NAS Congestion

Part I: Who's to Blame?

For four decades, governments have spent 10s of billions of tax dollars, plus huge amounts of time and effort, but failed to significantly reduce delays and airport/airspace congestion/chaos/inefficiency. Maybe it is time to look elsewhere.

Michael Baiada
ATH Group, Inc.

So, if ATC is not the root cause of airline delays and airspace/airport congestion, what is? The answer is the variance created by the airline's unmanaged, highly random, *"day of"* aircraft flows (2 to 5 hours prior to landing). The cause is not ATC, airports, runways, airspace, weather, and or even airline schedules.

Could ATC do better? Of course. Do weather and other non-airline factors have an impact? Absolutely. But these are minor in comparison to the accepted, but totally unacceptable, amount of *"day of"* variance within the movement of the airline's aircraft. Deal ATC a better *"day of"* hand, and they would do a whole lot better.

Airlines and ATC need to understand that the airlines' refusal to track and manage their aircraft and customers from a *"day of"*, flight-by-flight perspective, and coordinate with ATC in real time, produces a highly variant outcome. This is the root cause of most airlines delays and airspace/airport congestion. After all, this is about simple logistics. The outcome of any highly variant logistics process is chaos and queuing, as the Figure 1 depicts.

Airlines, by implementing Operational Excellence, powered by Business Based Flow Management Exchange (BBFM), could prevent many delays, burn less fuel, reduce costs, and free up large amounts of airspace, but they don't. Why is that?

The answer lies in a quote attributed to Mark Twain: *"It's what you know for sure that just ain't so that gets you in trouble."* For example, airlines know *"for sure"* that:

- Rapidly reducing delays and airport/airspace congestion/chaos/inefficiency with BBFM can't be done; it's too hard, too complex and there are too many variables (this is false)
- Rapidly reducing delays and airport/airspace congestion/chaos/inefficiency is way too expensive; it's not profitable (this is false)
- Only ATC will ever solve airport/airspace congestion/chaos/inefficiency (this is false)

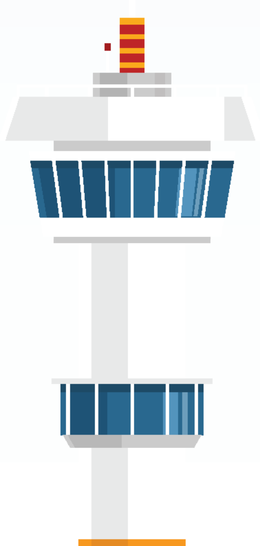
Unfortunately for passengers, shareholders, and taxpayers, airlines have a deep rooted belief in the above false statements. Yet, as two universities (Embry-Riddle Aeronautical University [ERAU] and Georgia Tech), at three airports, Atlanta (ATL), Charlotte (CLT), and Minneapolis (MSP) proved in the FAA-funded Task J program, these so-called facts above *"just ain't so."*

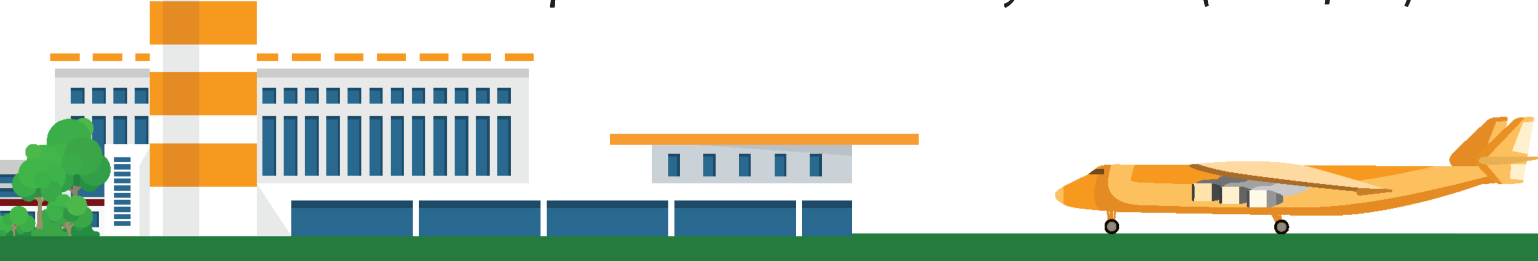
Background

The Civil Aeronautics Administration (CAA) was created in 1938 and took over control of air traffic at enroute ATC facilities and airports in 1942.

With no radar, no transponders, and few radio navigational aids, it must have been quite a challenge to keep airplanes safely separated, especially with thousands of military airplanes swarming through the airspace in support of World War II. The 1940s system consisted of instrument flight rules (IFR) flight plans, airways, position reports, and clearances, and is the basis of today's ATC system.[1]

"Rapidly reducing delays and airport/airspace congestion/chaos/inefficiency with BBFM can't be done; it's too hard, too complex and there are too many variables (this is false)."





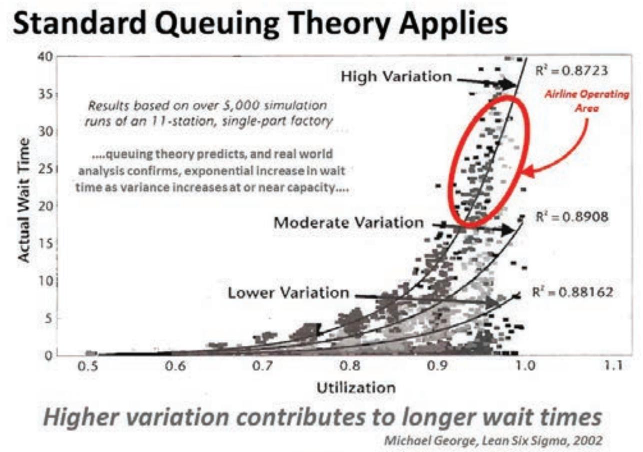


Figure 1.

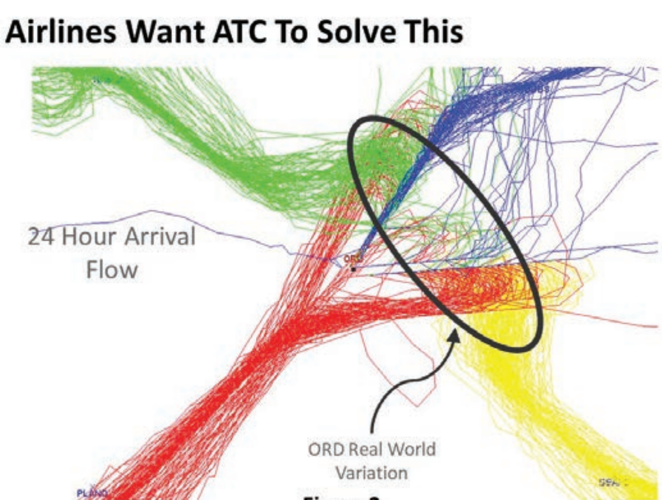


Figure 2.

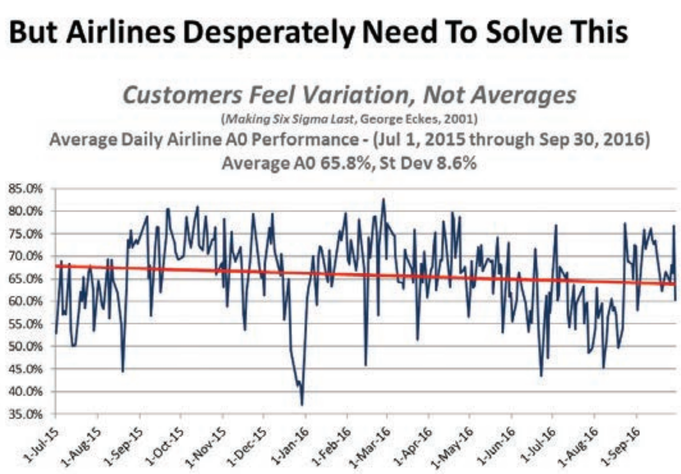


Figure 3.

This changed shortly after 1956 when a United DC-7 and a TWA Super Constellation collided over the Grand Canyon, killing everyone. Because of this, the government implemented Positive Control Airspace (PCA) in 1958. PCA ranges from 18,000 feet (FL 180) to 60,000 feet (FL 600). PCA airspace operation is in accordance with IFR, and the aircraft must be equipped with appropriate IFR instrumentation, including a Mode C altitude reporting transponder. The pilot must be instrument rated and an IFR flight plan is required. ATC is responsible for aircraft-to-aircraft separation.[2]

The next big changes were airline deregulation in 1978 and the controllers' strike of 1981. But while many point to deregulation as the cause of airspace/airport congestion, deregulation simply enabled airlines to dramatically expand demand, and build fortress hubs. And while highly variant demand was rapidly ramping up because of deregulation, the 1981 controllers' strike put an immediate clamp on capacity.

With the demand increase and sudden capacity decrease, the FAA really had only one option: tight control of the *"day of"* movement of the aircraft, with tools like the Ground Delay Program (GDP) and miles-in-trail (MIT). GDP held aircraft at their point of departure until the FAA felt the arrival airport's ATC system could handle the arrivals, while MIT spreads the enroute aircraft backwards at specified distances between aircraft. Now, 35 years later, GDP and MIT are still go to solutions for ATC.

Since the late 1950s, airlines have willingly abdicated aircraft control of their *"day of"* aircraft to the ATC system. Up until the mid-1990s, this was a necessity, as only the ATC system had the aircraft position data (radar) required to manage separation and sequencing. But with the FAA's release of the Aircraft Situation Display to Industry (ASDI) in the 1990s, this changed, as anybody can see the position of any aircraft, except some military, within the United States.

In other words, even today, once off the gate, airlines have unnecessarily concluded that their $100 million capital asset and customers are no longer their problem until the aircraft arrives at the destination gate. This presumption leads to a very simple question.

In what business operational model does it make sense to turn over control of your primary production facility to the government? In fact, not only do airlines unnecessarily abdicate control of their aircraft to the government (ATC, Privatized or not), airlines are actually lobbying the government to take over complete control of the movement of their aircraft (NextGen).

ATC Enabling Airlines

By accepting the blame for many airline delays and airspace/airport congestion, ATC enables the airlines to operate the same way they have for the last 50 years, i.e., abdicate control of their aircraft's movement — the airlines primary production process — to the ATC system. Unfortunately, this operational model hasn't worked out well for anyone (see Figure 2).

In fact, the FAA and the world's Air Navigation Service Providers (ANSP) have tried and tried to fix airline delays and airspace/airport congestion but have not reached the desired result.

For example, during the last 40 years, the FAA has spent billions of tax dollars on programs and initiatives like Microwave Landing System (MLS), Advanced Automation System (AAS), Initial Sector Suite System (ISSS), Global Positioning System (GPS), FreeFlight, Future Air Navigation System (FANS), Required Navigation Performance (RNP), Automatic Dependent Surveillance — Broadcast (ADS-B), Automatic Dependent Surveillance — Contract (ADS-C), and now NextGen, with little to no improvement in efficiency, capacity, or throughput.

For passengers, who are spending more and more time on the aircraft, the result is a highly variant product, as seen in the Figure 3. For airlines, the result is operational stagnation as they have operated the same way for decades. Of course, airlines have new technologies, but they have shoehorned these technologies into the current, highly siloed, linear production process instead of building a new, more efficient system.

This is the same mistake that General Motors made in the 1980s and 1990s, which took them 30 years to correct.

Separation Versus Sequencing

Next, we come to a big misunderstanding: the difference between separation and sequencing.

According to the ATC Controller's Handbook (FAA Order JO 7110.65W, 2015), "*The primary purpose of the ATC system is to prevent a collision between aircraft operating in the system and to provide a safe, orderly and expeditious flow of traffic, and to provide support for National Security and Homeland Defense*."

Controllers do a fantastic job with the first part, "*prevent a collision between aircraft operating in the system,*" but less so with the second part, "*orderly and expeditious flow of traffic*." How can any flow of materials be "*orderly and expeditious*" when you have no idea what constitutes an "*orderly and expeditious*" flow, and only work to sequence the highly random flow in the last part of the process (last 200 NM)?

Also, many believe that the "*orderly and expeditious flow of traffic*" is an ATC problem. But from my perspective, and as decades of history has proved, there is no way that ATC, by itself, can provide an "*orderly and expeditious flow of traffic*."

Separation is easy to understand: don't let aircraft A hit aircraft B. But I would add the following to the definition of aircraft separation: don't let aircraft A hit aircraft B in the next 20 minutes. After the 20-minute threshold, it starts to enter the realm of sequencing.

Sequencing truly is the "*orderly and expeditious flow of traffic*." But to do this properly, ATC needs a partner to identify the most efficient sequence, i.e., **the "*right*" aircraft to move forward and the "*right*" aircraft to slow down.** That partner is the airline, pilot, or aircraft operator, as only they know the most expeditious flow. Therefore, airlines need to get into the game, as only the operator can know the most efficient "*day of*" solution for each aircraft, 24/7/365, which then must be coordinated with the ATC system, all in real time.

ATC Privatization and NextGen

We keep hearing ATC modernization arguments from both sides. Unfortunately, for passengers, these arguments are based on many false assumptions.

Will ATC privatization reduce ATC and government costs? Perhaps. Will ATC privatization allow a better internally run ATC system — probably. But these are not my areas of expertise. Will ATC privatization help airline delays, airspace/airport inefficiency, or passenger dissatisfaction? **Absolutely not,** and this is my area of expertise. We need to clear the air on many misstatements about ATC privatization and clarify its costs and benefits. Consider the often-repeated inaccurate claims and arguments:

- ***Most US airlines support NextGen and ATC privatization because they think it will improve operations and airport throughput, while reducing delays*** — This is the only reason why any airline would support such a wide-ranging change to the ATC system. Unfortunately, these improvements will be limited at best since ATC cannot efficiently solve airline delays. The airline business model is simple: increase profits, improve quality, cut costs, and increase production efficiency by delivering the passenger where they were promised, when they were promised, something ATC can't, and shouldn't be concerned about.
- ***Privatization is about modernizing our aviation infrastructure faster*** — Actually, Privatization is about taking over full control of the movement of aircraft faster. How is an outside organization controlling the airlines' primary production process good for passengers or airline production efficiencies?
- ***The US ATC system is antiquated*** — This isn't entirely accurate, as much of the US ATC equipment (Standard Terminal Automation System [STARS], Enroute Automation Modernization [ERAM], etc.) has been updated over the last 10 years.

> *"Most US airlines support NextGen and ATC privatization because they think it will improve operations and airport throughput, while reducing delays..."*

- ***Aircraft still navigate using World War II era ground-based tools*** — This is very misleading since both radar and ground-based navigational beacons have been replaced many times. Further, almost all aircraft, especially commercial aircraft, use the ground navigational aids as sensors to power sophisticated aircraft navigational computers, in exactly the same way these systems use satellites.
- ***The FAA has tried to upgrade complicated software/solutions in the ATC system for four decades, but fail because they aren't funded, staffed, or capable of implementing*** — Since delays/congestion are not ATC's fault, FAA's failure to "fix" delays and airport congestion has nothing to do with ATC staff, capabilities, or funding.
- ***The FAA is poised to switch from ground-based radar to GPS surveillance*** — This assumes that all aircraft are equipped with the avionics to receive and transmit GPS to the ATC system, which is simply not the case. Additionally, given that GPS is easily jammed, radar will still be a significant part of the US surveillance system for decades to come. For example, imagine a single source GPS separation/navigation solution being jammed around New York City at 5 PM? Even when all aircraft are GPS equipped, the US military will require radar for security reasons to prevent losing aircraft tracking in case of GPS failure.
- ***The FAA's existing flight tracking system is broken and antiquated*** — This is completely inaccurate. The ATC system's structure is inefficient, but not broken or antiquated. This inefficiency is a symptom of the highly variant aircraft flows. Historically, ATC's only solution has been highly restrictive linear, nose-to-tail structure. However, this problem would ease if airlines focused more on real time aircraft time management and ATC coordination.
- ***Privatization will fix NAS delays*** — If we are only trying to reduce government inefficiency, privatization may have merit. But if we are trying to reduce airline inefficiency, as is often stated, neither Privatization nor NextGen will make a difference. Only airline Operational Excellence, powered by Business Based Flow Management (BBFM), can do this.

What is Business Based Flow Management Exchange (BBFM)?

From the 1970s to 1990s, Toyota leapfrogged the competition with an operational solution that dramatically improved quality, reduced costs, and increased throughput. [3] BBFM is that same approach for airlines and ATC — a real time, *"day of"*, airline Supply Chain and ATC coordinated solution that allows an airline to leapfrog the competition.

Aircraft arrival flows, especially hub and spoke or congested flows, represent a flow of materials problem, i.e., an interdependent logistics problem. And, as any production manager knows, in any interdependent material flow problem, having the right part in the right place at the right time is critical to the operation's efficiency, profitability and success. The system can easily collapse if even one element is overlooked.

Further, to achieve Operational Excellence, one must start with a different perspective of aircraft arrival congestion. For example, we must view the aircraft arrival process as a geographically dispersed, interdependent logistics process something only BBFM solution can manage efficiently.

Ensuring each element hits its optimal target every time requires a system-oriented process that actively manages the elements in real time from a system perspective. This process must not only determine a more optimal arrival time for each aircraft based on the schedule, connections, gate availability, crew legality, etc., it must coordinate this arrival time with ATC to ensure equitable access for runway capacity, departures, weather, etc. My points are simple.

- With the right vision and leadership, airlines can quickly and dramatically improve quality and profits while reducing delays.
- Airspace/airport congestion is mostly a symptom of an unmanaged, highly random aircraft flow and the decade's old, linear, nose-to-tail, localized sequencing process.
- While ATC must partner with airlines to implement BBFM, ATC by itself cannot significantly improve airline delays and wasted airspace.

At its core, BBFM is a 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, *"day of"* process (2 to 5 hours prior to landing) that coordinates all of airline's operational processes, to move airlines back to the desired operational state — on time zero arrival.

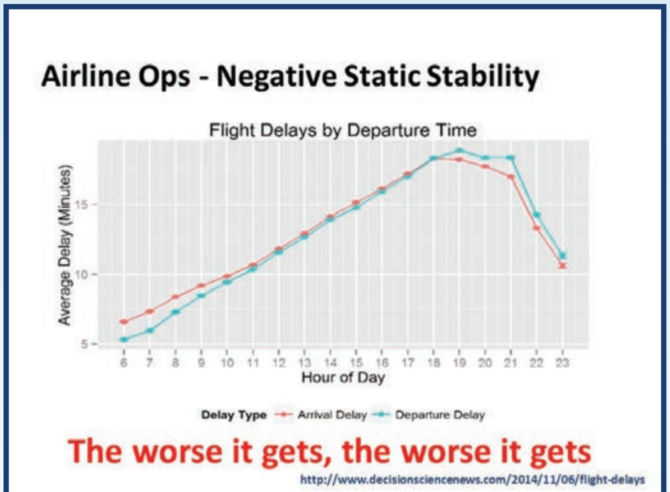


Figure 4.

But like any major change, one must pick a starting point. The aircraft's movement is the obvious choice because it's the customer's highest value proposition and the airlines' highest cost and stress inducer.

Further, as can be seen in the Figure 4 [4], today the aircraft's movement is dynamically unstable, in that delays are additive. Airlines will point to this graph and use it to justify their *"depart on time, or else"* policy, but I would disagree with their assertion because:

1. Airlines provide little to no real time, system based, *"day of"* input into the movement of their aircraft.
2. The airline schedule simply maps the historical, highly variant, actual block time and uses this to adjust schedules.

But by constantly applying *"day of"* speed/time pressure to the aircraft, hours prior to landing, BBFM stabilizes and improves the aircraft flow from a system perspective. For example, why fly fast enroute if the gate is unavailable? Not only does this waste fuel enroute, it congests the arrival fix, delays other aircraft, takes up a valuable landing slot, which should be used for a late aircraft, and leads to increased taxi times as early flights blocks the ramp waiting for their gate.

Additionally, the airline has ramp workers, fuelers, and other secondary processes *"standing by"*, wasting time and money. One action produces lower quality with numerous highly variant and costly effects.

Unfortunately, to date, airlines have very little interest in providing real time, tactical business input into their *"day of"* aircraft sequencing, a task that is critical to their operational performance, passenger experience, and profitability. For example, airlines refuse to track and manage their aircraft in real time. Operationally, sitting on the *"day of"* sidelines makes no business sense.

With BBFM, the airline has the ability to tactically choose and execute the most profitable business-based, system outcome for each individual aircraft and coordinate it with ATC in real time. Unique aspects of BBFM Exchange, which separates it from other metering systems, include:

- Ready to deploy today (operational at ATL airport for Delta Air Lines for eight years, as well as MSP, DTW and CLT)
- Improves on time performance
- Provides benefits to passengers and airlines immediately
- Reduces aircraft generated emissions
- Reduces airline/ATC costs
- Reduces ATC workload
- Expensive, yet to be developed technology or changes to the ATC system are not required today, but creates benefits for these technologies tomorrow
- Improves airport arrival efficiency by moving the entire arrival queue forward in time
- Eliminates the need for precise trajectory modeling for prediction
- Pilot involvement provides a much higher probability of meeting the plan
- Allows more advanced planning, providing enhanced optimization
- Inherently multi-center, easily crosses the Flight Information Region and ATC sector boundaries and can easily be extended to the ground
- When using BBFM Exchange (ANSP BBFM solution), system optimization/decision engine allows real time consideration of multi-user airline arrival flow business goals
- Builds a bridge to NextGen to help propel modernization benefits for all users

"NAS Congestion — Part II: Business Based Flow Management (BBFM) Implementation and Benefits" will appear in the September/October issue of *Managing the Skies*.

Citations

1. Cold War Air Museum — http://blog.cwam.org/2009/02/history-of-us-national-airspace-system.html
2. Airspace And Airport Types — http://www.co.saint-marys.md.us/docs/Airspace%20and%20Airport%20Types_1_2.pdf
3. The Toyota Way, Liker, 2004
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NAS CONGESTION

Part II: Business Based Flow Management (BBFM) Implementation and Benefits*

*Clearly, air traffic control (ATC), FAA, and airlines need a win. Airlines need to get more involved in the operational, real time, "**day of**" game, airspace/airport throughput must be increased, and passengers need to be treated better.*

The enroute BBFM solution is the only available solution that simultaneously meets all these goals. As FAA proved and independently validated, the Enroute BBFM Exchange solution can be implemented at the top 30 US airports within 36 months, with the first BBFM airport online within six months, at a cost of approximately $2 million per airport.

The enroute BBFM solution, implemented with the required time of arrival (RTA) process, is the only long-range air traffic flow management solution that has been operationally implemented (eight years) and independently validated by FAA's Task J program and Embry-Riddle Aeronautical University (ERAU) at CLT/MSP, providing real time coordination between the airlines and ATC.

The airline BBFM solution constantly monitors the arrival flow hours before landing, calculates small time/speed adjustments and then coordinates the airline's business needs with ATC (see Figure 5). After ATC's electronic, real time coordination is complete, the airline's BBFM optimization engine electronically sends the RTA to the aircraft as a suggested Mach or corner post time.

The RTA process is a 30-year-old, rarely-used, on board Fight Management Computer (FMC) function that allows the pilot to enter an arrival time at a specific fix, like an arrival fix, and then the FMC automatically adjusts the aircraft speed to achieve that RTA.

BBFM simultaneously gives ATC a win, brings airlines into the real time "*day of*" game and provides near-term benefits from advanced technologies, which in turn improves the customers' experience.

Independently-proven benefits of the enroute BBFM RTA solution include:

- Easily crosses ATC sector and Flight Information Region boundaries, a real problem with locally-based time-based flow proposals
- Does not require any new ATC equipment on the ground or in the aircraft
- Improves on time performance
- Saves fuel
- Reduces greenhouse emissions
- Reduces airspace complexity
- Does not increase controller workload

Further, as proven by FAA's Task J program, using enroute BBFM to pre-sort the arrival flow and ATC's Traffic Management Advisor (TMA) and Terminal Sequencing and Spacing (TSAS) tools to fine tune the flow within 200 NM of landing increases the benefit to the user and ATC system.

Another important factor is that BBFM builds beneficial time flow processes that will quickly incorporate new technologies. In other words, users can use the current tools to perfect the time-based flow process, and advanced tools to gain even more benefit. Also, by using the RTA as the ATC system's universal unit of currency, everyone knows what each aircraft wants, without providing the underlying business elements of that RTA.

Initially, given the accuracy of the RTA process today (+/- 30 to 40 seconds), the BBFM solution works as a density allocation process, managing the arrival flow to the arrival fixes close to, or slightly above actual capacity (see Figure 6). This allows time-based sequencing (RTAs) to the current arrival fixes (30 to 40 NM from the airport) at higher density airports and idle descents to a 5 NM final at smaller airports.

In the future, with an enhanced RTA process (+/- 5 to 10 seconds), the BBFM time-based RTA flow solution can be upgraded to a slot allocation process. With this increased RTA accuracy and a computerized conflict probe the idle descent to a 5 NM final can be expanded to higher density airports.

BBFM is a rapidly deployable solution that provides a more efficient, organized, and predictable aircraft flow. BBFM simultaneously helps passengers, airlines, and ATC **in real time** by coordinating what airlines want for each aircraft with ATC.

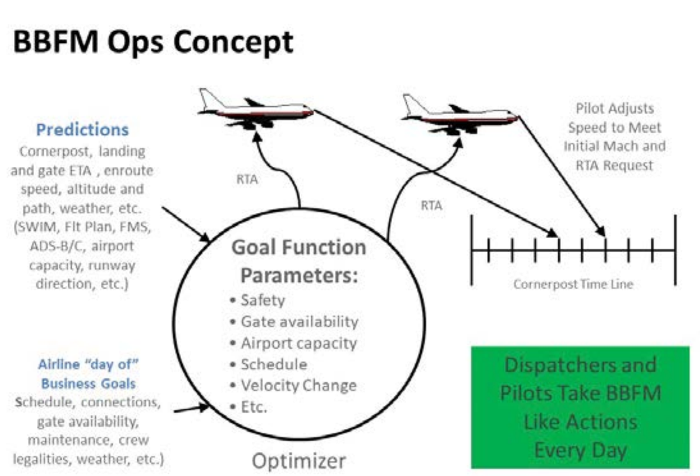

Figure 5.

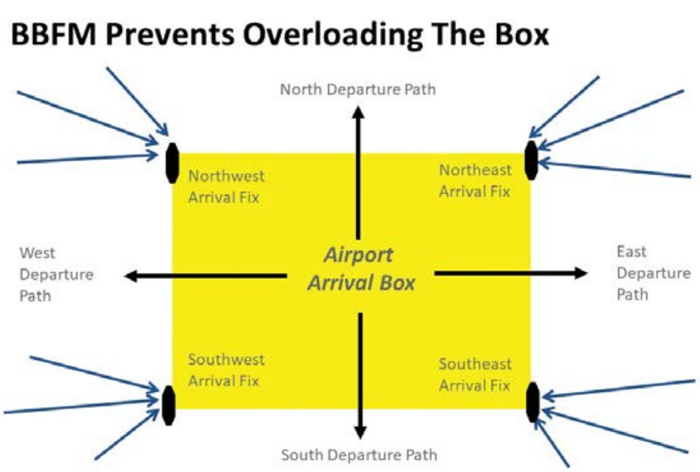

Figure 6.

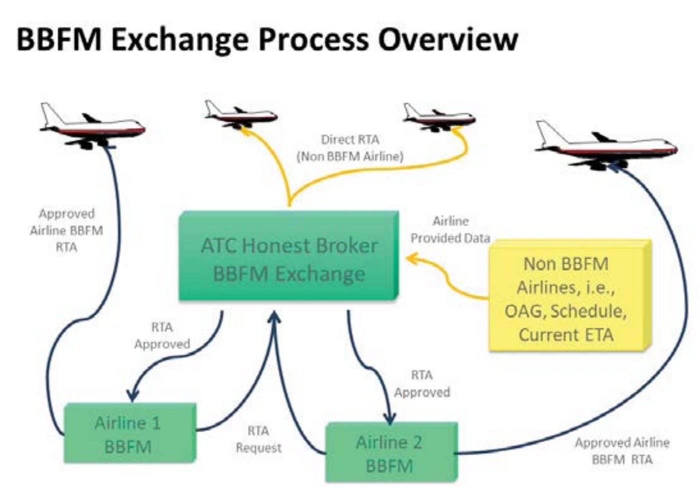

Figure 7.

ATC Acting as the BBFM Broker

Today, each aircraft in the arrival flow is managed independently, without regard to system effects, and left for ATC to deal with at the end (last 200 NM). Each arrival flow consists of hundreds of independent decisions and ensures a highly variant, random flow. This arrival flow "*randomizing*" leads to queuing and chaos and forces ATC to work harder, resulting in increased variance and cost.

Fortunately, airlines and ANSPs already have the data to utilize BBFM. The only thing they're missing is the BBFM process to correctly use this data.

The BBFM Exchange process (the ANSP version of BBFM), acting as an "*Honest Broker*" between multiple airline BBFM solutions, starts with the user determining a better arrival solution (RTA) for each aircraft based on the individual user's business needs (airline BBFM). Once a more optimal solution is determined by the airline, BBFM automatically sends the RTA request to ATC.

Once coordinated with ATC for equitability, the approved RTA is sent back to the airline, which then sends a message (i.e., Acars) with RTA target times to each pilot in the arrival flow. Like the airline BBFM tool, the BBFM Exchange tool then continuously monitors the arrival flow and adjusts accordingly (see Figure 7).

Smoothing the Flow

The goal of BBFM is to deliver an efficient, business driven, pre-coordinated aircraft flow to the airport. Below are a few examples.

Consider two aircraft at the front of a tightly packed 30-aircraft arrival queue. By identifying and speeding up the first two aircraft by two minutes, the entire arrival queue moves forward. This, in turn, saves two minutes for every aircraft in the queue. This creates what Dr. Clark of Georgia Tech labeled the "*draft effect*", thus dropping 60 minutes of flight time and delay from this one arrival queue alone (see Figure 8).

Another example was my flight from Portland (PDX) to Chicago (ORD). That day, the tailwinds were in excess of 180 knots, which would have put me into ORD 30 to 40 minutes early. The PDX agents wanted to shut the door 10 minutes early and "*push*" the aircraft to ORD since everyone was on board the aircraft. I prevented this and we left on time.

Next, I taxied slowly and cruised at a low speed for better fuel mileage, to the point that MSP Center asked why I was flying so slowly. When I arrived into ORD, I landed 16 minutes prior to schedule, instead of 30 to 40 minutes like the other arriving aircraft.

Of course, when so many aircraft land 30 to 40 minutes early at a hub airport, the gates were still full

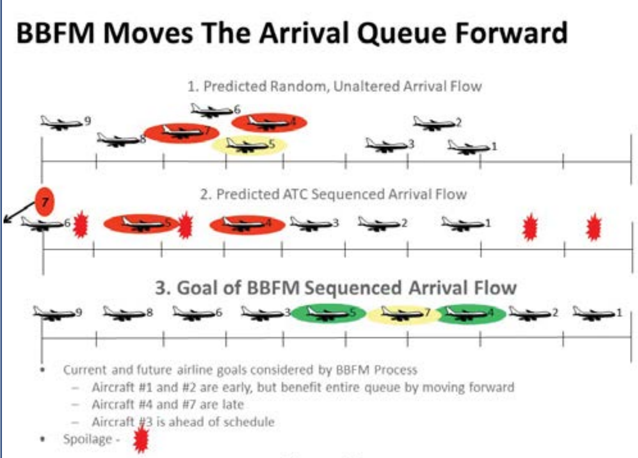

Figure 8.

from the previous arrival bank. This forces ATC to temporarily park and manage aircraft anywhere they can, to the point that as I exited the runway, I couldn't talk with the overwhelmed controllers for several minutes. Once I finally received clearance and entered the alley, my gate was open, but it was blocked by five other departing aircraft awaiting taxi clearance.

That day, ORD devolved into complete gridlock, overwhelming the ATC system and airport. I sat for 30 minutes looking at my empty gate 200 yards ahead, but couldn't get to it. Of course, like everyone else who landed 30 to 40 minutes early, I was also late to the gate (20 minutes), even though I landed 16 minutes early.

Could ATC and the airport have handled this better? Probably. But the real solution was for the airlines to manage their departures by "*pulling*" the right aircraft from their departure gate at the right time so as to not overload the ORD airport ATC system in the first place.

Clearly, if I, as a simple line pilot with limited data, recognized the problem hours prior to landing, an airline should have done the same and prevented the problem from ever developing.

Or we often hear the airline delay and congestion problem expressed in terms of the printed schedule, i.e., "*You can't schedule 10 aircraft to land at 8 AM and expect everyone to be on time*".

Of course, if all 10 aircraft showed up at exactly 8 AM, this would be true, but that is rarely the case, since airlines usually deliver upwards of 80 percent of their aircraft off schedule (some early, some late), the potential of actually having all 10 aircraft arrive at 8 AM is very low.

But the real answer to making this schedule work, is for the airlines to tactically manage their aircraft in real time so the first one lands at 7:51 AM (assuming a 60/hr. arrival rate), the second at 7:52, the third at 7:53, etc. Airlines currently have all of the necessary data and control to accomplish this, but refuse to use it.

Next, let's look at airport capacity. As a pilot for 40 years, I have never landed at a "*full*" airport. Of course, airports are over capacity at certain times (even Boise is over capacity when two aircraft want to land at the same time), but this isn't full and doesn't preclude reducing delays and congestion and realizing an improved on-time arrival performance.

Instead of waiting for ATC to de-peak the actual arrival flow backward in time (at around 200 NM from landing), an airline could proactively pull its aircraft off the arrival queue's front end (at 500 to 1,000 NM from landing, or *more*), which would increase airport throughput and improve reliability by using all the available landing slots.

By speeding its aircraft at the front of the arrival queue and moving the aircraft forward a couple of minutes, as discussed above, the entire arrival queue moves forward.

When optimizing an expeditious and efficient "*day of*" flow, only the airline, in coordination with ATC, can do the job efficiently. ATC should never make these business decisions.

Airline delays/congestion is a simple system logistics problem, which starts by the airline precisely tracking and managing their aircraft. Instead, airlines wait for ATC to manage (i.e., slow) the arrival flow locally (last 200 miles), with limited flow data and no business data. The result is that congestion will continue until airlines begin to track and manage their aircraft in real time, "*day of*."

FAA Task J BBFM Validation

Every independent analysis of ATH's enroute BBFM solution, has reached the exact same conclusion: BBFM works and provides significant benefits to airlines and ATC.

From 2010 to 2012, the FAA, in conjunction with ERAU, validated the BBFM (airline version) and BBFM Exchange (ANSP version) solutions, which they called Aircraft Arrival Management System (AAMS) in Task J at Charlotte and Minneapolis airports (see Table 1). They found the following benefits:

- Time-Based Flow Management (TBFM) provided evidence of system-wide and airline-specific benefits that can be attributed to the assessed systems.

"Airline delays/congestion is a simple system logistics problem, which starts by the airline precisely tracking and managing their aircraft. Instead, airlines wait for ATC to manage (...) the arrival flow locally (...) with limited flow data and no business data. "

Table 1: Independently Validated Benefits

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

- $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).

And while the individual aircraft savings numbers seem small, 50 seconds per flight for optimized flights (31.81 + 17.82), it is at a meager seven percent RTA compliance. But even at only 50 seconds per flight, with 1,000 flights per day at a single hub airport, this represents a savings of upwards of 14 hours/day of flight time, again at only seven percent compliance.

With an aircraft flight cost of $6,000 per hour, this is $83,000/day, $2.5 million/month and $30 million/year. And this is for only one hub airport, with minimal RTA compliance.

Additionally, with increased RTA compliance, ATH has measured savings of many more flight hours daily at a single hub airport (ATL, DBX, etc.). Also, with training and commitment, RTA compliance should be above 60 percent, which ERAU concluded would increase benefits.

Further, logistical flow and time management experts have consistently proven that variance is extremely costly and reducing variance allows the reduction of both set up time and production time, i.e., gate and block time.

Additionally, FAA, ERAU, and ATH Group completed an analysis of the before and after airspace complexity and distance flown:

- AAMS/BBFM Exchange operations produced a benefit outside of the corner post.
- ATH's "*day of*" metrics as measured by the ATH BBFM Statistical Tool compare very closely to the results of ERAU's Dwell Time savings results when excess distance is calculated.
- The airspace complexity was significantly lower in the terminal area's inner sectors (32 NM radius from the airport) when the AAMS/BBFM was active.
- The combined (lateral and vertical) measures at MSP's inner sector were significantly lower during the AAMS/BBFM active period, while cruise segments were not affected.
- ERAU also concluded that a higher compliance increases benefits.

Airline Operational Excellence

But BBFM is only the first step for airlines. With BBFM in place, airlines must then jump to the next level: Operational Excellence (85 percent on time zero arrival, less than three percent daily AO standard deviation and an eight- to 10-minute scheduled block/gate time reduction).

To reach Operational Excellence airlines must move beyond local optimization and independent action for all their processes, to a fully integrated, real time, "*day of*" system-based solution, where all 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 include:

- Adopt Operational Excellence as the airline overriding system goal by top management.
- Make the aircraft movement stable and predictable and driven to a better business solution with BBFM.
- Assign gates three to five hours prior to landing based on the predictable aircraft landing time.
- Manage all other "*day of*" assets to the highly predictable aircraft gate package.

Conclusion

An airline-managed combination of the airline BBFM and BBFM Exchange solutions has been independently proven to consistently reduce cost and flight time and improve system reliability by numerous independent studies.

Further, airline BBFM also is the first critical step towards Airline Operational Excellence. But to reach Operational Excellence, airlines/ATC must move beyond local optimization and independent action to a fully integrated, real-time system-based solution, where all of the airline's assets, starting with the aircraft, are tactically driven to the most profitable "*day of*" solution in real time and coordinated with ATC.

Working together, implementing the commercial off the shelf airline BBFM and ANSP BBFM Exchange solutions will reduce ATC airspace complexity/costs and move hundreds of millions to the airline industry's bottom line by rapidly increasing product quality and aircraft utilization while reducing scheduled block/gate time.

"NAS Congestion — Part I: Who's to Blame?" appeared in the July/August issue of *Managing the Skies*. ■

Enroute BBFM RTA Path to NextGen/SESAR

Present (Within 3-5 Years) **Requires No New Aircraft or ATC Equipment**	Current ATC procedures, separation and safety standards
	User-driven, ATC-coordinated, enroute Business Based Flow Management (BBFM), based on RTAs to current arrival fixes, issued once airborne, 300 NM to 1,000 (or more) from landing, inputs business criteria into the aircraft arrival flow
	Integration of enroute BBFM RTA and TMA/TSAS/AMAN processes, allowing enroute BBFM Exchange to pre-sort the arrival flow so that the local ATC TBFM process can more accurately fine tune the arrival sequence (FAA Task J proved a combined BBFM/TMA system increased benefits above what each of them provide separately)
	Required Time of Arrival (RTA) as Universal Unit of Currency within ATC system
	ATC to act as the "Honest Broker" Exchange solution, to equitably merge competing BBFM RTAs from users (i.e., airlines and GA) at the top airports
	Density allocation process
	Transition from GDP/MIT/CFMU operations to RTA based BBFM/AMAN operations
	Slow removal of structure around airports by moving the arrival fixes closer to the airport
	FMS to meet RTA, +/- 30 second accuracy
	RTA process to allow Constant Descent to 5 NM final at small, less busy airports
	RNP/PBN for approach and landing precision
	Expand BBFM time horizon such that the arrival BBFM Exchange RTA is coordinated prior to departure, second RTA coordinated and issued shortly after takeoff to a point 30 NM from airport and third RTA coordinated and issued (if required) one to two hours prior to landing for fine tuning the arrival flow, based on constantly updating the business criteria, winds, airport configuration, etc.
	Best Equipped, Best Trained, Best Served using easily measured RTA compliance metrics
Future (Within 5-8 Years) **Requires NextGen Technologies** 4D trajectory-based operations (RTA plus 3D path = TBO) using RTA as the Universal Unit of Currency within the ATC system	Enhanced ATC procedures and separation standards
	Reduced separation standards for operators who equip and train (Best Equipped, Best Trained, Best Served), based on aircraft specific RTA/PBN/RNP and comm capabilities
	Equip aircraft with NextGen/SESAR avionics based on rapid ROI using proven processes
	New FMS, +/- five to 10 second RTA accuracy, real time winds, new wind grid (especially for descent)
	Slot allocation process
	ADS-B position and intent
	Computerized Conflict Probe for ATC controllers to identify all 4D conflicts (i.e., provide angular separation during climb and descent)
	RTA based, constant Descent arrival to five NM final
	PBN/RNP for approach and landing precision

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