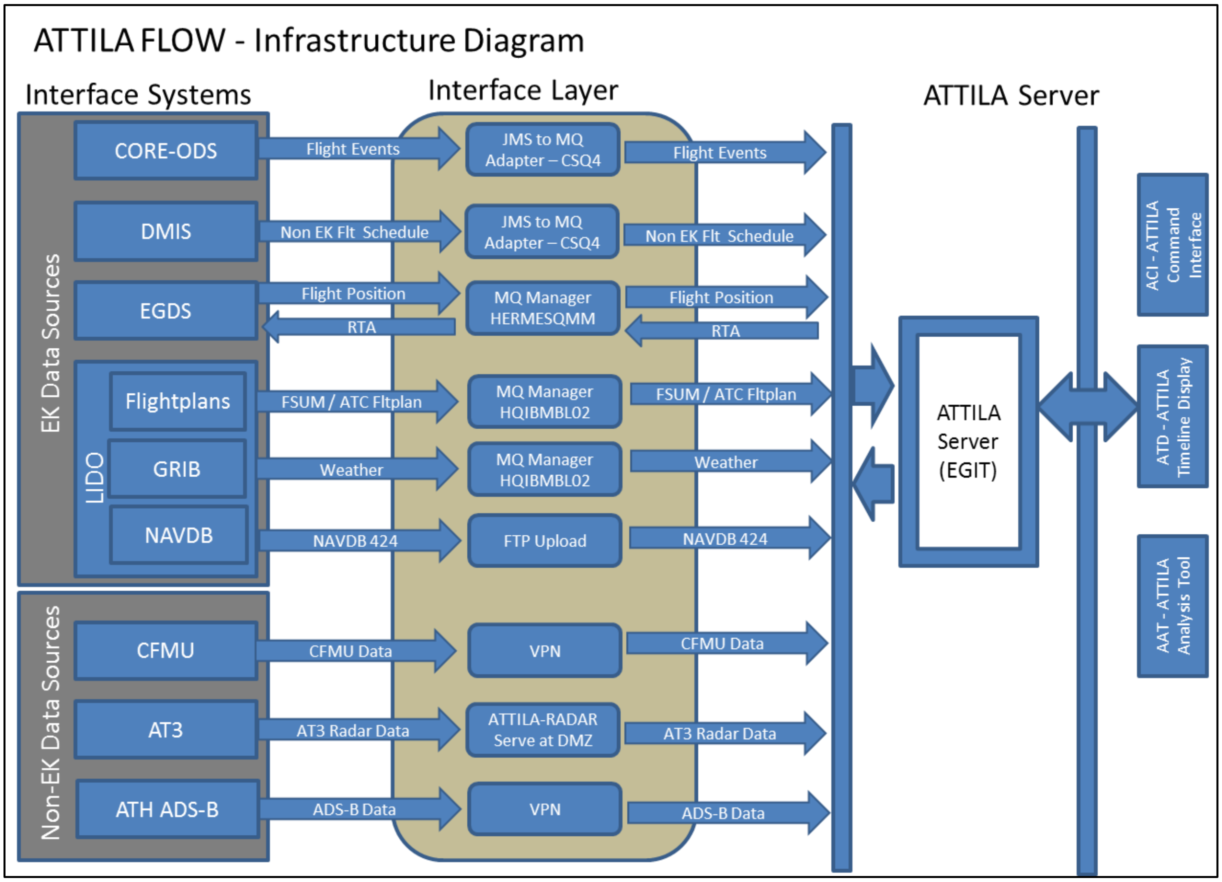


Figure 2-8: Attila™ ™ Installation Overview

2.2.2.1. Attila™ Tools

The Attila™ tools suite provides capabilities to control Attila™ operation as well as analyze flight data from previous day's flights. Appendix F provides a brief overview of each of the tools.

2.2.2.2. FLOW Familiarization

FLOW familiarization to EK dispatch and crews was primarily the task of AVTECH under subcontract to EK. GE/ATH provided source material to AVTECH in support of their preparation of training materials. GE/ATH also provided support in meetings with dispatch and training personnel as well as technical pilots.

2.2.2.3. Stakeholder Communication

Stakeholder communication regarding the FLOW project was primarily the task of AVTECH under subcontract to EK. GE/ATH provided support as requested.

2.2.3. Passive Mode Operation

Passive mode operation, where RTAs are calculated but not sent to any aircraft, began March 6, 2013. During passive mode, adjustments are made to the Attila™ processing to improve arrival time and dwell time accuracies based on the recorded flight data. The recorded data is used in the Attila™ simulator as adjustments are made to observe and quantify improvements. A sample data analysis plot is shown in Figure 2-9.

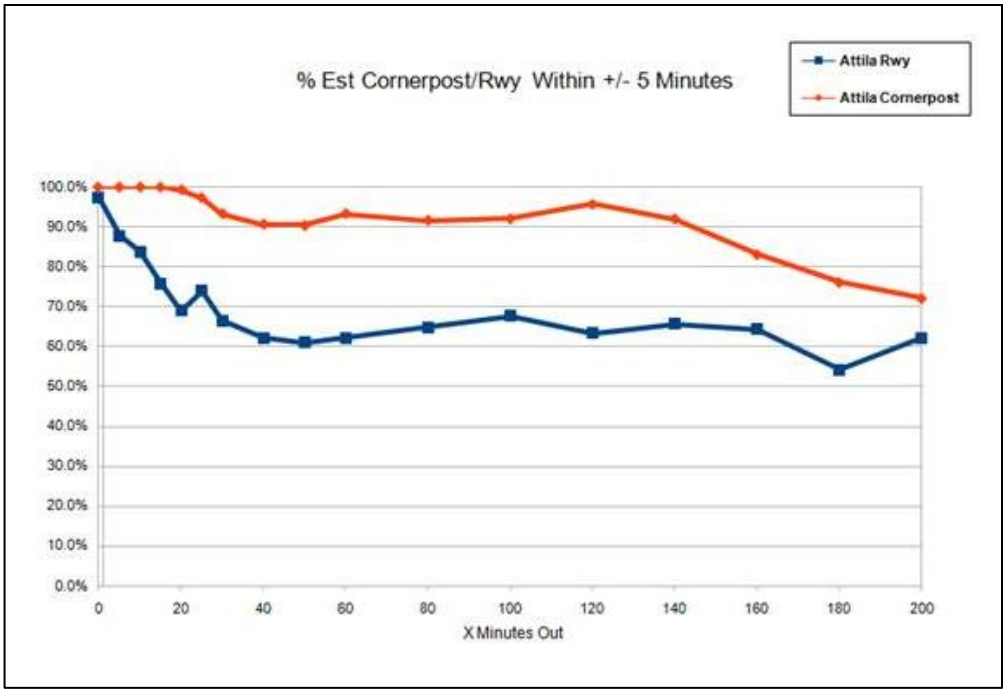


Figure 2-9: Sample Data Analysis Plots

RTAs were sent initially to selected flights having fleet technical pilots onboard during the week of May 5. Additional flights were selected to receive RTAs in the subsequent weeks. Passive mode operation ended with the transition to active mode operation on June 25, 2013.

2.2.3.1. Passive Mode Evaluation

An evaluation form, shown in Appendix H, was completed by each crew receiving an RTA uplink during passive mode operation. Please contact Mr. Peter Raw for access to the completed forms.

2.2.4. Active Mode Operation

Active mode operation, where RTAs are sent to all qualified EK flights, ran from June 25 – November, 2013. Activities undertaken during Active mode operations included:

- System Monitoring
- Attila™ Accuracy and Tuning

- Crew Feedback
- Functionality Enhancements

2.2.5. System Monitoring

During the Active phase ATH provided system monitoring to ensure that all positional, flight plan, and wind data sources were interfacing with the RTA optimization processes. ATH also reviewed any system abnormalities reported by the flight crews. See section 3.3 below.

2.2.6. Attila™ Accuracy and Tuning

ATH continued to make minor adjustments to the parameters and corrections as necessary. Work on refinement and reruns continue. Work is also being focused on the accuracy of non-Emirates flights. Analysis has shown that accuracy is much better for flights where CFMU data is available as compared to only DMIS data available. GE/ATH is pursuing obtaining flight plans for non-Emirates flights from AT3.

2.2.7. Functionality Enhancements

Two functionality enhancements were discussed and agreed to during the FLOW program:

- Dispatch in-the-loop
- RTA integration with DANS/Arrival Manager (AMAN)

2.2.7.1. Modifying Attila™ to provide dispatch interaction

The FLOW project further adds additional Dispatch Manager (DM) control of Attila™.

Currently, external control is limited to turning Attila™ optimization on and off and setting of arrival rate and runway via the Attila™ Command Interface (ACI). Internally, Attila™ optimization is "controlled" by the settings of the various cost functions used in the flight optimization processing.

Via e-mails and telecons, Emirates suggested providing additional control parameters for the dispatch manager, such as:

1) Priority marker for connection critical flights (Don't slow down unless you must)
2) Move aircraft up in queue, either to a specific location or as far as possible
3) Fuel critical flights. (Can't go faster – only slower)
4) Move aircraft back in queue, either to a specific location or as far as possible
5) Don't touch this aircraft
6) Cancel assigned RTA
7) Bunch like aircraft based on wake vortex considerations

Additional general requested functionality includes:

8) Control/display must be intuitive to the Dispatcher
9) Display could give an alert or pop up prior to a RTA being issued

One additional requirement results from those above:

10) Provide time for dispatch to accept/reject the RTA before Attila™ sends it out

Agreed Functionality:

GE and ATH evaluated the suggested functionality in terms of scope and schedule, and proposed the following to meet the Dispatch in the Loop contractual requirement, which was agreed to by EK. Remaining suggested functionality could be addressed in a follow-on phase of the project if operational experience with Attila™ shows the functionality is still desired. The approach proposed addresses items 5), 8), 9), and 10), and provides a manual mechanism which partially addresses items 1) and 3).

A new dialogue box (Figure 2-10) will be added to the Attila™ ACI interface. The pending Attila™ RTAs will sit in the ACI queue for a set period of time (settable parameter, i.e., 2 minutes). The display will provide the DM two manual control options – "Send Now" and "Don't Send" – as well as providing a timer to indicate when the RTAs will automatically be sent to the aircraft via EGDS.

Pending RTA(s)

ID	DEP	RTA	Requested Change (in min)	Seconds to Auto Send		
UAE321	EGLL	22:59:00	-1.5	57	Send now	Don't Send
UAE385	VTBS	05:57:00	1.0	57	Send now	Don't Send
UAE407	YMML	02:50:00	-2.2	57	Send now	Don't Send

Figure 2-10: Proposed Dispatch in the Loop dialogue box

Selecting "Send Now" will immediately send the RTA to EGDS for transmission to the aircraft and remove the corresponding flight from the dialogue box. Any other pending RTAs will remain displayed until either "Send Now" or "Don't Send" is manually selected or the Auto Send timer expires.

Selecting "Don't Send" will immediately remove the flight from the dialogue box and the flight will be marked as "Do Not Optimize" in future optimization cycles. Any other pending RTAs will remain displayed until either "Send Now" or "Don't Send" is manually selected or the Auto Send timer expires.

2.2.7.2. Arrival Manager Interface with Attila™ ™

Another task worked during the remainder of the project was sending FLOW RTAs to the Arrival Manager (AMAN) at SZC. Integration of the EK RTAs was expected to give the AMAN additional information it can incorporate in its processing to improve sequencing of aircraft into DXB. In the United States, Attila™ operating in conjunction with the Tactical Flow Management (TFM) system at Charlotte, NC was shown to have a multiplier effect on sequencing efficiency by an FAA demonstration program.

While GE/ATH is capable and ready to supply the RTA times, an agreement had still not been reached with SZC on formatting and/or process requirements at the time of report compilation.

3. Technical Challenges and Mitigations

The following section provides a summary of the challenges that were faced throughout the lifecycle of the FLOW trial. The mitigative action that was applied at the time, or that which could be implemented to overcome persistent systematic challenges, is also documented below.

3.1. System Monitoring

The most pressing issue facing the Attila™ system deployment at Emirates is the need for a dedicated system performance monitoring process. This process should focus on monitoring and managing the performance and availability of the Attila™ application and be deployed to detect, diagnose, remedy, and report on application performance issues to ensure that Attila™ performance meets or exceeds the expectations of Emirates, GE, and ATH.

Specific system monitoring issues faced during the Attila™ FLOW trial was:

- Server operability/Communication
  - Issue experienced with transmitting the FR24 ADS-B data to the Emirates Attila™ server from the ATH server. FR24 has the largest network of ADS-B data, and the impact of this was noticeable in the reduction of the number of flights optimized and the Attila™ benefit during the outage period (Aug. 22 to Sep. 17)
  - Issue with undetected RTA message outages - RTAs not sent over extended time periods (e.g. 01NOV13 through 05NOV13)
    - RTA messages queued during outage periods were sent multiple times and/or sent to the wrong aircraft upon re-establishing connectivity. EGIT has since implemented changes to prevent this type of a backup of data.

Mitigation Opportunities:

1. System Performance Monitoring Process

   ATH is working with EGIT to develop, document and deploy a System Performance Monitoring Process specifically for the Attila™ application.

   While the system has been very reliable during the trial period with no system crashes and only the issues related to interface data. The monitoring that is needed is to monitor:

   - The 4 system services that make up the Attila FLOW system
   - The processes that make up the services
   - Data flow across the input and output interfaces
     - RTA message delivery verification – currently the Attila system only knows that the RTA has been put on MQ for EGDS, however there is no confirmation that the message was delivered to the aircraft. EGDS has confirmed that

they could provide data to Attila indicating that the message was received by the aircraft.

3.2. Data Availability and Reliability

3.2.1. Trajectory Data

A loss of accurate trajectory, or positional data, presents Attila™ with a couple of challenges:

1. Queuing estimates – As ADS-B and CFMU are the sole source of position data for non-UAE aircraft outside of the DANS Terminal radar area, a loss of this data can lead to degraded queuing calculations, thereby decreasing the accuracy of the RTAs.
2. Accurate ETA information – Although ACARS position data (POS reports) is received from UAE aircraft, the frequency of that data may not be enough to generate accurate speed profiles. Without a confident speed profile the RTA generated by Attila™ may not be as accurate as possible and outside the performance capability of the aircraft.

Specific trajectory data issues faced during the Attila™ FLOW trial was:

- ADS-B availability/reliability
  - Bagdad and Kuwait ADS-B intermittently offline
  - Northern Iraq and eastern Turkey is not available with Erbil and Armenian ADS-B revivers' offline

Mitigation Opportunities:

1. ANSP Trajectory Data — Similar to the Central Flow Management Unit (CFMU) data received from EUROCONTROL, Attila™ has the capacity to ingest and process trajectory data from other Air Navigation Service Providers surrounding the UAE. While offering the most secure source of trajectory data, individual agreements would need to be signed with each authority, making this a long term and complex solution. For example, at time of writing, an agreement between Emirates Airlines and the Sheikh Zayed Air Navigation Centre in Abu Dhabi has still yet to be reached.

2. ADS-B Receiver installation — Given the ad-hoc nature of the ADS-B network, a permanent Emirates-GE receiver network could be established in those areas prone to data outages. Having an internally managed and controlled aircraft position and speed data source would increase the reliability of the Attila™ benefits.

3. POS Reports — Additional POS reports on as needed basis has been discussed with Emirates and maybe useful for certain routings. GE/ATH would need to identify where this additional data might be useful.

4. Flight-Ops. or — Explore extensibility of existing ACARS Flight Operations (i.e. Gate,

Maintenance ACARS messages	HOWGOZIT, etc.) and/or maintenance messages to tailor content and/or trigger-events for the purposes of Attila™.

3.2.2. Flight Plan Data

Flight plan data for all UAE flights is received directly from the LIDO flight planning system via the FSUM data. A loss of, or incomplete flight plan data is similar to the loss of trajectory data in that it impacts Attila™ 's capability to calculate both Queuing and ETA times thereby resulting in a degraded RTA calculation. However, in the case of non-UAE aircraft, flight plan data is the sole-position source should ADS-B and CFMU data also become interrupted.

Specific flight plan data issues faced during the Attila™ FLOW trial was:

- Inaccurate trajectory counts
  - Emirates Sky Cargo flights that were not processed by LIDO. Emirates have determined that these flights can be incorporated into the DMIS data stream.
  - During a technical visit to Dubai in late September 2013, a discrepancy between DANS daily arrival counts and Attila's counts was observed. The discrepancy was in the order of 20-30 flights per day. All of the flights were non-EK flights for which no data was received from DMIS.

Mitigation Opportunities:

1.	DANS AT3 Flight plan data	The primary source of all arriving flight plan data for non-Emirates aircraft into Dubai is the Dubai Air Navigation Service's AT3 flight plan data. While discussions between DANS, Emirates, and GE have been positive, there are concerns over the proprietary nature of the data coming from Raytheon's AutoTrac III ATM system.
2.	ADS-B based flight planned data	Analysis of the missing flights showed that a number of these are ADS-B reporting aircraft, for these flights a flight plan may be generated based on the ads-b information and historical routing data.

3.3. Crew Feedback

As part of the initial familiarization events conducted with the Emirates flight crews, the importance of feedback was stressed to the crews. As discussed in section 2.2.3.1 above, the crews are also provided with feedback forms for this very reason in an attempt to acquire all the data necessary to troubleshoot any areas of concern.

Specific crew feedback received during the Attila™ FLOW trial was:

- Unachievable RTA reports
  - While a few turned out to be achievable, others appear to have been as a result of erroneous estimates. Some of this was due to the issue of not receiving Flight Radar 24 ADS-B data from about 8/22 to 9/16. This was

not noticed because Attila™ was still receiving PlaneFinder ADS-B data, and unfortunately FR24 has a much more extensive coverage network.

- Prediction errors
  - There were some cases of DESDI flights where Attila™ seemed to be about 0.5 to 1 minute pessimistic in its estimate. ATH is looking into this to see if this is more than just a few flights and to see if a refinement is required.
- Aircraft Performance
  - The optimization Mach limits for all aircraft types was reviewed, most specifically the 777 and A340 (see Appendix C). In a recent release update GE/ATH added the ability to define the optimization Mach limits separate from the aircraft physical Mach limits to make it easier to set.
  - The schedule component of the goal function currently will slow down early flights, a refinement to make this more neutral could be made to reduce slowing flights down (this is a policy item)

Mitigation Opportunities:

1.	Data Availability and Reliability	As discussed in 3.1 above, the acquisition of secure, reliable data improves the overall accuracy and benefit of the Attila™ system.
2.	System monitoring	ATH continues to work with the EGIT team to develop a system monitoring plan to ensure that all required data is received and under what degraded capabilities Attila™ can operate.
3.	Aircraft Performance	ATH has recently updated the Emirates Aircraft Performance database which made adjustments to the optimization Mach limits.
4.	Passive Data re-runs	ATH continued to make minor adjustments to the parameters and corrections as necessary to improve the prediction accuracy of Attila™. Work on refinement and reruns continue.
5.	Communication and Training	Recommendation to review with crews the importance of up-to date wind information in the FMS.

4. Technical Opportunities

The following items are enhancements to the Attila™ system and would require changes to the technical configuration of the application. GE and ATH expect to work with Emirates to understand what, and if any, of these opportunities will be deployed in DXB.

4.1. Attila™ Enhancements

4.1.1. Emirates Feedback

During a technical visit to Emirates in September of 2013, the GE team had an opportunity to meet with the Emirates Flight Operations Group to discuss enhancements to the Attila™ system. Those were:

1. Dispatcher in-the-loop Functionality

Emirates Flight Operations staff walked through various operational scenarios that arise that may require human intervention over Attila™.

At the conclusion of those discussions the teams understood that some situations were strategic in nature (i.e. advance notice available) and would be best solved with changes or additions to the Attila™ Goal functions themselves, and the others were tactical requirements (i.e. situations arising with very little notice) and would be best solved with further enhancements to the Dispatcher-in-the-loop prototype.

Examples of strategic requirements (Changes/Additions to Attila™ Goals)

- VIP passengers and/or cargo
- Protection of DXB outbound connecting flights:
  - Crew duty-day issue on outbound flight requires inbound aircraft to arrive as soon as possible
  - Outbound flight has curfew imposed at destination and cannot compromise departure time
- Approaching BINGO and/or planned min. fuel at terminal arrival gate

Examples of tactical requirements (Dispatcher-in-the-loop enhancements)

- In-Flight Tail-Swap (Incoming aircraft now required to operate different (and earlier) flight than originally scheduled
- Medical Emergency

Additionally, before tactically overriding the Attila™ system, the ATC coordinators discussed 'What-if' functionality:

- If I speed up or slow down a certain aircraft what would that do to the arrival distribution of the entire Emirates?

2. Graphical User Interface (GUI) enhancements

This discussion was limited to the Attila™ Command Interface (ACI) and the Attila™ Timeline Display used extensively by Emirates Air Traffic Coordinators. Requests included:

- Viewing preferences by user:
  - Font size, colors, etc., etc.
- Scroll direction is not intuitive (backwards)
- RTA push time currently displayed in decimals v. HH:MM:SS
  - Understand the requirement to send RTA times to Boeing fleet in decimal format, but would like to view as HH:MM:SS
- Amend on-the-fly/as required (NOTAM)
  - Adjust called rate by exception. Maintain a known default rate that can be adjusted only as required by the ATC Coordinators (e.g. NOTAM)

2. DATA Output Analysis

Using data outputs for continuous improvements

- Emirates using data to peer back into the organization and make corrections through training
- Data extracts for Crew awareness/communication on the impact of Attila™ on the organization
  - Increase compliance rates
  - Increase feedback
- Data extracts for external shareholders to demonstrate benefit and encourage participation
- See figure 4-2 and figure 4-3. Examples of crew dashboards (Fuel and OTP) created by GE as examples of future reporting capabilities.

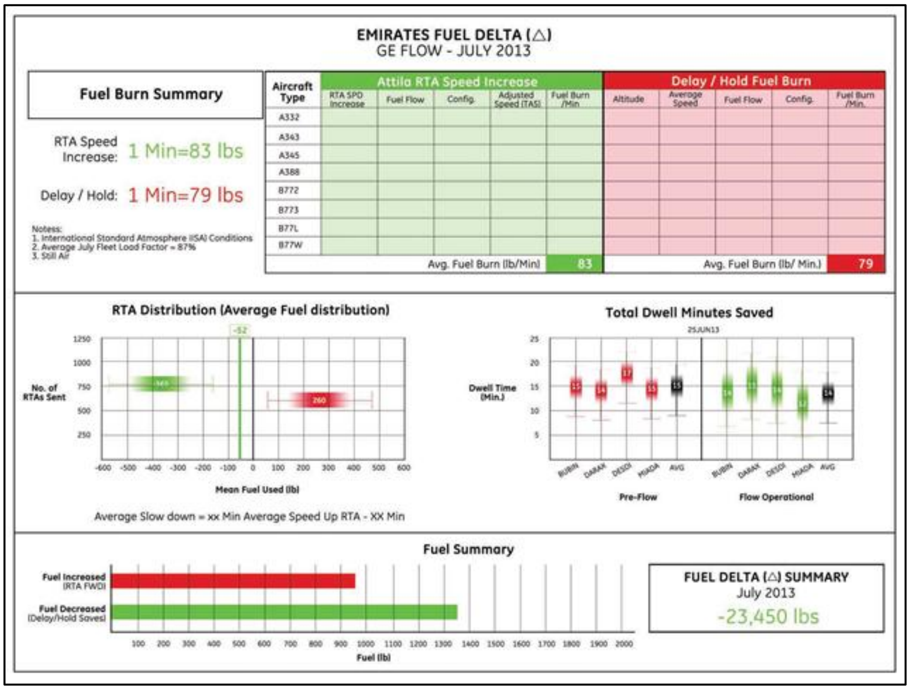


Figure 4-1 Conceptual Fuel Dashboard Example

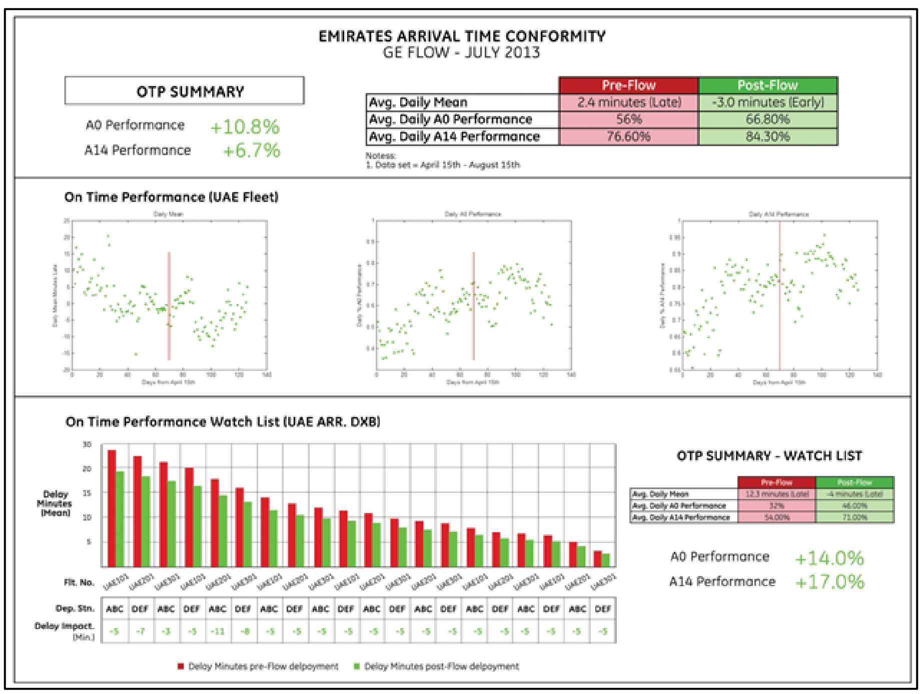


Figure 4-2 Conceptual OTP Dashboard Example

4.1.2. Future GOAL Functionality

While working with the goal functions for this phase of the FLOW project, a number of additional goal functions have been identified and are provided here for future consideration in a later phase of the FLOW:

- Gate Availability
- Wake Vortex Considerations
- Enhanced Arrival Queue processing
    - Location in Arrival Bank
    - Departure Demand
- Flight Dependent
    - Very Important Passengers
    - Connections
    - Fuel onboard
    - Crew legality
- Airport Attributes – time of day, arrival rate, other
- Ramp Congestion

4.2. Attila™ Exchange

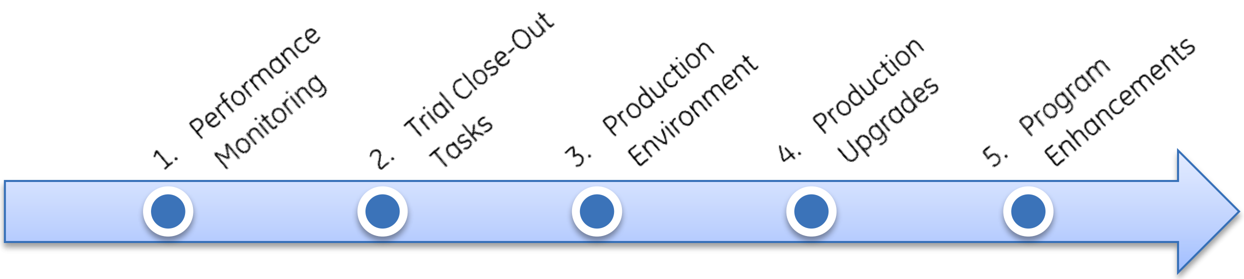
Emirates continue to express interest in other airlines operating into DXB in participating in the Attila™ program. This has been accomplished in other operational deployments and is known as Attila™ Exchange.

Attila™ Exchange is a multi-user management tool. It may be used by a control authority, or a group of participating airlines. Its job is to resolve the flow of aircraft into a single, pre-conditioned arrival flow. The goal is to provide an efficient and equitable allocation of the airport asset for everyone, while fully supporting the business goals of Airline Attila™ users.

In an Attila™ Exchange airport all users benefit. Those equipped with Airline Attila™ will have their dynamic business goals incorporated into the solution. Those that are not equipped will simply see an airport that runs a little smoother.

5. Technical Recommendations

For utilization of Attila beyond FLOW's conclusion, the following technical recommendations have been included and are listed in order of criticality; Improving not only the integrity and stability of the system, but also the benefits recovered by Emirates.



1.	Performance Monitoring Process	GE/ATH to assist Emirates in designing, deploying, and maintaining a System Performance Monitoring Process for the Attila™ application.
2.	Dispatcher-in the-loop Interface	Complete user familiarization of the Dispatcher-in-the-loop interface while on-site at Emirates (December 2013), and incorporate feedback into production version.
3.	Define Production Environment	GE/ATH to assist Emirates in developing the definition for an Attila™ production environment in Dubai (DXB). Definition to include system performance metrics such as stability, integrity, and Emirates benefit targets (goals and metrics).
4.	Production Upgrades	GE/ATH to schedule the following work tasks to improve the current production environment. a. New Queue Goal function implementation b. Increased speed Goal function implementation c. Updated Schedule Goal function implementation d. Position reporting integrity. (e.g. GE/Emirates ADS-B receiver network, Flight Operations ACARS messages, etc.)

5.	Program Enhancements	ATH/GE to work with Emirates on determining what and if any further program enhancements are required (See section 4). a. Dispatcher in-the-loop functionality b. GUI enhancements c. Data outputs d. ATC Interface d. Other enhancements as requested by Emirates

Appendix A. Integrated Flow Team

A.1. Integrated Product Team Members

A.1.1. GE Personnel

GE Aviation's project organization is illustrated in Figure 5-1.

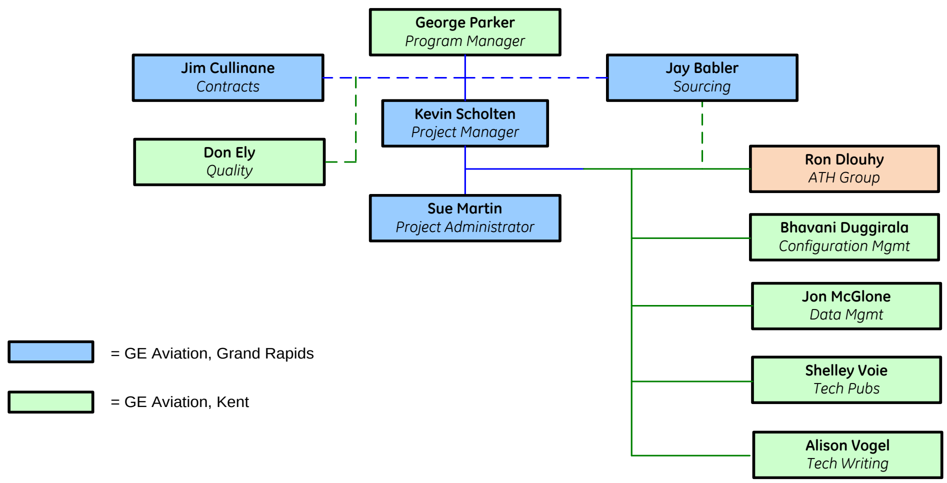


Figure 5-1: GE Personnel for FLOW Project

GE Aviation personnel include:

- George Parker, Program Manager
  +1 253 867 3953
  georgeedward.parker@ge.com
- Kevin Scholten, Senior Staff Engineer/Technologist
  +1 616 241 8680
  kevin.scholten@ge.com
- Iain Box, Lead Flight Operations Technical Specialist
  +1 604 345 3239
  iain.box@ge.com
- Jim Cullinane, Contracts Manager
  +1 616 241 8831
  jim.cullinane@ge.com

A.1.2. Emirates Airline Personnel

Emirates personnel include:

- Geoff Hounsell, Vice President – Flight Operations Support, Flight Operations
  +971 4 708 4300
  geoff.hounsell@emirates.com

- Robert Everest, Vice President – Flight Operations Support, Flight Operations
  +971 4 708 4300
  bob.everest@emirates.com

- Peter Raw, Aeronautical Services & ATM, Flight Operations Support
  +971 4 708 4302
  peter.raw@emirates.com

- Guido Knigge, Manager Flight Dispatch, Flight Operations Support
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  guido.knigge@emirates.com

- Farid Al Qaiwani, Procurement Manager - IFE & Avionics, Procurement Aircraft
  +971 4 218 1333
  farid.qaiwani@emirates.com

A.1.3. ATH Personnel

ATH personnel include:

- R. Michael Baiada, President, ATH Group, Inc.
  +1 303 674 0229
  michael.baiada@athgrp.com

- Ron Dlouhy, Senior Staff Engineer, ATH Group, Inc.
  +1 301 459 4484 ext. 115
  ron.dlouhy@athgrp.com

Appendix B. Available Data Sources

DATA TYPE	DETAILS
Flight Plan	Emirates' LIDO system provides four necessary pieces of information to Attila™ ™: 1. ATC Flight Plans: The ATC flight plan provides the planned lateral route, including the arrival fix and STAR; the planned cruise altitude(s), and planned climb/cruise/descent speeds. 2. Flight Summary (FSUM): FSUM data is used for 1) generating ATC-equivalent flight plans for locally filed flights, and 2) planned taxi times. 3. Winds: LIDO provides GRIB2 wind data, which is updated every six hours. 4. Navigation Database: The ARINC 424 Navigation Database is updated 28 days. The database provides detailed information for the waypoints specified in the flight plans.
FMS Position Reports	FMS Position Reports are routed via EGDS. The position reports contain current position, next waypoint and ETA at the next waypoint, and ETA at the destination.
DMIS	DMIS provides information for non-EK flights relative to estimated arrival time at DXB. Messages are received shortly after the aircraft become airborne. No flight plan associated route data is received from DMIS.
CORE	The CORE system provides Out-Off-On-In (OOOI) information, tail number, and schedule data for EK flights.
ADS-B	As of Feb 13th 2013, ATH is successfully sending ADS-B data to Emirates via VPN from ATH's Lanham, MD facility to the production server and the data is being processed by Attila™ . The data are assembled from three separate providers – FlightRadar24, PlaneFinder, and PlanePlotter. The benefit of ADS-B data is it provides position information outside of the AT3 radar area.
ADS-C	ADS-C messages 7 and 14 are received via the same queue as the FMS ACARS POS reports from EGDS. The ADS-C messages provide current position and speed, as well as estimated ETA at DXB. The ADS-C position data is decoded by the Attila™ data processing.
RADAR	Emirates receives broadcast AUTOTRAC III ASTERIX CAT 062 formatted radar data from Dubai World Central (DWC) via Dubai Air Navigation Services (DANS) equipment at Dubai International Airport (DXB). The messages conform to the definitions specified in Eurocontrol Standard Document for Surveillance Data Exchange Part 9: Category 62, SDPS Track Messages, Version 1.2. The specific fields used for the track messages are defined by Raytheon document H404310 Rev E, Interface Control Document for AUTOTRAC III System Track Output, dated 06 May 2009. The radar data from the AT3 system is being received via a multicast interface on the dedicated Attila™ Radar server at EK HQ. A service on this server reads the data and places it on a MQ queue for delivery to the Attila™ production server. This radar data is then unpacked using a new process. The radar data became available Feb 17 and was successfully integrated with Attila™ on the production server the next day.

DATA TYPE	DETAILS
CFMU EFD Messages	Eurocontrol's Central Flow Management Unit (CFMU) Enhanced Tactical Flow Management System (ETFMS) Flight Data (EFD) messages are used to provide Attila™ with updated position and flight plan information for flights originating in or transiting European airspace. Primarily these messages are used for non-EK flights; however they also are useful for updating EK flight information as well.

Appendix C. Aircraft Performance Table

Aircraft Type	Allowable Aircraft Mach Range	Attila™ Allowable Optimization Mach Range	Optimum Cruise Mach	Cruise Burn Rate (lb/hr)	Normal Cruise Speed	Approach Burn Rate (lb/hr)	Approach Speed (knots - KIAS)	Average Attila™ Speed Change (knots)
A319	.71 to .82	.74 to .81	.795	6500	440	6000	125	7
A332	.70 to .86	.72 to .82	.81	13000	464	13400	132	8
A343	.70 to .86	.72 to .82	.81	14000	464	11900	136	8
A345	.70 to .86	.72 to .83	.82	19000	470	19300	136	8
A388	.74 to .89	.79 to .87	.85	26500	487	22000	150	9
B772	.75 to .89	.80 to .85	.835	14,200	481	14200	134	9
B77L	.75 to .89	.81 to .85	.835	15,400	481	16800	137	9
B773	.75 to .89	.80 to .85	.835	16,000	481	15700	148	9
B77W	.75 to .89	.81 to .85	.835	15,900	481	17700	148	9

Appendix D. Default Dwell Times

FIX	STD DWT	DWT1	DWT2	DWT3	DWT4	DWT5	DWT5
WEST ARRIVALS (RWY30)							
BUBIN	15.9	00:30-03:00	03:15-07:30	08:00-10:00	10:00-14:00		
		17.4	13.7	17.2	13.8	13.0	
DARAX	19.4	00:30-03:00	07:20-10:30	13:00-17:00	17:01-20:00		
		21.5	20.5	19.9	21		
DESDI	17.9	00:45-03:00	03:01-07:15	07:16-09:59	10:00 14:00	16:00-1900	19:01-21:15
		20	16.3	19	17.3	19.1	21.1
MIADA	15.8	00:50-03:30	17:00-19:00				
		17.8	16.2				
EAST ARRIVALS (RWY12)							
BUBIN	17.3	00:30-02:20	07:00-10:00	11:00-16:45	19:00-23:45		
		19.3	19.8	19.1	15.1		
DARAX	18.9	00:00-04:15					
		20.8					
DESDI	15.4	00:40-02:55	14:00-17:59	18:00-21:00			
		20.5	17.4	20.5			
MIADA	16.0	00:15-01:45					
		18					

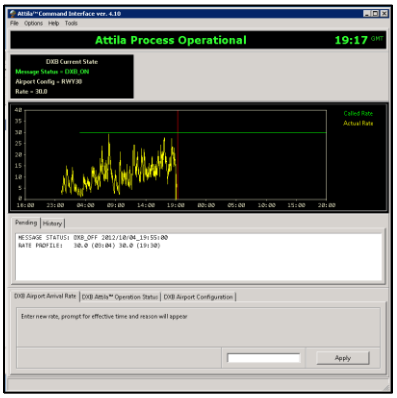
Appendix E. RTA Message

The following is a decoded example of the format of the Attila™ output message:

TIM OGI 26_13:22:46 fix=OMDB at=26_14:20.2 dep=JFK dday=26 tail=A6DVB UAE123	
Data Element	**Meaning**
TIM	3 character message type indicator to indicate that this is a Attila™ time (TIM) message
OGI	ID of the Attila™ process generating the message
26_13:22:46	DD_HH:MM:SS
Fix=OMDB	Name of the projected corner-post fix
at=26_14:20.2	The Attila™ requested time at the corner post with a resolution of tenths of minutes
dep=JFK	3 character departure airport code
dday=26	The number of the day of the month that is the scheduled departure day
tail=A6DVB	Alphanumeric string that makes up the registration number
UAE123	Flight identification (ICAO format, 4-7 characters) to which this message applies

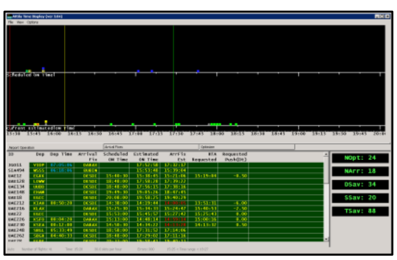
Appendix F. Attila™ Tools

F.1. Attila™ Command Interface (ACI)



ACI is a user interface used to display and update key Attila™ parameters such as Arrival Rate, Runway Direction, and Operational Status. ACI is shown in **Error! Reference source not found.**. Detailed information on ACI can be found in the Attila™ Suite User Manuals previously supplied to Emirates.

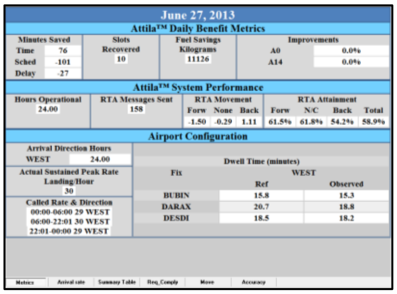
F.2. Attila™ Timeline Display (ATD)

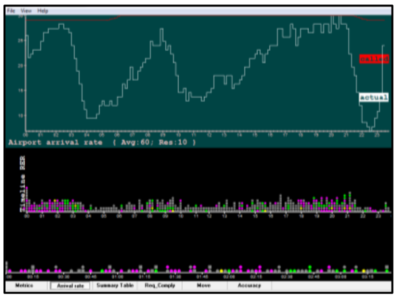


ATD is a user adjustable display, which shows the distribution of different times related to flights, properties/parameters of flights in tabular form, and statistical information applicable to the entire population of flights. Detailed information on ACD can be found in the Attila™ Suite User Manuals previously supplied to Emirates.

F.3. Attila™ Analysis Tools (AAT)

Delivered with the Attila™ application is a set of analysis tools which provide great visibility into daily airline operations. AAT is a user interface which performs background command-line arguments to execute any of the following four programs used for analysis purposes:

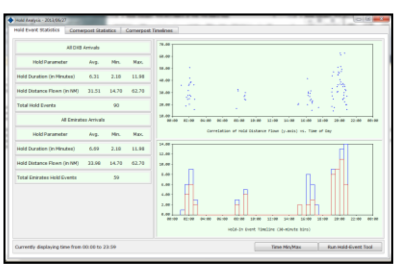




Attila™ Statistics Display (AST) provides basic statistical information about an Attila™ session (a session is defined as the period of time in which a contiguous .atx file is being written – typically this file will be closed out after a 24-hour period). Examples of the Metrics page and Arrival rate page are shown.

Airspace Visual Display (AViD™) is a fast-time/real-time situation display process that shows flight progress against a map containing user-controlled geographic information, including airspace structures.

Statmaster is a data reduction program used for quick-graphic of tabulated data. The setup of the graphs is done via ini-file setup and can be customized to whatever the user chooses to display to the extent of the availability of the data.



Hold Stats is an application custom-designed to use the realized trajectories (as-flown trajectories) to generate results pertaining to the Hold events within a defined radius of the Dubai airspace.

Appendix G. Server Installation/Communication

The RTA message is written out by Attila™ to the EGDS queue (MQ Series queue) and to a serial numbered text file in a specified Attila™ output directory when the flight is optimized. There is a single RTA per message.

The serial numbered files provide a log of all RTA messages generated. A new serial numbered file will be written out every time Attila™ optimizes (parameter time – every 1 to 10 minutes) and has messages to be sent out. The file name format is:

Name[123456].atm

Where:

- Name is the name of the initialization file being used to run Attila™ with a serial number starting at [000001]. For example for Emirates at DXB we use the ek_dxb initialization file name.
- atm is the file type to indicate Attila™ message output.

The file will have a different name until the Attila™ program has stopped writing to it so there is no danger of picking up an incomplete file.

Appendix H. Crew-Feedback Request Form

Emirates

Crew-Feedback Request Form

From: EK Aeronautical Services; Tel: +971 4 708 4304
E-Mail: navigationservices@emirates.com

GE Flow testing of RTA message for: delivery, format, validity.

Your kind collaboration in the trials to test RTA message format and applicability is greatly appreciated.

Objectives

- To ensure messages are received and understood.
- To check the validity of the RTA advisory. Can the requested RTA be managed

Questionnaire

Please fill in the questionnaire at the end of the flight

EK _____ Flight date (UTC) : ___/___/___ CPT ______________________

RTA message

Did you receive an RTA message?	Yes	No
Was the message readable and the action required understandable	Yes	No

Remarks ____
____

Validity of the RTA message. (When the RTA message was received)

What was the RTA at the requested fix?	
What was the ETA at the same fix?	
What was the Mach Number at time of receiving RTA?	
Could the requested RTA arrival over fix have been achieved?	

Suggestions for improving the RTA message / Remarks:

____
____
____
____
____

GE Flow RTA 1/1 → Kindly return to EK Flight Operations Support