Airline Business Based Flow Management

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1 Executive Summary

Each and every independent analyses of ATH’s aircraft Business Based Flow Management (BBFM) solution, without exception, has reached the exact same conclusion: BBFM works and provides significant benefits to airlines (Appendices A through D).

Independently verified system and airline monetized benefits include:

- **TBFM project provided evidence of system-wide and airline-specific benefits that can be attributed to the assessed systems**
- **$12.3 million system and $3.1 million airline (MSP, first year), $5.6 million system and $3.1 million (CLT, first year), annually, at modest levels of pilot compliance, which are easily improved**
- **2,100 flight hours and 4,400 slots for a fuel savings of over $4M a year (ATL, steady state)**

Further, logistical flow and time management has consistently proven that variance is extremely costly and that reducing variance allows the reduction of both set up time and production time, i.e., gate and block time (Appendices E through G available on request).

Yet today’s successful operation is no longer good enough. Airlines must jump to the next level - Operational Excellence, (85% on time zero arrival, 8-10 minute reduction in scheduled block/gate time).

But to reach Operational Excellence airlines must move beyond local optimization and independent action to a fully integrated, real time, system based solution - an internal Business Based Flow Management Exchange (BBFM) process, where all of the airline’s assets, starting with the aircraft, are tactically driven to the most profitable, real time solution.

The steps necessary to reach Operational Excellence and crush the competition include:

- Adopt Operational Excellence as the airline overriding goal.
- Implement airline managed, Business Based Flow Management, starting with the aircraft.
- Implement pilot/dispatcher training about the system value of BBFM to airlines to generate compliance in excess of 70%.

Working together, we can make Operational Excellence a reality. As outlined below, implementing ATH’s BBFM solution, powered by the Attila™ software, will move millions to the airline’s bottom line by rapidly reducing costs, block/gate time, and increasing aircraft utilization.

2 Summary of Independently Validated BBFM Benefits

Every independent analyses of ATH’s Attila™ Business Based Flow Management, outlined below and in the available appendices, without exception, has reached the exact same conclusion - BBFM works and provides significant benefits to airlines.
2.1 FAA Task J Benefit (2012-09-30)

FAA, in coordination with Embry-Riddle University, independently validated actual BBFM, queue management operations at the Charlotte International US Airways and Minneapolis International Airports (Delta Airlines).

Using BBFM (labeled AAMS in the Task Report) to time synchronize the arrival flow (starting around 2 hours or more prior to landing) to the arrival fixes (30 NM from landing), based on a Required Time of Arrival (RTA) process, produced significant benefits.

With limited operational support and marginal compliance, the FAA “Task J” Report (excerpts available on request) listed the following benefits.

a) 15.94 second per flight system-wide benefits (managed and unmanaged, compliant and not);
b) Optimized flights that complied have 31.81 seconds shorter time in the terminal airspace;
c) Optimized flights have better on-time performance than non-optimized flights;
d) TMA-BBFM interaction: 17.82 seconds shorter dwell time when TMA and BBFM work together;
e) Multi-user BBFM operations saved 2,073,454 pounds of fuel (307,178 gallons);
f) 7.6% RTA Compliance (benefits improve with more flights optimized and complied).

Additionally, the BBFM system, powered by the Attila™ software, airline monetized benefits include:

<table>
<thead>
<tr>
<th>Table 2. Monetized Benefits Summary (for first year of operation)</th>
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<tbody>
<tr>
<td>US Airways-CLT</td>
</tr>
<tr>
<td>Active Phase 1</td>
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<tr>
<td>----------------</td>
</tr>
<tr>
<td>Total System Costs</td>
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<tr>
<td>System Monetized Benefits</td>
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<tr>
<td>System Benefit/Cost Ratio</td>
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<tr>
<td>Total Participant Costs</td>
</tr>
<tr>
<td>Participant Monetized Benefits</td>
</tr>
<tr>
<td>Participant Benefit Cost Ratio</td>
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</table>

(*) One Airline Attila™ system

Also, important to the business case, FAA Task J independently validated that, as outlined below, BBFM reduces airspace complexity, holding and excess distance flown, all of which reduces costs and the airline environmental impact

2.2 FAA Task J Excess Distance Report (2011-10-01)

- Aircraft Arrival Management System (AAMS) Exchange operations produced a benefit outside of the cornerpost, and,
• ATH’s “day of” metrics as measured by ATH Attila™ Statistical Tool compare very closely to the results of ERAU’s Dwell Time savings results when Excess Distance is added to the results.
• ERAU also concluded that an increased compliance increases benefits.

2.3 FAA Task J Airspace Complexity Report (2011-10-01)

• The results indicate that the airspace complexity was significantly lower in the inner sectors of the terminal areas (32 nmi radius from the airport) when the AAMS was active.
• The combined (lateral and vertical) measures in the MSP inner sector were significantly lower during the AAMS active period, while cruise segments were not affected.

2.4 Delta Air Lines Benefit Summary (2007-14)

ATH Group operated Business Based Flow Management (BBFM) for Delta at Atlanta, Detroit and Minneapolis airports.

BBFM provided Delta aircraft assigned Required Time of Arrival (RTA) arrival fix messages via Acars for the pilot to execute. Even with lower than expected compliance, BBFM produced the following benefits for Delta.

In addition, during the BBFM operation, ATH also provided Delta with the world’s most accurate runway and gate Estimated Time of Arrival (ETA) solution for all Delta arrivals, thus improving predictability.

2.5 Dr. John-Paul Clark’s Atlanta BBFM/Attila™ Analysis (Georgia Tech)

Delta contracted with Dr. John Paul Clarke from Georgia Tech to come in and do an independent statistical analysis of what the Attila™ data was indicating. This took several months and Dr. Clarke’s methods are insightful into why we’re convinced that Attila™ is a good thing.

Dr. Clarke’s Analysis - The two primary parameters for measuring success with Attila™ are dwell time and recovered or unused slots. Dwell time measures the time from the forty mile corner-posts in Atlanta to touchdown. Recovered slots measures the number of times additional aircraft are
placed forward in the queue to unused slots for a particular arrival. Both of these measures started to look promising in Dr. Clarke’s analysis. Recall that in the fall of 2006 we took down runway 26L in Atlanta for resurfacing. This made any analysis very difficult. Dr. Clarke was able to complete his analysis (using much more conservative assumptions than ATH) in November of 2006.

His findings pointed to even greater potential savings than that predicted by ATH. Armed with this, Attila™ was again implemented in January 2007. Runway 26L was then open and taxiway Victor was close to opening. As the year progressed, signs that Attila™ was effective were increasing.

2.6 Delta Air Lines Checklist Article (2007-09)

Tom Hendricks, Delta General Manager, Line Operations - Flight Operations

- Okay, I’m convinced. After nearly two years of fits, starts, analysis and re-analysis, I feel confident in telling you that Attila™ RTAs are something we need to get on board with and do it in a big way.
- When Attila™ began its limited rollout, we began to receive feedback that the RTA solutions seemed to work against the aims of a particular flight. For example, “My flight was late and I got an RTA message to slow down!” and, “I was given an RTA message to speed up and was put into holding!” The critical piece to remember about Attila™ is that it is a system solution, not an individual flight solution. What is transparent to a crew faced with situations like these is the recovery of unused slots in the queue that might be fifteen aircraft ahead of or behind you (and possibly on a different frequency). The data that ATH provided convincingly shows that when Attila™ is operating, we are recovering unused slots. This means a much more efficient flow of aircraft into Atlanta.
- Here’s an important “bottom line” to understand. The apples-to-apples comparison showed that whether with compliance with RTA requests or just plain magic, Delta’s overall ATL operation runs more efficiently when Attila™ is running than when it isn’t.
- I’m now a strong advocate for incorporating Attila™ into our daily operation in Atlanta and elsewhere.

Neil Stronach, Delta Vice President - Operations Reliability and Control

- As this CHECKlist illustrates, our operation benefits immensely from Attila through a variety of factors including increased arrival rate, decreased flight time, and improved fuel burn.
- The bottom line… Attila helps airline’s bottom line. For example, we can expect to save approximately $4 million this year if we can achieve just a 42% compliance rate.
- Additional savings are possible with higher program compliance rates.

Captain Ron Baker, Delta 73N line check airmen - Flight Operations

- Our data shows slots recovered and decreased dwell time. This has been cross-checked through independent research completed by Dr. John-Paul Clarke of GA Tech and the FAA’s ARMT (airport resource management tool)…… Attila™ RTA’s are saving time and fuel through reduced dwell time and recovered slots in Atlanta.
- Dr. John-Paul Clarke, Director - Air Transportation Laboratory, Georgia Tech coined “the Draft Effect” to describe the overall improvement in the arrival sequence to ATL. As aircraft are moved forward to recover slots, subsequent aircraft are pulled forward whether they receive an Attila™ RTA message or not. Analysis of over 17,000 non-participating flights
(i.e., flights that did not receive an Attila™ message) on days that Attila™ was operational, showed that all aircraft in the arrival queue are pulled forward by upwards of 40 seconds.

- Conservative in-house tracking since December, 2006 has shown significant financial benefits for Delta. A daily average reduction in flight time of 5.75 hours due to reduced dwell times and 12 recovered slots translate into saving approximately $11,000 per day. And this savings is calculated with less than full participation during the beta testing and is based solely on Atlanta operations. Annualized, this is close to 2,100 flight hours and 4,400 slots for a fuel savings of over $4M a year at $2.00 per gallon.

2.7 GE FLOW Final Report Excerpts (2012 through 2013)

In April of 2012, GE partnered with ATH Group Inc., to explore an air traffic flow management solution to increasing traffic congestion. 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), powered by ATH’S Attila™ software, 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 the concept that an airline acting in their own best interests, could perform actions outside of local airport arrival flow (2 to 3 hours, or more, prior to landing) that would provide a positive benefit to both the airline as well as the ATC system as a whole.

Below is an empirical assessment of the operational performance measured by GE 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 GE program team at the onset of the project.

With compliance around 50%, BBFM benefits include.

- Improvement in 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 was an improvement in all 3 key areas.

<table>
<thead>
<tr>
<th>KEY METRIC</th>
<th>RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A0 Improvement (Passive to Active)</td>
<td>14.82 %</td>
</tr>
<tr>
<td>A14 Improvement (Passive to Active)</td>
<td>12.04 %</td>
</tr>
<tr>
<td>Dwell Time Reduction</td>
<td>2.98 Minutes</td>
</tr>
<tr>
<td>Fuel Reduction</td>
<td>25.055 Kg / Day</td>
</tr>
</tbody>
</table>

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.

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

Table 2 displays an overview of the analysis results specific to On-Time Performance.

![Table 2 Hub Protection Summary]

**Reduced Fuel Usage**

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

1. GE Fuel Flow figures calculated delay savings
2. GE Fuel Flow figures and Attila™ calculated delay savings
3. Airline fuel flow figures calculated delay savings
4. Airline fuel flow figures and Attila™ calculated delay savings

![Table 6 Net Fuel Impact Scenarios]
Increased Capacity and Throughput

Attila™ is actively de-peakings arrivals and moving the demand into the shoulder areas of the heavy bank periods as evidenced in the 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.

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.

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.

**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 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.

**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.

**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.

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.
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.

2.8 Airline’s Annual Cost of Poor Quality (COPQ)

Along with benefits from BBFM, aviation must also look at what it costs individual airlines to not act, i.e., not manage their “day of” operations, 24/7-365, in real time, what manufacturing calls the Cost of Poor Quality (COPQ). The airline COPQ below is calculated based on a single airline with 2,000 flights per day, an average of 1.66 hours per flight and a conservative 18 minutes of scheduled block/gate buffer time.

![Single Airline Cost of Poor Quality Analysis](image)

3 ATC System

Airlines and pilots routinely abdicate to the ATC system (Appendices H and I available on request). Yet, only the airline can:

- generate the most profitable solution for their aircraft and their customers.
- quickly coordinate and communicate with their aircraft.
- rapidly look beyond the aircraft’s current position to identify congestion.
- easily reach across FIR boundaries to profitably manage their aircraft and customers.

The conclusion is that, even if the ATC upgrade is successful, which is highly doubtful given the last 40 years, it would allow the ATC system to exercise even more control over the airline’s aircraft. This is not a desirable business outcome.

4 What is Business Based Flow Management

In the 1970s through 1990s, Toyota leapfrogged the competition with an operational solution that dramatically improved quality, reduced costs and increased throughput (*The Toyota Way*, Liker, 2004). Business Based Flow Management is the path forward to allow an airline to blow away the competition and become the Toyota of the airline industry.
At its core, BBFM is an interdependent logistics solution that constantly applies pressure to move the right part, to the right place at the right time. BBFM is a tactical, real time process that coordinates all of airline’s operational process, to move airlines back to the desired operational state - on time zero.

But like any major change, one must pick a starting point. The movement of the aircraft is the obvious choice in that it is the customer’s highest value proposition, the airline’s highest cost process and the single process within airline’s operation that is the most unstable, generating a huge amount of defects on a daily basis (pax not where they want, when they want).

Further, as can be seen in the graph, today the movement of the aircraft is dynamically unstable, in that delays are additive - the later the aircraft gets during the day, the later the aircraft gets during the day (http://www.decisionsciencenews.com/2014/11/06/flight-delays/).

By constantly applying speed/time pressure to the aircraft, hours prior to landing, BBFM stabilizes the aircraft flow from a system perspective.

For example, why fly fast enroute if your gate is not available. Not only does this waste fuel enroute, it congests the arrival fix and delays other aircraft, takes up a valuable landing slot which should be used by a late aircraft, congests the ramp, and, as proven by ATH, leads to increased taxi times while early flights wait for gates. Further, the airline has ramp workers, fuelers and other secondary processes “standing by”, wasting time and costing money. One action produces numerous highly variant and costly effects.

Or consider 2 of airline’s aircraft at the front of a tightly packed arrival queue of 30 aircraft. By identifying/speeding up the first 2 aircraft, moving them forward 2 minutes, the entire arrival queue moves forward. In other words, moving 2 aircraft forward at the front end of a large arrival queue doesn't just save 2 minutes, but saves 2 minutes for every aircraft in the queue behind the first 2 flights, as the entire queue moves forward. This creates what Dr. Clark labeled the “draft effect”, thus dropping 60 minutes of flight time and delay from this one arrival flow alone.

ATH’s aircraft BBFM solution constantly monitors the arrival flow hours before landing, makes small business based adjustments for schedule, arrival demand/capacity/queuing, gate availability, etc. Then the BBFM optimization generates a coordinated arrival time for each aircraft and then electronically sends it to the aircraft as a suggested Mach or cornerpost time for the pilot to execute.

Of course, many will ask why an aircraft BBFM solution is better than some of the airline’s internal processes like Tactical Cost Index (TCI). The problem with TCI, and other programs like it, is that it is a local solution for a single aircraft, driven by independent action. And while beneficial, the value is limited by the interaction and variance allowed to remain in the system.
For example, under a Tactical Cost Index solution, if XYZ 1 is 3 minutes late and XYZ 2 is 15 minutes late. Using TCI, both of these aircraft would independently speed up. But if XYZ 1 arrives at the cornerpost, just ahead of XYZ 2, ATC will very predictably slow XYZ 2 a few minutes, thus wasting the extra fuel XYZ 2 burned, and making XYZ 2 miss the DOT A14 on time goal.

Conversely, in an airline controlled aircraft BBFM solution, hours prior to landing, XYZ 1 is assigned a cornerpost time behind XYZ 2, so they present themselves to the ATC system in the correct business order as chosen by the airline. In this solution, both aircraft are DOT on time.

The point is that with BBFM, the airline has the ability to tactically choose and execute the most profitable business based system outcome and coordinate it with ATC in real time. Programs like TCI cannot, and never will.

5 Conclusion

An airline managed, aircraft Business Based Flow Management (BBFM) solution has been independently proven to consistently reduce cost, flight time and improve system reliability, by numerous independent studies.

Airlines must jump to the next level - Operational Excellence (85% A0, 8-10 block/gate time reduction). But to reach Operational Excellence and crush the competition, airlines must move beyond local optimization and independent action to a fully integrated, real time, system based solution - an internal BBFM Process, where all of airline’s assets, starting with the aircraft, are tactically driven to the most profitable solution in real time.

The steps necessary to reach Operational Excellence and crush the competition include:

- Adopt Operational Excellence as the airline overriding goal.
- Implement airline managed, Business Based Flow Management, starting with the aircraft.
- Implement pilot/dispatcher training about the system value of BBFM to airlines to generate compliance in excess of 70%.

Working together, we can make Operational Excellence a reality. As outlined above and in the appendices, Implementing ATH’s BBFM solution will move millions to your bottom line by rapidly reducing costs, block/gate time, and increasing aircraft utilization.

Additional articles outlining why the Operational Excellence solution (85% A0, <3% day to day A0 Standard Deviation, 8 to 10 minute scheduled block and gate time reduction), driven by BBFM, is the path forward to make airlines dramatically better and more profitable. All it takes is one airline and/or ANSP to lead the way.

- **NAS Congestion - Who’s to Blame?** (Journal of Air Traffic Control, Winter 2017)
- **Not Working!** (ATCA Tech Symposium, Atlantic City, May 16th)
- **BBFM Operational Benefits Review** (2018 review of validated BBMF operations)
- **Air Traffic Control Is Not The Real Cause Of Airline Delays** (Forbes.com, 2017-03-23)
- **Solving the Right Airline Problem** (ATHGrp.com, 2017-10-14)
- **ATC Can’t Solve Airline Delays** (LinkedIn, 2017-11-19)
• **ATC Privatization - Good or Bad?** (LinkedIn, 2017-09-10)
• **Parked Planes Cost Airlines Billions** (Forbes.com, 2017-08-15)
• **BBFM and RTA Path to NextGen and Sesar** (ATHGrp.com, 2017-07)
• **Airlines Need to Stop Taking Customers for Granted** (Fortune.com, 2017-05-11)
• **Airlines should stop blaming others and fix their problems** (Boston Globe, 2017-06-22)