GreenLandings™ Benefit Summary

Airline Managed Landing Time Delay, Congestion, CO2 and Cost Reduction Solution

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1. EXECUTIVE SUMMARY

Each and every independent analyses of ATH's GreenLandings™ solution, without exception, has reached the exact same conclusion: GreenLandings™ works and provides significant benefits to airlines and all users.

Independently verified system and airline monetized benefits include:

- ***GreenLandings™ 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, every logistical flow and time management analysis, across numerous industries, has consistently shown that variance is extremely costly and that removing variance reduces both set up time and production time, i.e., gate and block time.

Clearly, as article after article has shown, today's airline 1950s "*day of*" operation is no longer good enough. Airlines must jump to the next level - Operational Excellence, (>%5 CO2 reduction, >85% A0, <3% day to day A0 Standard Deviation, >8 minute scheduled block/gate time reduction per flight).

But to reach Operational Excellence airlines must move beyond local optimization (i.e., silos) and independent action to a fully integrated, real time, system based solution - an internal GreenLandings™ process, where all of the airline's assets, most importantly starting with the aircraft landing time, are tactically driven to the most profitable, real time solution.

Working together, we can make Operational Excellence a reality. As outlined below, implementing ATH's GreenLandings™ solution will move $100s of millions to an airline's bottom line by rapidly reducing excess CO2, costs, block/gate time, and increasing aircraft utilization.

Facts:

1. ATC is Not the Problem, nor is it the solution (Managing the Skies, Spring 2022).
2. Airline Operational Excellence is an internal airline solution that rapidly (starting within months) and inexpensively reduces cancellations, delays, congestion, costs and CO2.
3. Airline Operational Excellence has been independently validated by FAA, Embry-Riddle, GE Aviation and others in actual airline operations at some of the world's busiest airports.
4. Easily correctable "*day of*" variance in the landing time of the aircraft is the root cause of most delays, congestion and unnecessary CO2/costs. These unmanaged aircraft landing times, driven by hundreds of independent decisions, without regard to system/business/ATC effects, negatively infects the airline operation throughout the day (the worse it gets, the worse it gets). This cascading conga line of defects, hour after hour,

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constantly increases emissions and costly end level defects (pax not where promised, when promised).
5. An efficient landing time for each aircraft can only be determined by the individual airline/operator (schedule, connections, gates, ramp, crew legality, maintenance, etc.).
6. Airline Operational Excellence is a real time, system solution that easily crosses FIR and ATC sector boundaries and works within the current ATC system.
7. All of the necessary data, communications, Cloud driven AI and operational flexibility to implement Airline Operational Excellence has been readily available for years.
8. Airline Operational Excellence is inexpensive, easily implementable, rapidly scalable and does not require any new avionics or ATC procedures.

In the following independent reports, GreenLandings™ is referenced as Attila™, AAMS (FAA Task J Aircraft Arrival Management System) and FLOW (GE Aviation). These are all the same GreenLandings™ solution and software product.

Every independent analysis of ATH's GreenLandings™ solution outlined below, without exception, has reached the exact same conclusion - GreenLandings™ works and provides significant benefits to airlines, airports, business aviation, GA, passengers, ATC, employees and the environment.

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2. SUMMARIES OF INDEPENDENTLY VALIDATED GREENLANDINGS™ BENEFITS

2.1 FAA Task J Benefit (2012-09-30)

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

Using GreenLandings™ (labeled AAMS in the Task Report) to time synchronize the arrival landing times (starting around 2 or more hours prior to landing) at the arrival fixes (35 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-GreenLandings™ interaction: 17.82 seconds shorter dwell time when TMA and GreenLandings™ work together;**
e) **Multi-user GreenLandings™ 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 GreenLandings™ system airline monetized benefits include:

Table 2. Monetized Benefits Summary (for first year of operation)

	US Airways-CLT		*Delta Air Lines-MSP*	
	Active Phase 1	*Active Phase 2*	*All Observations*	*Representative Days*
Total System Costs	$1,587,458	$4,337,458	$1,553,530	$1,553,530
System Monetized Benefits	$1,232,774	$5,649,473	$12,328,152	$5,242,340
System Benefit/Cost Ratio	0.78	1.30	7.94	3.37
Total Participant Costs	$1,587,458	$1,587,458*	$1,553,530	$1,553,530
Participant Monetized Benefits	$1,130,337	$3,127,668	$3,330,214	$1,373,975
Participant Benefit Cost Ratio	0.71	1.97	2.16	0.88

(*)One Airline Attila™ system

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

FAA and Embry-Riddle Task J Final Report 2012-09-30 - Final report of FAA and Embry-Riddle's 2-year validation of ATH Group's Attila™ solution for US Airways at CLT and for Delta at MSP.

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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 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.

Task J CLT Excess Distance Analysis 2011 - As requested by FAA, ATH preformed the Incoming Excess Distance analysis. This analysis compared the differences between the 'realized' (or as-flown) trajectory and the flight-plan (or planned trajectory).

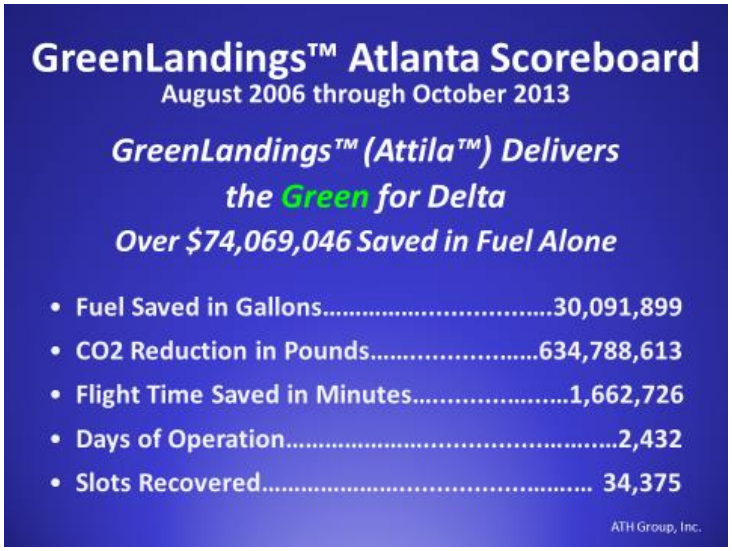
2.3 FAA Task J Airspace Complexity Report (2011-10-01)

- 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.

Task J Airspace Complexity Paper 2013 - FAA Task J 2013 analysis of CLT and MSP airspace complexity before and during Attila™ operations. Sherry S. Borener, Ph.D. Federal Aviation, Vitaly S. Guzhva, Ph.D.1 Embry-Riddle Aeronautical University College of Business Department of Economics and Lonnie H. Bowlin Aerospace Engineering and Research Associates, Inc.

2.4 Delta Air Lines Benefit Summary (2007-14)

ATH Group operated GreenLandings™ for Delta at Atlanta, Detroit and Minneapolis airports.



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GreenLandings™ provided Delta aircraft assigned Required Time of Arrival (RTA) arrival fix messages via ACARS for the pilot to execute so Delta could manage the landing times of their aircraft in real time. Even with lower than expected compliance, GreenLandings™ produced the following benefits for Delta.

In addition, during the GreenLandings™ 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 for the gates, ramp, maintenance, passengers, etc.

2.5 Dr. John-Paul Clark's Atlanta GreenLandings™ Analysis (Georgia Tech)

Delta contracted with Dr. John Paul Clarke from Georgia Tech to complete an independent statistical analysis of the GreenLandings™ benefits. This took several months and Dr. Clarke's methods are insightful into why we're convinced that GreenLandings™ is a good thing.

Dr. Clarke's Analysis - The two primary parameters for measuring success with GreenLandings™ 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, GreenLandings™ was again implemented in January 2007. As the year progressed, signs that GreenLandings™ 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 GreenLandings™ RTAs (Attila™) are something we need to get on board with and do it in a big way.
- When GreenLandings™ 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 GreenLandings™ 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 GreenLandings™ is operating, we are recovering unused slots. This means a much more efficient landing times 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

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overall ATL operation runs more efficiently when GreenLandings™ is running than when it isn't.
- I'm now a strong advocate for incorporating GreenLandings™ into our daily operation in Atlanta and elsewhere.

Delta_Attila_CheckList_Article_2007-09 - Captain Tom Hendrick's (Delta GM - Line Operations) 2007 article about why Delta pilots need to support Attila™.

Neil Stronach, Delta Vice President - Operations Reliability and Control
- As this *CHECKList* illustrates, our operation benefits immensely from GreenLandings™ through a variety of factors including increased arrival rate, decreased flight time, and improved fuel burn.
- The bottom line… GreenLandings™ 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)….. GreenLandings™ 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 a GreenLandings™ RTA message or not. Analysis of over 17,000 non-participating flights (i.e., flights that did not receive an GreenLandings™ message) on days that GreenLandings™ 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 GreenLandings™ (FLOW) Final Report Excerpts (2012 through 2013)

In April of 2012, GE partnered with ATH Group Inc., to explore an air traffic Demand 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 GreenLandings™, powered by ATH'S GreenLandings™ software, which enables airlines, in coordination with ATC, to sequence arrival traffic to avoid current and potential future airport delays/congestion/inefficiency.

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A successful outcome would prove the concept that an airline acting in their own best interests, could perform actions outside of local airport arrival landing times (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 GreenLandings™ 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%, GreenLandings™ benefits (FLOW) 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 GreenLandings™ data indicates that there was an improvement in all 3 key areas.

KEY METRIC	RESULT
A0 Improvement (Passive to Active)	14.82 %
A14 Improvement (Passive to Active)	12.04 %
Dwell Time Reduction	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.

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

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

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

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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 GreenLandings™ calculated delay savings
3. Airline Fuel flow figures calculated delay savings
4. Airline Fuel flow figures and GreenLandings™ calculated delay savings

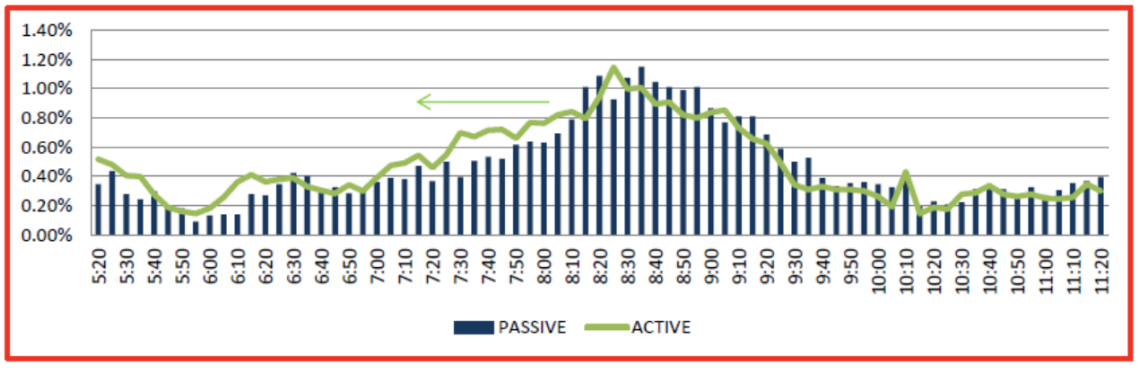
Table 6 Net Fuel Impact Scenarios

	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 fleet composition
[5] Dwell flight time savings based on ATC data at .64 minutes/flight.
[6] Dwell flight time savings based on Attila data of 2.98 minutes/flight

Increased Capacity and Throughput

GreenLandings™ is actively de-peaking 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.

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Of note is the trend from November 1st through December 5th, when GreenLandings™ 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

GreenLandings™ 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 GreenLandings™ reduces the total arrival variance. Early indications, as supported in section 3.2.6 above, that GreenLandings™ 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

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. GreenLandings™ 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 GreenLandings™, A0 performance improved 14.82%, while A14 improved 12.04%. See section 3.2.6 above.
2. Variance reduction - Since the implementation of GreenLandings™, 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 GreenLandings™ thereby reduces the amount of gate rest time needed between operations.

1. Variance reduction - Since the implementation of GreenLandings™, 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.

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Better Aircraft Utilization

As a result of decreased variance in the block-times due to GreenLandings™'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 GreenLandings™ is having is best measured by the reduction in dwell time.

1. Dwell reduction - Since the implementation of GreenLandings™, 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.

The complete Emirates GreenLandings™ Report can be found at Emirates Final Report.

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3. APPENDIX

3.1 Airline's Annual Cost of Poor Quality (COPQ)

Along with benefits from GreenLandings™, 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 fact is that a single large airline unnecessarily wastes upwards of $5 Billion annually, of which 20% is easily recoverable ($1.324 Billion).

Additionally, based on the current block/gate time buffers in a large airline's schedule, that airline wastes 103 aircraft, 1,333 pilots, 363 million gallons of fuel, generating 24 million tons of CO2. And again, around 20% can be easily recovered/prevented.

Single Airline Annual GreenLandings™ Benefit Analysis
Preventing CO2, Defects, Fuel Waste and Productivity Loss

Annual Crew Buffer Cost	$	304,166,667
Annual Defect Rework Cost	$	113,150,000
Annual Overnight Rework Cost	$	169,725,000
Annual Fuel Buffer Cost	$	937,145,672
Annual Aircraft Lost Productivity Cost	$	3,090,333,333
Annual Lower Ticket Revenue with Low A0 Quality	$	226,300,000
Total Single Airline Annual Buffer/Rework Cost	**$**	**4,840,820,672**
Annual Recoverable Crew Buffer Cost	$	91,250,000
Annual Recoverable Defect Rework Cost	$	28,287,500
Annual Recoverable Overnight Rework Cost	$	42,431,250
Annual Recoverable Fuel Buffer Cost	$	281,143,701
Annual Recoverable Aircraft Productivity Revenue	$	618,066,667
Annual Additional Ticket Revenue with A0 Quality	$	226,300,000
Total Annual Recoverable Buffer/Rework Cost	**$**	**1,287,479,118**
Total Annual Tons of Single Airline CO2 Generated		**32,686,567**
Total Annual Tons of Buffer/Excess CO2 Generated		**4,358,209**
Total Annual Tons of Buffer/Excess CO2 Easily Prevented		**1,307,463**
Total Annual Fuel (gallons)		**3,268,656,716**
Total Annual Buffer/Excess Fuel (gallons)		**435,820,896**
Total Annual Buffer/Excess Fuel Easily Saved (gallons)		**130,746,269**
Total Buffer/Excess Aircraft Required		**103**
Total Buffer/Excess Aircraft Easily Recovered		**21**
Total Number of Buffer Pilots Required		**1,333**
Total Number of Buffer Pilots Easily Recovered		**400**

Analysis based on 4,000 flts/day, $2.15/gallon, 20 min/flt block/gate buffer and 6 min/flt easily recoverable.

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). GreenLandings™ is the path forward to allow an airline to do the same and blow away the competition to become the Toyota of the airline industry.

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GreenLandings™ is a easily implementable (within months), low cost, cloud based solution, that uses "*day of*" Big Data, predictive analytics, cloud based AI/machine learning, real time optimization engine, driving ***system focused/business based real time prescriptive actions*** (RTAs) and the currently available airspace flexibility to allow an airline to internally manage the movement of its aircraft.

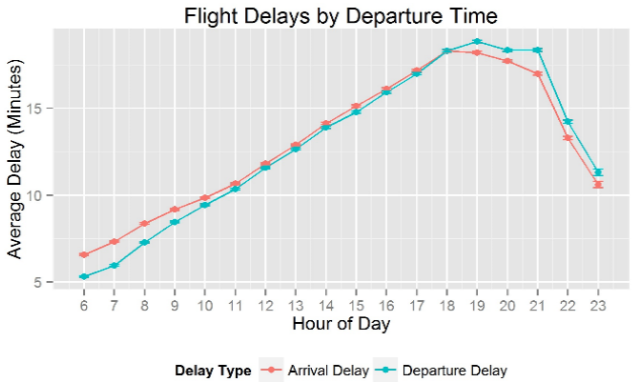
GreenLandings™ uses the ACARS communication system to provide small, but constant landing time pressure, well within the aircraft speed capabilities, to make the arrival landing times more stable, predictable, and driven to a better outcome (less congestion, better on time, lower CO2, etc.).

3.2 The Why

The biggest problem facing aviation, airlines, ATC, airports and the environment is the huge amount of landing time variance and instability within the airline "*day of*" operation, equating to over an average of 14 minutes per flight. And as proven time and time again, by industries around the world, easily mitigated variance (i.e., instability), leads to negative outcomes.

Consider that the movement of the aircraft is:

1. The process that adds the most to the customer's value proposition and the primary reason customers buy tickets,
2. The process that generates the lion's share of the revenue for the airline,
3. The airline's highest direct and capital cost item,
4. The most ***unstable*** "*day of*" performer and the process that injects the most ***variance*** into the finished airline product (pax/bag destination curb),
5. The process that is the biggest curb to curb bottleneck to increasing system throughput,
6. The process that creates the most "*day of*" service delivery defects (pax not where promised, when promised),
7. The single process that, by itself, if improved, will improve the airline's other "*day of*" processes (gate, ramp, maintenance, crew management, galley, etc.), and;
8. Finally, the one process that has the greatest potential for increasing airline service performance, perception, preference and profitability.



These unmanaged aircraft landings times, driven by literally hundreds of independent decisions, without regard to system or business effects negatively infects the airline operation throughout the day, This cascading conga line of defects, hour after hour, constantly increases emissions and costly end level defects (pax not where promised, when promised).

Fortunately, there is a solution that a single airline can easily deploy to mitigate this problem - GreenLandings™.

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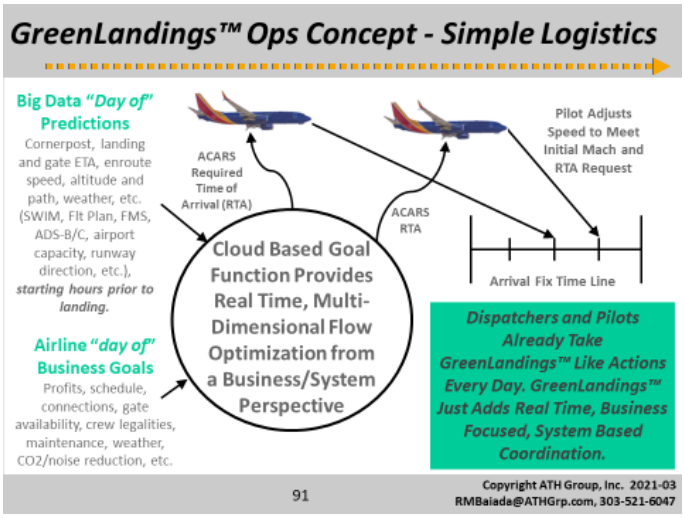
Finally, while weather and ATC will certainly impact the aircraft landing times, managing the aircraft hours prior to these events (i.e., Defect Prevention), the negative impact is less severe and shorter in time.

3.3 The How

GreenLandings™ is a real time, "*day of*" solution that uses ACARS communication to advise the pilot to speed up or slow down to drive the arrival landing times to a more optimum outcome (stable, predictable, on time, etc.).

Using a unique real time optimization engine, GreenLandings™ takes in huge amounts of "*day of*" data about each of the aircraft arrival into the airport, from many different sources (ATC, schedule, flight plan, connections, airport capacity, airline, gate availability, ramp availability, crew legality, maintenance, catering, etc.), and combines that data ***from a system perspective***, to drive each individual aircraft's arrival time towards a more business/efficient system optimum.

After the real time optimization engine generates a ***system focused, business based real time prescriptive action for each aircraft (managed landing time)***, GreenLandings™ uses ACARS, or any available communication process, to send the pilot a Required Time of Arrival (RTA), hours prior to landing, assured to be within the aircraft's speed envelope, to make the arrival landing times more stable. RTA is an onboard navigational tool that automatically speeds up or slows down the aircraft so it arrives at the airport arrival fix at the assigned target time (+/- 30 seconds). Along with the automated Flight Management System's RTA process, the pilot can also easily calculate the required speed manually, as military pilots have done for decades.



GreenLandings™ uses "*day of*" Big Data, predictive analytics, cloud based AI/machine learning, real time optimization engine, driving ***system focused/business based real time prescriptive actions*** (RTAs) and the currently available airspace flexibility to allow an airline to internally manage the their aircraft's landing time.

As described by Captain Tom Hendricks (Dir Line Ops, Delta retired), "*The critical piece to remember about GreenLandings™ is that it is a system solution, not an individual flight solution.....The data that ATH provided convincingly shows that when GreenLandings™ is operating, we are recovering unused slots.*"

Further, while GreenLandings™ will provide the most benefit for a hub airline at their hub, i.e., more managed aircraft, it will also provide benefits to all users, even individual aircraft into an airport.

Finally, GreenLandings™ can be easily combined across all airlines into an airport (GreenLandings™ Exchange™) and integrated with the ATC process to generate even more benefits for all users.

4. CONCLUSION

The airline managed GreenLandings™ solution has been independently proven, by numerous independent studies, to consistently reduce cost, flight time and excess CO2, while improving system reliability.

FAA and Embry-Riddle jointly proved this (Steve Bradford, Dr. Vitaly Guzhva and Dr. Ahmed Abdelghany), Georgia Tech proved this (Dr. John-Paul Clark) and GE Aviation proved this.

Also consider that, after careful analysis, Captain Tom Hendricks (Delta Dir Line Ops, now retired) stated that, "***I feel confident in telling you that GreenLandings™ RTAs are something we need to get on board with and do it in a big way***".

Airlines must jump to the next level - Operational Excellence (>%5 CO2 reduction, >85% A0, <3% day to day A0 Standard Deviation, >8 minute scheduled block/gate time reduction per flight). 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 GreenLandings™ 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, GreenLandings™, starting with the aircraft landing times.
- Implement pilot/dispatcher training about the system value of GreenLandings™ to airlines to generate compliance in excess of 70%.

Working together, airlines can make Operational Excellence a reality. As outlined above, Implementing ATH's GreenLandings™ solution will move millions to an airline's bottom line by rapidly reducing costs, block/gate time, excess CO2 and increasing aircraft utilization.

Further, the **GreenLandings™ process easily crosses sovereign airspace, FIR and ATC sector boundaries**, a highly complex political/technical problem for any ATC centric Demand Management program. In effect, GreenLandings is a long range, business based, demand management overlay to the ATC system.

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Finally, below are a few articles outlining why ATH's Operational Excellence solution (>%5 CO2 reduction, >85% A0, <3% day to day A0 Standard Deviation, >8 minute scheduled block/gate time reduction per flight), driven by GreenLandings™, is the achievable path forward to make airlines and ATC dramatically better and more profitable. Like Toyota did in the 1980s for the auto industry, all it takes is one airline, airport and/or ANSP to lead the way.

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The first group of web links tells the GreenLandings™ story, while the second group of web links provides additional information.

- Aviation Needs a New Direction - Driven by Vision and Leadership (MTS, Nov/Dec 2019)
- Air Traffic Control is not the problem (MTS, Spring 2022)
- Russ Ackoff System Discussion Video (YouTube, 1994, 12 minutes)

- GreenLandings™ Heathrow Interview by Harold Goodwin - Responsible Tourism (YouTube - 46:46, 2020-12-30)
- Institutionalizing Operational Dismality (MTS, Fall 2021)
- Not Working! (ATCA Tech Symposium, Atlantic City, 2018-05-16)
- Air Traffic Control Is Not The Real Cause Of Airline Delays (Forbes.com, 2017-03-23)
- Still Complaining After All These Years: Airlines Ignore Their Own Culpability In Flight Delays (Dan Reed, Forbes.com, 2016-09-16)
- Dubai Final FLOW Report (GE Aviation, 2013-12-15)
- Confessions of an GreenLandings™ Doubter (Delta Air Lines Checklist, 2007-09-01)
- Task J D29 Final Delta v US Air (FAA Task J, 2012-09)
- Task J CLT Excess Distance Analysis (FAA Task J, 2011)
- Task J Airspace Complexity Paper (FAA Task J, 2013)
- DNAV: What's So Different About it (Pro Pilot Magazine, 1984-04)

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