Federal Aviation Administration

Optimization of Airspace and Procedures in the Metroplex (OAPM)

Study Team Final Report

Atlanta Metroplex

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1 Background

In September 2009, the Federal Aviation Administration (FAA) received the RTCA's Task Force 5 Final Report on Mid-Term NextGen Implementation containing recommendations concerning the top priorities for the implementation of NextGen initiatives. A key component of the RTCA recommendations is the formation of teams leveraging FAA and Industry Performance Based Navigation (PBN) expertise and experience to expedite implementation of optimized airspace and procedures.

Optimization of Airspace and Procedures in the Metroplex (OAPM) is a systematic, integrated, and expedited approach to implementing PBN procedures and associated airspace changes. OAPM was developed in direct response to the recommendations from RTCA's Task Force 5 on the quality, timeliness, and scope of metroplex solutions.

OAPM focuses on a geographic area, rather than a single airport. This approach considers multiple airports and the airspace surrounding a metropolitan area, including all types of operations, as well as connectivity with other metroplexes. OAPM projects will have an expedited life-cycle of approximately three years from planning to implementation.

The expedited timeline of OAPM projects centers on two types of collaborative teams:

- Study Teams provide a comprehensive but expeditious front-end strategic look at each major metroplex.
- Using the results of the Study Teams, Design and Implementation (D&I) Teams provide a systematic, effective approach to the design, evaluation and implementation of PBN-optimized airspace and procedures.

2 Purpose of Atlanta Team Effort

The principle objective of the Atlanta OAPM Study Team (OST) is to identify operational issues and propose PBN procedures and/or airspace modifications in order to address them. This OAPM project for the Atlanta Metroplex seeks to optimize and add efficiency to the operations of the area. These efficiencies include making better use of existing aircraft equipage by adding Area Navigation (RNAV) procedures, optimizing descent and climb profiles to eliminate or reduce level-offs, creating diverging departure paths that will get aircraft off the ground and on course to their destination faster, and adding more direct high-altitude RNAV routes between two or more metroplexes, among others.

The OST effort is intended as a scoping function. The products of the OST will be used to scope future detailed design efforts and to inform FAA decision-making processes concerning commencement of those design efforts.

3 Atlanta OAPM Study Team Analysis Process

3.1 Five Step Process

The Atlanta OST followed a five step analysis process:

1. Collaboratively identify and characterize existing issues:
    a. Review current operations
    b. Solicit input to obtain an understanding of the broad view of operational challenges in the metroplex
2. Propose conceptual procedure designs and airspace changes that will address the issues and optimize the operation:
    a. Use an integrated airspace and PBN "toolbox"
    b. Obtain technical input from operational stakeholders
    c. Explore potential solutions to the identified issues
3. Identify expected benefit, quantitatively and qualitatively, of the conceptual designs:
    a. Assess the rough-order-of-magnitude impacts of conceptual designs
    b. To the extent possible, use objective and quantitative assessments
4. Identify considerations and risks associated with proposed changes. Describe, at a high-level, considerations (e.g., if additional feasibility assessments are needed) and/or risks (e.g., if waivers may be needed)
5. Document the results from the above steps

Steps 1 and 2 are worked collaboratively with local facilities and operators through a series of outreach meetings. Step 3 is supported by the OAPM National Analysis Team (NAT). The methodology used for the quantitative analysis is described in Section 3.4. The NAT is a centralized analysis and modeling capability that is responsible for data collection, visualization, analysis, simulation, and modeling. Step 4 is conducted with the support of the OAPM Specialized Expertise Cadre (SEC). The SEC provides "on-call" expertise from multiple FAA lines of business, including environmental, safety, airports, and specific programs (e.g., Traffic Management Advisor [TMA]).

The Atlanta OST process and schedule are shown below:

- Pre-coordination Meeting - ATL OAPM Informational Briefings
    - FAA Facility - Atlanta Air Traffic Control Tower (ATL ATCT) - June 21, 2011 (at ATL ATCT)
    - FAA Facility - Atlanta Approach Control (A80) - June 22, 2011 (at A80)
    - FAA Facility - Eastern Service Center (ESC) - June 22, 2011 (at ESC)

  - FAA Facility - Atlanta Air Route Traffic Control Center (ZTL) - June 23, 2011 (at ZTL)
- Kickoff Meeting
  - FAA Facility - ESC - August 3, 2011 (at ESC)
- Administrative week
  - MITRE - August 8-12, 2011 (at MITRE)
- First Outreach: Existing Operations and Planning
  - FAA Facility - ZTL - August 16-17, 2011 (at ZTL)
  - FAA Facility - A80 - August 17-18, 2011 (at A80)
  - FAA Facility - ATL ATCT - August 19, 2011 (at ATL ATCT)
  - Industry - August 23, 2011 (at Atlanta Airport Conference Center)
- Study Team work (focus on operational challenges)
- Second Outreach: Enhancement Opportunities
  - FAA Facilities - A80, ATL ATCT, and ZTL August 13-16, 2011 (at A80)
  - Industry - August 20, 2011 (at ESC)
- Study Team work (focus on solutions, costs, and benefits)
- Final Outreach: Summary of Recommendations
  - FAA Facilities - A80, ATL ATCT, and ZTL October 18, 2011 (at A80)
  - Industry - October 19, 2011 (at ESC)
- Documentation - Final report, briefing, and D&I Team package
  - November 10, 2011

There were three rounds of outreach to local facilities and industry stakeholders, including Department of Defense, airlines, business and general aviation, airports and others. The first outreach focused on issue identification, the second on conceptual solutions, and the third on summarizing the analyses of benefits, impacts and risks. Assessments at this stage in the OAPM process are expected to be high-level, as detailed specific designs (procedural and/or airspace) have not yet been developed. More detailed assessments of benefits, impacts, costs and risks are expected after the Design phase has been completed.

3.2 Atlanta Study Area Scope

The Atlanta Metroplex consists of airspace delegated to A80 and ZTL. Operations at The Hartsfield-Jackson Atlanta International Airport (ATL) within the lateral confines of A80's airspace were closely examined due to high density traffic flows in the airspace.

Other airport operations and issues were also examined, as appropriate, including Dekalb-Peachtree Airport (PDK), Fulton County Airport-Brown Field (FTY), Cobb County Airport-McCollum Field (RYY), Gwinnet County Airport-Briscoe Field (LZU), Columbus Metropolitan Airport (CSG), Middle Georgia Regional Airport (MCN), Dobbins Air Reserve Base (MGE), and Polk County Airport-Cornelius Moore Field (4A4). Nearby traffic flows to and from Charlotte/Douglas International Airport (CLT), Birmingham-Shuttlesworth International Airport (BHM), Charleston Air Force Base/International Airport (CHS), Savannah/Hilton Head International Airport (SAV), Nashville International Airport (BNA), Montgomery Regional Airport (Dannelly Field) (MGM), and Greenville Spartanburg International Airport (GSP) were also considered.

3.3 Assumptions and Constraints

OAPM is an optimized approach to integrated airspace and procedures projects; thus, the proposed solutions center on airspace redesign and PBN procedures. The OST is expected to document those issues that cannot or should not be addressed by airspace and procedures solutions, as these will be shared with other appropriate program offices. These issues are described in Sections 4.5.6 and 4.6 of this report.

The OAPM expedited timeline and focused scope bound airspace and procedures solutions to those that can be achieved without requiring an Environmental Impact Statement (EIS) (e.g., only requiring an Environmental Assessment [EA] or qualifying for a Categorical Exclusion [CATEX]) and within current infrastructure and operating criteria. OST results may also identify airspace and procedures solutions that do not fit within the environmental and criteria boundaries of an OAPM project. These other recommendations then become candidates for other integrated airspace and procedures efforts.

ATL is the only major airport in A80 airspace. The Atlanta Airport design incorporates five parallel east-west runways, two of which are designated as primary departure runways (Runways 8R/26L and 9L/27R), two as primary arrival runways (Runways 8L/26R and 9R/27L), and one as an offload runway for either departures or arrivals as demand dictates (Runway 10/28). Figure 1 depicts the primary departure runways with yellow arrows, the primary arrival runways with blue arrows, and the offload runway in green. This figure depicts a West Operation.[1] The departure and arrival runway configuration remains the same for an east operation. For modeling purposes throughout this report, the NAT quantitatively analyzed both East and West Operations for ATL. Historical data determined ATL operated on a West Operation 60 percent of the time and this percentage was used in the analysis.

[1] Aircraft arrive and depart to the west.

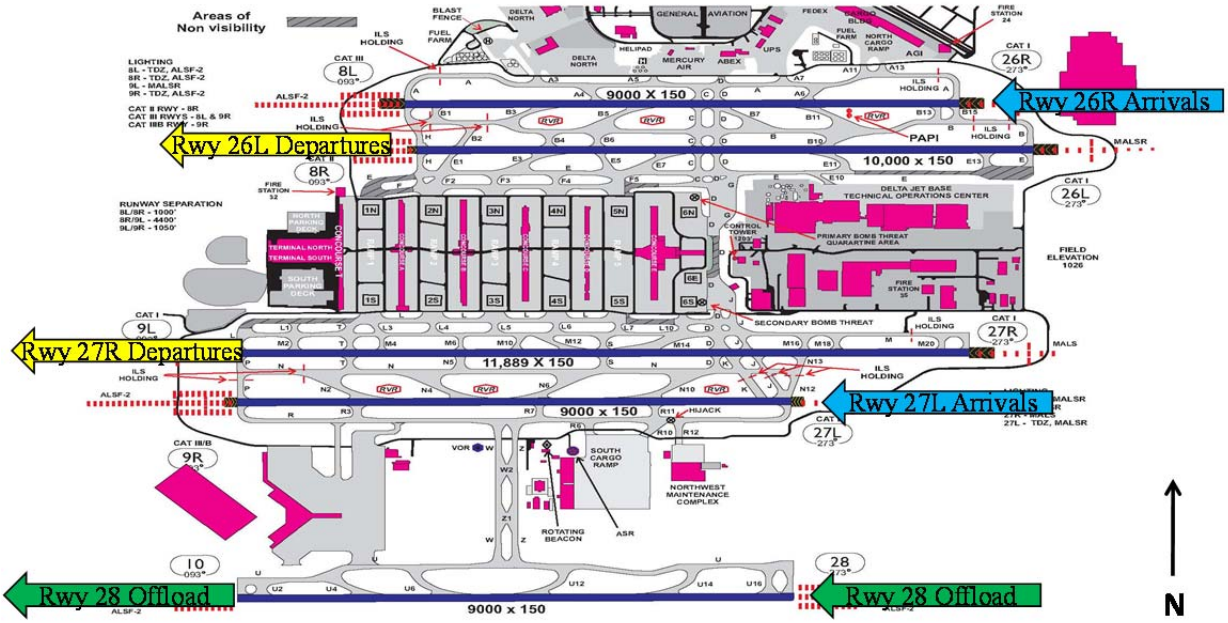

Figure 1. ATL Departure and Arrival Runways

3.4 Assessment Methodology

Both qualitative and quantitative assessments were made to gauge the potential benefits of proposed solutions.

The qualitative assessments are those that the OST could not measure but would result from the implementation of the proposed solution. These assessments included:

- Impact on air traffic control (ATC) task complexity
- Ability to apply procedural separation (e.g., laterally or vertically segregated flows)
- Ability to enhance safety
- Improved connectivity to en route structure
- Reduction in communications (cockpit and controller)
- Improved track predictability and repeatability
- Reduced reliance on ground-based navigational aids (NAVAIDs)

Task complexity, for example, can be lessened through the application of structured PBN procedures versus the use of radar vectors, but quantifying that impact is difficult. Reduced communications between pilot and controller, as well as reduced potential for operational errors, are examples of metrics associated with controller task complexity that were not quantified.

For the quantitative assessments, the OST relied on identifying changes in track lengths, flight times, and fuel burn. Most of these potential benefits were measured by comparing a baseline case with a proposed change using both fuel burn tables based on the European Organization for the Safety of Air Navigation (EUROCONTROL) Base of Aircraft Data (BADA) fuel burn model and a flight simulator, which was used to establish a relationship between simulator fuel burn results and BADA tables.

Equivalent Lateral Spacing Operation (ELSO) procedures were implemented at ATL on October 20, 2011. These procedures permit initial (immediately after departure) reduced divergence between aircraft established on RNAV Standard Instrument Departures (SIDs). The lateral paths of most RNAV SIDs were changed inside A80 airspace to accommodate ELSO procedures. However, the RNAV SID A80 exit waypoints and en route transitions remained the same. Since ELSO was implemented near the end of the ATL OAPM process, minimal data were available to determine baseline tracks for these procedures inside A80 airspace. The OST compared published ELSO procedures to the OST recommended solutions to identify quantitative benefits inside A80 airspace. Since ELSO procedures did not change lateral paths outside of A80 airspace, historical track data outside of A80 airspace were used to develop baseline procedures outside of A80 airspace. OST recommended solutions were compared to these baseline procedures outside of A80 airspace. ELSO procedures did not impact arrival procedures and baselines were created for all arrival procedures and compared to OST recommended solutions.

It was assumed that flights assigned direct radar vector routes today would continue to be provided that benefit in the future. The percentage of aircraft provided direct radar vector routes was determined by the evaluation of historical track data.

3.4.1 Track Data Selected for Analyses

During the study process, a representative set of radar traffic data was selected in order to maintain a standardized operational reference point.

For determining the number, length, and location of level-offs for the baseline of operational traffic, thirty high-volume days, operating under Visual Meteorological Conditions (VMC) between March 1, 2010 and November 12, 2010, were selected. Appendix A lists the VFR traffic days between March 1, 2010 and November 12, 2010 that were selected for the analysis of level-offs, en route transition sectors, mile-in-trail (MIT) restrictions, and traffic interactions. These days are all considered high-volume days, comprising 70th percentile or higher 14-hour traffic tracks to ATL.

In addition to the radar traffic data identified above, sample days were selected to analyze traffic flows during Instrument Meteorological Conditions (IMC). IMC traffic days were selected using Airport Specific Performance Metrics (ASPM) operational counts and weather data. Table 1 depicts the dates used for the analysis of traffic flows.

Table 1. TARGETS Track Data Analysis Dates

West Operation	
2010	2011
March 24, 2010 (VMC) April 23, 2010 (VMC)	March 31, 2011 (IMC)

East Operation	
2010	2011
April 12, 2010 (VMC) April 30, 2010 (VMC)	March 29, 2011 (IMC)

For these traffic days, historical radar track data was used to allow the OST to identify the flows and where short-cuts were routinely applied as well as where flight-planned routes were more rigorously followed. The track data was also used as a baseline for the development of several conceptual solutions including PBN routes and procedures. In many cases, the OST overlaid the historical radar tracks with PBN routes or procedures to minimize the risk of significant noise impact and an associated EIS.

3.4.2 Analysis Tools

The following tools were employed by the OST and the NAT in the process of studying the Atlanta Metroplex:

- **Performance Data Analysis and Reporting System (PDARS)**
  - Historical traffic flow analysis using merged datasets to analyze multi-facility operations (A80 and ZTL)
  - Customized reports to measure performance and air traffic operations (i.e., fix loading, hourly breakdowns, origin-destination counts, etc.)
  - Identification and analysis of level flight segments for A80 arrivals and departures
  - Graphical replays to understand and visualize air traffic operations
  - Verification of level segments in ZTL and A80 airspace
- **Terminal Area Route Generation Evaluation and Traffic Simulation (TARGETS)**
  - Comparison of historical track data to proposed routes when developing cost/benefit estimates
  - Conceptual airspace and procedure design
- **Integrated Terminal Research, Analysis, and Evaluation Capabilities (iTRAEC)**
  - Identification of location, altitude and magnitude of level-off segments

- **Air Traffic Airspace Lab (ATALAB) National Offload Program (NOP) data queries**
  - Quantification of traffic demand over time for specific segments of airspace
  - Identification of runway usage over time
- **National Traffic Management Log (NTML)**
  - Identification of occurrence and magnitude of TMIs
- **Enhanced Traffic Management System (ETMS)**
  - Traffic counts by aircraft group categories for annualizing benefits
  - Examination of filed flight plans to determine impact of significant re-routes

3.4.3 Determining the Number of Operations and Modeled Fleet Mix

Due to the compressed schedule associated with this study effort, there was not sufficient time to model the entire Atlanta Metroplex fleet mix. As a result, a representative fleet mix was developed, consisting of the primary aircraft types that service ATL. The number of arrivals and departures by aircraft type was determined by examining one calendar year (2010) of PDARS data. The categories were normalized to take into account the approximately three percent of aircraft that did not fit into one of the four categories. It was assumed that the aircraft that did not fit into a category would fit into one of the four defined aircraft categories. The ATL fleet mix analysis is shown in Table 2.

Table 2. ATL Fleet Mix Analysis

ATL Fleet Mix Analysis (January 1 - December 31, 2010)		
Total Turbojet Operations - 913,740		
	Yearly Counts	% of Jet Types
Total # CRJX (includes CRJ2/7/9, E145/190)	365,496	40%
Total # B73X (includes all B73X series, B75X series, A319/320, B717)	274,122	30%
Total # MD8X (includes all MD8X and MD9X series and DC9)	182,748	20%
Total # B76X (includes all heavy jets)	91,374	10%

3.4.4 Determining Percent of RNAV Capable Operations by Airport

The principal objective of the Atlanta OST was to identify operational issues and propose PBN procedures and airspace modifications in order to address them. The PBN Dashboard was used to determine the percent of operations at each airport that would benefit from these new procedures. The PBN Dashboard is an online tool that reports this percentage through analysis of two sources: the equipment suffix of instrument flight rules (IFR) flight planned operations from ETMS and the percentage of PBN-equipped aircraft by type from a Part 121 avionics database maintained by The MITRE Corporation's Center for Advanced Aviation System Development (CAASD). At ATL, 97 percent of all aircraft were RNAV equipped in 2010.

3.4.5 Profile Analyses

To determine the current location and extent of arrival level-offs in the Atlanta Metroplex, the OST examined the selected track data. Using CAASD's iTRAEC toolset, the OST identified the altitudes where level-offs occurred and their average length in nautical miles (NM). The OST also used TARGETS to compare the length of proposed routes to the published routes and historical track data. The reduction in level segments and the distance savings were then converted into fuel savings through application of the BADA fuel flow model, taking into account the modeled aircraft fleet mixes at the metroplex airports. The fuel savings were then annualized, assuming a fuel price per gallon of $2.92 based on fuel costs for July 2011 from Research and Innovative Technology Administration (RITA) Bureau of Transportation Statistics. The resulting numbers were used as the basis for the minimum potential fuel benefit contained in this report.

During the Washington D.C. Metroplex Prototype Study Team effort, US Airways conducted fuel burn analyses using an A320 flight simulator comparing an existing arrival with a proposed optimized procedure. Values for fuel burn per minute in level flight, idle descent, and geometric descent were determined. This allowed comparison of the static BADA aircraft performance numbers with simulator performance that included pilot intervention. The results of the flight simulator runs were extrapolated by the Prototype Study Team and applied to the BADA results to represent a maximum potential fuel burn benefit. The Atlanta OST applied this same methodology to the BADA results in order to determine a maximum fuel burn savings per flight. It should be noted that early simulator runs of notional Houston procedures in a Continental Airlines Boeing 737-800 flight simulator showed a similar relationship between the conservative BADA-based estimates and the simulator results. Applying both the BADA and flight simulator methods provides for a range of potential benefits:

- Lower bound potential benefit: BADA speed/fuel burn
- Upper bound potential benefit: Flight simulation speed/fuel burn

3.4.6 Cost to Carry

Aircraft fuel loading is based on the planned flight distance, and planning for additional air miles requires extra fuel loading. This is known as the cost to carry (CTC). CTC can vary widely among airlines, generally ranging from about 2 to 15 percent of the total fuel load. For this

analysis, CTC was assumed to be 10 percent, based on input from OST industry representatives. CTC is included in all of the fuel burn estimates presented in this report, reflecting the benefits of developing procedures that more closely align with existing aircraft flight paths.

3.4.7 Benefits Metrics

The benefits metrics were generated using the following process:

1. The radar track data from the 30 high-traffic days were parsed into flows into and out of Atlanta. These flows were then analyzed to determine geographic location, altitude, and length of level-offs in the airspace. The average overall track flow length was also estimated.
2. Arrival baseline routes were developed using the average vertical and lateral path of the tracks in the flows. Departure baseline routes were developed using only lateral path since no vertical restrictions were identified in the track data.
3. Proposed conceptual routes were designed by the OST. Departure proposed conceptual routes were designed considering ELSO procedures that were implemented at ATL on October 20, 2011 (refer to Section 3.4 for more information on ELSO procedures).
4. The impacts of the proposed conceptual routes were estimated as compared to the current published procedure for the flow, if any, and the baseline route.
    a. Vertical savings: For Arrivals only, the *baseline* vertical path with its associated level-offs was compared with the *proposed* vertical path, which ideally has fewer and/or shorter level-offs.
    b. Lateral filed miles savings: Compare the length of the *published* procedure to the length of the *proposed* procedure.
    c. Lateral distance savings: Compare the length of the *baseline* procedure to the length of the *proposed* procedure.
5. The fuel and cost savings were then estimated based on the above impacts.
    a. Vertical profile savings accrue fuel savings for *arrivals only*.
    b. Lateral *filed* miles savings accrue CTC savings only.
    c. Lateral *distance* savings accrue fuel savings.

Figure 2 shows published, baseline, and proposed routes for a flow, with the comparisons for lateral savings highlighted, and sample vertical profiles as well.

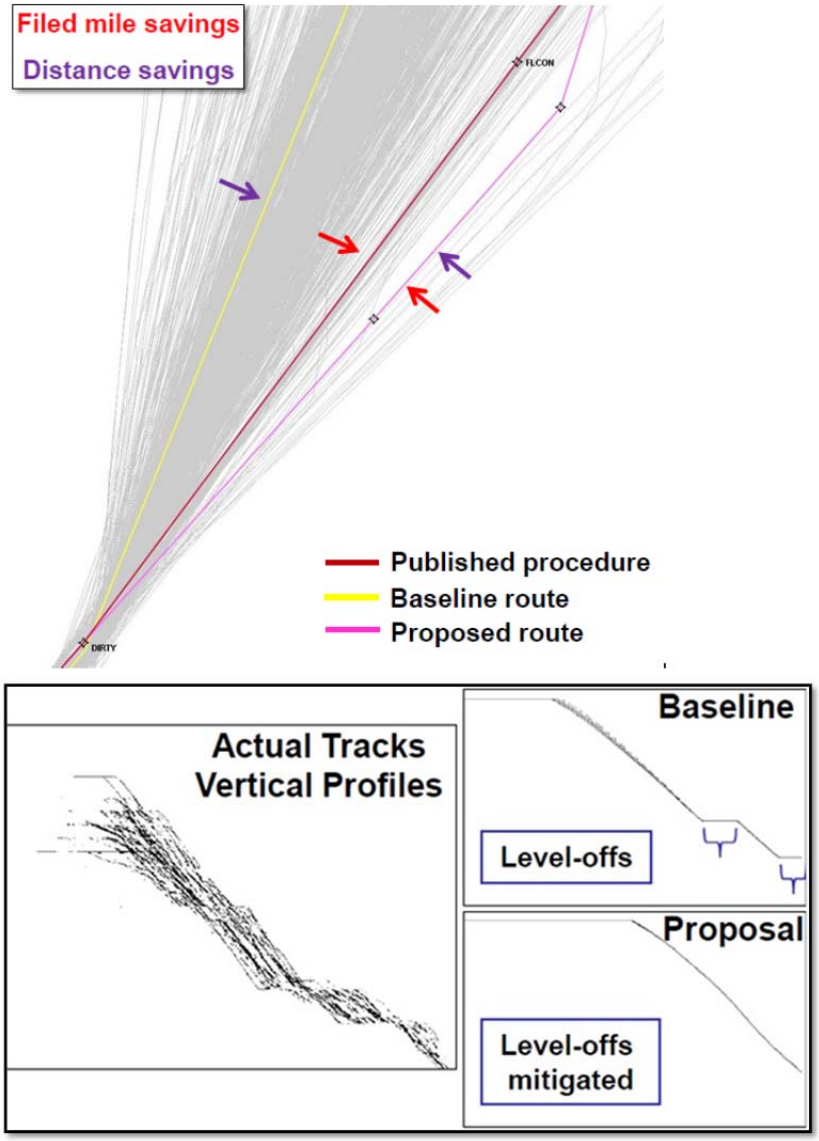

Figure 2. Sample Analysis: Lateral and Vertical Baseline

3.5 Key Considerations for Evaluation of Impacts and Risks

In addition to the quantitative and qualitative benefits assessments described in Section 3.4, the Atlanta OST was tasked to identify the impacts and risks from the FAA operational and safety perspective as well as from the airspace user perspective. The departure impacts and risks are summarized in Section 4.1.7 and the arrival impacts and risks are summarized in Section 4.2.7. However, there are a number of impacts and risks that generally apply to many proposed solutions, as described below.

- Controller and Pilot Training – With the increased focus on PBN and the proposed changes in airspace and procedures, controller and pilot training will be a key consideration for nearly all proposals.
- "Descend Via" Procedure Issues – The proposed use of "descend via" clearances will similarly require controller and pilot training, and agreement must be reached during D&I on exactly how procedures will be requested, assigned, and utilized from both the FAA and stakeholder perspectives.
- Aircraft Equipage – There are challenges with working in a mixed equipage environment, and these risks must be considered during D&I. While procedures have been designed to take advantage of PBN efficiencies, procedures and processes must be developed for conventional operations as well.
- Safety Risk Management (SRM) – Safety is always the primary concern, and all of the proposed solutions will require a SRM assessment, which will occur during the Evaluation Phase of D&I.
- TMA Issues – Optimized Profile Descents (OPDs) are relatively new with regard to Traffic Management tools and there are no definitive standards on how many miles are required from a common altitude to begin an OPD and still maintain standard separation all the way to the runway. Current TMA technology does not provide a seamless merge of dual arrival flows from a common corner post or multiple flows in the approach environment to the finite degree needed to allow aircraft to take full advantage of an OPD. Discussion with the National TMA/Time Based Flow Management (TBFM) Operations Team has advised that no future enhancements of TMA/TBFM will address the OST and Facility concerns over the next few years.

  Reduction in throughput is another area of concern. Vectoring and speed control are tools currently used to maximize capacity. Until an effective TMA product can be developed that will accommodate these tools or remove the need for their use, controllers must be allowed to stop aircraft descents for separation, vector aircraft for spacing and merging, and apply speed control.

  There is also no common standard from facility to facility on how TBFM is configured and there is no requirement for all facilities nationwide to Adjacent Center Meter (ACM) for surrounding facilities. Difficulties arise when facilities must blend metered aircraft with aircraft that are delivered with a mile-in-trail requirement. This blending reduces the fidelity of the tool and increases track miles and fuel burn.
- Environmental Issues – All proposed solutions are subject to environmental review, and the OAPM schedule limits that review to a CATEX or EA rather than an EIS. The OST worked with environmental specialists to determine whether any of the proposed solutions has the potential for significant environmental impacts, and developed mitigation alternatives if necessary.

4 Identified Issues and Recommended Solutions

This section presents the findings and results of the Atlanta OST analysis. It reviews identified issues, recommended solutions and alternatives, benefits/impacts/risks, and analysis results. During the first industry and facility interface meetings, over 40 issues were identified by A80, ATL ATCT, ZTL, and industry stakeholders. Twenty two issues were identified by ZTL, eight by A80, seven by ATL ATCT, and six issues by the various industry stakeholders. Similar issues were raised by all stakeholders, and the issues were consolidated and categorized by the OST to determine potential solutions:

- ATL and Satellite Airport Departures (see Section 4.1)
- ATL and Satellite Airport Arrivals (see Section 4.2)
- ATL ATCT Issues (see Section 4.3)
- T-Routes (see Section 4.4)
- Airspace Issues (see Section 4.5)

Some issues required additional coordination and input and could not be addressed within the time constraints of the OST process. These issues may be explored further during the D&I process or outside of OAPM, and include the following (see Sections 4.5.6 and 4.6):

- Speed restrictions on ATL and satellite airport departures
- Turbojet and turboprop aircraft departing A80 airspace to East Coast airports (landing at, or located south of SAV) are currently routed via A80 south departure gates. Vectoring aircraft to these departure gates from the northern Atlanta satellite airports (primarily LZU) can lead to circuitous routings and extended low level segments.
- Means of increasing departure rates on a single departure track
- Delta Air Lines ramp turn-arounds
- Difficulty in Tower sequencing for flow management windows

4.1 Atlanta and Satellite Airport Departures

RNAV departure procedures have been conducted at ATL since 2005. There are 16 RNAV SIDs, four in each cardinal direction, and eligible aircraft fly RNAV off the ground SIDs in a dual runway departure configuration. During triple runway departure operations, aircraft fly a combination of either initial vectors as assigned by controllers or RNAV off the ground procedures. ELSO procedures, which permit reduced (less than 15 degrees) divergence between aircraft on the same or parallel runways and eliminate the requirement to assign initial vectors during triple runway departure operations, were implemented on October 20, 2011. The published ELSO procedures served as a baseline for comparison to the OST initial concepts.

The ATL RNAV SIDs are highly efficient and ELSO procedures are designed to increase this efficiency. The OST found departure level-offs to be minimal. The existing efficiencies of the

ATL departures limited the OST's ability to design new procedures with any additional quantitative benefits. Additionally, the impact of CLT arrival and departure traffic on ATL eastbound departure traffic had to be considered. To enable increased ATL departure benefits, the OST proposed the following applications:

- Reducing divergence to less than 15 degrees at the final A80 divergence waypoint for downwind departures, which permits more direct routing to the A80 exit waypoints
- Creating independent SIDs where beneficial, while maintaining a minimum of seven NM between all A80 exit waypoints
- Optimizing en route transitions to enable procedural de-confliction and reduce interaction between adjacent facilities/sectors whenever possible.

Currently SIDs do not exist for aircraft departing from Atlanta satellite airports. These aircraft are vectored on routes that emulate the ATL RNAV SIDs. The OST designed satellite airport RNAV SIDs for each cardinal direction that complement the ATL RNAV SIDs and proposed that these SIDs initially be implemented at satellite airports with operating control towers. Alternative satellite airport SID proposals were created to address additional methods for transitioning aircraft over the top of ATL.

4.1.1 ATL North Departures

This section describes the operational issues, recommendations, and expected benefits the OST has identified for departures from ATL to the north.

4.1.1.1 ATL North Departures – Issues, Recommended Solutions and Benefits

Issue

- Excess track miles inside A80 airspace: The OST identified opportunities to reduce track miles on published procedures within 40 NM of ATL.

Recommendations

- Redesign all four of the north RNAV SIDS (COKEM, CADIT, NUGGT, SUMMT) for ATL departures on a West Operation to reduce track miles flown and further align routes to match tracks flown.
  - The OST COKEM SID design may create opposite direction courses, instead of the current crossing courses, with respect to ATL northwest arrivals. This design could inhibit the climb of COKEM departures. The D&I team will further investigate the impact of this design.
- Ensure that 15 degrees of departure separation is maintained at ZELAN waypoint. Intermediate fixes on the COKEM and SUMMT departures are used to ensure divergence.

Figures 3 and 4 depict the current and proposed ATL north SIDs (West Operation).

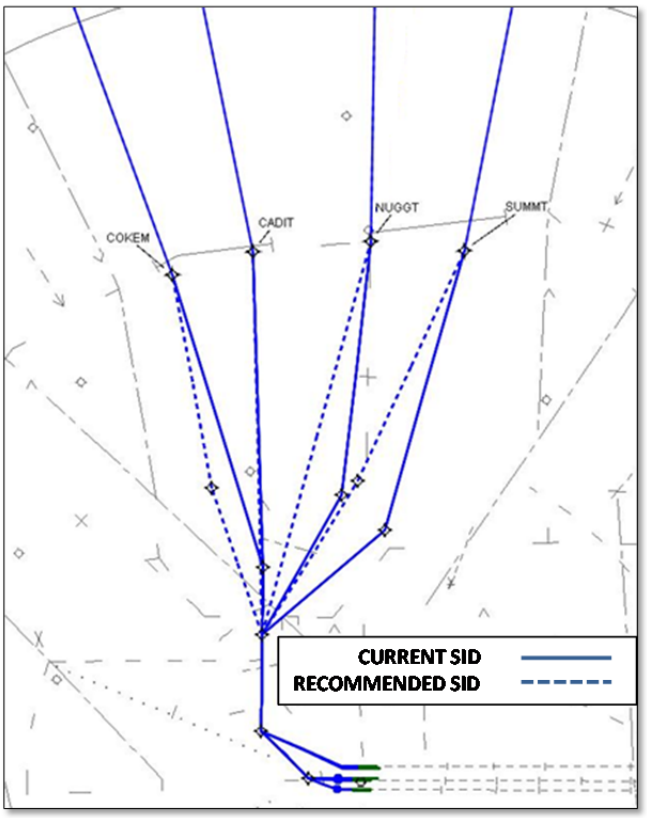

Figure 3. Current and Proposed ATL North Departures (West Operation)

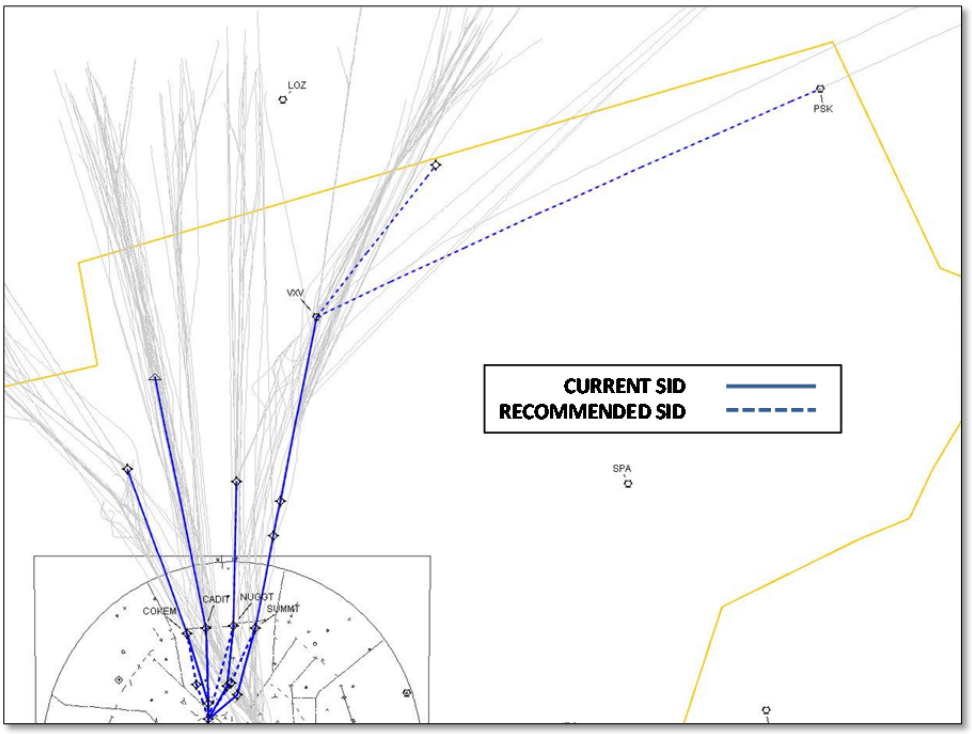

Figure 4. Current and Proposed ATL North Departures
En Route Transitions

Benefits

- Table 3 shows the estimated annual benefits of the proposed ATL north SIDs relative to the existing ATL north SIDs. The enhancements result in annual fuel savings and corresponding reductions in carbon emissions. Initial environmental screening indicates minimal risk of significant noise impacts.

Table 3. ATL North Departures – Estimated Annual Benefits

North Departures			
		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$169K	169K
	Profile	N/A	N/A
	Cost to Carry	$12K	$12K
Total Estimated Fuel Savings	Annual (Dollars)	$181K	$181K
Total Estimated Fuel Savings	Annual (Gallons)	62K	62K
Total Estimated Carbon Savings	Annual (Metric Tons)	1K	1K

4.1.1.2 ATL North Departures – Alternative Solution

Discussion during Facility Outreach meetings identified an issue with the high volume of traffic on the SUMMT RNAV SID. The facility suggested, and the OST investigated, a recommendation to design a parallel route using the NUGGT RNAV SID. The OST identified an opportunity to equitably split the existing traffic over Henderson VORTAC (HNN) in Indianapolis Air Route Traffic Control Center (ZID) airspace. Figure 5 depicts the alternative NUGGT SID transition and includes proposed transitions on the SUMMT SID. The red tracks in Figure 6 depict SUMMT SID traffic that would remain on the SUMMT SID in the alternative solution and the blue tracks show traffic that currently is on the SUMMT SID that could be routed on the alternative NUGGT SID transition. Initial discussions with ZID showed they were open to dual routings near HNN.

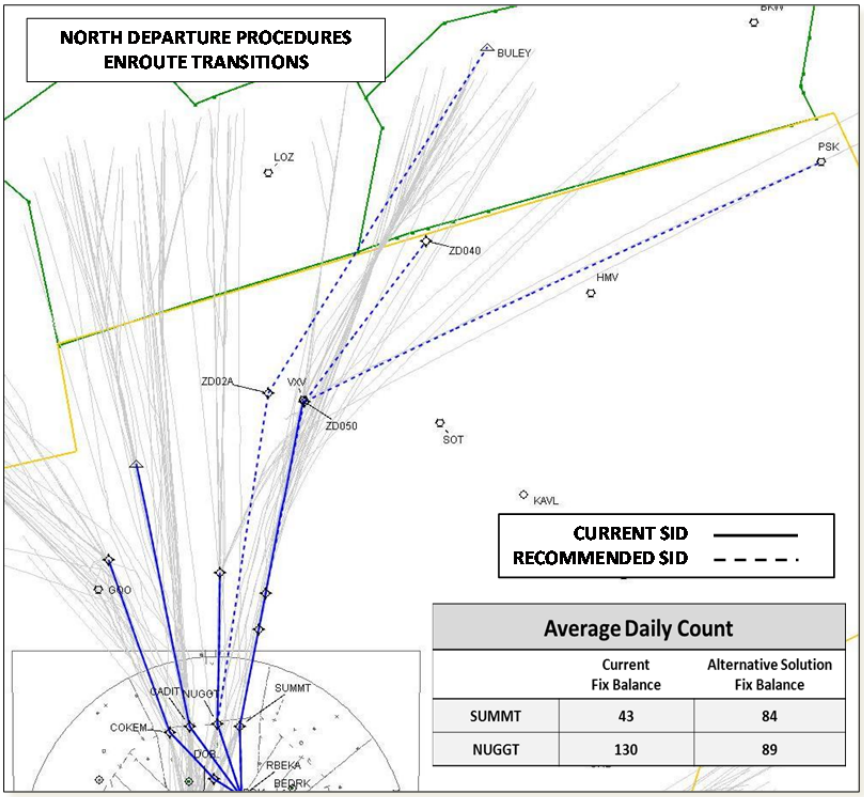

Figure 5. ATL North Departures – Alternative Solution

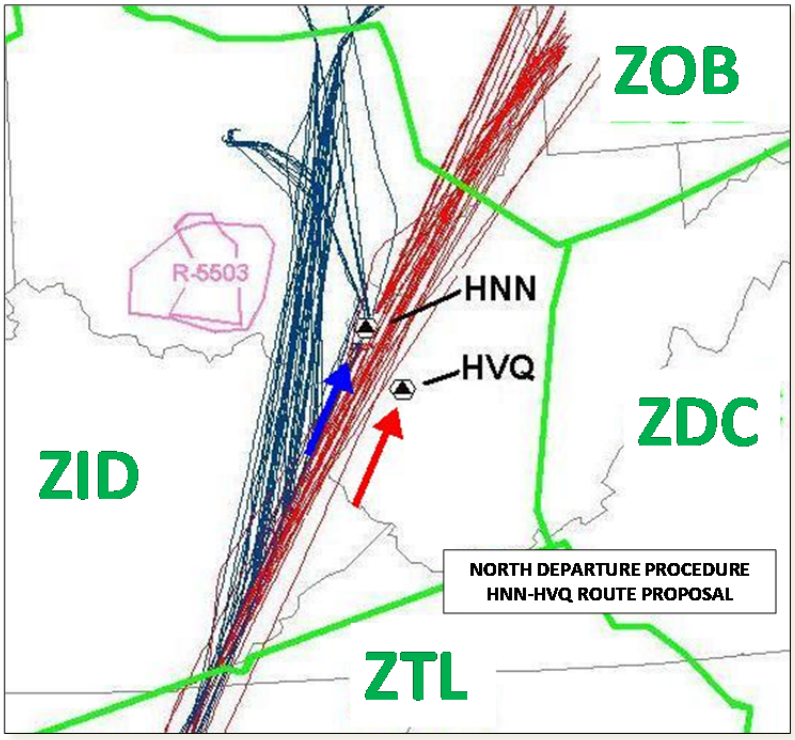

Figure 6. Traffic Flows over HNN

Initial designs incorporated the parallel routings to the north, however, the resulting distance increase of approximately six NM (East Operation), which resulted in an annual increase of over three hundred thousand dollars in fuel burn, prevented the OST from recommending this solution. Further investigation in ZID airspace by the D&I team may result in an overall mileage reduction between city pairs.

4.1.2 ATL East Departures

This section describes the operational issues, recommendations, and expected benefits the OST has identified for departures from ATL to the east.

Issues

- Lack of lateral separation between BGRED CLT traffic and DAWGS and UGAAA traffic: The BGRED transition on the DEBIE RNAV SID (CLT) is 5.1 NM from the ATL DAWGS and UGAAA RNAV SIDS. These closely spaced, opposite direction procedures create numerous traffic alerts for aircraft flying the routes. These traffic alerts increase task complexity for both controllers and pilots.
- Excess track miles inside A80 airspace: The OST identified opportunities to reduce track miles on published procedures within 40 NM of ATL.

Recommendations

- Relocate DAWGS, UGAAA, and DOOLY waypoints to increase lateral distance between these waypoints, and increase the distance between the DAWGS and UGAAA SIDs and the BGRED transition. This reduces the interaction between the routes and related traffic alerts. Figure 7 depicts current and proposed ATL east SIDs.
- Use DOOLY SID exclusively for traffic landing at CLT and GSP to accommodate future CLT OST designs.
- Create a new transition on the UGAAA SID in ZTL airspace that joins J208 at GLOVR intersection and J209 at DARYL intersection. This reduces track miles flown, and operationally de-conflicts CLT arrivals routed over the Atlanta VORTAC and ATL departures filing J209.
- Establish direct routings for downwind departures from HYZMN and KLEGG waypoints to the A80 exit waypoints. A80 determined there was no need for 15 degrees of divergence at the HYZMN and KLEGG waypoints. This resulted in a design that reduces track miles flown and aligns routes to match tracks flown.
- Figures 8 and 9 depict the current and proposed ATL east SIDs for West and East Operations.

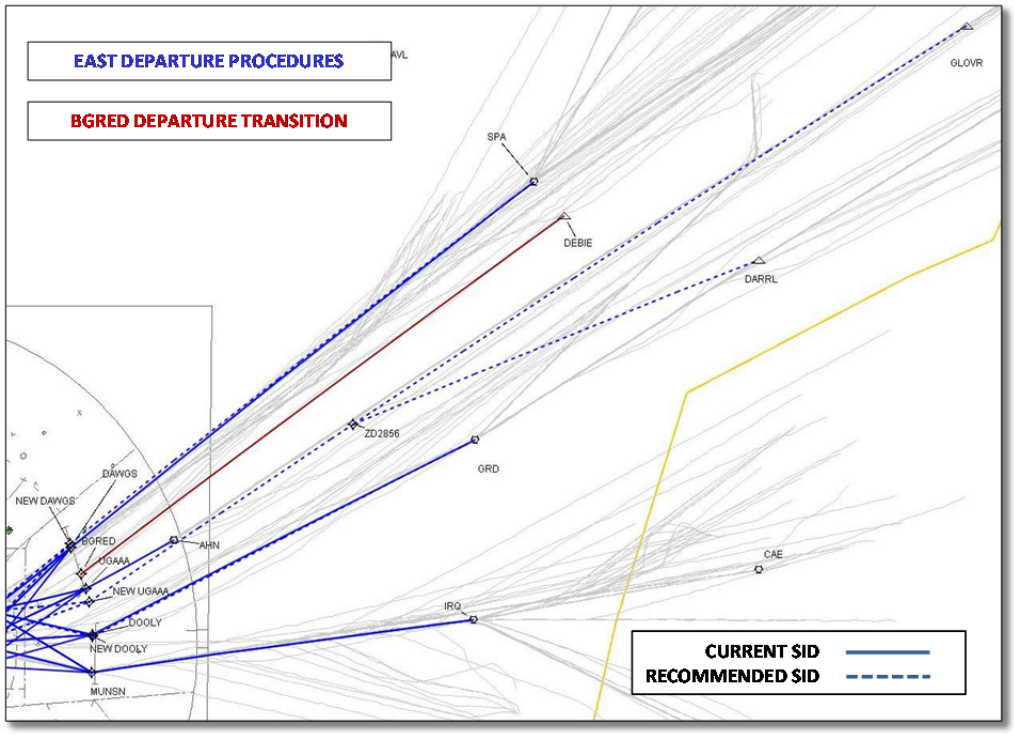

Figure 7. ATL East Departures and CLT BGRED Transition Interaction

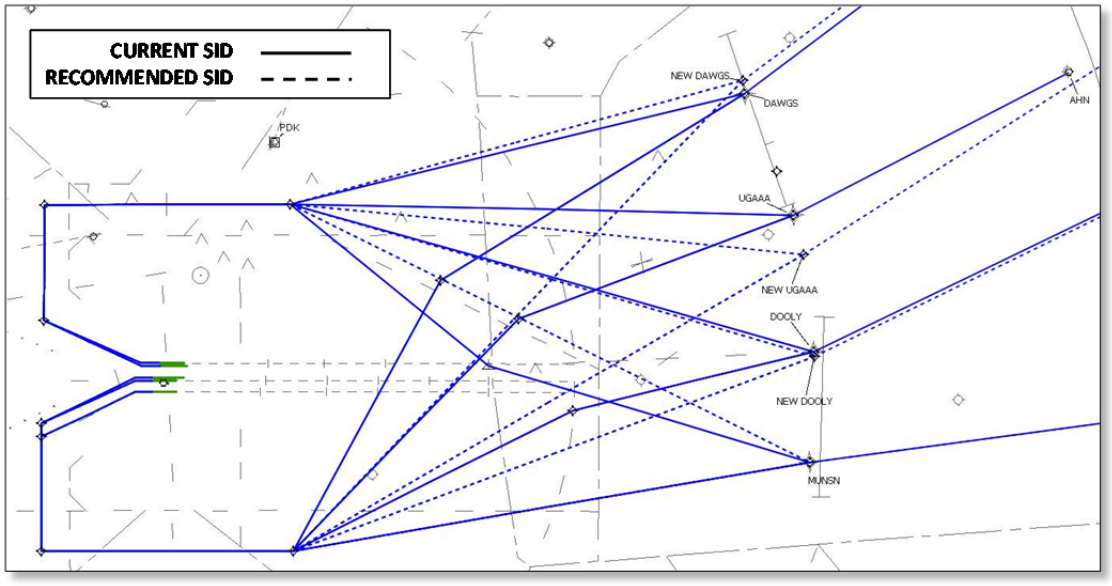

Figure 8. Current and Proposed ATL East Departures (West Operation)

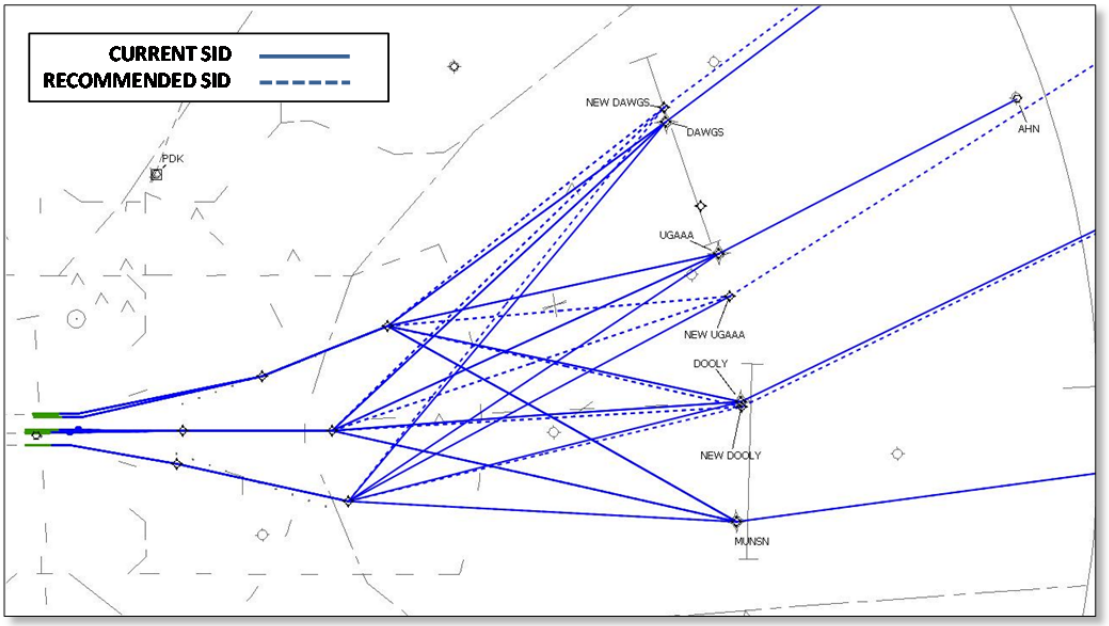

Figure 9. Current and Proposed ATL East Departures (East Operation)

Benefits

- Table 4 shows the estimated annual benefits of the proposed ATL east SIDs relative to the existing ATL east SIDs. The enhancements result in annual fuel savings and corresponding reductions in carbon emissions. Initial environmental screening indicates minimal risk of significant noise impacts.

Table 4. ATL East Departures – Estimated Annual Benefits

East Departures			
		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$294K	$294K
	Profile	N/A	N/A
	Cost to Carry	$31K	$31K
Total Estimated Annual Fuel Savings (Dollars)		$325K	$325K
Total Estimated Annual Fuel Savings (Gallons)		112K	112K
Total Estimated Annual Carbon Savings (Metric Tons)		1K	1K

4.1.3 ATL South Departures

This section describes the operational issues, recommendations, and expected benefits the OST has identified for departures from ATL to the south.

Issues

- NOVSS/THRSR SIDs are not independent routes: The current Letter of Agreement (LOA) between A80 and ZTL requires that these two fixes be treated as a single exit fix, thereby requiring a minimum of 7 NM between successive departures. This limits tower flexibility when queuing departures and when fix balancing during triple departure runway configurations.

Recommendations

- Relocate NOVSS waypoint to the west in order to create independent SIDS over THRSR and the new NOVSS waypoints.
- Figures 10 and 11 depict the current and proposed ATL south SIDs for West and East Operations.
- Figure 12 depicts the en route transitions for the ATL south SIDs.

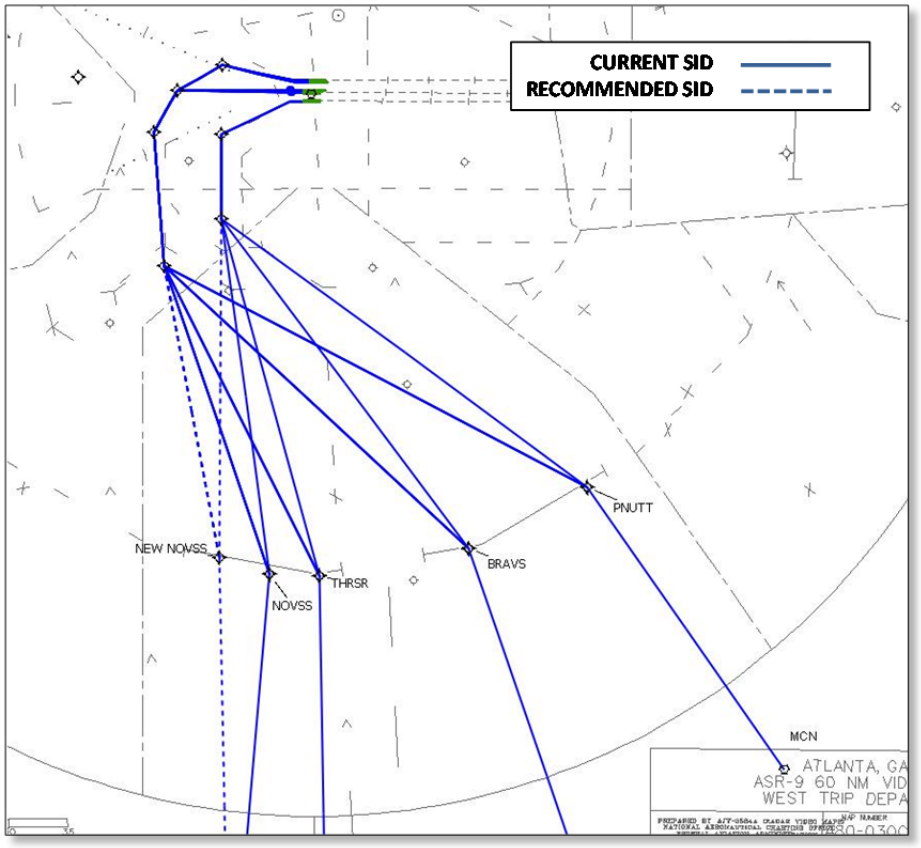

Figure 10. Current and Proposed ATL South Departures (West Operation)

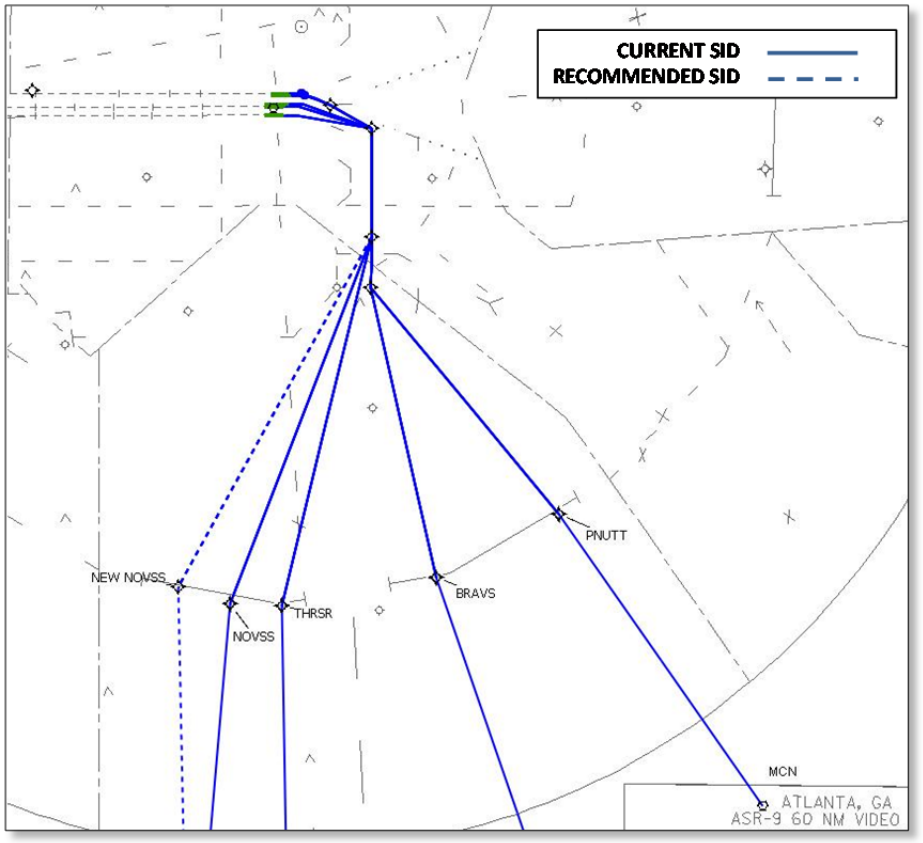

Figure 11. Current and Proposed ATL South Departures (East Operation)

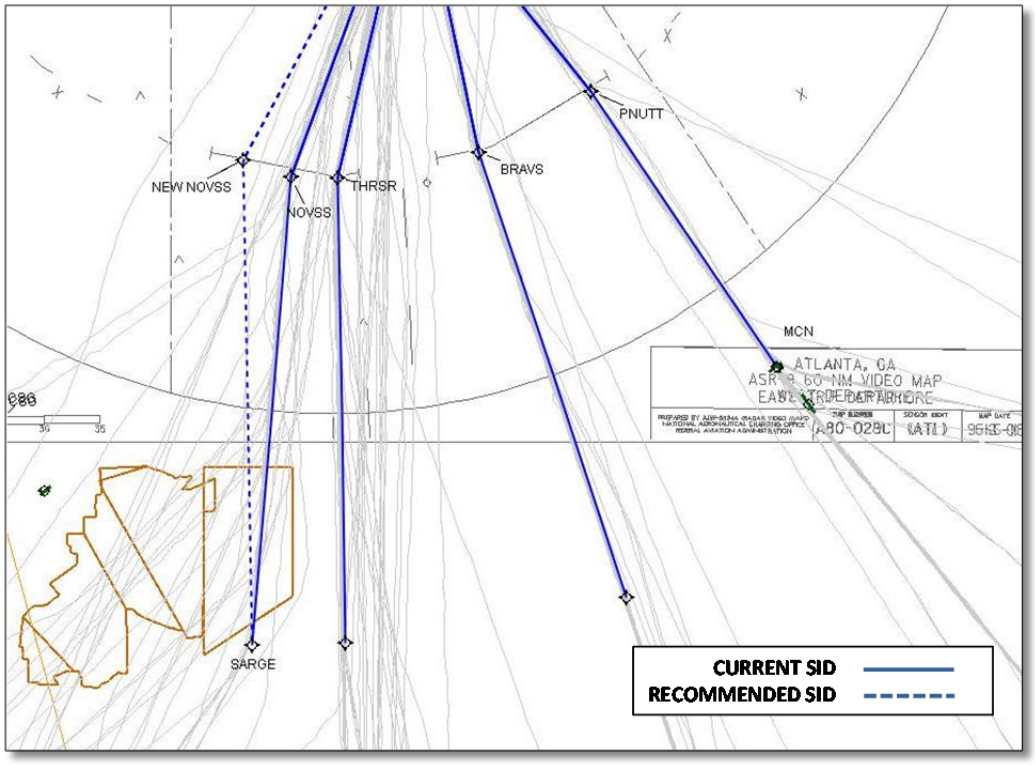

Figure 12. Current and Proposed ATL South Departures En Route Transitions

Benefits

- Table 5 shows the estimated annual costs of the proposed ATL south SIDs relative to the existing ATL south SIDs. The changes result in an estimated annual increase in fuel and corresponding increases in carbon emissions. The distance dis-benefit should be offset by the addition of an independent SID. ATL ATCT must no longer treat these two SIDs as a single route which enhances queuing opportunities and reduces miles in trail requirements for aircraft on these SIDs. The additional route enables more efficient fix balancing during triple departure runway operations. Initial environmental screening indicates minimal risk of significant noise impacts.

Table 5. ATL South Departures – Estimated Annual Benefits

South Departures			
		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	($4K)	($4K)
	Profile	N/A	N/A
	Cost to Carry	0	0
Total Estimated Annual Fuel Savings (Dollars)		($4K)	($4K)
Total Estimated Annual Fuel Savings (Gallons)		(1K)	(1K)
Total Estimated Annual Carbon Savings (Metric Tons)		0	0

4.1.4 ATL West Departures

This section describes the operational issues, recommendations, and expected benefits the OST has identified for departures from ATL to the west.

Issues

- JCKTS/JOGOR SIDs are not independent routes. The current LOA between A80 and ZTL stipulates that these two exit fixes must be treated as a single exit fix, thereby requiring a minimum of 7 NM between successive departures. This limits ATL ATCT flexibility when queuing departures and when fix balancing during triple departure runway configurations.
- Transitions in ZTL airspace are not laterally optimized: Some en route transitions can be shortened, allowing aircraft to file direct routes.
- Excess track miles inside A80 airspace: The OST identified opportunities to reduce track miles on published procedures within 40 NM of ATL.

Recommendations

- Create a new GEETK SID transition in ZTL airspace that joins J41 at LOBBS intersection and J14 at YAALL intersection, reducing track miles flown. D&I may be able to terminate GEETK SID at waypoint ZD2359 (OST designed waypoint) with direct routings afterward.

- Establish direct routings for downwind departures from ZALLE and ZELAN waypoints to the A80 exit waypoints. A80 determined there was no need for 15 degrees of divergence at ZALLE and ZELAN waypoints.
- Terminate RMBLN SID at HANKO intersection to facilitate earlier direct routing.
- Relocate JCKTS waypoint to the north and JOGOR waypoint to the south in order to create independent SIDs over the new JCKTS and JOGOR waypoints.
- Terminate JCKTS SID at a waypoint east of JAMMR intersection to facilitate earlier direct routing.
- Extend JOGOR SID to resolve ZTL arrival and departure sector issues. Current ATL arrival traffic over the Meridian VORTAC (MEI) and Greene County VORTAC (GCV) are either descended early or leveled-off to facilitate direct routings for departure traffic over the JOGOR SID. This restricts arrivals from remaining at optimal top of descent (TOD) altitudes and flying the most economical descent profile. Additionally, confusing ZTL Automated Information Transfer AIT procedures promote inefficiency and increase controller task complexity.
- Figures 13 and 14 depict the current and proposed ATL west SIDs for West and East Operations.
- Figure 15 depicts the recommended en route transitions for the ATL west SIDs.

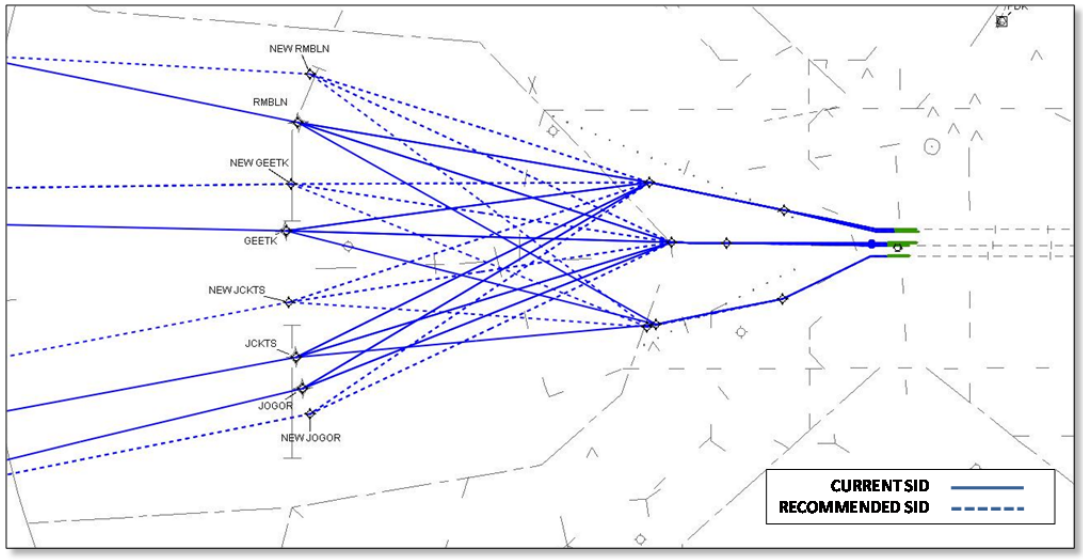

Figure 13. Current and Proposed ATL West Departures (West Operation)

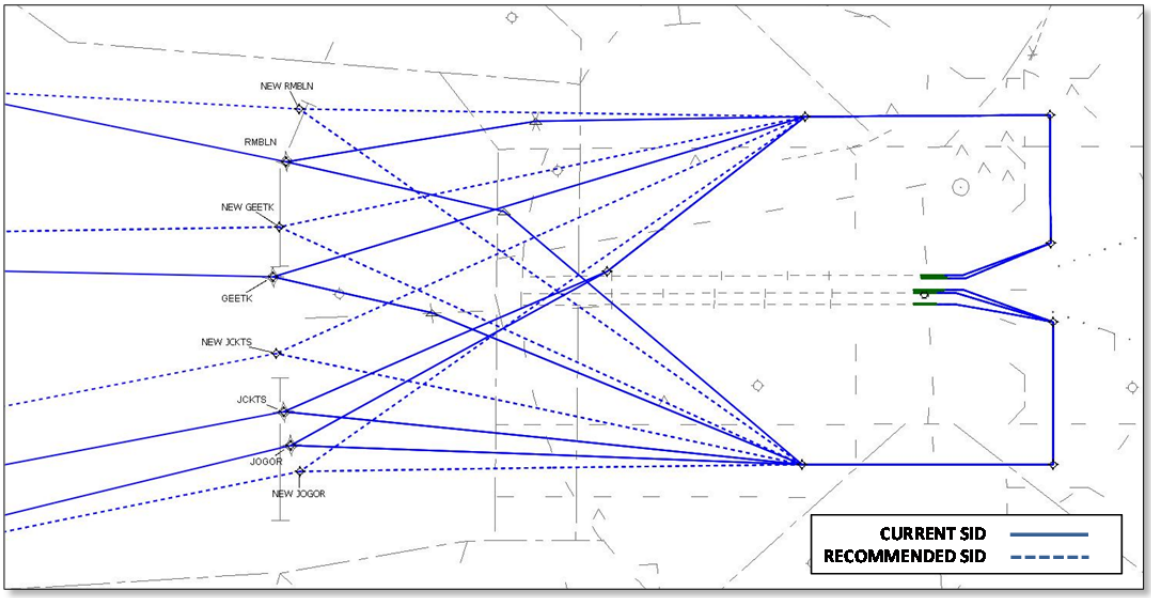

Figure 14. Current and Proposed ATL West Departures (East Operation)

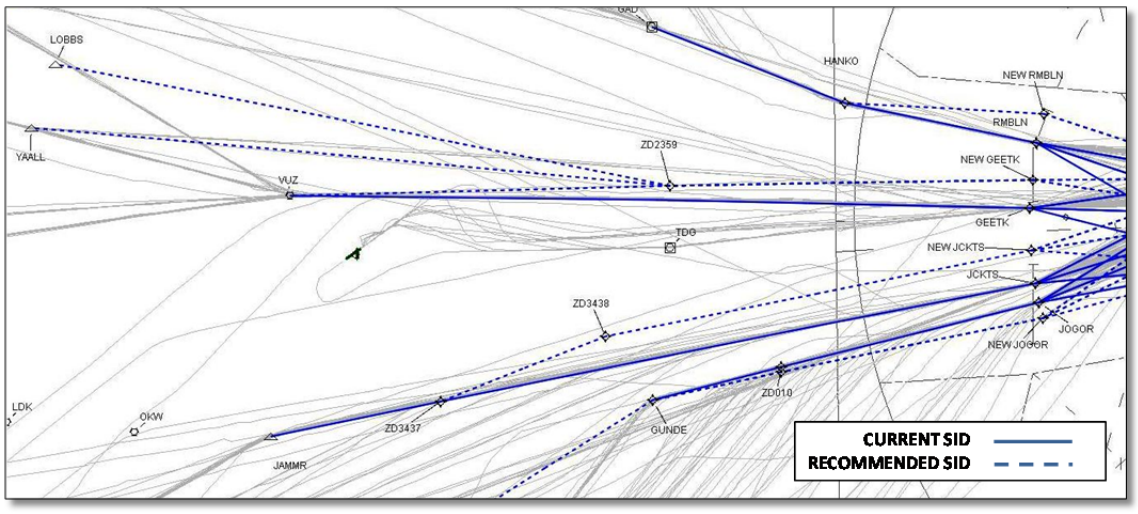

Figure 15. Current and Proposed ATL West Departures En Route Transitions

Benefits

- Table 6 shows the estimated annual benefits of the proposed ATL west SIDs relative to the existing ATL west SIDs. The enhancements result in annual fuel savings and corresponding reductions in carbon emissions. Initial environmental screening indicates minimal risk of significant noise impacts.

Table 6. ATL West Departures – Estimated Annual Benefits

West Departures			
		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$171K	$171K
	Profile	N/A	N/A
	Cost to Carry	$23K	$23K
Total Estimated Annual Fuel Savings (Dollars)		$194K	$194K
Total Estimated Annual Fuel Savings (Gallons)		67K	67K
Total Estimated Annual Carbon Savings (Metric Tons)		1K	1K

4.1.5 Summary of ATL Departure Benefits

In general, the current ATL SIDs are very efficient procedures. RNAV SIDs were introduced in 2005 and numerous updates have been initiated to optimize the SIDs. The established method of determining a baseline for SID performance was not used for A80 airspace due to the implementation of ELSO procedures on October 20, 2011. The OST used the published ELSO SIDs as a baseline within A80 airspace, as opposed to using historical track data, which is the normal method of determining baselines. The ELSO SIDs exit A80 airspace at the current SID exit waypoints, which permitted the OST to use historical track data flown for a baseline outside A80 airspace.

SID benefits are obtained from the following changes:

- Moving A80 SID exit waypoints. This allowed for the creation of two additional independent SIDs and additional direct en route transitions from these waypoints,
- Eliminating 15 degree divergence at the A80 divergence waypoint for downwind departures. This allowed for direct routing from these divergence waypoints to the A80 exit waypoints,
- Optimizing en route transitions to reduce track miles flown.

Additional track mileage was added to some of the SIDs due to the relocation of the A80 exit waypoints. However, this enables procedural de-confliction by reducing interactions between adjacent facilities/sectors which increases the overall efficiency of the operation.

Table 7 depicts the estimated benefits by cardinal direction for ATL departures. Additional qualitative benefits are anticipated in the south and west departure areas due to the creation of independent SIDs. These independent SIDs will provide added flexibility when queuing departures and balancing runway demand.

Table 7. ATL Departures – Estimated Annual Benefits

All Departures			
		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$630K	$630K
	Profile	N/A	N/A
	Cost to Carry	$66K	$66K
Total Estimated Annual Fuel Savings (Dollars)		$696K	$696K
Total Estimated Annual Fuel Savings (Gallons)		240K	240K
Total Estimated Annual Carbon Savings (Metric Tons)		3K	3K

4.1.6 Satellite Airport Departures

4.1.6.1 Satellite Airport Departures – Issues and Recommended Solutions

Issue

- No published departure procedures for satellite airports. Current procedures in A80 require controllers to vector satellite departures near A80 exit waypoints, and then mimic ATL departures to join the en route structure. Figure 16 shows the current satellite airport departure tracks.

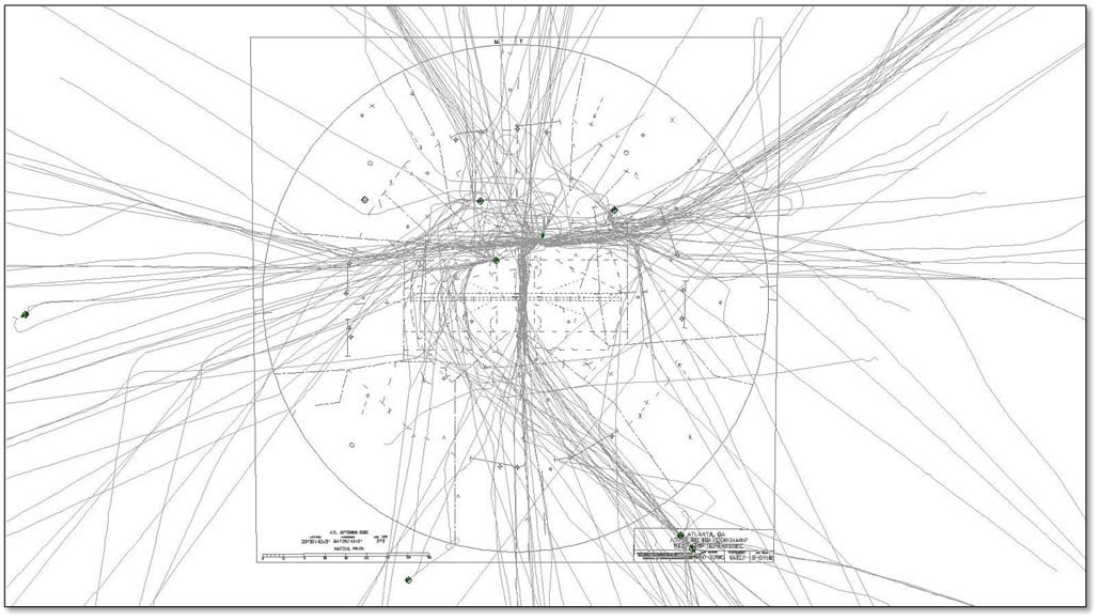

Figure 16. Current Satellite Airport Departure Tracks

Recommendations

- Design RNAV SIDs for aircraft departing tower-controlled satellite airports (PDK, FTY, LZU, RYY, and MGE). These RNAV SIDs should emulate the proposed ATL departure RNAV SIDs, joining the en route structure at the A80 exit waypoints. The recommended solution establishes 15 separate SIDs. The D&I team will finalize the design based on the best operational solution that meets FAA criteria.
- Replace the proposed Colliers VORTAC (IRQ) transition on the MUNSN SID with an IRQ transition on the DOOLY SID to reduce track miles flown.
- Employ a single route over ATL that ensures radar coverage, has minimal interaction with ATL arrivals/departures, and is independent of ATL runway configuration.

Figure 17 depicts the proposed satellite airport SIDs.

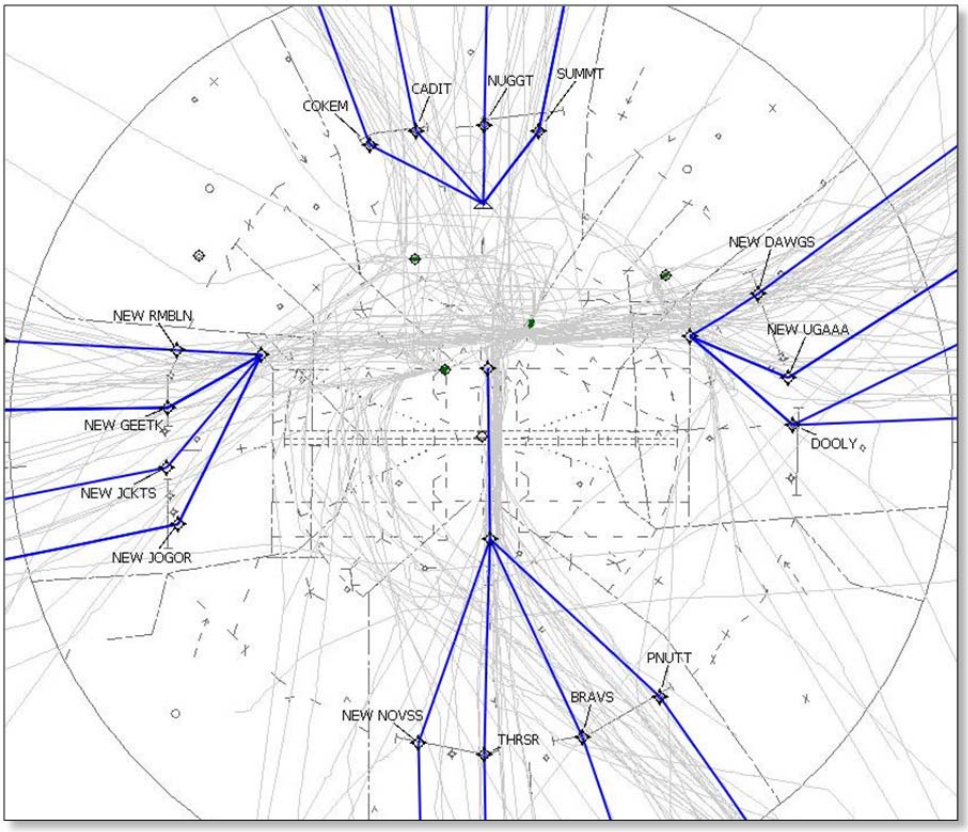

Figure 17. Satellite Airport Departures – Recommended Solution

4.1.6.2 Satellite Airport Departures – Alternative Solution 1

One of the requirements of the recommended solution was a single route over ATL that ensures radar coverage, has minimal interaction with ATL arrivals/departures, and is independent of ATL runway configuration. There are concerns as to whether these requirements can be met; therefore further technical evaluation is needed. In the event that these requirements cannot be met, alternative solutions have been proposed.

- Design RNAV SIDs for aircraft departing tower-controlled satellite airports (PDK, FTY, LZU, RYY, and MGE).
- Design two RNAV SIDs for south departures that mimic current satellite flight tracks over ATL, and are dependent on ATL runway configuration. These RNAV SIDs will be issued by satellite towers, based on ATL runway configuration.

- The proposed ATL departure RNAV SIDs must join the en route structure at the A80 exit waypoints.
- Replace the proposed IRQ transition on the MUNSN SID with an IRQ transition on the DOOLY SID to reduce track miles flown.
- Figure 18 depicts Alternative Solution 1.

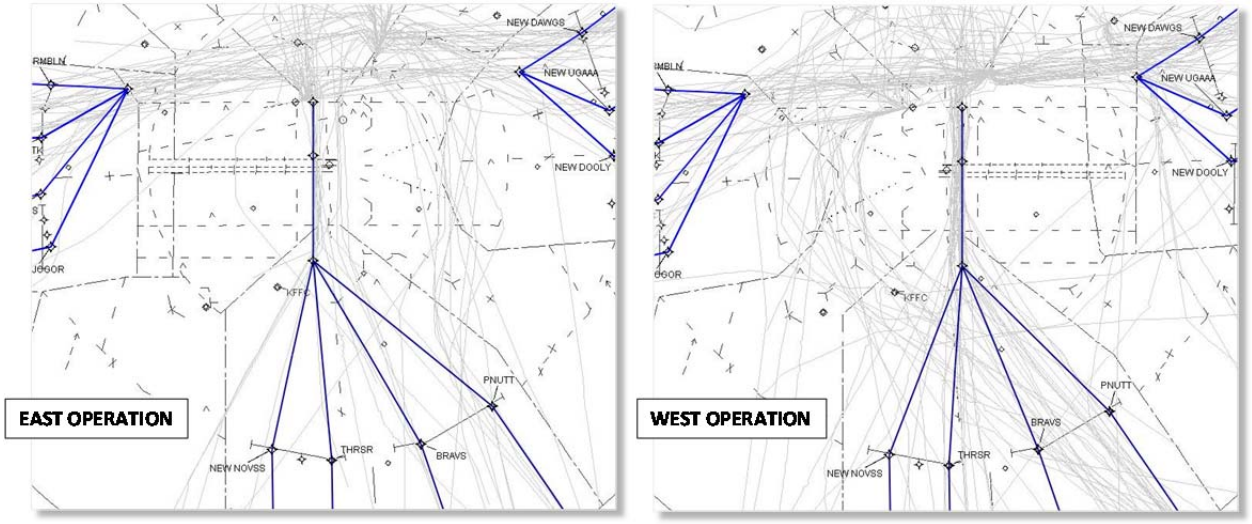

Figure 18. Satellite Airport Departures – Alternative Solution 1 (ATL East/West)

4.1.6.3 Satellite Airport Departures – Alternative Solution 2

- Design RNAV SIDs for aircraft departing tower-controlled satellite airports (PDK, FTY, LZU, RYY, and MGE). These RNAV SIDs should emulate the proposed ATL departure RNAV SIDs, joining the en route structure at the A80 exit waypoints.
- Replace the proposed IRQ transition on the MUNSN SID with an IRQ transition on the DOOLY SID to reduce track miles flown.
- To maintain the flexibility currently available to A80 controllers, the transition(s) over ATL are not included. Satellite south departures are vectored to an initial departure fix similar to the other proposed satellite procedures.
- Figure 19 depicts Alternate Solution 2.

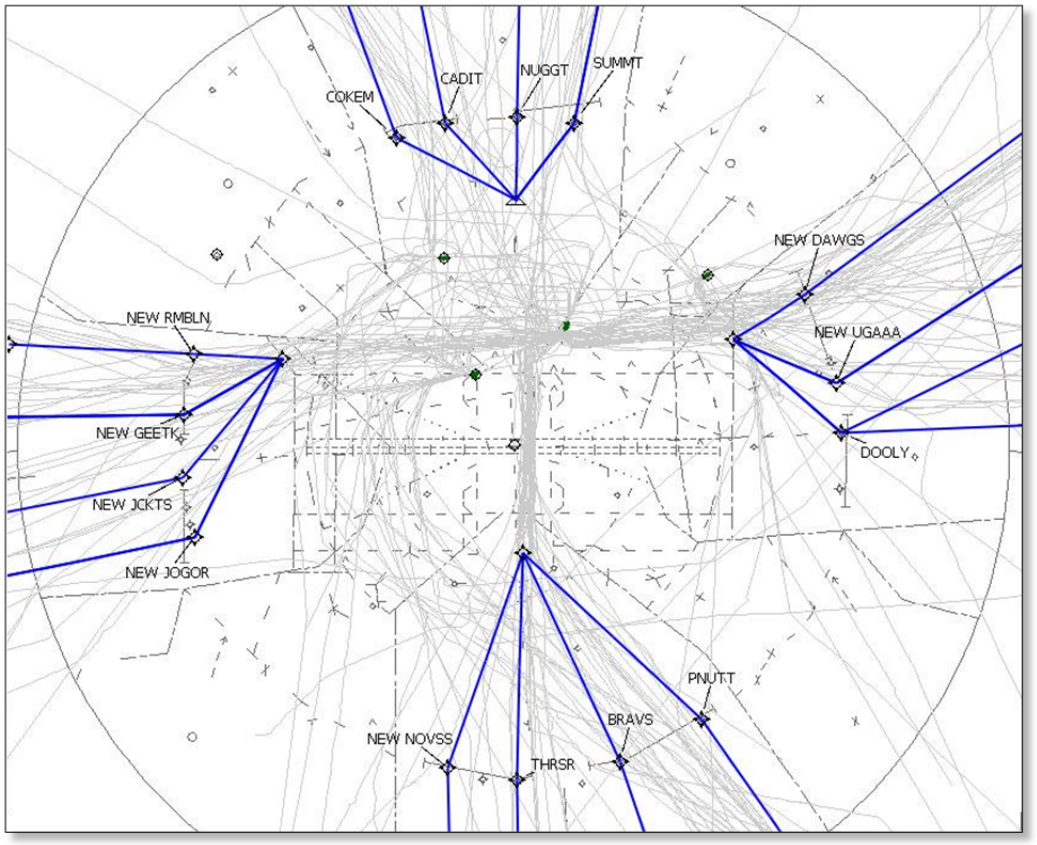

Figure 19. Satellite Airport Departures – Alternative Solution 2

4.1.7 Proposed Departures – Benefits, Impacts, and Risks

Tables 8 and 9 summarize the expected benefits, impacts and risks from the FAA and airspace user perspectives for ATL and satellite airport departures. Initial environmental screening indicates minimal risk of significant noise impacts.

Table 8. Proposed Departures – Benefits, Impacts and Risks (FAA)

Operational/Safety	
Benefits	**Impact/Risks**
- Balances traffic on departure routes - Eliminates high altitude crossover and provide more direct paths - Creates connectivity to en route structure that allows for future Q-Route designs - Design routes that mimic actual traffic flows - Reduces level-offs - Increases airport and sector throughput - Reduces ATC task complexity - Reduces Traffic Alerts on tightly spaced fixes - Enhances safety due to significant reduction of control instructions (reduces chance for controller/pilot read-back/hear-back errors - Develops more opportunities for weather playbook routings	- Increases departure volume - May require airspace modifications for first tier ARTCCs - Increases controller task complexity due to mixed equipage/type aircraft on same routings - 15 degree divergence eliminated during certain configurations - Less separation between proposed arrival and departure routings - Possible loss of radar target on proposed satellite south departure SID - Radar/radio coverage analysis
	Initial Environmental Screening
	- Environmental Assessment required - Routes do not appear to overlay any National Parks or Wilderness Areas

Table 9. Proposed Departures – Benefits, Impacts and Risks (Airspace User)

Airspace User	
Benefits	**Impact/Risks**
- Reduces vectoring for arrival flow sequencing - Reduces distance flown - Reduces fuel burn and emissions - Reduces pilot task complexity - Reduces departure level-offs - Increases airport and sector throughput - Reduces "out to Off" times - Provides connectivity for satellite airport departures	- Possible increase in track miles flown for some Atlanta departures and aircraft departing/arriving some adjacent airports

4.2 ATL and Satellite Airport Arrivals

A80 arrival airspace is configured as a four cornerpost design for ATL arrivals. RNAV STARs were implemented in 2005 and are assigned to all eligible aircraft by the appropriate en route facility host computer (HOST). Dual RNAV STARs are available on the northwest and northeast cornerposts and single RNAV STARs are available on the southwest and southeast cornerposts. Conventional STARs are designed at each cornerpost for non-RNAV equipped aircraft.

The dual STARs are designed as a primary STAR and an offload STAR. The offload STAR is designated as an ATC-assigned only STAR. All eligible aircraft are assigned the primary STAR by HOST, even if the offload STAR is filed. Offload STARs are used to balance traffic flows when advantageous. The northwest offload STAR overflies a parachute drop area and is rarely used (approximately 1.5 percent of all flights are assigned this STAR). The northeast offload STAR is also infrequently used, with less than 3 percent of all flights being assigned this STAR.

RNAV OPD STARs that terminate at a fix on the ATL Runway (RWY) 9R Instrument Landing System Approach are published for both northwest STARs. The VIKNN STAR mimics the offload STAR and is not used due to the parachute drop area. The RPTOR STAR mimics the primary STAR and was published in September 2011, however due to ATC capacity reduction concerns and training issues, the procedure has not been used.

Arrival aircraft enter A80 airspace established on a STAR and level at an altitude as specified by the A80/ZTL LOA. This altitude ranges between 12,000 and 14,000 feet. Aircraft typically encounter 8-10 NM level segments on the short-side[2] and 15-18 NM level segments on the long-side[3] near the A80/ZTL Transfer of Control Point (TCP). Long-side runway transitions are

[2] Short-side is defined as the shortest flying distance from the arrival gate to the landing threshold (base leg entry side).

[3] Long-side defined as the longest distance from the arrival gate to the landing threshold (downwind entry side).

designed on all STARs. A80 uses these long-side runway transitions on a regular basis as aircraft are "flowed" from one side of the airport to the other in order to balance arrival runway demand.

Review of flight tracks in the en route environment indicate that most arrivals do not fly the lateral tracks of the current STARs and are generally cleared direct to the A80/ZTL TCP. Besides the level-offs near the TCP, no other significant level-offs were noted except at the southwest cornerpost, where 25 NM level-offs routinely occurred at Flight Level (FL) 240.

To enable ATL arrival benefits, the OST proposed the following applications:

- RNAV STARs with optimized profile descents that mimic current flight tracks
- More equitable distribution of traffic on the northwest and northeast dual STARs. This distribution would reduce delay vectors by eliminating the requirement to sequence all aircraft into a single arrival flow. Lateral paths would be optimized.
- Flow-dependent vertical profiles to accommodate east and west configurations
- Terminating OPDs on the long-side at 25 distance measuring equipment (DME) from the Atlanta VORTAC to facilitate flowed traffic for runway load balancing
- Short-side runway transitions and airspace shelves at A80 northwest and northeast cornerposts to allow for short-side runway transition assignment

Currently, metering capabilities limit the consistent use of dual STARs and OPDs. The present northeast and northwest dual STAR design supports more equitable distribution of traffic, however single STARs are used more than 97 percent of the time. An OPD is published for the northwest cornerpost and is not being assigned. Metering tools must effectively accommodate dual flows and allow for OPDs without negatively impacting throughput or adversely affecting arrival sector integrity. An OST discussion with the Time-Based Flow Metering/Traffic Management Advisor Program Office indicated that additional enhancements to these tools will not be available until after 2015. The OST calculated benefits for the north cornerposts alternative designs in the event that D&I determines dual OPD STARs at each cornerpost are not a viable option.

Currently there are satellite airport STARs at each cornerpost. However, only the southeast cornerpost incorporates an RNAV STAR. The OST proposed RNAV STAR designs for the other three corner posts that would be procedurally de-conflicted from ATL STARs and SIDs to the extent practical. Most of the proposed satellite airport STARs reduce distances and enable earlier lateral separation from ATL routes. Earlier lateral separation allows more efficient descent profiles for aircraft flying satellite STARs. An additional satellite STAR at the northwest cornerpost was also recommended. Currently aircraft are assigned a specific route as required by the A80/ZTL LOA, but a STAR is not published. The new proposed STAR aids in pilot planning and reduces task complexity. Due to the limited number of aircraft on the satellite airport STARs, benefits were not calculated on these STARs.

4.2.1 ATL Northwest Arrivals

This section describes the operational issues, recommendations, expected benefits and alternative solutions that the OST has identified for arrivals to ATL from the northwest. Figure 20 shows the current northwest arrivals.

4.2.1.1 ATL Northwest Arrivals

Issues

- Historical flight tracks do not follow the current arrival procedures. The majority of aircraft are cleared from the ZID and Memphis Air Route Traffic Control Center (ZME) boundaries direct to ERLIN intersection, the TCP between A80 and ZTL.
- Inefficient vertical profiles. While current level-off segments in ZTL airspace are minimal, aircraft are required to level at the TCP, resulting in extended level-off segments in A80 airspace.
- The current HERKO/VIKNN STARs overfly the Cedartown Airport (4A4) parachute drop area. This limits the use of these STARs and aircraft are generally sequenced to the ERLIN STAR to avoid this airspace. This results in additional track miles flown and the inability to separate two heavy flows.
- Sequencing difficulties due to variable winds. Local wind characteristics impact multiple routes that must be merged into a single flow. This can increase spacing requirements in order to allow for speed differences between in-trail aircraft.

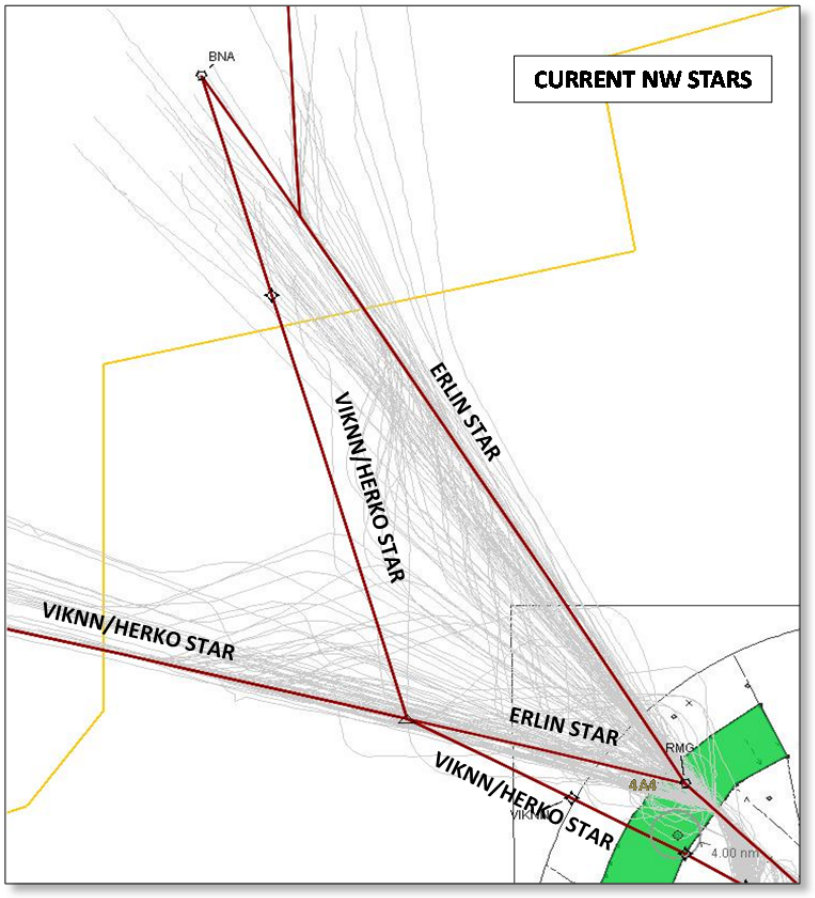

Figure 20. ATL Northwest Arrival – Current Procedures

Recommendations

- Design HERKO/VIKNN STARs to avoid 4A4 parachute drop area. The STAR was moved northeast of 4A4 and also resulted in the relocation of the ERLIN STAR.

- Create catch points[4] on ZTL boundary that minimize track miles. Currently, aircraft are routed via ground-based NAVAIDS, which can result in additional miles flown. Catch points based on waypoints can provide more direct routing and serve as key locations for controllers to assign restrictions.
- Create PBN STARs that mimic tracks currently flown.
- Design runway transitions for the short-side arrivals.
- Design OPDs to accommodate flowed traffic in A80 airspace. Flowed traffic is long-side traffic that A80 transitions from one side of the airport to the other in order to balance runway demand. Figure 21 depicts flowed traffic on a west operation. Level segments are required to reduce controller task complexity when transitioning these aircraft. The proposed solution maximizes OPD benefits by not beginning a level-off segment until 25 DME from the Atlanta VORTAC (level-offs currently begin approximately 45 DME from the Atlanta VORTAC) and still permits controllers to sequence flowed traffic.

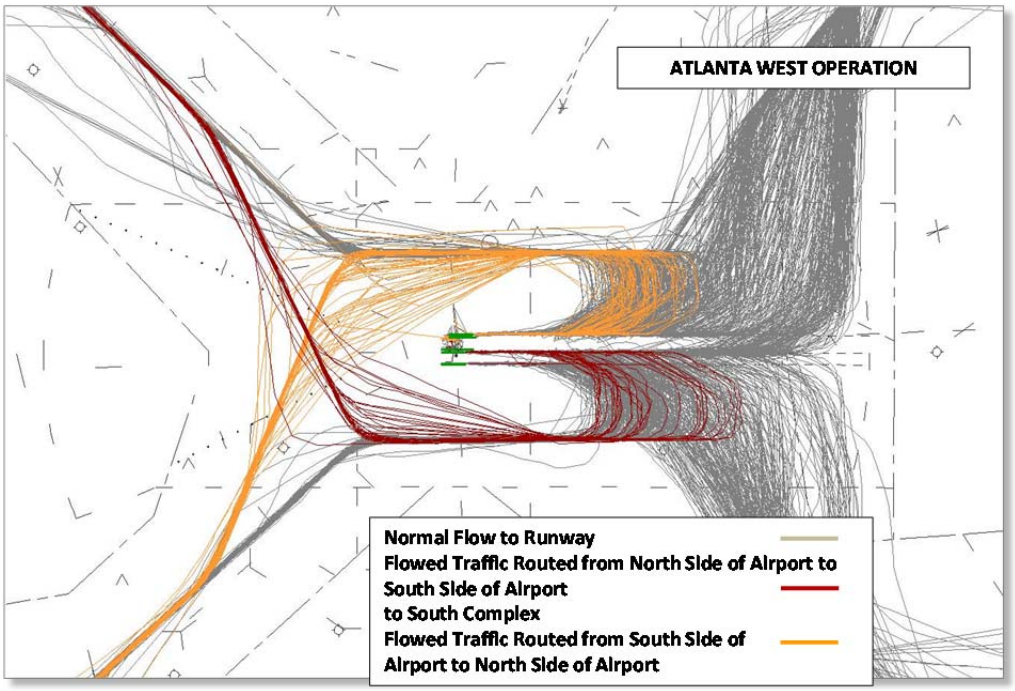

Figure 21. Flowed Traffic – West Operation

[4] Fix or waypoint near an airspace boundary used to route traffic flows.

- Create stand-alone waypoints or transitions between the two STARs. These two options are generally available when transitioning between STARs. The OST recommended solution applies the waypoint option. D&I teams will determine which technique they prefer.
- Consider future Nashville Airport (BNA) procedures. BNA SIDs are currently being designed independently of the OAPM initiative and may impact ATL northwest arrivals.
- Segregate ATL and satellite airport traffic flows.
- Design an arrival shelf to allow assignment of runway transitions. Rules require that runway transitions be assigned a minimum of 10 NM prior to the transition waypoint. Current A80 airspace does not permit this assignment in a timely manner.
- Figures 22, 23, and 24 depict the recommended solutions for northwest arrivals in en route and terminal airspace configurations.

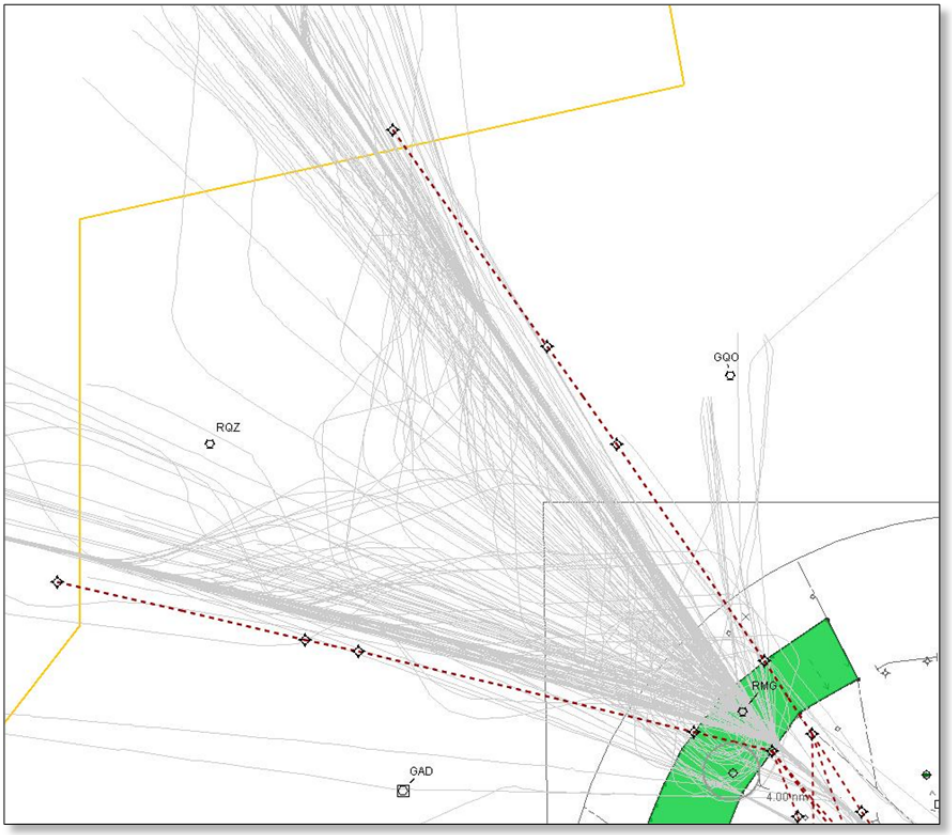

Figure 22. ATL Northwest Arrival – Recommended Solution

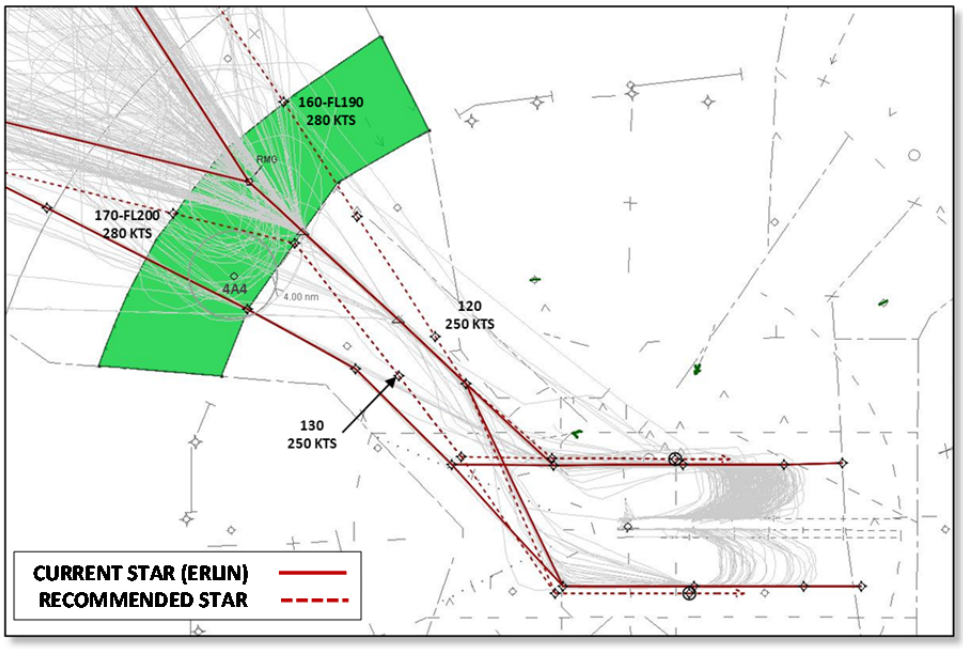

Figure 23. ATL Northwest Arrival – Recommended Solution A80 View (West Operation)

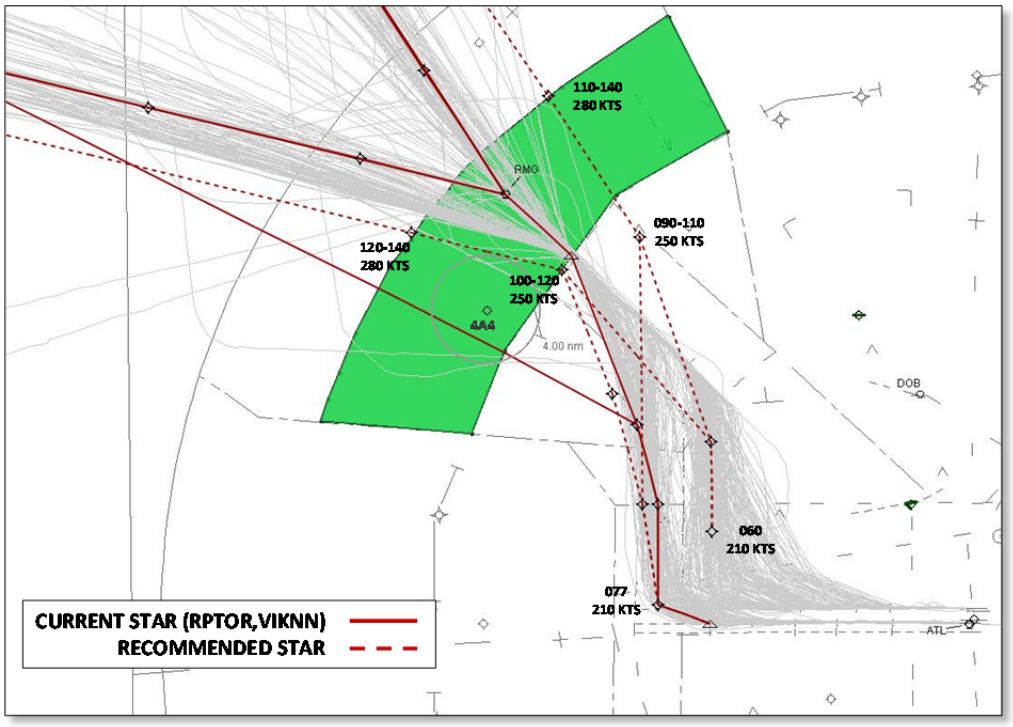

Figure 24. ATL Northwest Arrival – Recommended Solution A80 View (East Operation)

4.2.1.2 ATL Northwest Arrivals – Alternative Solution 1

Alternative Solution 1 incorporates dual STARs on the long-side and a single STAR on the short-side. Dual STARs are currently available but are limited in use due to merging two traffic flows into a single flow within A80 airspace, and technical limitations of TMA in the sequencing of multiple flows. Dual flows on the long-side allow additional airspace to merge two flows into a single flow within A80 airspace. This alternative provides the additional benefit of long-side dual STARs while realizing the operational limitations of merging two flows into a single flow in limited airspace on the short-side. Figures 25, 26, and 27 depict Alternative Solution 1 for northwest arrivals in en route and terminal airspace configurations.

It should be noted that future advances in TMA capabilities may permit improved sequencing, metering and merging of multiple flows.

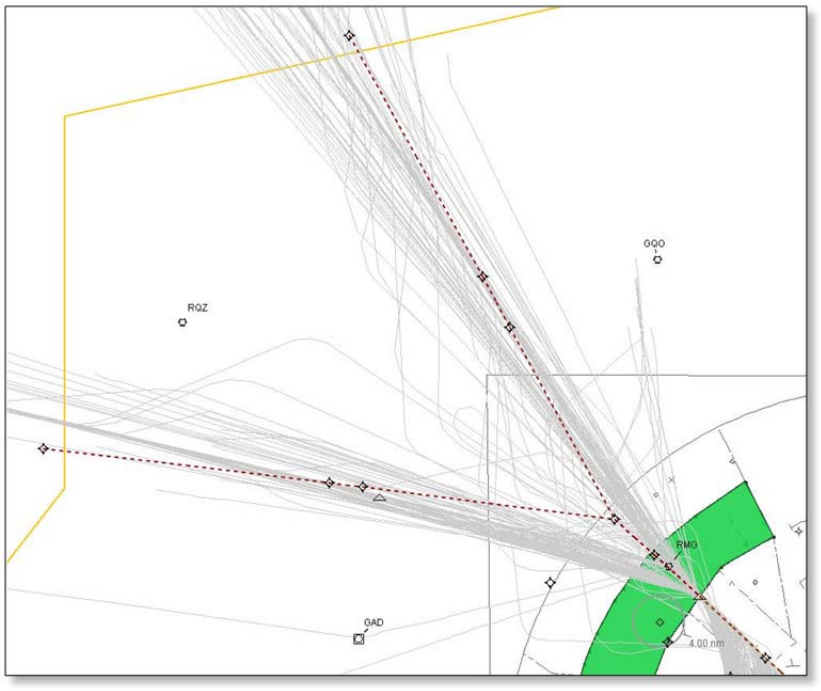

Figure 25. ATL Northwest Arrival – Alternative Solution 1

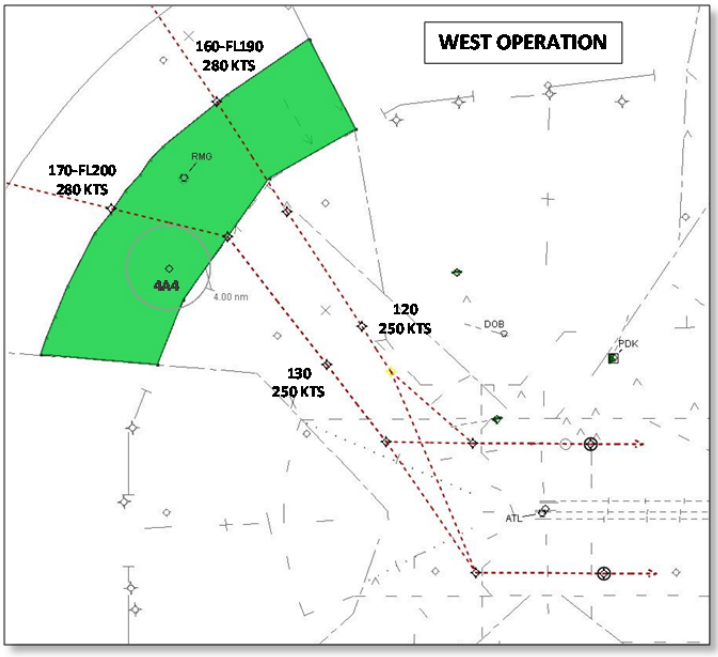

Figure 26. ATL Northwest Arrival – Alternative Solution 1 A80 View (West Operation)

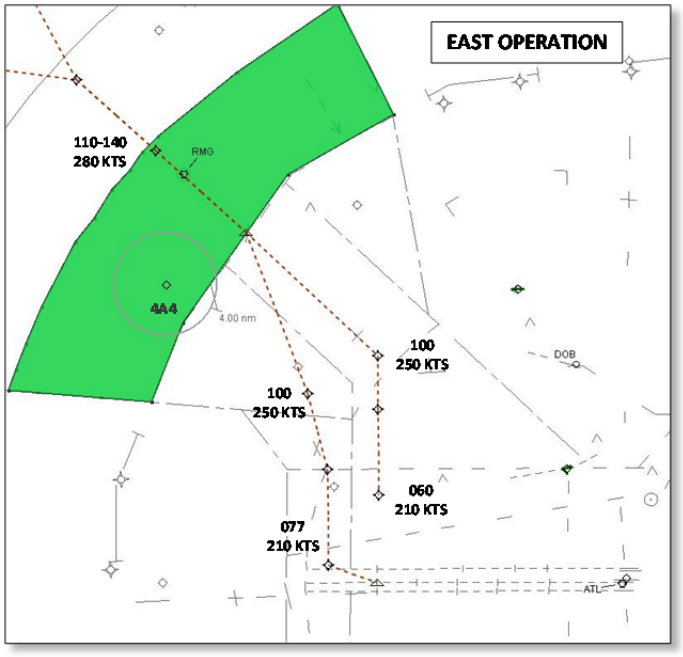

Figure 27. ATL Northwest Arrival – Alternative Solution 1 A80 View (East Operation)

4.2.1.3 ATL Northwest Arrivals – Alternative Solution 2

Alternative Solution 2 incorporates single STARs on the long and short-sides. In the event that future advances in TMA do not permit improved sequencing, metering or merging of multiple streams, this alternative provides a single STAR that is optimized laterally and vertically. Figures 28 and 29 depict Alternative Solution 2 for northwest arrivals in terminal airspace configurations.

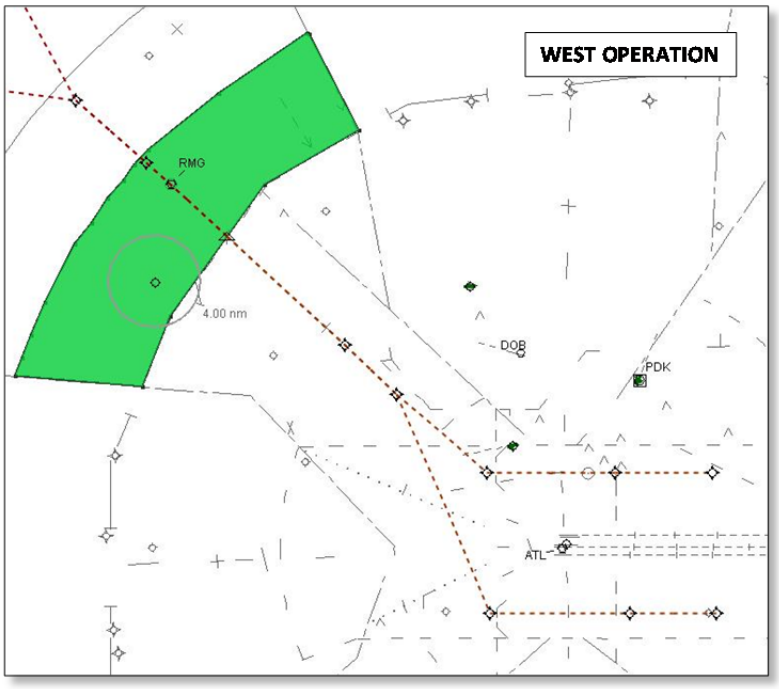

Figure 28. ATL Northwest Arrival – Alternative Solution 2 A80 View (West Operation)

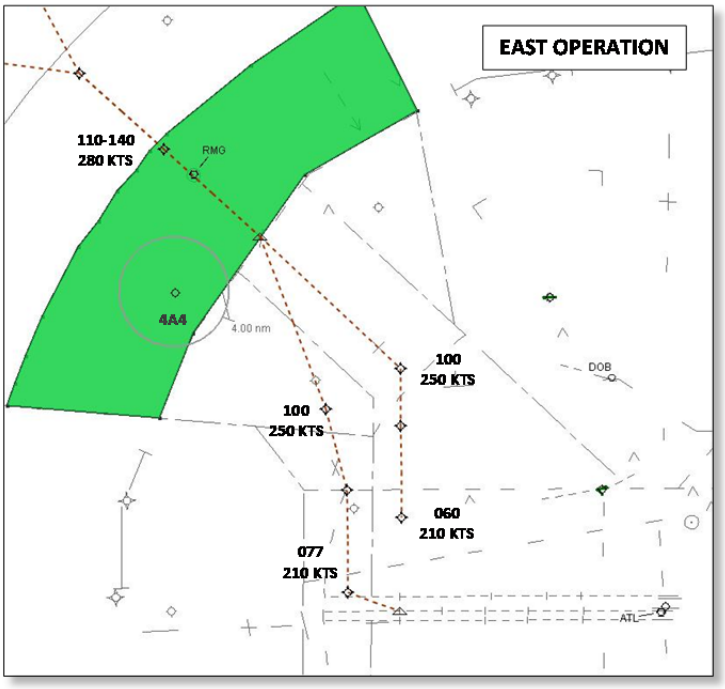

Figure 29. ATL Northwest Arrival – Alternative Solution 2 A80 View (East Operation)

4.2.1.4 ATL Northwest Arrival Benefits

Table 10 shows the estimated annual benefits of the recommended and alternative solutions for the ATL northwest arrivals relative to the existing ATL northwest arrivals. Both the recommended and alternative solutions show a distance dis-benefit. Historical track data showed that aircraft at this cornerpost are generally cleared direct to the (current) TCP fix/waypoint. The OST could not duplicate this design in its solutions, which results in increased distances at this cornerpost. The OST optimized lateral paths to the extent possible. However, the proposed airspace shelves that are designed to accommodate issuance of short-side runway transitions require a new TCP further from ATL, resulting in increased distances as compared to historical tracks. The D&I Team may determine that the airspace shelves are not required, which may result in reduced distances. Initial environmental screening indicates minimal risk of significant noise impacts.

Table 10. ATL Northwest Arrivals – Estimated Annual Benefits

		Recommended		Alt #1		Alt #2	
		Low	High	Low	High	Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	($55K)	($55K)	($569K)	($569K)	($1.3M)	($1.3M)
	Profile	$2.1M	$6.4M	$2.1M	$6.4M	$2.1M	$6.4M
	Cost to Carry	$7K	$7K	($38K)	($38K)	($70K)	($70K)
Total Estimated Annual Fuel Savings (Dollars)		$2.1M	$6.4M	$1.5M	$5.8M	$730K	$5.0M
Total Estimated Annual Fuel Savings (Gallons)		703K	2.2M	512K	2.0M	234K	1.7M
Total Estimated Annual Carbon Savings (Metric Tons)		7K	22K	5K	20K	2K	17K

4.2.2 ATL Northeast Arrivals

This section describes the operational issues, recommendations, expected benefits and alternative solutions that the OST has identified for arrivals to ATL from the northeast. Figure 30 shows the current northeast arrivals.

4.2.2.1 ATL Northeast Arrivals

Issues

- Historical flight tracks do not follow current arrival procedures. The majority of aircraft are cleared from the Washington Air Route Traffic Control Center (ZDC) and ZID boundaries direct to DIRTY, the TCP between A80 and ZTL.
- Inefficient vertical profiles. While current level-off segments in ZTL airspace are minimal, aircraft are required to level at the TCP, resulting in extended level-off segments in A80 airspace.
- The PECHY STAR is rarely used due to TMA concerns, resulting in additional track miles flown and streams being sequenced into a single flow.

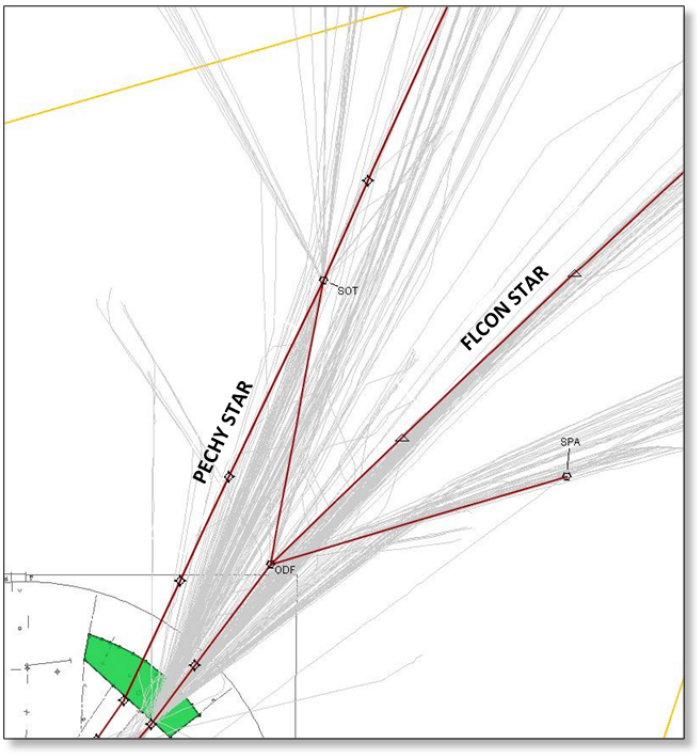

Figure 30. ATL Northeast Arrival – Current Procedures

Recommendations

- Create catch points on ZTL boundary that minimize track miles. Current aircraft are routed via ground-based NAVAIDS, which can result in additional miles being flown. Catch points based on waypoints can provide more direct routing and also serve as key locations for controllers to assign restrictions.
- Create PBN STARs that mimic tracks currently flown.
- Design runway transitions for the short-side arrivals.
- Design OPDs to accommodate flowed traffic in A80 airspace. Currently A80 balances runway demand on the long-side by transitioning aircraft between the north and south runway complexes (See Figure 20). Level segments are required to reduce controller task complexity when transitioning these aircraft. The proposed solution maximizes OPD benefits by not beginning a level-off segment until 25 DME from the Atlanta VORTAC (level-offs currently begin approximately 45 DME from the Atlanta VORTAC) and still permits controllers to sequence flowed traffic.
- Create stand-alone waypoints or transitions between the two STARs. These two options are generally available when transitioning between STARs. The OST recommended solution applies transitions. D&I teams will determine which technique they prefer.
- Segregate ATL and satellite airport traffic flows.
- Design an arrival shelf to allow assignment of runway transitions. Rules require that runway transitions be assigned by a minimum of 10 NM prior to the transition waypoint. Current A80 airspace does not permit this assignment in a timely manner.
- Figures 31, 32, and 33 depict the recommended solution for northeast arrivals in en route and terminal airspace configurations.

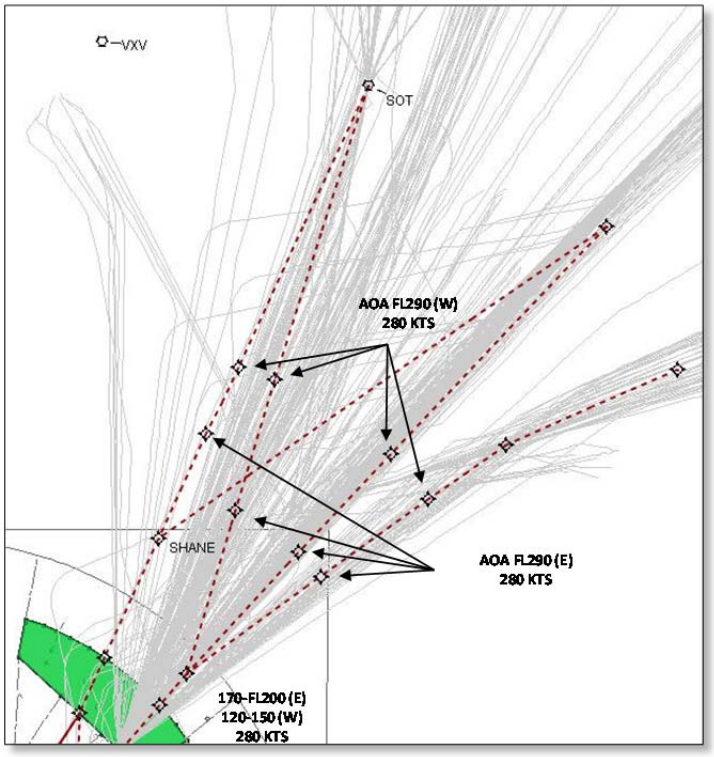

Figure 31. ATL Northeast Arrival – Recommended Solution

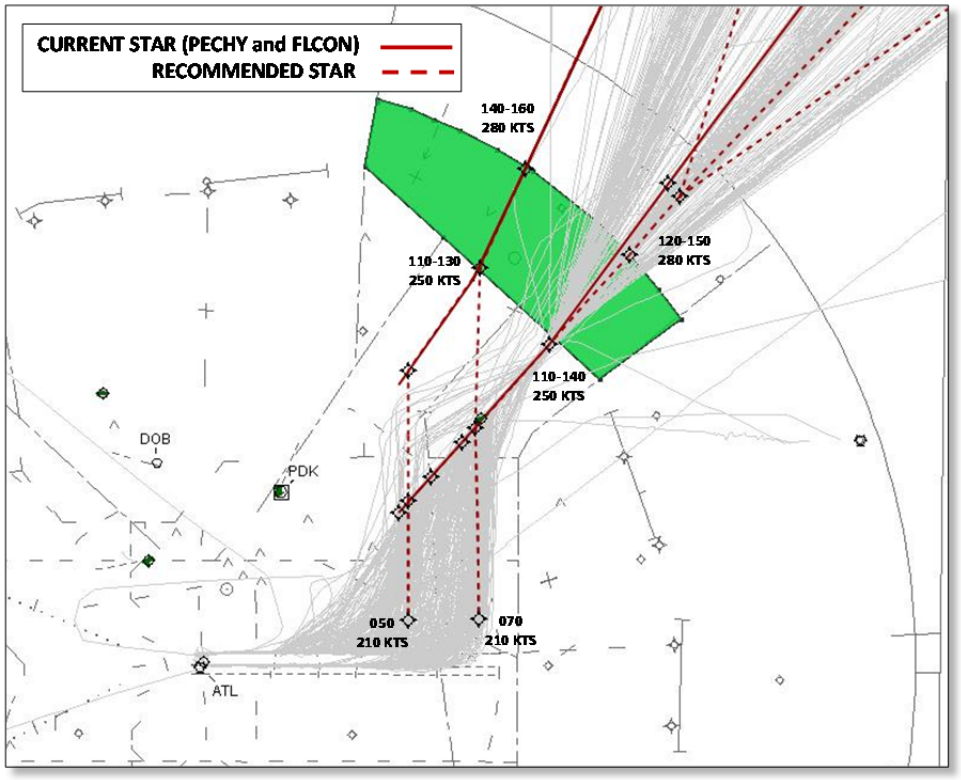

Figure 32. ATL Northeast Arrival – Recommended Solution A80 View (West Operation)

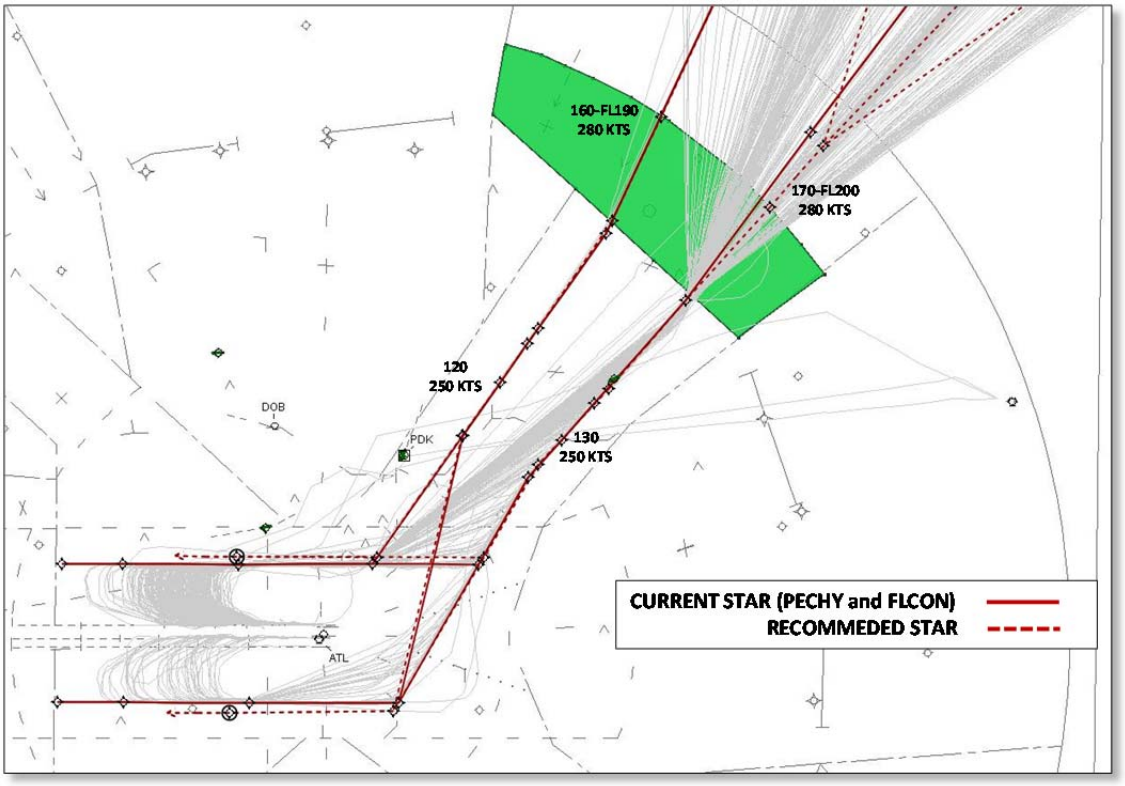

Figure 33. ATL Northeast Arrival – Recommended Solution A80 View (East Operation)

4.2.2.2 ATL Northeast Arrivals – Alternative Solution 1

Alternative Solution 1 incorporates dual STARs on the long-side and a single STAR on the short-side. Dual STARs are currently available but are limited in use due to merging two heavy streams into a single flow within A80 airspace, and technical limitations of TMA. Dual flows on the long-side allow additional airspace to merge two flows into a single flow within A80 airspace. This alternative provides the additional benefit of long-side dual STARs while realizing the operational limitations of merging two flows into a single flow in limited airspace on the short-side. Figures 34, 35, and 36 depict Alternative Solution 1 for northeast arrivals in en route and terminal airspace configurations.

It should be noted that future advances in TMA capabilities may permit improved sequencing, metering and merging of multiple arrival flows.

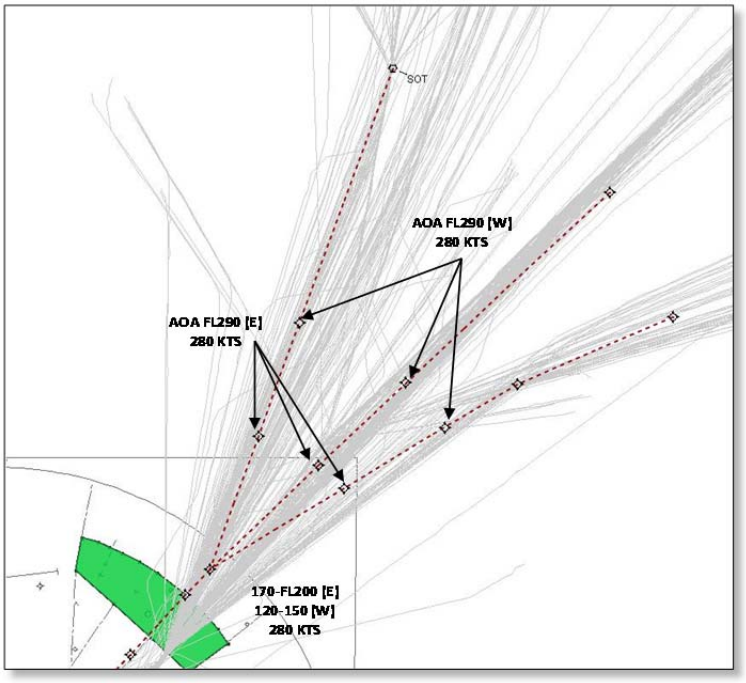

Figure 34. ATL Northeast Arrival – Alternative Solution 1

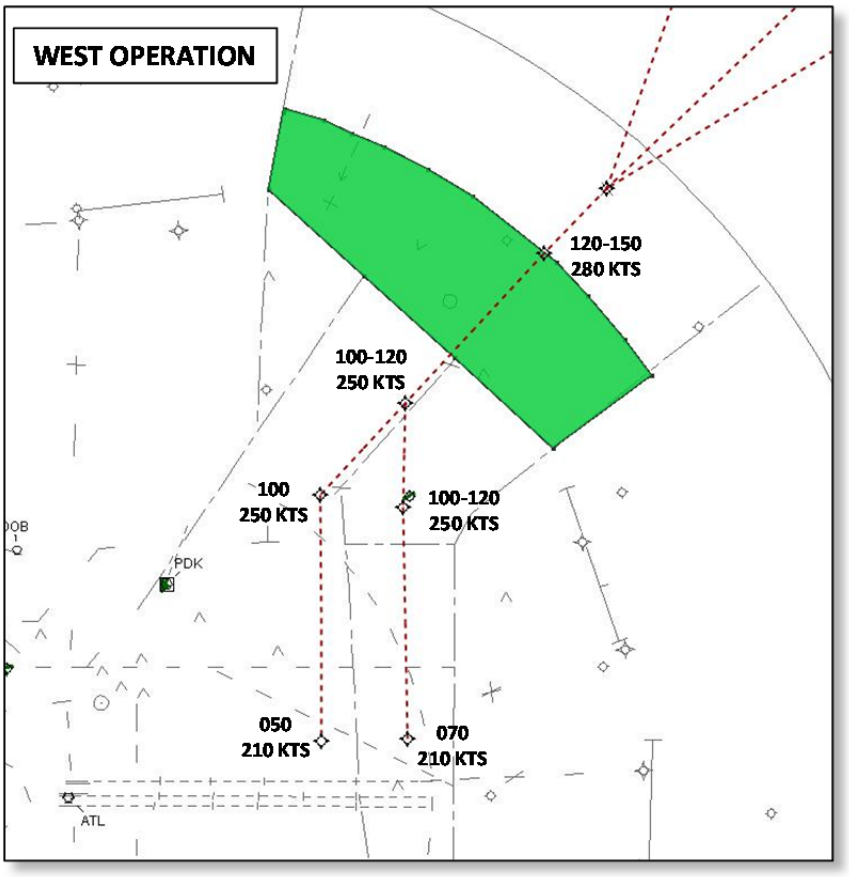

Figure 35. ATL Northeast Arrival – Alternative Solution 1 A80 View (West Operation)

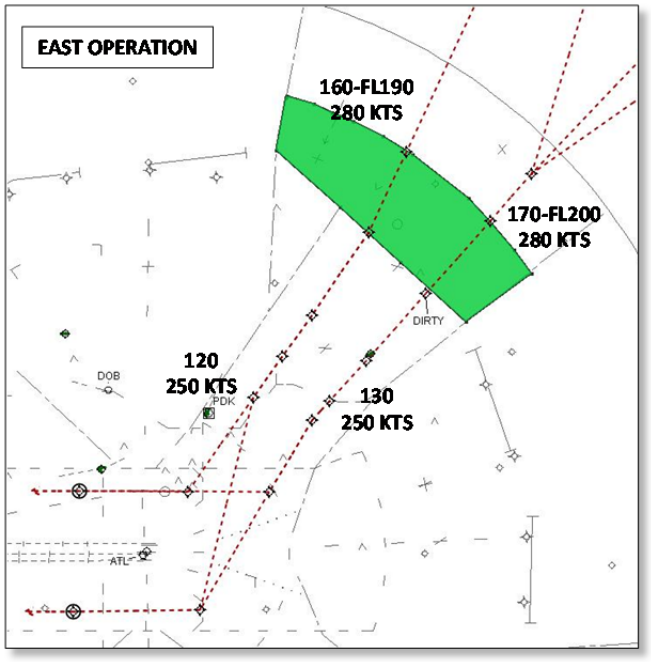

Figure 36. ATL Northeast Arrival – Alternative Solution 1 A80 View (East Operation)

4.2.2.3 ATL Northeast Arrivals – Alternative Solution 2

Alternative Solution 2 incorporates single STARs on the long and short-sides. In the event that future advances in TMA do not permit improved sequencing, metering or merging of multiple arrival flows, this alternative provides a single STAR that is optimized laterally and vertically. Figures 37 and 38 depict Alternative Solution 2 for northeast arrivals in terminal airspace configurations.

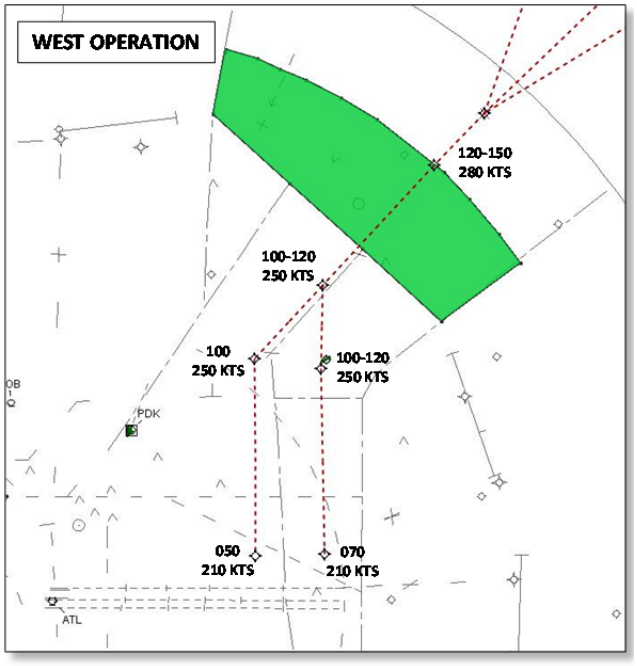

Figure 37. ATL Northeast Arrival – Alternative Solution 2 A80 View (West Operation)

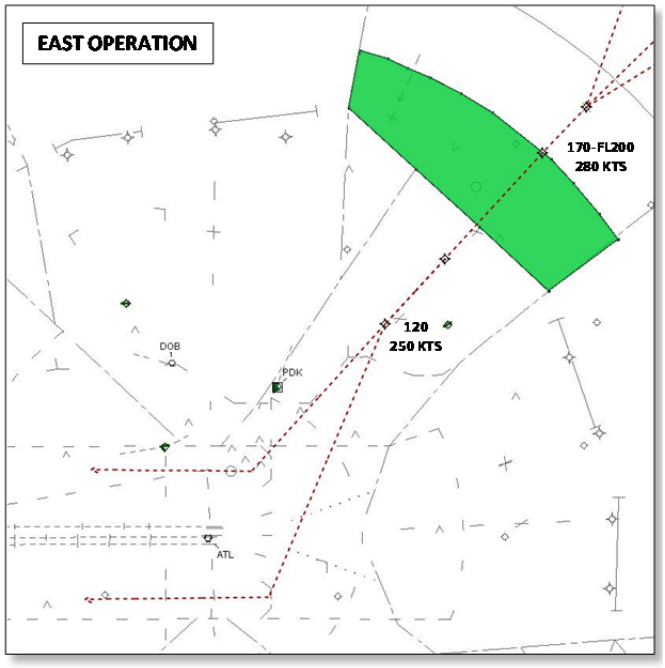

Figure 38. ATL Northeast Arrival – Alternative Solution 2 A80 View (East Operation)

4.2.2.4 ATL Northeast Arrival Benefits

Table 11 shows the estimated annual benefits of the recommended and alternative solutions for the ATL northeast STARs relative to the existing ATL northeast STARs. Similar to the northwest STARs, both the recommended and alternative solutions show a distance dis-benefit. The OST optimized lateral paths to the extent possible. However, the proposed airspace shelves that are designed to accommodate issuance of short-side runway transitions required a new TCP further from ATL, resulting in an increase in distance as compared to historical tracks. The D&I Team may determine that the airspace shelves are not required, which may result in reduced distances. Initial environmental screening indicates minimal risk of significant noise impacts.

Table 11. ATL Northeast Arrivals – Estimated Annual Benefits

		Recommended		Alt #1		Alt #2	
		Low	High	Low	High	Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	($175K)	($175K)	($1.3M)	($1.3M)	($1.2M)	($1.2M)
	Profile	$2.4M	$7.1M	$2.4M	$7.1M	$2.4M	$7.1M
	Cost to Carry	$73K	$73K	($21K)	($21K)	$128K	$128K
Total Estimated Annual Fuel Savings (Dollars)		$2.3M	$7.0M	$1.1M	$5.8M	$1.3M	$6.0M
Total Estimated Annual Fuel Savings (Gallons)		797K	2.4M	393K	2.0M	468K	2.1M
Total Estimated Annual Carbon Savings (Metric Tons)		8K	24K	4K	20K	5K	21K

4.2.3 ATL Southeast Arrivals

This section describes the operational issues, recommendations, expected benefits and alternative solutions that the OST has identified for arrivals to ATL from the southeast. Figure 39 depicts the current southeast arrival.

Issues

- Historical flight tracks do not follow current arrival procedures. The majority of aircraft are cleared from the Jacksonville Air Route Traffic Control Center (ZJX) boundary direct to CANUK intersection, the TCP between A80 and ZTL.
- Inefficient vertical profiles. While current level-off segments in ZTL airspace are minimal, aircraft are required to level at the TCP, resulting in extended level-off segments in A80 airspace.
- Present CANUK STAR does not incorporate transitions for the proposed SAV and CHS SIDs.
- CANUK and JRAMS STARs are not procedurally de-conflicted, resulting in forced level-offs or non-optimal altitude assignments.
- No transitions when Bulldog Special Activity Airspace (SAA) is inactive. Numerous aircraft today fly over the SAA when it is not in use. A defined procedure is not published for aircraft flying this route.

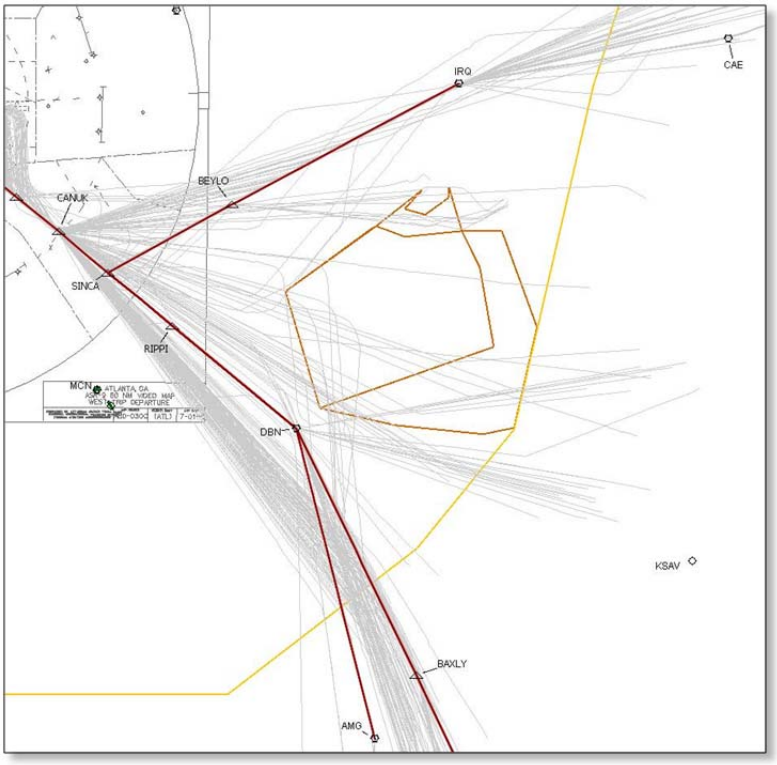

Figure 39. ATL Southeast Arrival – Current Procedure

Recommendations

- Develop Allendale (ALD) transition for CHS departures and to be used when Bulldog SAA is active.
- Develop a new transition immediately south of Bulldog SAA for SAV departures.
- Reduce track miles flown by creating STARs that utilize PBN procedures and mimic tracks currently flown.
- Create catch points on ZTL boundary that minimize track miles. Current aircraft are routed via ground-based NAVAIDS, which result in additional miles flown. Catch points based on waypoints can provide more direct routing and serve as key locations for controllers to assign restrictions.
- Design a runway transition for the short-side arrivals.
- Design OPDs to accommodate flowed traffic in A80 airspace. The proposed solution maximizes OPD benefits by not beginning a level-off segment until 25 DME from the Atlanta VORTAC (currently begins approximately 45 DME from the Atlanta VORTAC) and still permits controllers to sequence flowed traffic.

- Move IRQ transition south to de-conflict with CLT arrivals.
- Segregate ATL and satellite airport traffic flows.
- Figures 40 and 41 depict the recommended solution for the southeast arrival in en route and terminal airspace configurations.

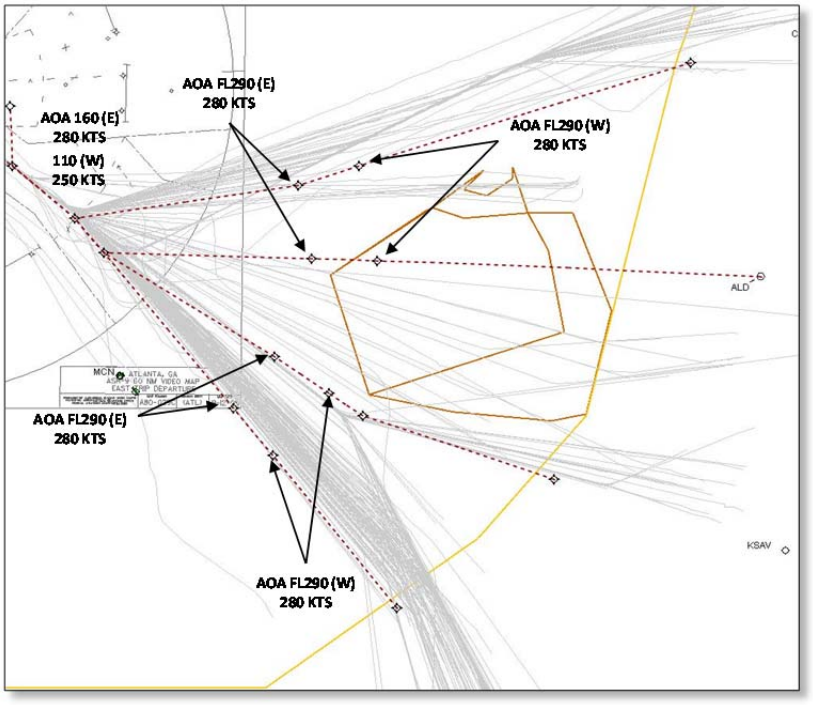

Figure 40. ATL Southeast Arrival – Recommended Solution

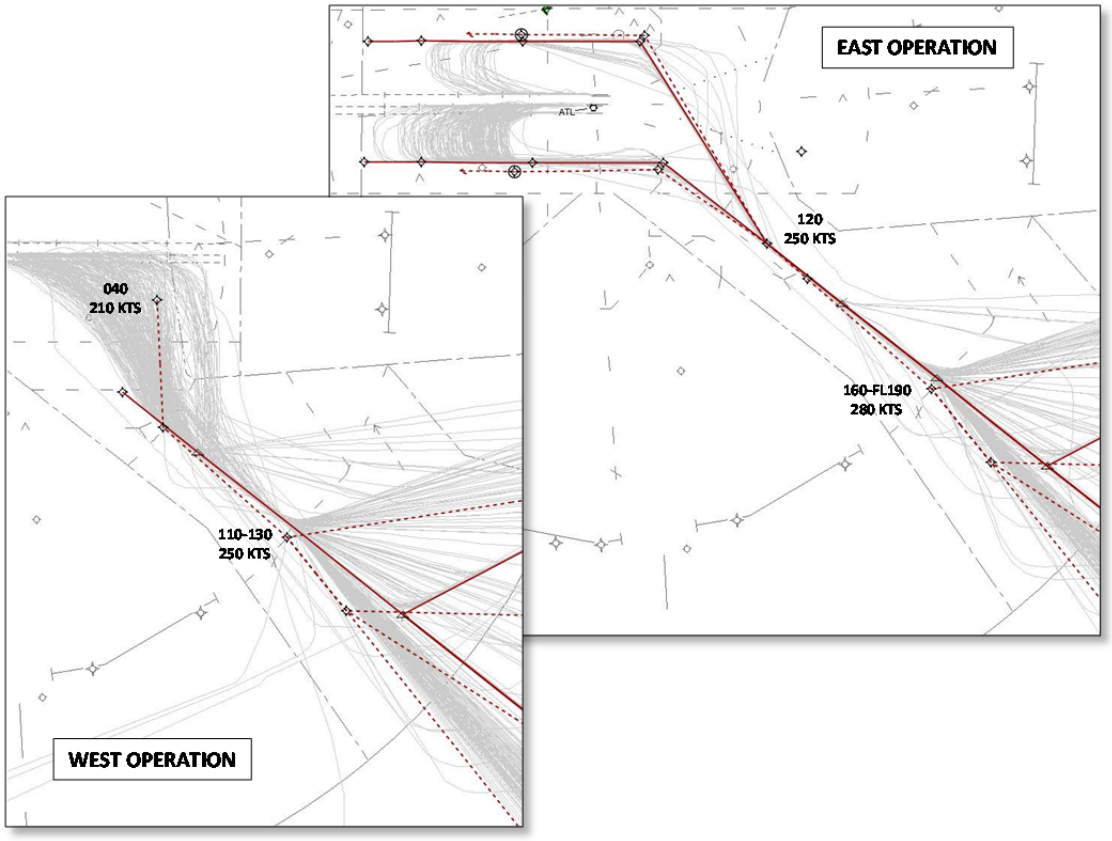

Figure 41. ATL Southeast Arrival – Recommended Solution A80 View (West/East)

4.2.3.1 ATL Southeast Arrival Benefits

Table 12 shows the estimated annual benefits of the recommended solution for ATL southeast STARs relative to the existing ATL southeast STARs. Initial environmental screening indicates minimal risk of significant noise impacts.

Table 12. ATL Southeast Arrivals – Estimated Annual Benefits

SE Arrivals			
		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$844K	$844K
	Profile	$1.1M	$3.5M
	Cost to Carry	$219K	$219K
Total Estimated Annual Fuel Savings (Dollars)		$2.2M	$4.6M
Total Estimated Annual Fuel Savings (Gallons)		746K	1.6M
Total Estimated Annual Carbon Savings (Metric Tons)		7K	16K

4.2.4 ATL Southwest Arrivals

This section describes the operational issues, recommendations, expected benefits and alternative solutions that the OST has identified for arrivals to ATL from the southwest. Figure 42 shows the current southwest arrival.

4.2.4.1 ATL Southwest Arrivals

Issues

- Historical flight tracks do not follow current arrival procedures. The majority of aircraft are cleared from the Houston Air Route Traffic Control Center (ZHU) and ZJX boundaries direct to HONIE intersection, which is the TCP. For example, numerous aircraft between the GCV and Seminole VORTAC (SZW) transitions do not fly a published route. These two transitions are separated by approximately 150 NM, and aircraft departing Florida panhandle airports are generally cleared direct to HONIE intersection. OPD benefits cannot be realized for aircraft not on a published route.
- The HONIE STAR is normally the first fix to go into holding, and numerous MIT restrictions increase ATC task complexity.
- The MEI and GCV transitions cross within ZTL airspace.
- Proposed Pensacola North SAA vertical expansion may impact future STAR design.

- The LaGrange VORTAC (LGC) holding pattern on the HONIE STAR is too close to the A80 boundary. This makes it difficult for ZTL to sequence aircraft to A80 when leaving the holding pattern.
- Inefficient vertical profiles. Numerous aircraft on the MEI and GCV transitions level-off at FL240 for approximately 25 NM. Aircraft are also required to level at the TCP, resulting in additional level-off segments in A80 airspace.
- Sequencing difficulties due to variable winds. Local wind characteristics impact multiple routes that must be merged into a single stream. This can increase spacing requirements in order to allow for speed differences between in-trail aircraft.
- J73 traffic impacts arrivals from the southeast corner of the airspace. J73 is a busy route from the Midwest to Florida, and is head-on with ATL arrivals on the SZW transition.

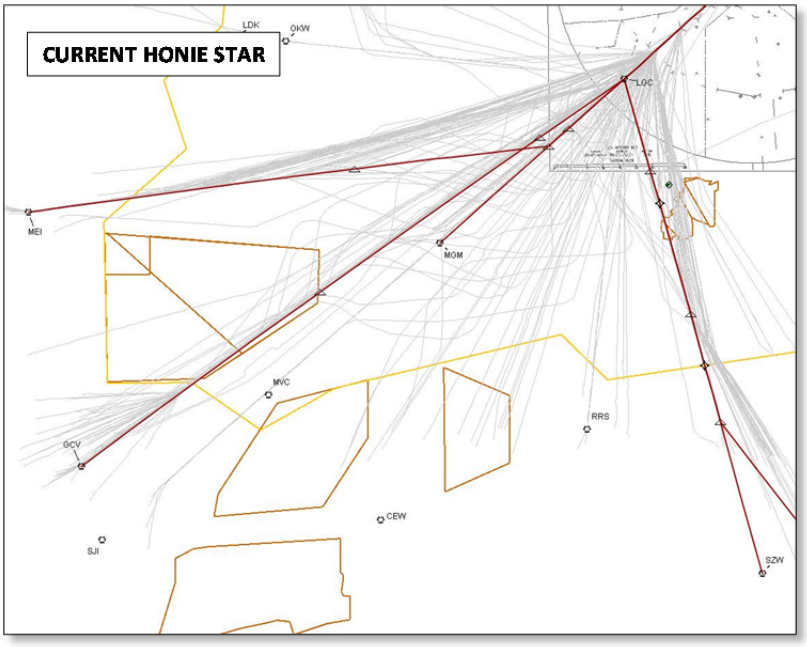

Figure 42. ATL Southwest Arrival – Current Procedure

Recommendations

- Create STARs that utilize PBN procedures and mimic tracks currently flown.
- Create catch points on ZTL boundary that minimize track miles. Currently, aircraft are routed via ground-based NAVAIDS, which can result in additional miles flown. Catch points based on waypoints can provide more direct routing and serve as key points for controllers to assign restrictions.

- Design OPD as a single STAR. The northwest and northeast cornerposts are the busiest, and traffic management usually minimizes delays to those corners by placing additional restrictions on the southwest corner. Dual STARs were considered but not pursued due to this practice and lower volume of traffic.
- Design OPD to accommodate flowed traffic in A80 airspace. The proposed solution maximizes OPD benefits by not beginning a level-off segment until 25 DME from the Atlanta VORTAC (currently begins approximately 45 DME from the Atlanta VORTAC) and still permits controllers to sequence flowed traffic.
- Design a runway transition for short-side arrivals.
- Procedurally de-conflict the JOGOR SID with the southwest OPD.
- Design southeast corner transition east of J73, as most historical tracks are west of J73 direct to SZW.
- D&I to determine the most efficient location for a holding pattern(s).
- Figures 43, 44, and 45 depict the recommended solution for the southwest arrival in en route and terminal airspace configurations.

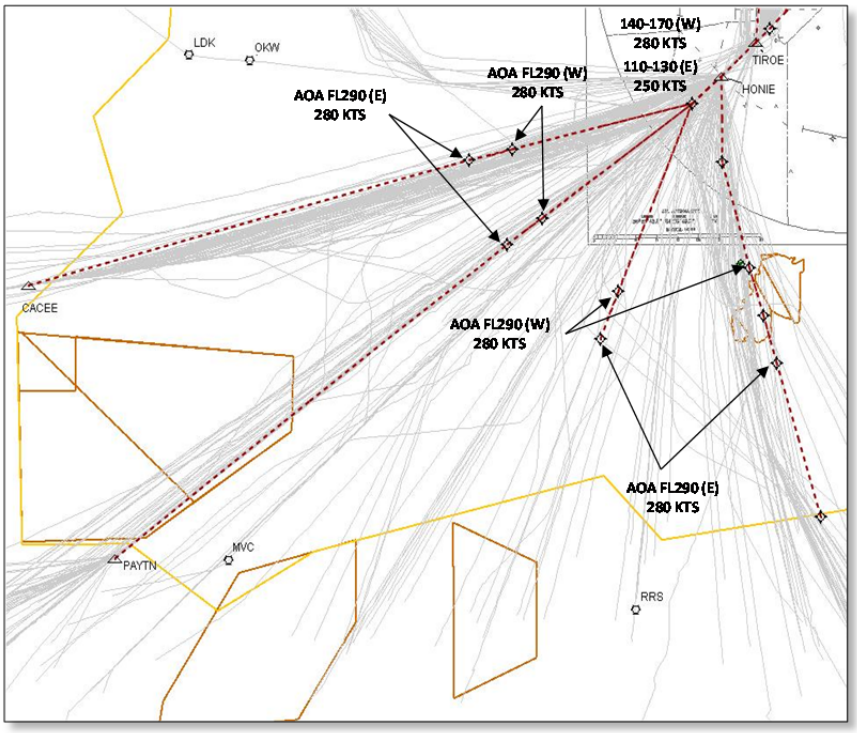

Figure 43. ATL Southwest Arrival – Recommended Solution

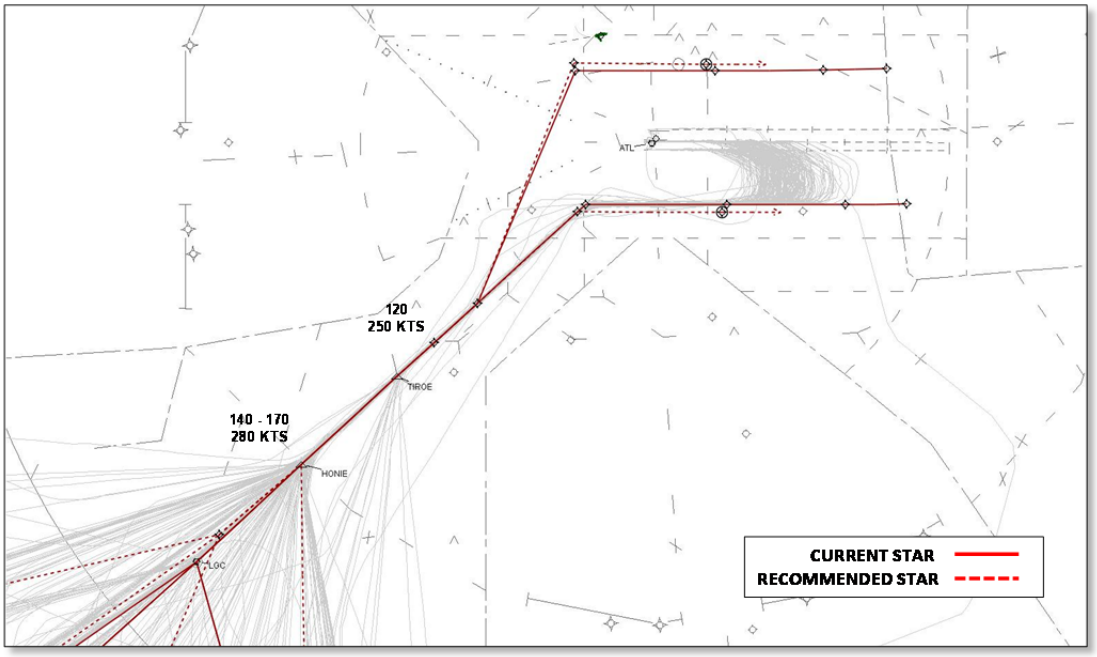

Figure 44. ATL Southwest Arrival – Recommended Solution A80 View (West Operation)

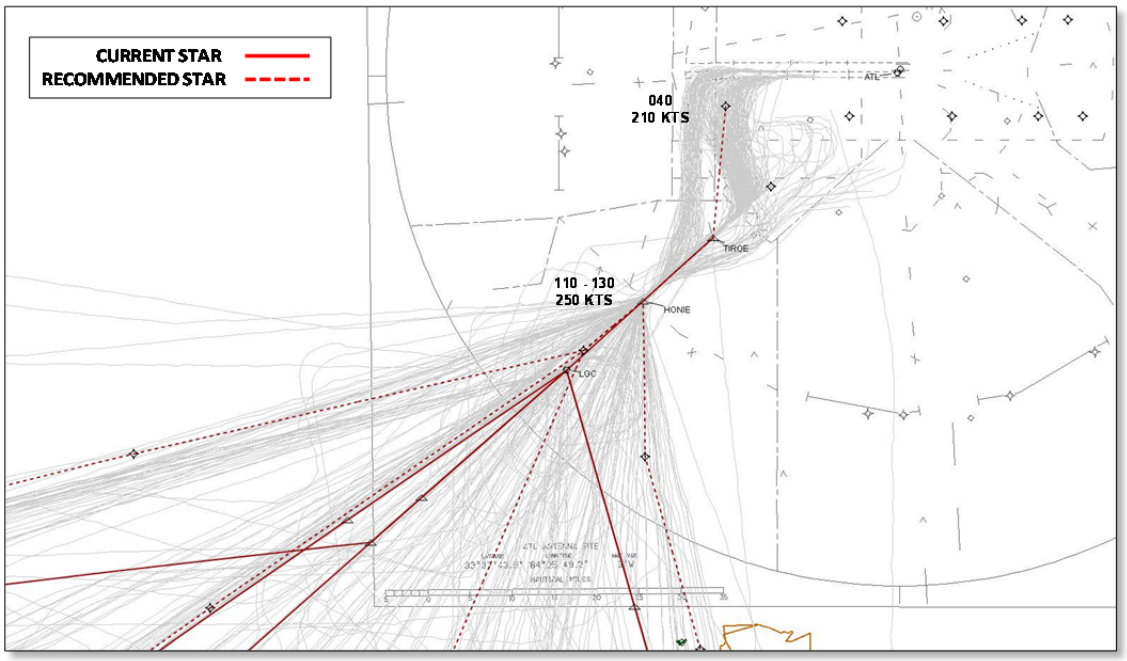

Figure 45. ATL Southwest Arrival – Recommended Solution A80 View (East Operation)

4.2.4.2 ATL Southwest Arrivals – Alternative Solution

ZTL expressed several concerns regarding the OST recommended solution:

- J73 traffic conflicting with SZW transition traffic. ZTL recommended designing the SZW transition west of J73 to accommodate a higher initial OPD altitude.
- ZTL requested that the location of the holding pattern and the merging of all transitions be accomplished further from the TCP. This will allow a single holding pattern for all transitions and allows for shortcuts on the SZW transition to aid in sequencing due to varying wind conditions.
- Figures 46, 47, and 48 depict the Alternative Solution for southwest arrivals in en route and terminal airspace configurations.

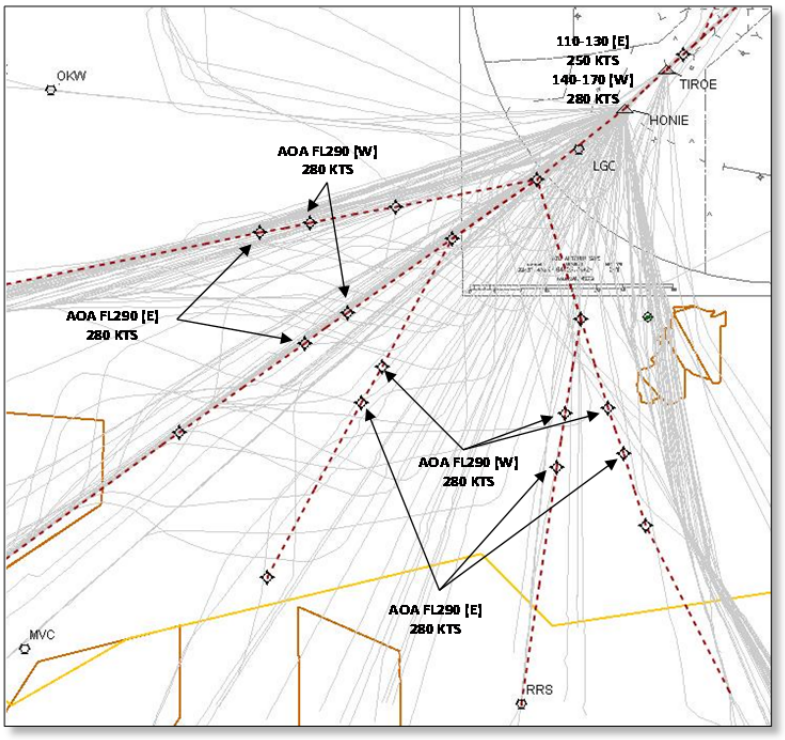

Figure 46. ATL Southwest Arrival – Alternative Solution

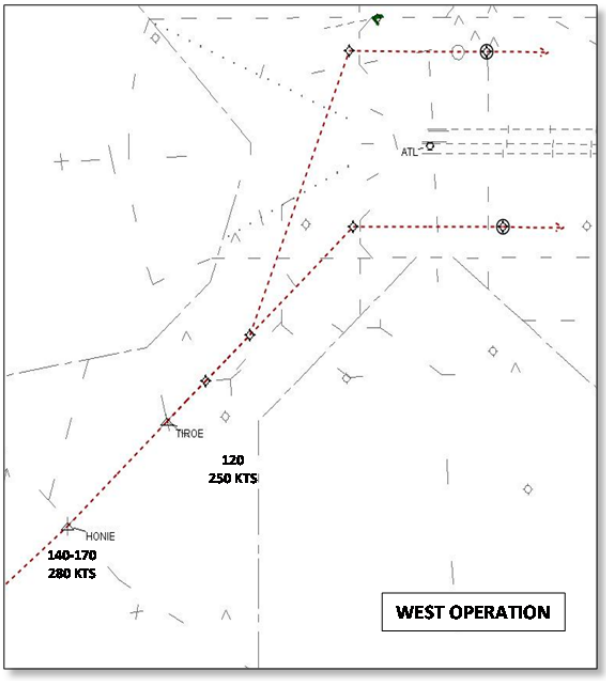

Figure 47. ATL Southwest Arrival – Alternative Solution A80 View (West Operation)

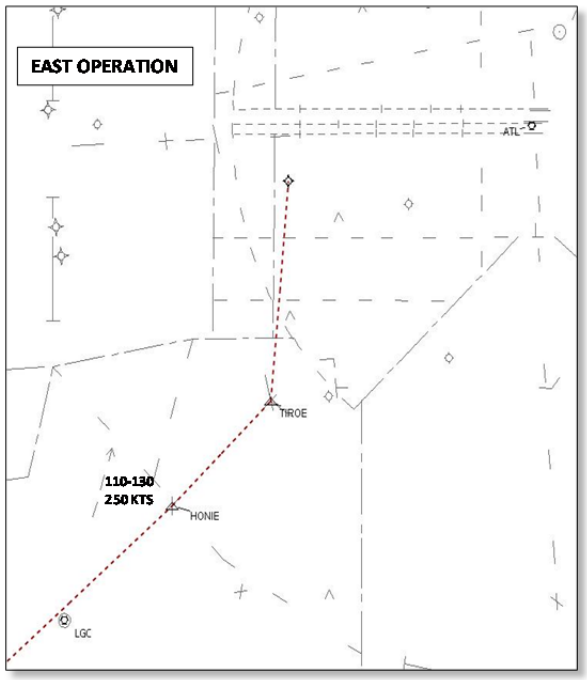

Figure 48. ATL Southwest Arrival – Alternative Solution A80 View (East Operation)

4.2.4.3 ATL Southwest Arrival Benefits

Table 13 shows the estimated annual benefits of the recommended and alternative solution for the ATL southwest STARs relative to the existing ATL southwest STARs. Initial environmental screening indicates minimal risk of significant noise impacts.

Table 13. ATL Southwest Arrivals – Estimated Annual Benefits

		Recommended		Alternative	
		Low	High	Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	($210K)	($210K)	($312K)	($312K)
	Profile	$1.3M	$4.0M	$1.3M	$4.0M
	Cost to Carry	$76K	$76K	($35K)	($35K)
Total Estimated Annual Fuel Savings (Dollars)		$1.2M	$3.9M	$953K	$3.7M
Total Estimated Annual Fuel Savings (Gallons)		408K	1.3M	335K	1.3M
Total Estimated Annual Carbon Savings (Metric Tons)		4K	13K	3K	13K

4.2.5 Summary of ATL Arrival Benefits

Arrival benefits were achieved using a multitude of tools from the OST PBN "toolbox". In general, level-offs were not a major issue in the en route environment other than the southwest arrival over HONIE intersection. These level-offs are a direct result of strong winds from the west and the interaction with departures on the JOGOR SID. The OST recommended solution minimizes the level-offs at this cornerpost by incorporating OPDs and redesigning the JOGOR SID. Level-offs in A80 airspace were identified. Aircraft are delivered to A80 at the TCP at a level altitude. After discussion with A80, it was determined that aircraft could possibly be delivered at higher altitudes crossing the TCP, still descending to an altitude that would provide for level segments in order to reduce controller task complexity for flowed traffic. All benefits were calculated assuming a FL290 starting point near the top of descent for most aircraft.

Optimized lateral paths were developed through analysis of historical flight tracks and designing routes as close to the tracks as possible. Some OST recommended PBN procedures increased lateral track distances in order to optimize holding patterns and the use of runway transitions. However, these increases are typically small and the benefit of OPDs significantly outweighs the additional mileage. Catch points on boundaries were developed as points that aircraft can file to

or be given direct routings from other facilities. These points will be finalized in partnership with other facilities to ensure that their placements are the most efficient for all involved. Additional distance and procedural de-confliction benefits may be realized once these catch points are incorporated.

Dual flows in the northwest and northeast were designed as recommended options since ATL's highest demand comes from these directions and dual routings are already in place. ZTL rarely uses the offload STARs because of holding pattern concerns. Airspace limitations do not permit separate holding patterns for each STAR to be established near the A80 boundary. In the event of no-notice holding initiated by A80, ZTL controllers are concerned regarding the ability to hold the number of aircraft using the dual STARs. Further investigation revealed that the current TMA settings are not designed for six flows of traffic, but instead the four that are normally used. This could explain why holding occurs when dual routings are used since A80 may become oversaturated with traffic in a short period of time. Alternative solutions were designed in the northwest and northeast due to concerns of merging dual flows on a short-side, TMA limitations, and oversaturation that may have an effect on throughput.

Table 14 depicts quantitative arrival benefits for all ATL arrivals. These benefits were determined from approximately 125 NM from the airport. OPDs account for almost all benefits. Minimal distance and cost to carry benefits are also realized. It is expected that future catch point placement may deliver additional distance benefits.

Table 14. ATL Arrivals – Estimated Annual Benefits

ATL Arrivals			
		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$404K	$404K
	Profile	$6.9M	$21.0M
	Cost to Carry	$375K	$375K
Total Estimated Annual Fuel Savings (Dollars)		$7.7M	$21.8M
Total Estimated Annual Fuel Savings (Gallons)		2.7M	7.5M
Total Estimated Annual Carbon Savings (Metric Tons)		27K	75K

4.2.6 Satellite Airport Arrivals

4.2.6.1 AWSON Arrival

Issues

- Historical flight tracks do not follow current arrival procedures. The majority of aircraft are cleared from the ZID and ZDC boundaries direct to AWSON intersection, the TCP between A80 and ZTL.
- Inefficient vertical profiles. Satellite aircraft are often forced below ATL arrivals or ATL SUMMT departures over VXV, resulting in level-offs or early descents.
- Figure 49 depicts the current AWSON arrival.

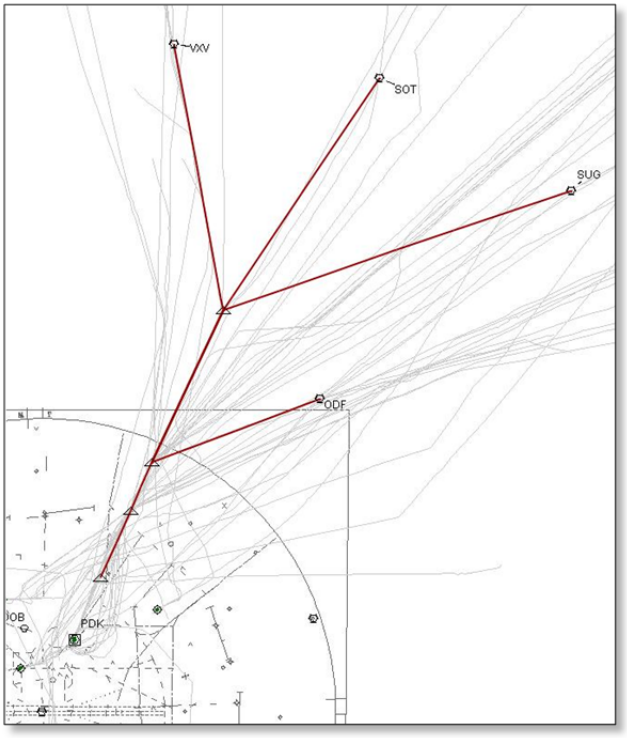

Figure 49. Current AWSON Arrival

Recommendations

- Optimize lateral paths to align with current flight paths
- Create waypoint east of VXV to procedurally de-conflict from SUMMT departures.
- Figure 50 depicts the recommended solution for the AWSON arrival.

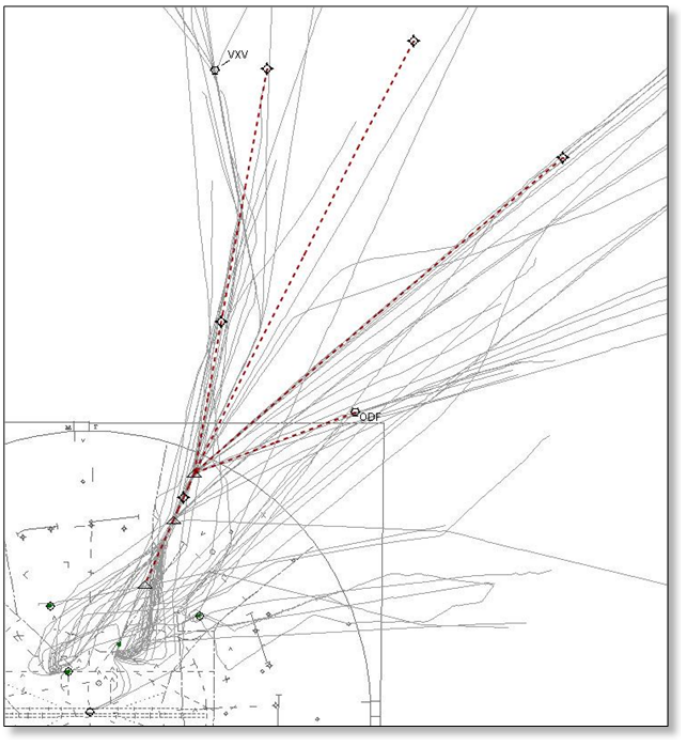

Figure 50. Recommended Solution – AWSON Arrival

Figure 51 shows the interaction between the recommended solution for the AWSON Arrival and the recommended solution for the SUMMT Departure.

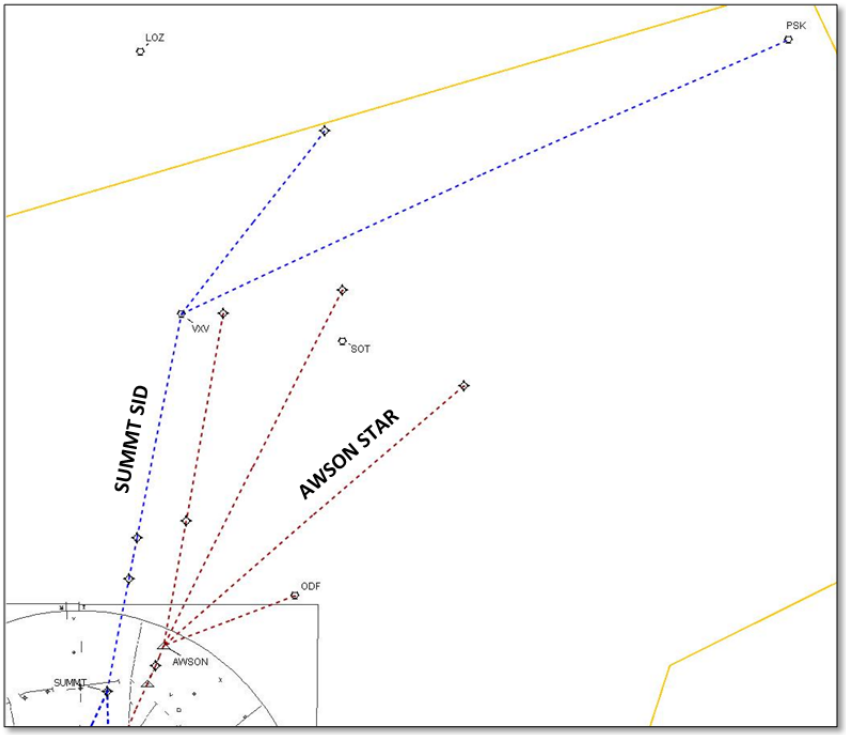

Figure 51. Interaction between the Recommended AWSON Arrival and SUMMT Departure

4.2.6.2 JRAMS Arrival

Issues

- The CANUK and JRAMS STARs are not procedurally de-conflicted, resulting in forced level-offs or non-optimal altitude assignments.
- Actual flight tracks do not follow current arrival procedures. The majority of aircraft are cleared to TRBOW intersection, the TCP between A80 and ZTL.
- Figure 52 depicts the current JRAMS arrival.

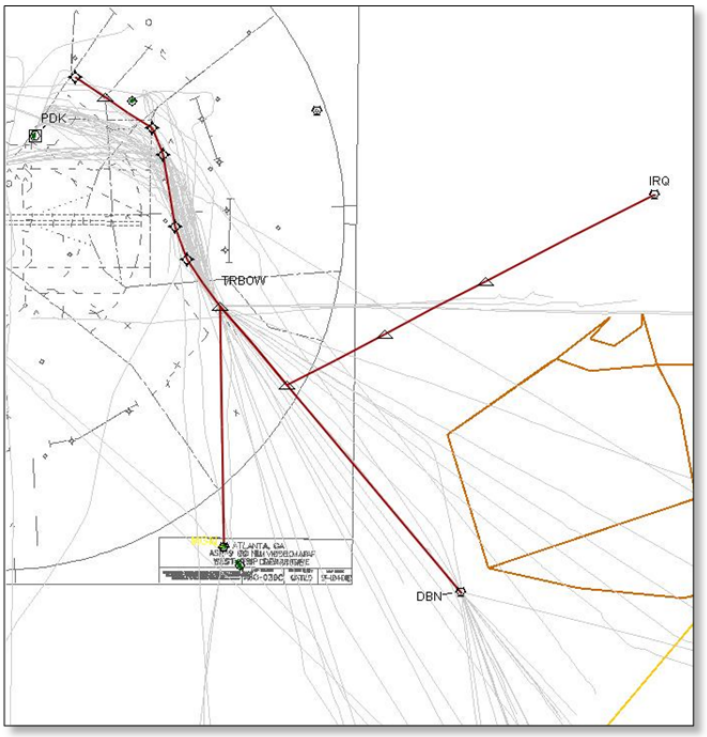

Figure 52. Current JRAMS Arrival

Recommendations

- Optimize lateral paths to align with current flight paths.
- Design transitions near IRQ and over Dublin VORTAC (DBN) to remain procedurally separated from the recommended CANUK STAR.
- Design a transition on the JRAMS STAR to remain south of IRQ to de-conflict with MUNSN SID traffic.

- Create catch point in ZJX airspace to procedurally separate from the recommended CANUK STAR.
- Figure 53 depicts the recommended solution for the JRAMS arrival.

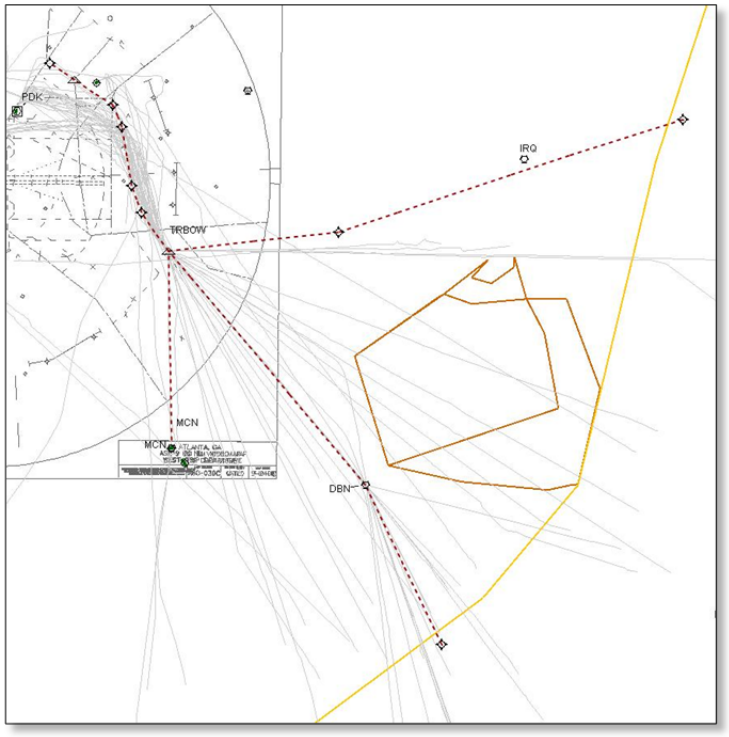

Figure 53. Recommended Solution – JRAMS Arrival

Figure 54 shows the interaction between the recommended solution for the JRAMS arrival and the recommended solution for the CANUK arrival.

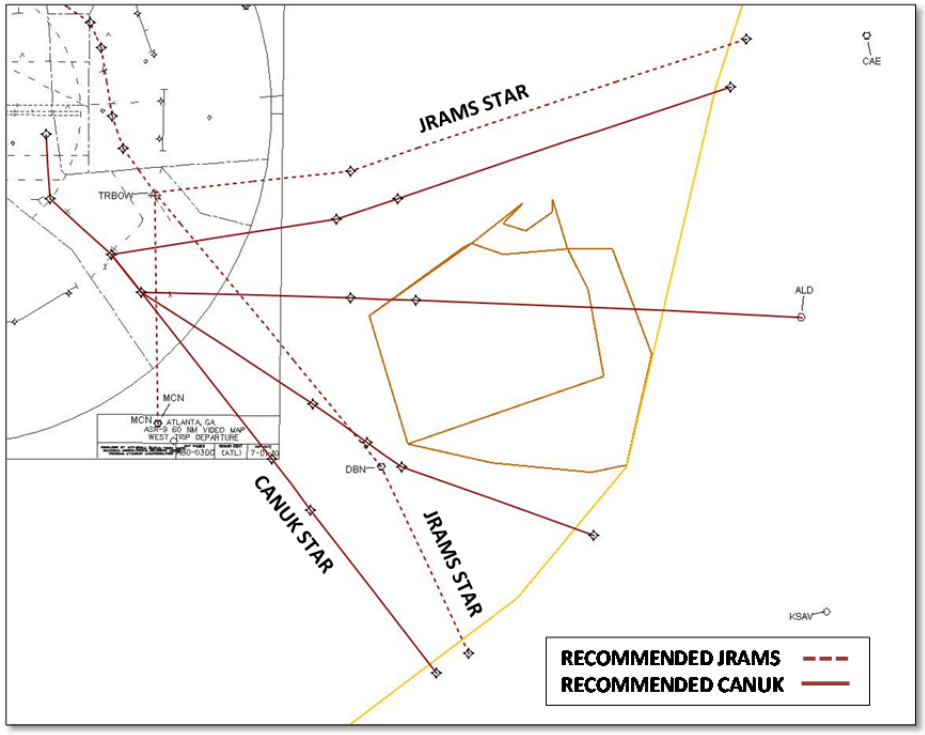

Figure 54. Interaction between the Recommended JRAMS Arrival and CANUK Arrival

4.2.6.3 DIFFI Arrival

Issues

- ATL satellite non-turbine powered propeller driven arrivals are routed via Fix/Radial/Distance and must be issued lengthy ATC clearances.
- DIFFI arrival is a turbojet and turboprop arrival only.
- Figure 55 depicts the current DIFFI arrival.

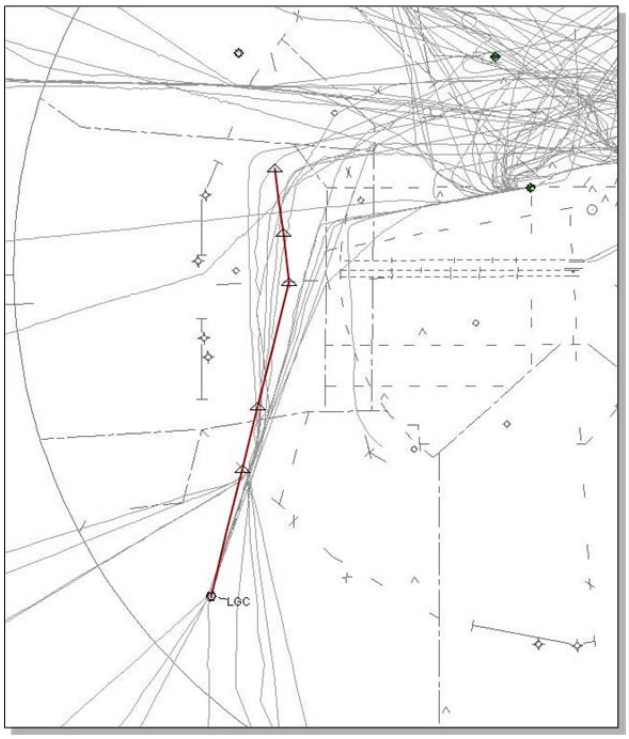

Figure 55. Current DIFFI Arrival

Recommendations

- Create an RNAV procedure that emulates current DIFFI STAR
- Change DIFFI STAR language to include props or change LOA with ZTL to permit heading or other suitable method for aircraft delivery
- Figure 56 depicts the recommended solution for the DIFFI arrival.

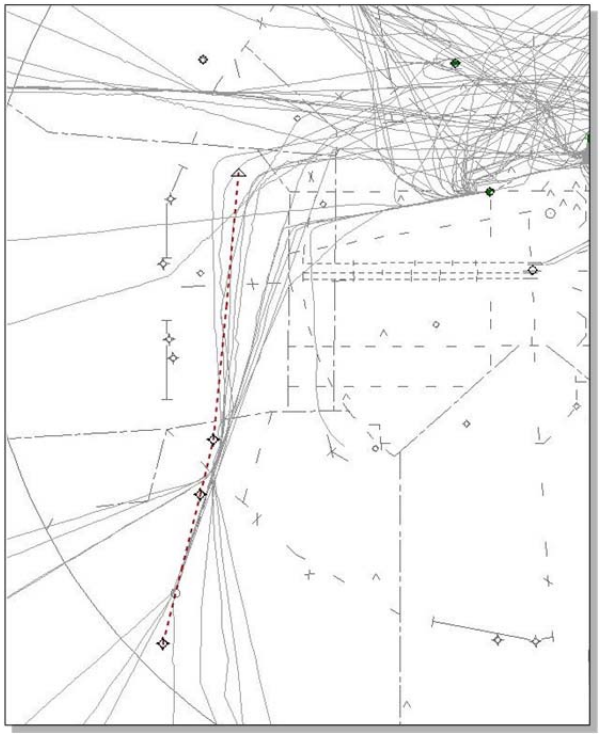

Figure 56. Recommended Solution – DIFFI Arrival

4.2.6.4 V325.CARAN..DALAS and BUNNI Arrival

Issues

- BUNNI arrivals conflict with ATL COKEM departures. Aircraft that are routed over the Chattanooga VORTAC (GQO) transition of the BUNNI arrival are head-on with ATL COKEM departures.
- Additional airspace required to descend BUNNI arrivals through ATL departures due to the proximity of the ZID/ZTL low altitude airspace boundary. Increased ATC task complexity required to coordinate with ZID.
- No BNA transition exists on the BUNNI STAR.
- V325.CARAN..DALAS route is defined by the A80/ZTL LOA and a STAR does not exist. These arrivals conflict with RMBLN departures.
- There are no current RNAV procedures.
- Figure 57 depicts the current V325.CARAN..DALAS and BUNNI arrivals.

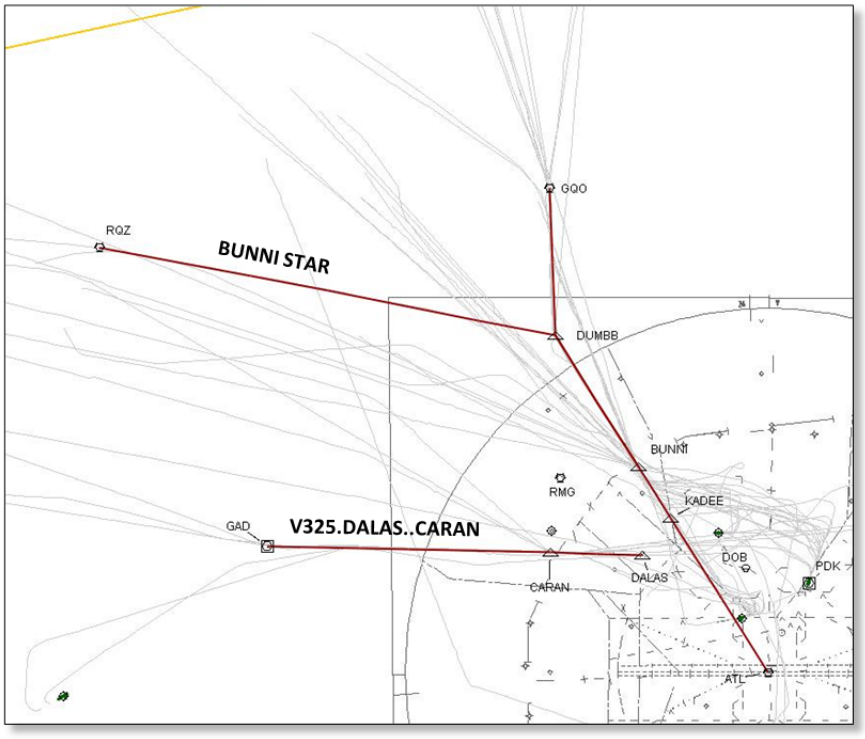

Figure 57. Current V325.CARAN..DALAS and BUNNI Arrivals

Recommendations

- Create RNAV STARs for both procedures that optimize lateral paths to align with current flight paths.
- Create catch point on BUNNI STAR in ZID airspace to accommodate BNA area traffic and procedurally separate from the recommended ERLIN arrival.
- Create catch points on V325.CARAN..DALAS STAR in ZME airspace to procedurally separate from the recommended RMBLN departure.
- Catch points in ZID and ZME airspace can be used for direct routings and altitude restrictions required by current LOAs.
- Establish waypoint where lateral separation terminates between BUNNI and ERLIN arrivals to reduce ATC task complexity when assigning altitude restrictions.
- Create a transition waypoint for traffic over GQO.
- Figure 58 depicts the recommended solution for the V325.CARAN..DALAS and BUNNI arrivals.

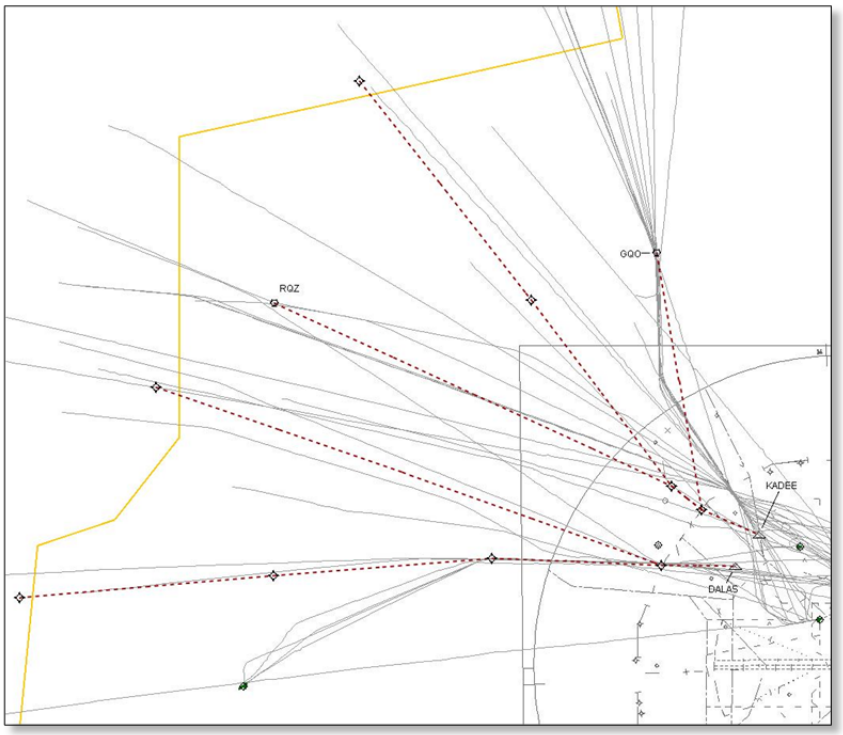

Figure 58. Recommended Solution – V325.CARAN..DALAS and BUNNI Arrivals

Figure 59 shows the interaction between the recommended solutions for V325.CARAN..DALAS and BUNNI procedures with the recommended solutions for the ERLIN, HERKO, RMBLN and COKEM procedures.

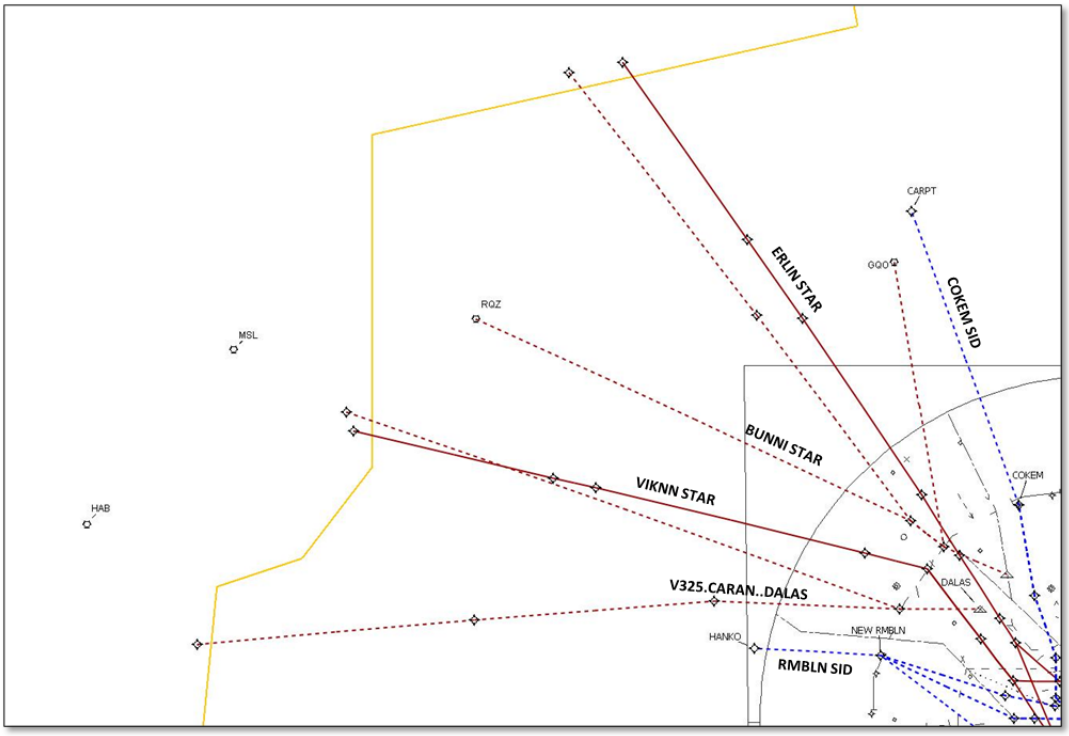

Figure 59. Interaction between the Recommended V325.CARAN..DALAS, BUNNI, ERLIN, HERKO, RMBLN and COKEM Procedures

4.2.7 Proposed Arrivals – Qualitative Benefits, Impacts, and Risks

Tables 15 and 16 outline the qualitative benefits, impacts and risks from the FAA and airspace user perspective for ATL and satellite airport arrivals. Initial environmental screening indicates minimal risk of significant noise impacts.

Table 15. Proposed Arrivals – Benefits, Impacts and Risks (FAA)

Operational/Safety	
Benefits	**Impact/Risks**
- Reduces sequencing of arrival flows for ZTL - Increases opportunity to permit aircraft to fly OPDs by not having to merge multiple flows in en route airspace - More predictable flight paths and descent profiles - Reduces ATC task complexity - Reduces Traffic Alerts on tightly spaced fixes - Enhance safety due to significant reduction of control instructions (reduces chance for controller/pilot read-back/hear-back errors - Procedurally de-conflicts satellite airport and ATL traffic	- May require airspace modifications - More coordination may be required during weather events - Opportunity to overload A80 airspace - En route facilities assign STAR based on ATL landing direction, creating increase in ATC task complexity - Holding pattern design for dual STARs - Mixed equipage/type aircraft increases controller task complexity
	Initial Environmental Screening
	- Environmental Assessment required - No additional flight tracks below 10,000 feet MSL for ATL procedures - Routes do not appear to overlay any National Parks or Wilderness Areas

Table 16. Proposed Arrivals – Benefits, Impacts and Risks (Airspace User)

Airspace User	
Benefits	**Impact/Risks**
- Reduces vectoring for arrival flow sequencing - Reduces distance flown - Reduces fuel burn and emissions - Reduces pilot task complexity - Promotes more efficient use of ATL RNAV OPD STARs	- Increases flying distances for some arrival flows

4.3 ATL ATCT Issues

The OST met with ATL ATCT personnel regarding airspace and procedural issues. The ATL ATCT operation is very efficient and ground controllers optimize departure operations by queuing departing aircraft to enable the most efficient departure sequence. The implementation of ELSO procedures should enhance departure rates, particularly off RWYs 8R and 27R. Two departure procedure issues were addressed by the OST and recommended solutions were developed.

4.3.1 Cross Complex Departures

Issue

- Cross Complex Departures create additional coordination and departure delays
  - As shown in Figure 60, aircraft departing the center runway for operational purposes delay aircraft departing the north runway. ATL ATCT operates by assigning specific departure fixes to specific runways which allows independent operations on each departure runway (e.g., all north departures depart the northern most departure runway, which is RWY 26L). Due to operational purposes (e.g., weight) some north departures are required to depart RWY 27R (the longest runway at ATL). After departure, their flight paths cross the RWY 26L departure corridor, causing delays.
  - ATL ATCT controllers must delay RWY 26L departures until cross complex departures have cleared their departure corridor.

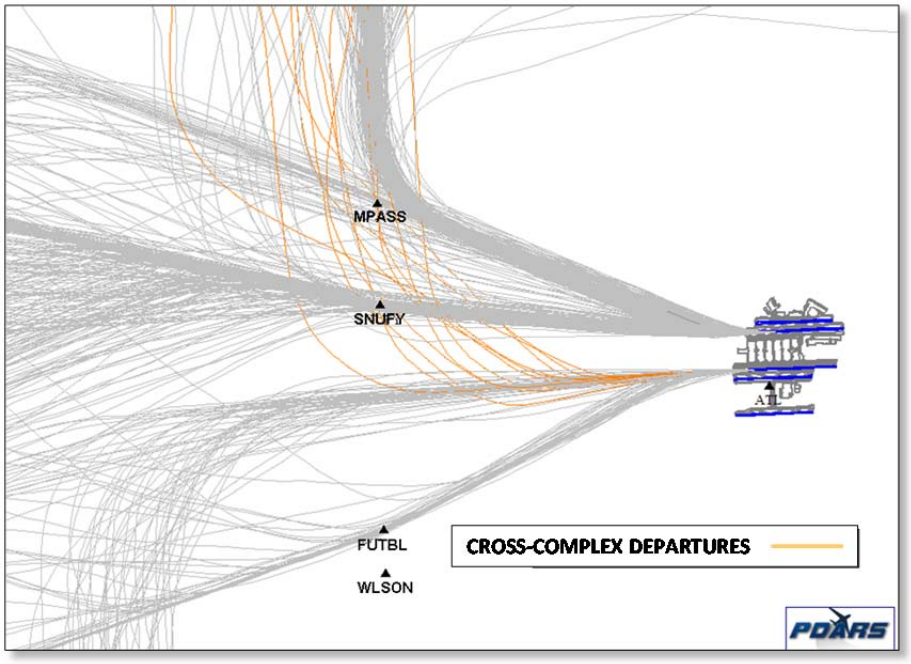

Figure 60. Cross Complex Departure Issue

Recommendation

- ELSO was implemented on October 20, 2011. These new procedures create clearly defined paths for cross complex departures and flight paths cross over sooner. Further review by D&I is recommended to determine if ELSO has reduced delays and coordination to an acceptable level.

Figure 61 shows the ELSO Cross Complex Departure Design.

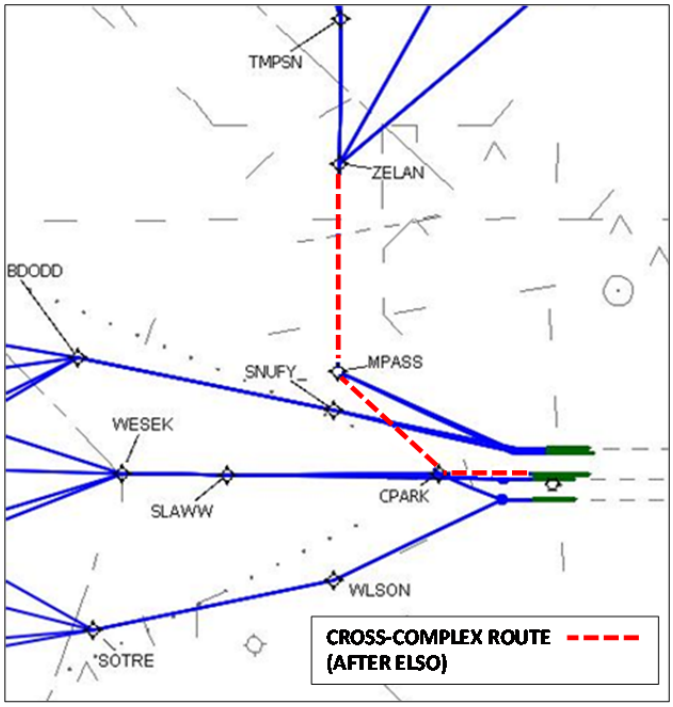

Figure 61. Recommended Solution – ELSO Cross Complex Departure Design

4.3.2 Single Departure Routes on NE/SW Departure Configuration

Issues

- As shown in Figure 62, only a single off the runway RNAV track is available from each departure runway when ELSO procedures are implemented and:
  - ATL is in a dual east departure operation
  - The north and east SIDs depart from the north departure runway
  - The south and west SIDs depart from the center departure runway
- Independent operations cannot be conducted off of the south and center runways when ELSO procedures are implemented and:
  - ATL is in a triple East Operation
  - The north and east SIDs depart from the north departure runway
  - The south SIDs depart from the center departure runway
  - The west SIDs depart from the south departure runway
- Reduces departure rate from a maximum of 138 (triple departure runway rate) to 92 (dual departure runway rate using a single track)
- These configurations occurred for a total of 16 hours from 7/1/2011 to 8/9/2011 and were mostly due to weather-related activity.

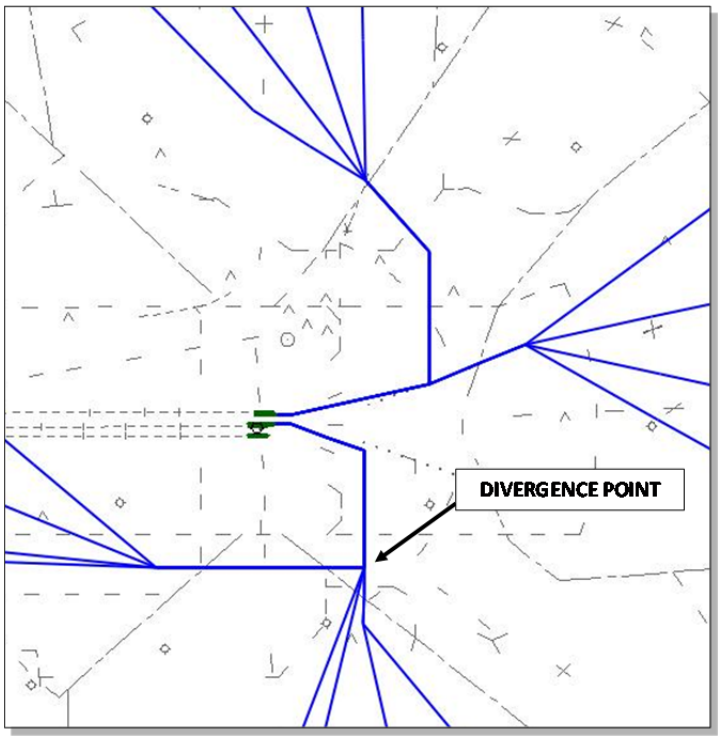

Figure 62. Current Single Departure Route (NE/SW Departure Configuration)

Recommendations

- Develop an ATC assigned RNAV SID to permit aircraft on southbound SIDs to depart the center complex on a runway-heading procedure, similar to southbound SIDs on a West Operation. This will require tower controllers to re-issue the SIDs to all affected aircraft, which may increase ATC task complexity. These procedures will permit dual RNAV tracks on a dual east departure runway configuration and independent operations on a triple east departure runway configuration.
- Design procedure as a single SID with multiple transitions to reduce ATC and pilot task complexity.
- Figure 63 depicts the recommended solution for dual departure routes on a NE/SW departure configuration.

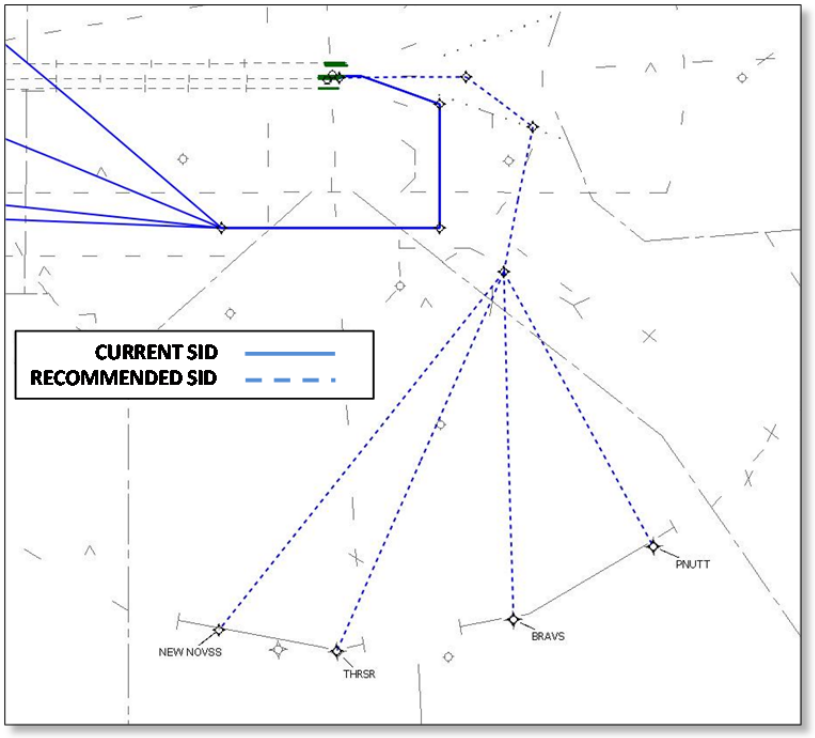

Figure 63. Recommended Solution – Dual Departure Routes (NE/SW Departure Configuration)

4.4 T-Routes

Issue

- Designated routes are not available for aircraft to file in order to circumnavigate busy A80 airspace. ZTL commonly vectors or reroutes aircraft around A80, resulting in increased track miles flown and ATC/pilot task complexity.

Recommendation

- Design T-Routes to allow predictable, repeatable routes through A80 airspace that are procedurally de-conflicted from arrivals departures, and SAAs. The recommended solution is depicted in Figure 64. These routes would remain within A80 airspace and promote connectivity to the current airway structure. Routes are designed through the "corridor" over the top of ATL.

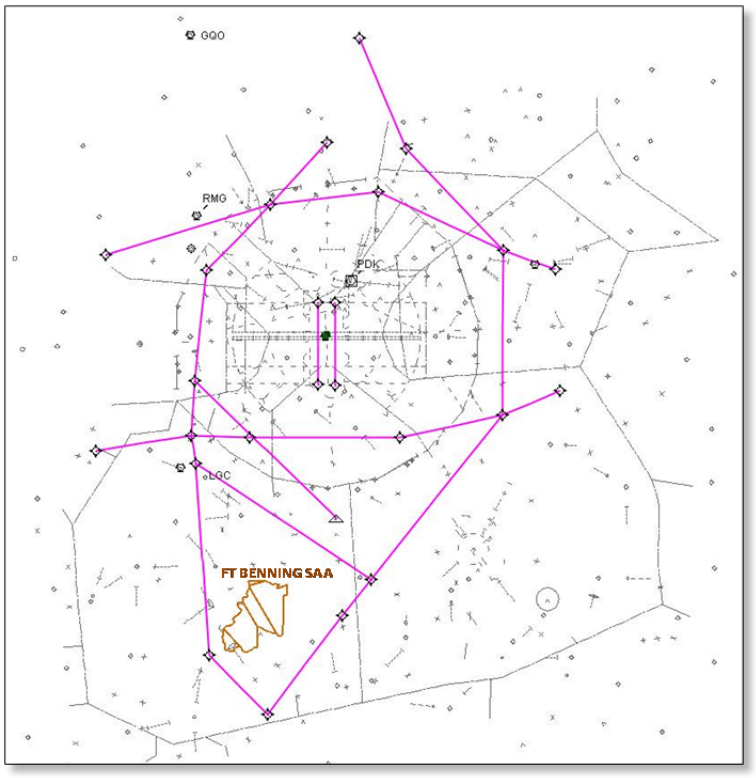

Figure 64. Recommended Solution – T-Routes

4.5 Airspace Issues

Airspace modifications designed to reduce ATC task complexity usually go unnoticed by the airspace user. These changes typically reduce coordination required between controllers and allow them to complete other tasks that move aircraft more efficiently. The facilities addressed several issues with regard to airspace. Airspace shelves in the northwest and northeast arrival areas are recommended to meet FAA requirements for the assignment of runway transitions.

ELSO procedures went into effect on October 20, 2011. It is believed that these new procedures will change flight tracks and require several boundary changes in the areas of TCPs between A80 and ZTL. Boundary changes were recommended to aid in sequencing of CLT arrivals by reducing coordination and to reduce point-outs.

The OST performed a cursory evaluation of ZTL airspace stratification. The OST recommends a more detailed evaluation be conducted and expects benefits to be identified.

4.5.1 A80 Northeast and Northwest Arrival Airspace

Issue

- Current airspace does not permit timely assignment of proposed short-side runway transitions. In order to facilitate OPDs on the short-side, the OST designed runway transitions. Runway transitions must be assigned at least 10 NM from the transition waypoint. Operational requirements dictate that transition waypoints must be approximately 10 NM from the current A80 airspace boundary. The location of the current boundary and the 10 NM operational requirement does not permit A80 to assign these short-side transitions in a timely manner.

Recommendation

- Design arrival airspace extensions at altitudes between 10,000 and 14,000 feet (mean sea level [MSL]) and relocate the A80 TCP to 50 NM as shown in Figure 65. This will facilitate A80's ability to issue runway transitions in a timely manner. The recommended OPD design allows aircraft to enter this airspace extension from above. The OST reviewed PDARS traffic data and observed that no overflight traffic used the arrival airspace extension.

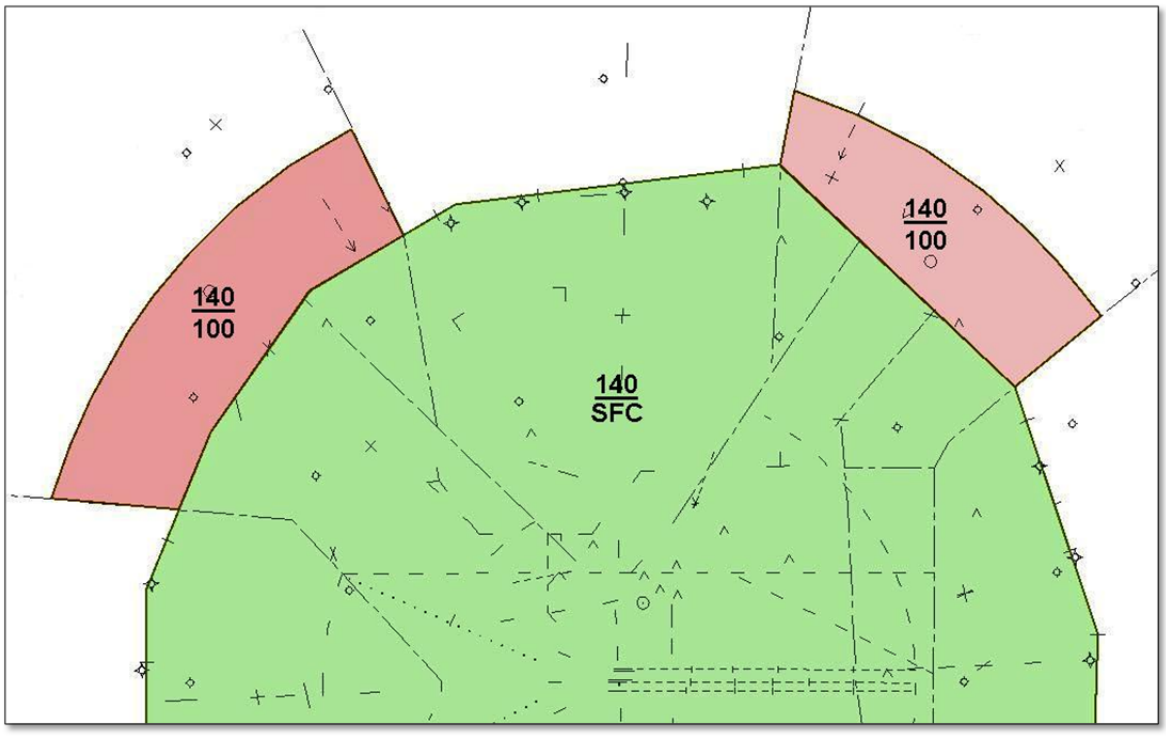

Figure 65. Recommended Solution – A80 Arrival Airspace Extensions

4.5.2 ATL South SIDs through ZTL East Departure Airspace

Issue

- Inability to climb ATL south departures on a West Operation without coordination. ATL PNUTT and BRAVS SIDs are often given direct routings to A80 exit waypoints. These aircraft reach the vertical limit of A80 airspace prior to entering the lateral confines of ZTL Sector 21 as shown in Figure 66. These aircraft must be pointed-out to ZTL Sector 04 in order to climb above A80 airspace.

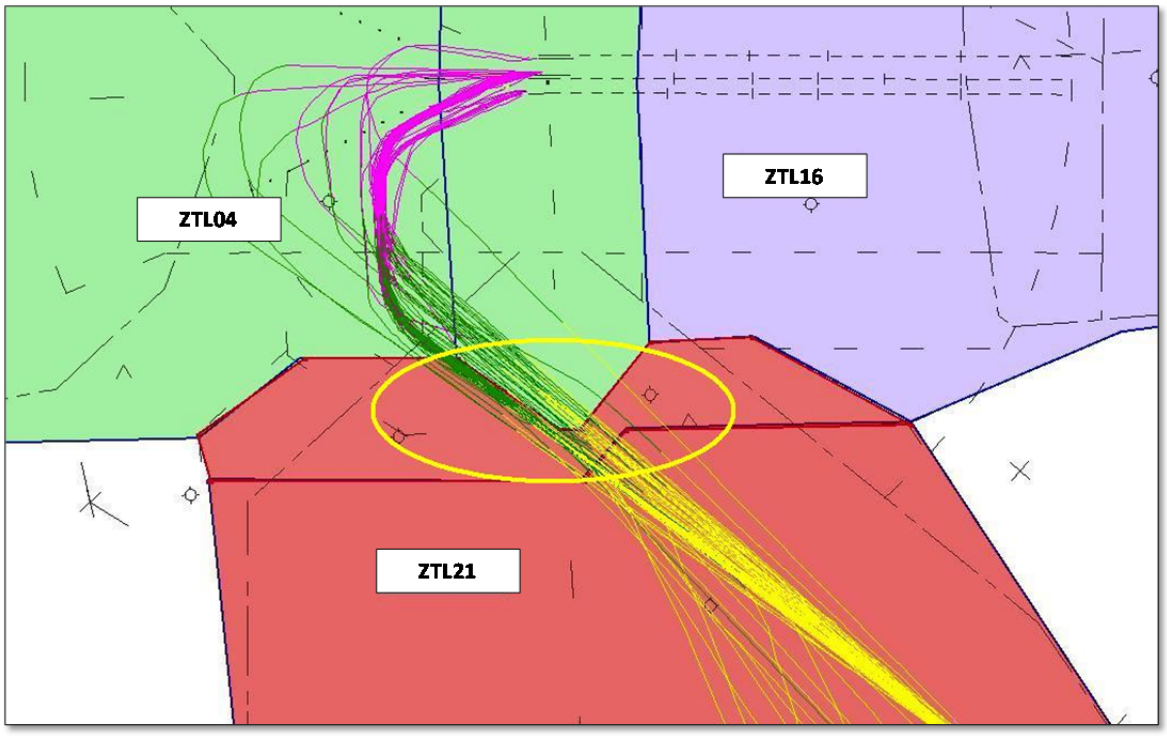

Figure 66. Recurrent Point-Outs – ZTL Sectors 04, 16 and 21

Recommendation

- Modify ZTL Sectors 04, 16 and 21 to permit continuous climb for the ATL PNUTT and BRAVS SID departures that are given direct routings to the A80 exit waypoints. The OST did not finalize a design for this recommended solution, as further analysis is required due to the implementation of ELSO altering climb profiles.

4.5.3 ATL East SIDs through ZTL East Departure Airspace (ZTL Sectors 22 and 32)

Issue

- Inability to climb ATL east departures on a West Operation without coordination. These departures typically level-off in ZTL Sector 22 prior to entering the lateral confines of ZTL Sector 32. ZTL Sector 32 must coordinate with ZTL Sector 22 in order to climb these aircraft.

Recommendation

- As shown in Figure 67, extend the existing ZTL Sector 32 FL240-270 airspace shelf west, in order to permit aircraft to enter ZTL Sector 32 airspace sooner. The ceiling of the expanded shelf will be raised to FL290. These modifications will allow aircraft departing east on a West Operation to make continuous climbs without coordination.

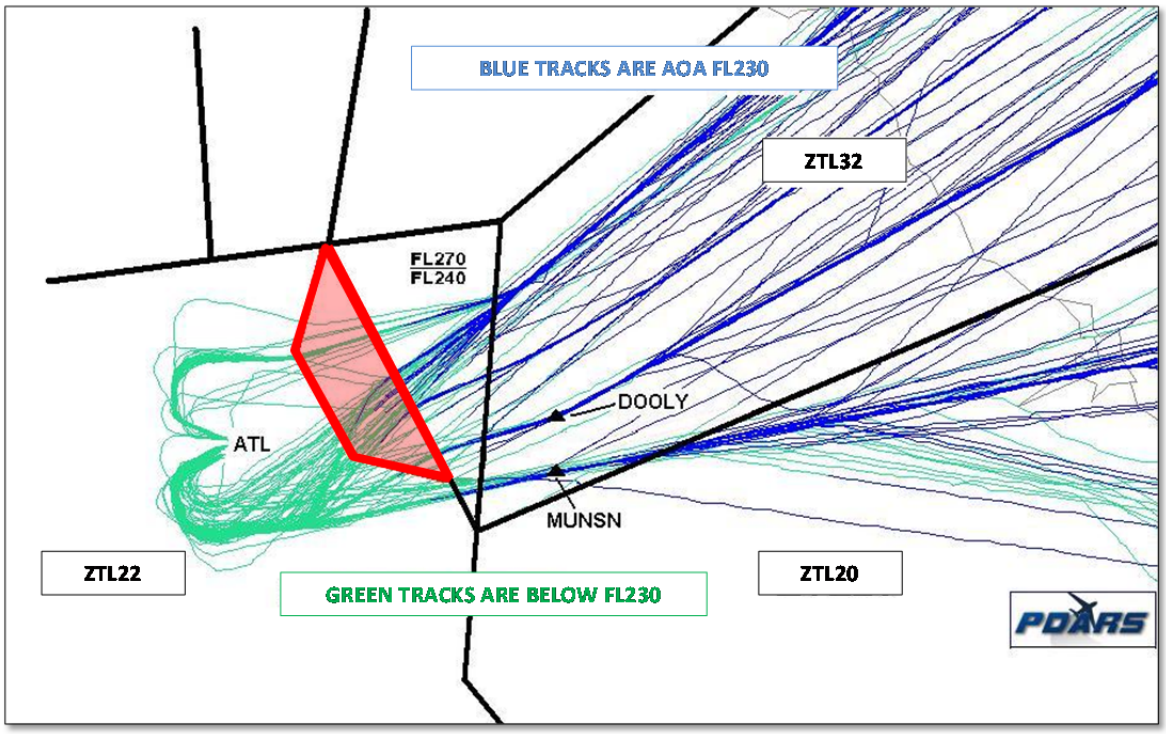

Figure 67. Recommended Solution – Modifications to ZTL Sectors 22 and 32

4.5.4 ATL East SIDs through ZTL East Departure Airspace (ZTL Sectors 20 and 32)

Issue

- Inability to climb DOOLY SID departures on a West Operation without coordination and inability to turn CLT arrivals for sequencing without coordination. Currently MUNSN SID departures transition ZTL Sector 32 prior to entering ZTL Sector 20, which can result in increased coordination and/or level-offs. The current ZTL Sector 20 and 32 airspace boundary restricts controllers' ability to vector CLT arrivals to the southeast without coordination.

Recommendation

As shown in Figure 68, relocate the common boundary of ZTL Sectors 20 and 32 beginning at a point equidistant between DOOLY and MUNSN waypoints; extending east to a point where the ZTL-ZJX boundary bends between ZJX Sector 66 and ZTL Sector 20.

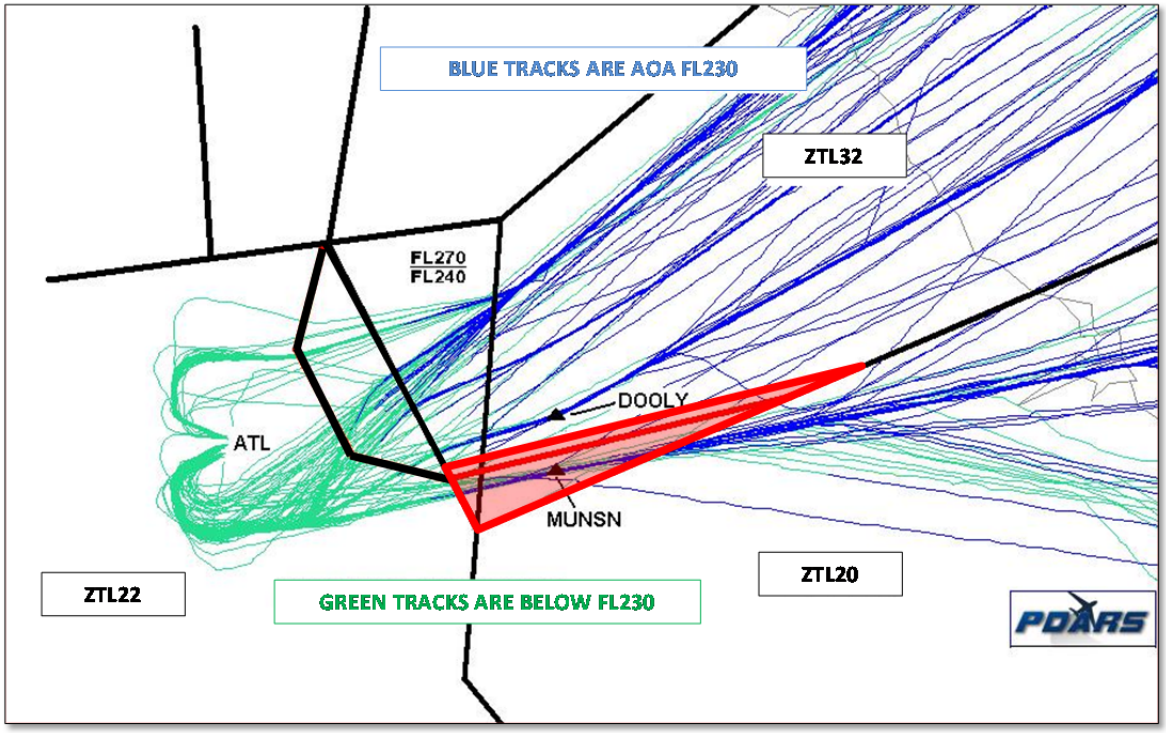

Figure 68. Recommended Solution – Modifications to ZTL Sectors 20 and 32

4.5.5 COKEM Airspace Change

Issue

- COKEM SID departures must routinely be pointed-out to ZTL Sector 05. ZTL Sector 05 has a ceiling of FL230. Slow climbing aircraft cannot top this sector and must be pointed-out.

Recommendation

- As shown in Figure 69, ZTL has already proposed a boundary change to resolve this issue. The OST concurs with the facility airspace boundary change proposal between ZTL Sectors 05, 38, and 41 associated with COKEM SID.

Figure 69. Recommended Solution – Modifications to ZTL Sectors 05 and 38

4.5.6 ZTL Airspace Stratification

Issue

- Current stratification may not be compatible with OPDs and may not provide an optimal distribution of traffic.

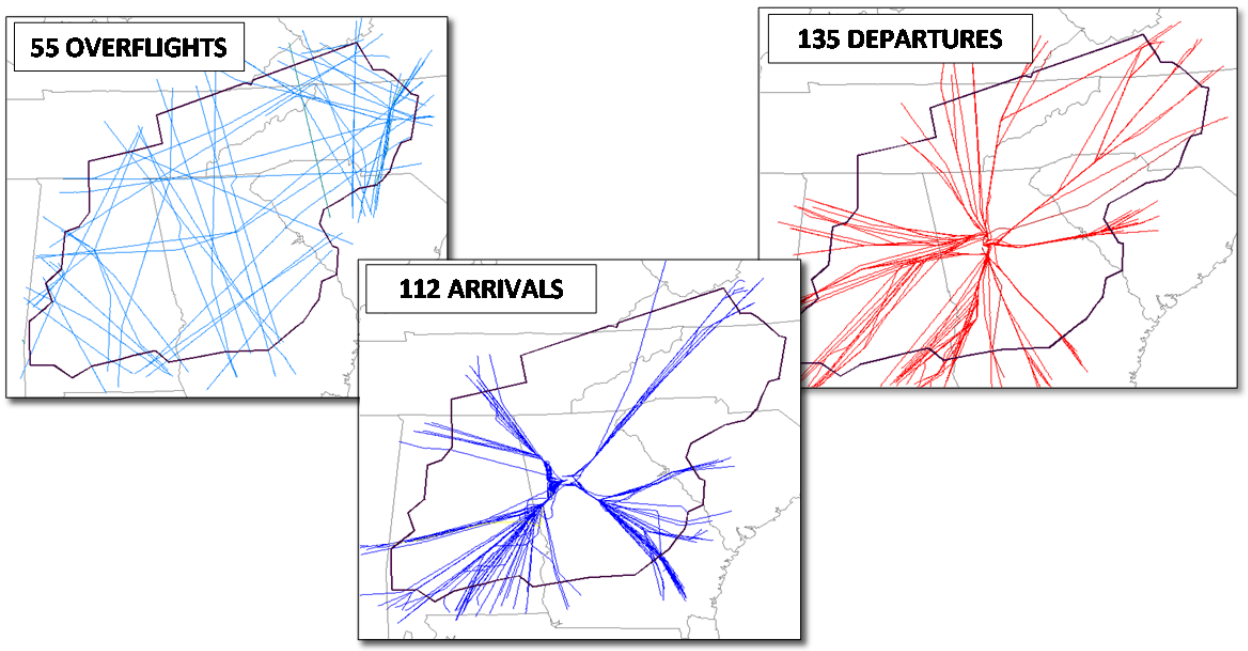

Figure 70. ZTL Airspace Stratification

Recommendation

- Identified several ZTL departure sectors that have airspace shelves from FL240-270. A center-wide re-stratification to include surface up to FL270 should be investigated for a balanced split. The OST did not fully investigate the potential benefit of a ZTL airspace stratification. Figure 70 illustrates the preliminary analysis performed by the OST showing the impact of raising the ceiling of low altitude sectors to FL270. This would result in a transfer of approximately 55 overflights, 110 arrivals, and 134 departures from high altitude to low altitude sectors. Although this shift in traffic does not appear to be substantial (approximately four percent of all ZTL traffic), further investigation is required to identify the potential benefits, including an examination by sector. The Washington, DC, CLT and ATL OAPM D&I Teams are the appropriate avenue for this concept to be considered.

4.6 Additional Issues Recorded For Consideration

The Atlanta OST identified and characterized a range of issues and developed a number of conceptual solutions; however, some issues require additional coordination and input and could not be addressed within the time constraints of the OST process. Other stakeholder-identified issues were considered to be outside the OAPM process since they did not involve optimization of airspace and procedures. These issues may be explored further during D&I or outside of the OAPM process.

4.6.1 Speed restrictions on ATL and Satellite Airport Departures

ZTL identified concerns with aircraft performance differences on the same SIDs. Since both ATL and satellite airport turbojet departures use the same departure areas, satellite departures were included in this issue. In order to account for performance differences between aircraft, the current A80/ZTL LOA requires a minimum of seven NM constant or increasing separation between aircraft on the same SID. ZTL is requesting that a speed restriction be considered on all ATL and satellite airport turbojet departures. The OST did not offer a solution, and recommends this issue be addressed during D&I or outside of the OAPM process.

4.6.2 Reduced mileage in A80 Airspace for Satellite Airport Departures

Turbojet and turboprop aircraft departing A80 airspace to east coast airports (landing at, or located south of SAV) are currently routed via A80 south departure gates. Vectoring aircraft to these departure gates from the northern Atlanta satellite airports (primarily LZU) can lead to circuitous routings and extended low level segments. A80 requested these aircraft be routed via east departure gates to reduce level-offs and ATC task complexity in A80 airspace. ZTL advised routing these aircraft via east departure gates causes conflictions with southeast cornerpost arrivals. The OST did not offer a solution, and recommends this issue be addressed during D&I or outside of the OAPM process. Figure 71 shows the current and proposed departure routes.

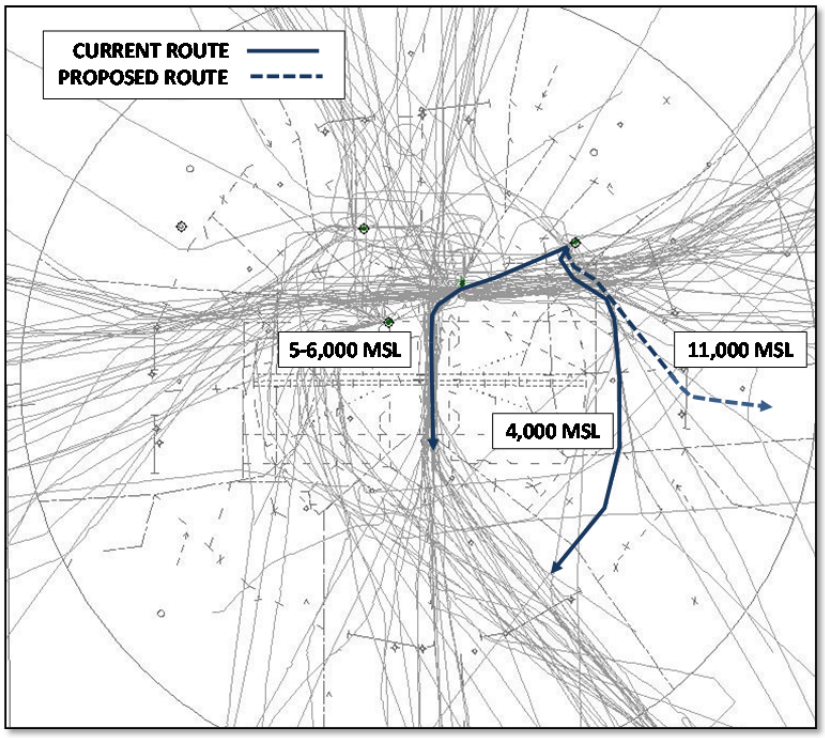

Figure 71. Satellite Routes for South Departures (Current and Proposed)

4.6.3 Increasing Departure Rate

Previously, ATL ATCT requested a waiver to reduce initial longitudinal separation requirements for consecutive non-wake generating departures on the same initial heading/track. This waiver request was not approved. ELSO procedures partially mitigated this situation by providing additional diverging tracks on all dual departure runway configurations. MITRE is presently preparing a study on reduced initial longitudinal separation requirements and will provide the information to the Atlanta facilities pending public disclosure approval.

4.6.4 Ramp Turn-Arounds

Delta Air Lines (DAL) company policy prohibits aircraft from making a 180 degree turn inside the ATL ramp areas. The other primary stakeholders at ATL (Atlantic Southeast Airlines and AirTran Airways) permit this practice. By not permitting aircraft to make these turns, an ATC clearance is required for DAL aircraft to enter an active taxiway and make the requested turn-around. During busy periods, this causes potential delays for aircraft on the taxiways and additional frequency congestion. OST research, in collaboration with industry partners, indicates that DAL considers this a safety issue due to previous jet blast incidents on the ramp. DAL informed the OST that this policy will not change at this time. Figure 72 depicts a busy ATL period and shows the potential impact of a turn-around aircraft on adjacent taxiways.

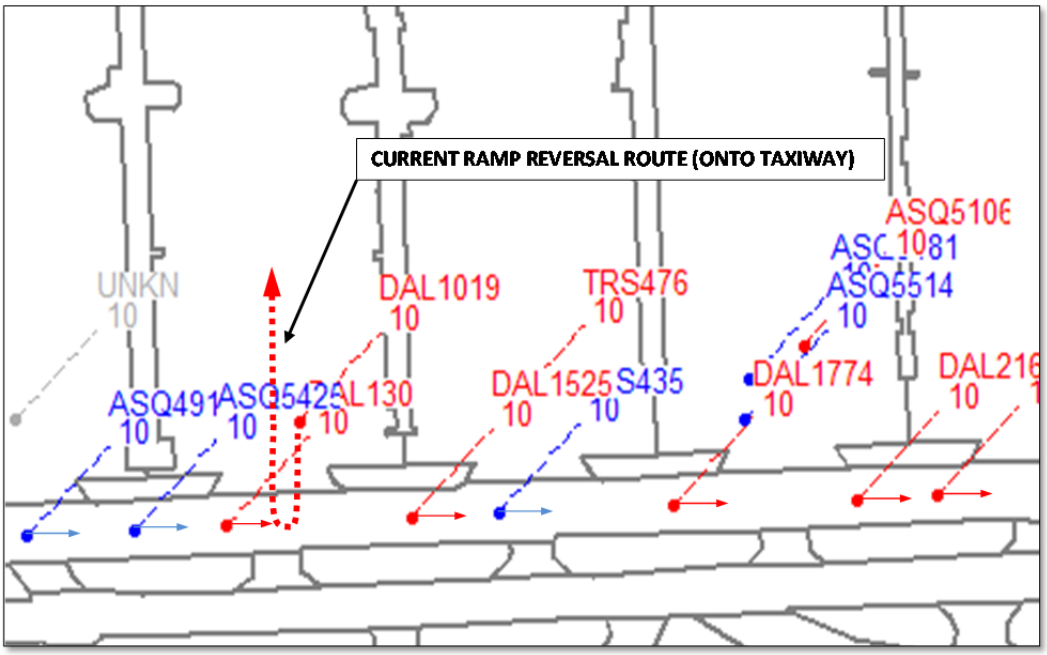

Figure 72. Ramp Turn-Around Issue

4.6.5 Difficulty in Tower Sequencing for Flow Management Windows

Release times for departure aircraft to comply with flow management windows can be difficult to plan for at ATL. Controllers are given a five minute window (flow management window) to comply with traffic management initiatives (TMIs). ATL has minimal hold areas for these aircraft and must sequence them in an extended taxi queue with other departing traffic. Due to a variety of reasons, the aircraft may reach the runway prior to its window and cause delays for subsequent aircraft. The aircraft may arrive at the runway late for its time and delay subsequent aircraft as a new time is coordinated.

Interviews with facility personnel indicated that during taxiway construction projects, special TMIs were implemented at ATL that did not require specific release times for ATL departures. The special TMI program was successful.

The ZTL Airspace and Procedures Manager (ZTL-530) is investigating the tower sequencing for flow management windows outside OAPM process. Figure 73 shows ground control congestion during typical busy ATL departure periods and depicts the difficulty in sequencing to meet flow management windows.

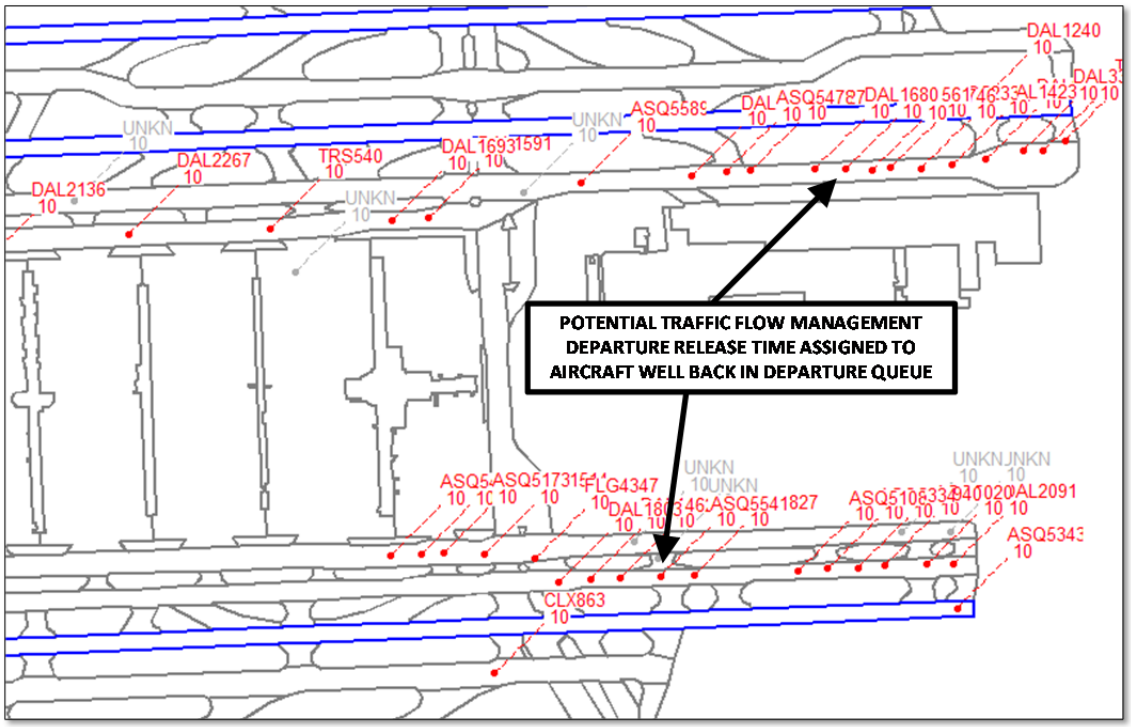

Figure 73. ATL Ground Congestion – Departure Queue

5 Summary of Benefits

5.1 Qualitative Benefits

5.1.1 Near-Term Impacts

The benefits of the PBN procedures proposed by the OST include the following:

- Reduced phraseology, frequency congestion, and pilot workload:

  Reduced phraseology due to PBN will reduce the number of radio transmissions needed to accomplish required restrictions by combining multiple clearances into a single transmission. Prior studies have demonstrated transmission reductions on the order of 18 to 34 percent with a fleet mix of 85 percent RNAV capable aircraft,[5] and the OST believes it is reasonable to expect a similar level of savings. Reduced transmissions will translate into less frequency congestion which could potentially reduce "hear back/read back" errors. In addition, the consolidation of clearances associated with an RNAV procedure reduces pilot workload, which allows for more "heads-up" time and allows the crew to focus on high-workload situations.

- Repeatable, predictable flight paths and accurate fuel planning:

  The introduction of PBN ensures lateral flight path accuracy. The predictable flight paths help assure procedurally separated traffic flows and allow airlines to more accurately plan for a consistent flight path. It also allows users to more accurately predict the amount of fuel required for a procedure.

5.1.2 Long-Term Impacts to Industry

Implementation of these proposed procedures will have long-term effects for industry.

- Flight planning

  OAPM proposed PBN procedures will result in reduced mileage and fuel burn in the long-term, particularly as more metroplexes are optimized. In the near-term, more direct paths that are not dependent on ground-based navigational aids, plus optimized flight profiles, will lead to reduced fuel burn only within an optimized metroplex. Reduced fuel loading will also allow for a reduction in CTC.

- Timetable

  Shortened, more efficient routes will necessitate timetable adjustments, particularly as more metroplexes are optimized. This will potentially benefit crew scheduling, connecting information, time on gates, ramp scheduling, etc.

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[5] Sprong, K., et al., June 2006, "Benefits Estimation of RNAV SIDs and STARs at Atlanta," F083-B06-020, (briefing), The MITRE Corporation, McLean, VA.

5.2 Quantified Annual Benefits

The quantified benefits of the Atlanta OST recommendations are broken down into annual fuel savings in dollars, annual fuel savings in gallons, annual CTC, and annual carbon emissions reductions in metric tons. The primary benefit drivers are reduced miles flown and improved vertical profiles. The Atlanta OST found that current track data indicated aircraft were already flying efficient lateral paths and therefore much of the benefits result from improved vertical profiles.

Table 17 breaks these benefits down for ATL. The estimated annual fuel savings for ATL are between $8.3M and $22.4M (between 2.9M and 7.7M gallons), and carbon emissions reductions are between 30K and 78K metric tons. For arrival procedures, the results were calculated by comparing current track miles flown and vertical profiles to the recommended solutions' track miles and vertical profiles. For departure procedures, the results were calculated by comparing ELSO published track miles to recommended solutions' track miles inside A80 airspace. Outside A80 airspace historical track information existed and was used for comparison.

It is fully expected that ATC will continue to offer shorter vector routings and remove climb restrictions, when feasible, further increasing operator benefits. The benefits analysis assumes aircraft will fly the specific lateral and vertical RNAV procedures.

The OST recognizes that ELSO procedures were implemented during the OAPM process eliminating a conventional baseline process. Given that, the D&I team will evaluate historical track data once a sufficient amount has been accrued.

Table 17. Annual Benefits Summary

Benefits Summary			
		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$1.0M	$1.0M
	Profile	$6.9M	$21.0M
	Cost to Carry	$441K	$441K
Total Estimated Annual Fuel Savings (Dollars)		$8.3M	$22.4M
Total Estimated Annual Fuel Savings (Gallons)		2.9M	7.7M
Total Estimated Annual Carbon Savings (Metric Tons)		30K	78K

Appendix A List of Selected Traffic Dates

Table A-1. List of Selected Traffic Day/Dates – West Operation

WEST OPERATION TRAFFIC DAYS/DATES			
Day/Date	Percentile Ranking	Local Time	GMT Time
	ATL		
Friday, March 05, 2010	91.7%	7am – 9pm	12:00 – 02:00
Thursday, April 22, 2010	91.2%		11:00 – 01:00
Friday, April 23, 2010	91.2%		
Wednesday, April 21, 2010	85.1%		
Friday, March 19, 2010	82.4%		
Thursday, April 01, 2010	80.2%		
Thursday, March 04, 2010	79.6%		
Wednesday, May 19, 2010	78.8%		
Wednesday, March 24, 2010	78.2%		
Wednesday, March 31, 2010	77.4%		
Thursday, October 14, 2010	75.2%		
Thursday, October 21, 2010	75.0%		
Thursday, October 07, 2010	73.3%		
Tuesday, May 18, 2010	72.5%		
Friday, October 01, 2010	71.1%		

Table A-2. List of Selected Traffic Day/Dates – East Operation

WEST OPERATION TRAFFIC DAYS/DATES			
Day/Date	Percentile Ranking ATL	Local Time	GMT Time
Friday, April 30, 2010	87.3%	7am – 9pm	11:00-01:00
Thursday, April 15, 2010	86.8%		
Thursday, May 20, 2010	86.2%		
Thursday, April 29, 2010	85.4%		
Monday, August 30, 2010	82.9%		
Wednesday, May 05, 2010	82.4%		
Monday, April 12, 2010	81.3%		
Wednesday, April 14, 2010	77.7%		
Monday, May 10, 2010	76.9%		
Monday, May 24, 2010	74.1%		
Tuesday, May 25, 2010	74.1%		
Friday, October 08, 2010	72.5%		
Monday, April 19, 2010	72.2%		
Monday, March 01, 2010	69.2%		12:00 – 02:00
Friday, November 12, 2010	68.1%		11:00 – 01:00

Appendix B Acronyms

Acronyms	
A80	Atlanta Large Terminal Radar Approach Control (TRACON)
ACM	Adjacent Center Metering
ASPM	Airport Specific Performance Metrics
ATALAB	Air Traffic Airspace Lab
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
ATL	The Hartsfield-Jackson International Airport
BADA	Base of Aircraft Data
CAASD	Center for Advanced Aviation System Development
DME	Distance Measuring Equipment
CATEX	Categorical Exclusion
CHS	Charleston Air Force Base/International Airport
CTC	Cost to Carry
D&I	Design and Implementation
DEP	Depart
EA	Environmental Assessment
EIS	Environmental Impact Statement
ESC	Eastern Service Center
ELSO	Equivalent Lateral Spacing Operations
ETMS	Enhanced Traffic Management System
EUROCONTROL	European Organization for the Safety of Air Navigation
FAA	Federal Aviation Administration
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
iTRAEC	Integrated Terminal Research, Analysis, and Evaluation Capabilities
L/R	Left/Right
LOA	Letter of Agreement
MSL	Mean Sea Level
NAT	National Analysis Team

Acronyms	
NAVAID	Navigational Aid
NM	Nautical Mile/s
NOP	National Offload Program
NTML	National Traffic Management Log
OAPM	Optimization of Airspace and Procedure in the Metroplex
OPD	Optimized Profile Descent
OST	OAPM Study Team
PBN	Performance-Based Navigation
PDARS	Performance Data Analysis and Reporting System
RITA	Research and Innovative Technology Administration
RNAV	Area Navigation
RTCA	Radio Technical Commission for Aeronautics
SAA	Special Activity Airspace
SEC	Specialized Expertise Cadre
SID	Standard Instrument Departure
SRM	Safety Risk Management
STAR	Standard Terminal Arrival
TARGETS	Terminal Area Route Generation Evaluation and Traffic Simulation
TBFM	Time Based Flow Management
TCP	Transfer of Control Point
TMA	Traffic Management Advisor
TMI	Traffic Management Initiative
TRACON	Terminal Radar Approach Control
VMC	Visual Meteorological Conditions
ZDC	Washington Center
ZHU	Houston ARTCC
ZID	Indianapolis ARTCC
ZJX	Jacksonville ARTCC
ZME	Memphis ARTCC
ZTL	Atlanta ARTCC