# Dubai FLOW Report Excerpts
## (2012 through 2013)

In April of 2012, Emirates Airlines partnered with GE Aviation and ATH Group Inc. 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 was to test the deployment of a simple, yet potentially effective tool marketed as Business Based Flow Management (BBFM), which enables airlines, in coordination with ATC, to sequence arrival traffic to avoid current and potential future airport delays/congestion/inefficiency.

A successful outcome would prove, to Emirates, the concept that an airline acting in their own best interests, could perform actions outside of local Dubai Air Navigation Service's airspace (2 to 3 hours, or more, prior to landing) that would provide a positive benefit to both Emirates' fleet as well as the ATC system as a whole.

Below is an empirical assessment of the operational performance experienced by Emirates while under the direction of the BBFM optimization software. 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.

With compliance around 50%, BBFM benefits include.

- Improvement in Emirates On Time Performance through improvements to A0/A14
- Improvement in Dwell time reduction 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

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.


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

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

## 1.1 Improved On Time Performance for Arrival and Departure (Hub Protection)

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

## 1.2 Reduced Fuel Usage

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 Dubai Air Navigation Services (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


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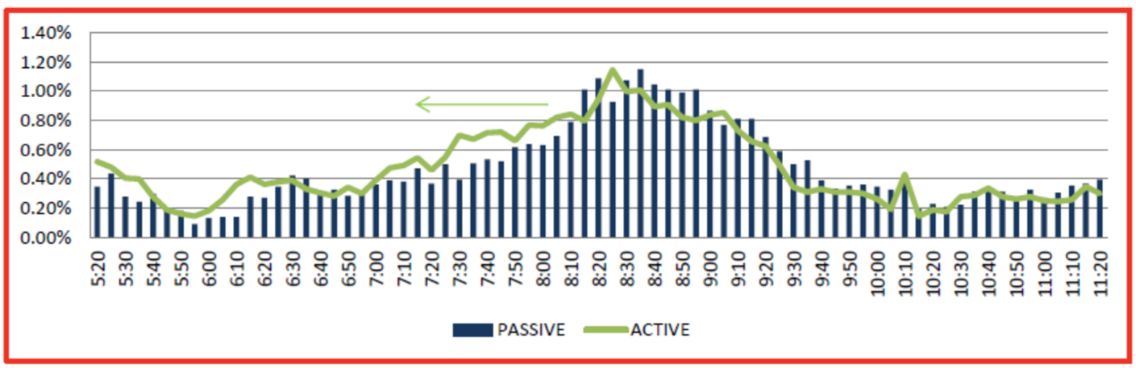
Table 6 Net Fuel Impact Scenarios

| | 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

## 1.3 Increased Capacity and Throughput

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.




For the period of April 1st, 2013 through October 31st, 2013, the average daily arrival delta 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.

## 1.4 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.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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

## 1.5 Improved Air/Crew Ground 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.

## 1.6 Better 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.

## 1.7 Better 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.

1. Dwell reduction - Since the implementation of Attila™, the average dwell reduction is 2.98 minutes.

## 1.8 Crew Confidence in Arrival Sequencing to Mitigate 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.


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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.

## 1.9 Increased Cargo and/or Takeoff Performance Because of Reduced Extra Fuel

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.


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