



**Federal Aviation
Administration**

OAPM Study Team Final Report

Washington D.C. 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 will provide a comprehensive but expeditious front-end strategic look at each major metroplex. Using the results of the Study Teams, Design and Implementation Teams will provide a systematic, effective approach to the design, evaluation and implementation of PBN-optimized airspace and procedures. The Washington D.C. Metroplex Prototype Study Team (PST) was one of the first OAPM Study Teams formed.

2 Purpose of the Washington D.C. PST Effort

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

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

3 PST Analysis Process

3.1 Five Step Process

The Washington D.C. PST followed a five-step analysis process:

1. Collaboratively identify and characterize existing issues: review current operations and solicit input to obtain an understanding of the broad view of operational challenges in the metroplex.
2. Propose conceptual designs and airspace changes that will address the issues and optimize the operation: using an integrated airspace and PBN “toolbox” and technical input from operational stakeholders, explore potential solutions to the identified issues.
3. Identify expected benefit, quantitatively and qualitatively, of the conceptual designs: assess the rough-order-of-magnitude impacts of conceptual designs, to the extent possible use objective, 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 analysis methodology used for the quantitative approach 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 management, airports, and specific programs (like Traffic Management Advisor [(TMA)]).

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 accurate assessments of benefits, impacts, costs and risks are expected after the Design phase has been completed.

3.2 PST Study Area Scope

The Washington D.C. Metroplex consists of those facilities and airspace that contain the primary flows of traffic serving Baltimore Washington International (BWI), Washington Dulles International (IAD), and Ronald Regan Washington National (DCA) airports along with their associated satellite airports. The principle Air Traffic Control (ATC) facilities serving the Washington D.C. Metroplex are Potomac Consolidated Terminal Radar Approach Control (PCT), Washington Air Route Traffic Control Center (ZDC), and New York Air Route Traffic Control Center (ZNY).

3.3 Assumptions and Constraints

OAPM is an optimized approach to integrated airspace and procedures projects, thus the solution space is centered on airspace redesign or procedurally-based, most probably PBN, solutions. The Study Teams are 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 at the end 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. The Study Team 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.

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 PST could not measure, but would certainly result from the implementation of the proposed solution. These assessments included:

- Impact on 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
- Improvements to security (avoiding restricted airspace)
- Reduction in communications (cockpit and controller)
- Reduction in need for Traffic Management Initiatives (TMIs)
- 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 PST relied in 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 a flight simulator (to establish a relationship between simulator fuel burn results and the European Organization for the Safety of Air Navigation Base

of Aircraft Data (BADA) fuel burn model and MITRE CAASD's Monte Carlo FMS Aircraft Simulation Tool (MFAST).

3.4.1 Track Data Selected for Analyses

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

For an initial glimpse at how operations occur on a "good" weather day with a high operational count, 93rd-percentile traffic days were selected: 17 June 2010 (North flow) and 02 June 2010 (South flow). These days were selected using the Airport Specific Analysis Page (ASAP) operational counts matched with Meteorological Aviation Report (METAR) weather data. These days were also used as input for examining sector load analyses for notional sector boundary re-designs.

For determining the number, length, and location of level-offs for the baseline of operational traffic, fourteen 93rd-percentile traffic days were utilized.

- June 22-25 and 28-30 2010
- July 9, 16, 19-22, and 29 2010

For these traffic days, historical radar track data was used to allow the PST to visualize the flows and identify 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 PST generally overlaid the historical radar tracks with PBN routes or procedures to minimize the risk of significant noise impact and an associated EIS. Some of the conceptual arrival and departure procedures contain runway transitions that were included for analysis purposes only. The determination as whether to include runway transitions (e.g., the development of "off the ground" RNAV departures) in the proposed procedures will need to be made during the Design and Implementation process.

3.4.2 Determining the Modeled Fleet Mix

Due to the compressed schedule associated with this study effort, there was not sufficient time to model the entire fleet mix that services the Washington D.C. Metroplex airspace. As a result, the analyzed fleet mix had to be reduced to a manageable number of aircraft types. The PST determined that regional jets (CRJ-series and Embraer-series), B73X-series, and A319/A320s accounted for almost 67% of the aircraft types operating in the area. The remaining fleet is comprised of multiple aircraft types individually representing no more than 3.5% (B75X-series).

The fleet mix was queried from the FAA's Enhanced Traffic Management System (ETMS) reporting of aircraft operations in 2009.

AC Type	# Ops	% Ops
RJs	313,337	34.8%
Other	300,389	33.5%
B73X-series	178,250	19.8%
A319/A320	107,186	11.9%
Grand Total	899,162	100.0%

3.4.3 Profile Analysis

To establish a baseline, the PST examined track data using the FAA’s Graphical Airspace Design Environment (GRADE) tool to identify and measure level-off characteristics: altitude, along-track distance from runway to the start of the level-off, and length of the level-off.

For comparison, the concepts proposed by the PST were modeled using MITRE CAASD’s MFAST assessing the same characteristics as the baseline: altitude, along-track distance from runway to the start of the level-off, and length of the level-off. The results were then reviewed by PST Subject Matter Experts to ensure continuity with intent of the design. The PST then applied the BADA fuel flow model and flight simulations to determine a range of fuel burn.

Flight simulations were also run on an actual arrival as well as the proposed conceptual design. The flight simulator values were obtained through a US Airways A320 flight simulator fuel burn analysis for two transitions on a proposed versus baseline arrival procedure.

Derived values for fuel burn per minute in level flight, idle descent, and less-efficient descent were then used to validate the relationship between the flight simulator fuel saving estimates and the BADA-based fuel burn estimates (calculated in gallons per nautical mile). This method was applied to determine a maximum fuel savings per flight. Applying both the flight simulator and BADA methods provides for a range of potential benefits:

- BADA numbers (speed/fuel burn – lower bound potential benefit)
- Flight simulation numbers (speed/fuel burn – upper bound potential benefit)

4 Identified Issues and Proposed Solutions

This section presents the findings and results of the Washington D.C. Metroplex PST effort. It is organized by phase of flight beginning with departures, then arrivals, followed by more general en route and terminal area issues. Each issue is characterized and solutions are proposed. For all proposed solutions, expected benefits, considerations and risks are identified. Where applicable, the results of quantitative analyses are also presented. The issue numbers shown beneath the section headers are the tracking numbers associated with each unique issue identified during the study process.

4.1 Departure Issues

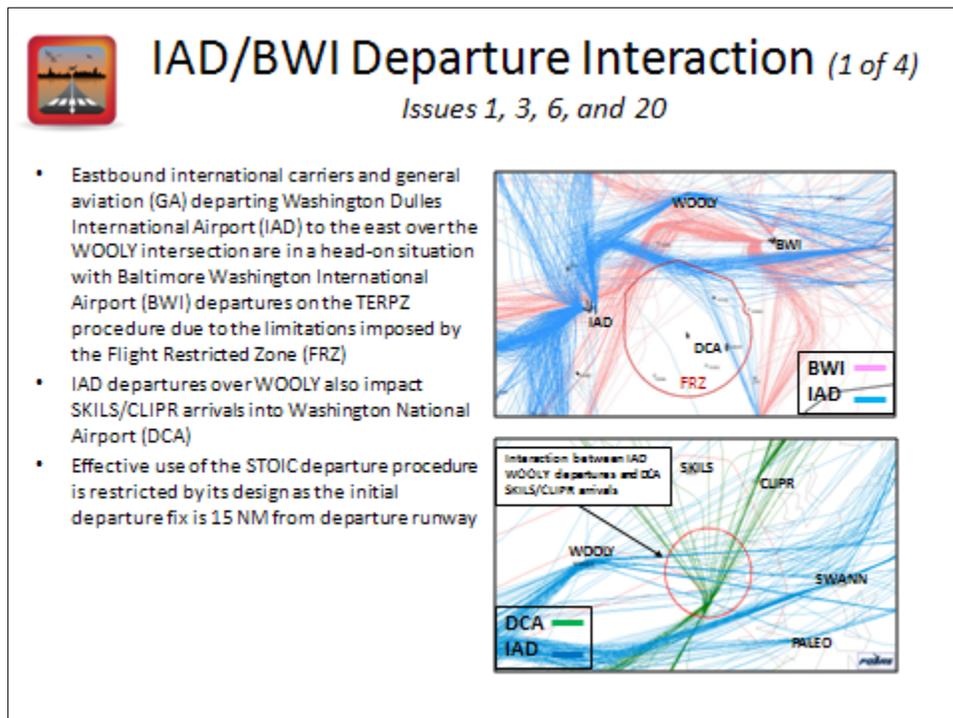
The PST found that departures within the Washington D.C. Metroplex area have few issues, especially with regard to efficient climb profiles. The only exception to this were departures over the fix PALEO from IAD and DCA which were found to level-off for a short period (Issue 38). Of more concern to the Industry and FAA participants was the current interaction between DCA and BWI departures (Issues 1, 3, 6, and 20). For all airports within the study area, there are few RNAV Standard Instrument Departures (SIDs) and most of the departure traffic relies on radar vectors for the initial portion of their routes (Issue 2). Finally, there is frequent application of Miles-in-Trail (MIT) for those aircraft departing via the fixes MOL, GVE, LDN, and RAMAY (Issues 4 and 5).

4.1.1 IAD/BWI Departure Interaction

Issues 1, 3, 6 and 20

With the introduction of the Flight Restricted Zone (FRZ), international and general aviation (GA) carriers were restricted to fly over the WOOLY intersection, then re-sequenced with the non-restricted flows over SWANN, PALEO and DAILY. Although vertically separated, the IAD departures are in a head-on situation with the BWI departures climbing in the opposite direction. Additionally, the SKILS and CLIPR arrivals into DCA conflict with the IAD WOOLY departures. Issue 20 relates to the IAD Air Traffic Control Tower (ATCT) desire to segregate departure operations. To summarize:

- IAD departures over DAILY go north, then east, to go south (FRZ restricts options)
- Departure routes need to be decoupled from other airports (BWI/IAD TERPZ and STOIC)
- Jet departures only climb to 3,000 feet (interim restriction that is not normally applied by Departure Control; proposed SIDs may help to remove the need for this restriction)
- Currently, when in north configuration, LDN/AML/GVE/MOL traffic depart off the same runway, as they are all worked by the same departure controller. They could potentially be routed from two different runways (staging/ground operations)
- Unable to conduct triple parallel Instrument Landing System (ILS) approaches (PCT/IAD team is working this issue)



The STOIC RNAV departure is not used by IAD and is scheduled to be decommissioned as a result. As currently designed, the procedure does not provide an optimal route for departures to the west due to the current location of the initial departure waypoint STOIC. The proposed changes to IAD STOIC will move the initial departure waypoint farther east from its current location and closer to the runway. It will also eliminate potential interactions between these IAD eastbound departures and DCA arrivals over SKILS and CLIPR. The WOOLY transition would be maintained for props and other traffic as needed.

The proposed modifications to the BWI TERPZ procedure include:

1. Move WONCE one mile to the west and shift the procedure track 1.5-2 miles north
2. Add/extend en route transitions with the exception of SWANN, PALEO, and DAILY.

The shift in the track to the north initially resulted in a slight increase in track distance. This was mitigated by adjusting the point of divergence into the en route environment (at proposed waypoint WP39) closer to WONCE, shortening the overall length of the route.

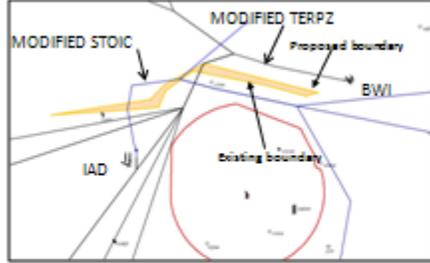
The proposed changes also eliminate potential interactions between DCA arrivals over SKILS and CLIPR and IAD eastbound departures. Airspace modifications between ZDC 02, 05, 06, and 17, and PCT would be necessary (PCT PHL departures on J48 were found to be above the proposed modified flows).



IAD/BWI Departure Interaction *(2 of 4)*

Issues 1, 3, 6, and 20

- Proposed solution
 - Modify /replace published IAD STOIC2
 - Currently not used by IAD
 - Remain clear of FRZ
 - Optimize by moving STOIC waypoint
 - Maintain a WOOLY transition for prop/Tower En Route aircraft
 - Modify BWI TERPZ2
 - Optimize climb and turn by moving WONCE waypoint
 - Add an exit gate to the south (see issue #4/5)
 - Shift nominal path to accommodate changes to STOIC procedure
- Expected benefits
 - Increased efficiency for IAD International and GA departures
 - Increased connectivity by adding/extending en route transitions to separately tie into high altitude route structure (e.g. J6, J37, J75)



The graphic below explains the risks and benefits of the IAD/BWI departure procedures and provides an extended view of BWI TERPZ SID and the modified IAD STOIC SID. The graphic shows the TERPZ with en route transitions to enhance connectivity with the existing route structure. The current procedures end at LDN, RAMAY, HAFNR, FLUKY, and the transfer of control points should remain in the same area.

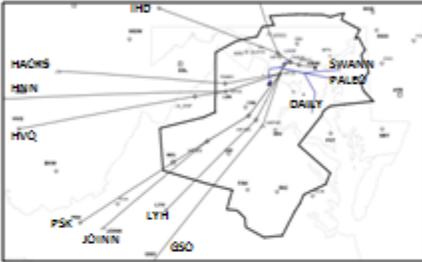
To the west, one additional transition was added, from LDN to HVQ, and the HACKS transition was modified to the north. To the southwest, one additional departure gate was created between the current FLUKY and HAFNR gates. In total, four transitions were created to the en route environment over PSK, JOINN, LYH, and GSO.



IAD/BWI Departure Interaction *(3 of 4)*

Issues 1, 3, 6, and 20

- Considerations/Risks
 - Would require boundary changes to Potomac Consolidated TRACON (PCT) BINNS, KRANT, BUFFR and LURAY sectors
 - Boundaries affected by additional exit gates between PCT and ZDC02 and ZDC60 will need to be modified (see Issues 4 and 5)
 - Initial environmental assessment to evaluate use of runway transitions
 - Potential need for modeling to ensure international flight paths will clear FRZ
 - Slight increase in track distance for IAD DAILY departures (can be mitigated by direct to fix for aircraft allowed to traverse the FRZ)
 - Impact from boundary changes on WOOLY sector flexibility



PCT boundary shown in black

There were not many benefits expected in relation to the departures procedures within the metroplex airspace. This is predominantly due to an already effective effort by controllers in currently getting the departures up and out with very few (if any) level-offs.

In notionally conceptually modifying the IAD STOIC2 departure procedure and the BWI TERPZ2 departure procedure, we did expect to obtain some benefit associated with the international air carrier departures from IAD no longer having to navigate the WOOLY sector. Transiting the WOOLY sector adds an additional 3 nautical miles of track length when compared to direct routing to the PALEO or SWANN transitions. In shifting the STOIC2 and TERPZ2 north, it will become operational viable for the international carriers to now travel direct to SWANN or PAELO, avoiding the FRZ and removing the complexity associated with re-merging the WOOLY traffic into the streams at SWANN and PAELO.

In order to determine the benefits associated with this proposed design, the number of operations traversing WOOLY over the year (utilizing ETMS flight messages) was queried. Based upon the standard set of traffic data, it was observed that roughly 9% of the aircraft utilizing WOOLY currently were GA flights, which would not shift back onto the SWANN or PAELO transitions. Utilizing a standard fuel price of \$2.52 per gallon, a lower-bound yearly savings of approximately \$350,000 was calculated. Applying the relationship between the BADA-based fuel burn model and the flight simulator fuel burn calculations resulted in the upper-bound estimated savings of approximately \$1,000,000.



IAD/BWI Departure Interaction *(4 of 4)*

Issues 1, 3, 6, and 20

- **Estimated benefits**
 - Modifications to IAD STOIC2
 - No statistically significant increase in the track length of SWANN or PAELO transitions
 - Modifications to BWI TERPZ2
 - Decrease in track length to transitions ranging from 1.5nm (to IHD) to 5nm (to HACKS)
 - No statistically significant increase in efficiency
 - Comparative benefits
 - Approx. 46% of northeast/east-bound utilize the WOOLY sector route
 - Believe that 9% of those flights are GA aircraft and would not shift to the proposed SWANN
 - Savings can be achieved with the International aircraft no longer needing to use the WOOLY transition.
 - Approx. 3.2nm less track length per flight
 - Approx. \$353,000 to \$1,059,000 in annual fuel savings due to decreased track distance

Yearly IAD Ops flying on STOIC transitions			
	A320/B73x	RJs	Other ACs
STOIC DAVID	558	2,006	2,621
STOIC PAELO	600	2,117	2,766
STOIC SWANN	1,830	6,463	8,444
STOIC WOOLY	2,588	9,138	11,939
Total	5,586	19,724	26,753

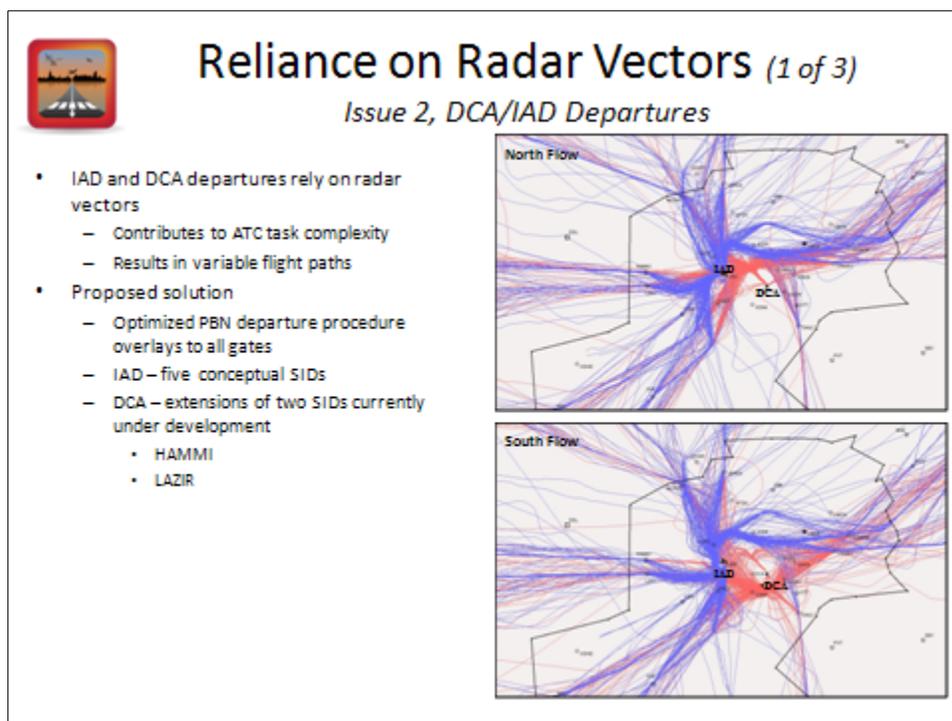
Yearly IAD Operations on WOOLY			
	A320/B73x	RJs	Other ACs
Could Transition to SWANN	2,588	9,138	10,864
Assumed GA flight to stay	0	0	1,075
Total	2,588	9,138	11,939

Annual Fuel Savings:
\$353,000 – \$1,059,000

4.1.2 Reliance on Radar Vectors for DCA/IAD Departures

Issue 2

The figures below show historical radar track data for departures from DCA and IAD in both north and south flows. All aircraft are on radar vectors to join the en route structure. There are only two RNAV SIDs published, and of those, only one is currently in use (the BWI TERPZ). This requires that most departures be radar vectored by controllers for the initial phase of their departure. This results in increased ATC task complexity and significant variation in flight tracks. There are existing plans to introduce two new RNAV departures from DCA (LAZIR and HAMMI), but no other procedures are proposed.



The PST proposed DCA procedures may need to be amended by the Design and Implementation Team to separate RNAV SIDs that serve specific departure fixes and directions.

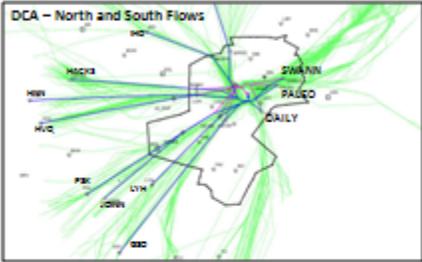
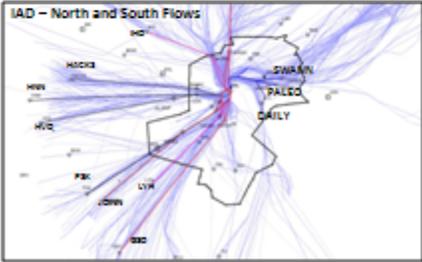
Proposed changes to the HAMMI and LAZIR procedures currently under development are expected to enhance utility and connectivity with the en route structure. Additionally, the transition to WOOLY could be retained for prop departures.



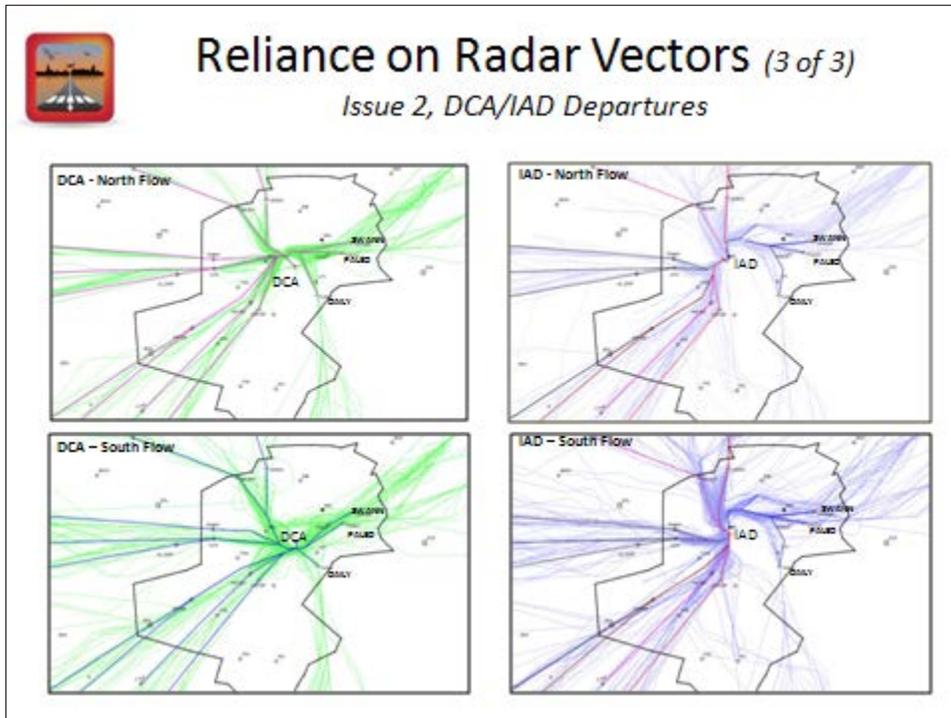
Reliance on Radar Vectors *(2 of 3)*

Issue 2, DCA/IAD Departures

- Expected benefits
 - Reduced ATC task complexity
 - Predictable, repeatable flight paths
 - Additional exit gates
 - Additional route from LDN to HVQ
- Considerations/Risks
 - Determine need for vertical profiles/restrictions
 - Controller training
 - Need for staged implementation
 - PSK departure routing will require airspace modifications between PCT and ZD002/60
 - Need for initial environmental review to determine if procedures qualify for categorical exclusion
 - Controller acceptance of PBN SIDs versus radar vectors
 - Planning for non-participating aircraft

Historical radar track data are shown with proposed PBN departures (IAD and DCA Departures) in separate flows. These procedures are intended to reflect the existing radar tracks and as such, may qualify for Categorical Exclusion as overlays. Note that these conceptual procedures do not include vertical profiles. A Design and Implementation Team will need to consider whether to include altitudes/speeds in the procedure in accordance with operational requirements and aircraft performance.



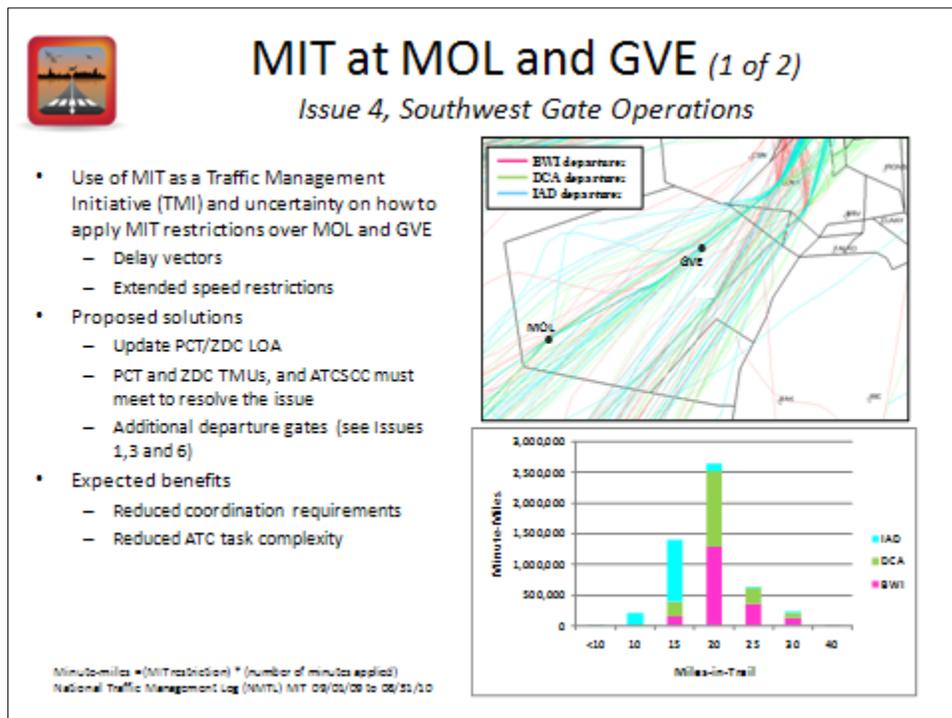
4.1.3 Southwest Gate Operations, MIT at MOL and GVE

Issue 4

There is some uncertainty on the application of MIT which originates from a communication gap between facilities (ZDC and PCT), ATCTs, and Traffic Management Units (TMUs). The request for MIT is not always communicated clearly between positions. Also, controllers suggested that there can be confusion as to whether the MIT is to be provided between all aircraft over a particular fix or only between aircraft from a specific airport. Most importantly, there is a need for the PCT and ZDC TMUs to coordinate and meet with Air Traffic Control System Command Center (ATCSCC) staff to develop a systematic approach to issuing TMIs (whether MIT or others), to brief controllers on how to apply these TMIs, and to update relevant Letters of Agreement (LOAs).

The MIT restrictions shown below are for DCA/IAD/BWI departures due to volume only (no weather or equipment failure), and include only those issued by ZDC to PCT or by PCT to IAD/DCA/BWI (pass-back restrictions are filtered out). The graphic on the lower right shows the impact of this miscommunication. For the sample year, IAD departures were issued mostly 15 MIT while BWI and DCA departures were issued primarily 20 MIT.

One proposed solution is to provide an additional departure gate to the southwest. Proposed routes will require boundary changes within ZDC.



Sector redesign within ZDC will be necessary to ensure route separation between ZDC 02 and 60. The proposed conceptual IAD/BWI/DCA SIDs all use the same extended exit routes into ZDC airspace. All these southwest en route transitions have connectivity to either a jet route or an arrival procedure (e.g., the JOINN arrival procedure into Atlanta International Airport). There are minimal impacts to current city pair routes.

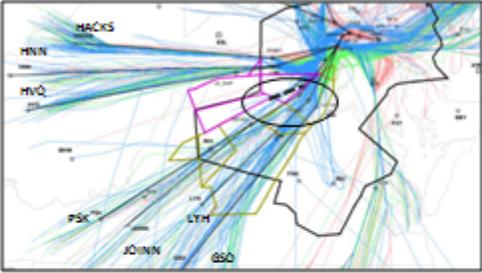
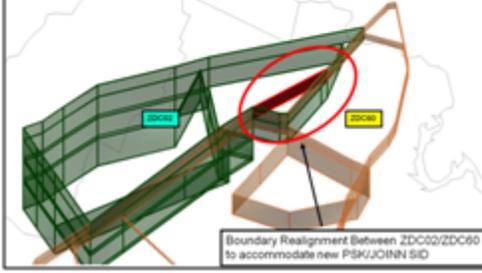


MIT at MOL and GVE (2 of 2)

Issue 4, Southwest Gate Operations

- Considerations/Risks
 - ZDC Sectors 02/60 boundary realignment
 - No improvement in sector capacity
 - Requires sector re-design
 - Transitional separation between PCT and ZDC

- Southwest gate connectivity
 - PSK – J22 (e.g., IAH, MSY, TYS)
 - JOINN – J48 (e.g., ATL)
 - GSO – J75 (e.g., MCO, TPA, MIA, MMUN)
 - LYH – J37 (e.g., CLT)

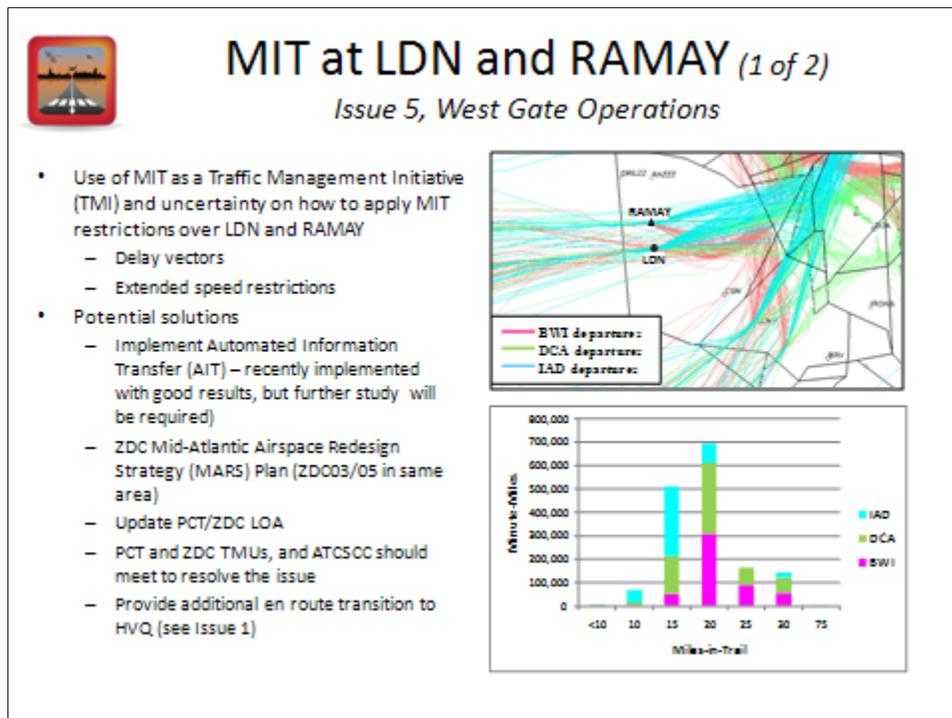



4.1.4 West Gate Operations MIT at LDN and RAMAY

Issue 5

Just as with the situation at MOL and GVE, uncertainty on MIT originates from a communication gap between facilities (ZDC and PCT), ATCTs, and TMUs. Potential solutions include the implementation of Automated Information Transfer (which occurred after the start of this study and has shown improvement though reduced MIT restrictions); however, additional study will be necessary to confirm. Additionally, ZDC's proposed Mid-Atlantic Airspace Redesign Strategy (MARS) is expected to improve the ability for controllers to interact with each other by reorganizing the positions by market flow, aligning subsequent sectors in the same operational area. Most important is the need for PCT and ZDC TMUs to coordinate and meet with ATCSCC staff to develop a systematic approach to issuing TMIs (whether MIT or others) and to update relevant LOAs and/or Standard Operating Procedures (SOPs) and train controllers.

The resolution proposed for Issue 1, IAD/BWI Departure Interactions, also addresses this issue through application of PBN.



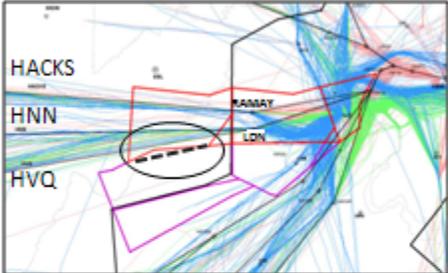
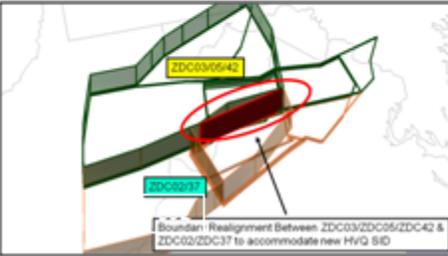
Sector redesign within ZDC will be necessary to ensure route separation between ZDC 03 and 05. Proposed IAD/BWI/DCA SIDs all use the same extended routes into ZDC airspace. All these West Gate en route transitions have connectivity to jet routes. There are minimal impacts to current city pair routes.



MIT at LDN and RAMAY (2 of 2)

Issue 5, West Gate Operations

- Expected benefits
 - Reduced coordination requirements
 - Reduced ATC task complexity
- Considerations/Risks
 - MARS will require changes in infrastructure and additional training (see Issue 4)
 - ZDC Sectors 03/05/42 boundary realignment (see issues 1,3,6)
 - Transitional separation between PCT and ZDC
- West gate connectivity
 - HACKS – J149 (LAS, ORD, DEN)
 - HNN – J134 (OKC, CVG, LAX)
 - HVQ – J6 (DFW, ABQ, PHX)

Boundary Realignment Between ZDC03/ZDC05/ZDC42 & ZDC02/ZDC37 to accommodate new HVQ SID

4.1.5 Departure Level-offs at PALEO for DCA and IAD Departures

Issue 38

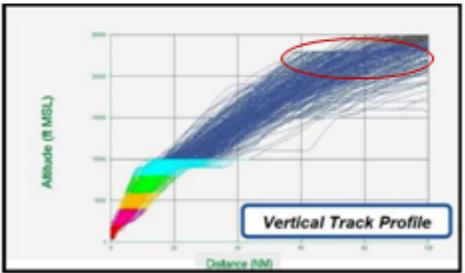
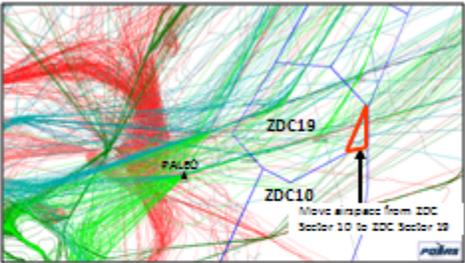
This issue is addressed by boundary changes in the ZDC MARS plan.



Departure Level-offs at PALEO

Issue 38, DCA/IAD Departures

- DCA/IAD departures over PALEO must level-off at FL230
- Proposed solution
 - Addressed in ZDC MARS plan
 - Realign boundary between ZDC19 and 10, resulting in one point out to climb this flow
- Expected benefits
 - Reduce the number of point-outs to ZDC10
 - Improved efficiency
- Considerations/Risks
 - Incorporate into proposed PBN SIDs
 - Continuity with the New York Airspace Redesign project



Vertical Track Profile

4.2 Arrival Issues

The PST review and analysis of arrival procedures in the Washington D.C. Metroplex led to the conclusion that several opportunities existed for optimizing descent profiles (Issue 32). This included optimization specific to the arrivals from the West (Issues 21, 22, 24, 32, and 34), as well as from the South (Issues 29, 30, 31, and 32). The ATC facilities also expressed a need for additional arrival transitions for existing Standard Terminal Arrivals (STARs) and the need for a new STAR over the fix MXE for BWI arrivals (Issues 12, 17, and 23). Finally, the airspace within the PCT BINNS sector was identified as needing expansion (Issue 11). Specifically, the solution proposals to increase arrival efficiency included the following:

- Maximizing the use of Optimized Profile Descent (OPD)
 - Arrivals from the west
 - ELDEE/WZZRD
 - SHNON
 - Westminster (EMI)
 - Arrivals from the south
 - OJAAY
 - BARIN
 - RAVNN (south and west arrivals)
- Creating additional en route transitions and new STARs (non-OPD)
 - RAVNN (added a transition from the east non-OPD)
 - BILIT (added runway transition to DCA Runway 01)
 - NEW STAR: MXE to BELAY to BWI
- Segregating flows within the BINNS Sector (HYPER and PRTZL)

4.2.1 West Arrivals

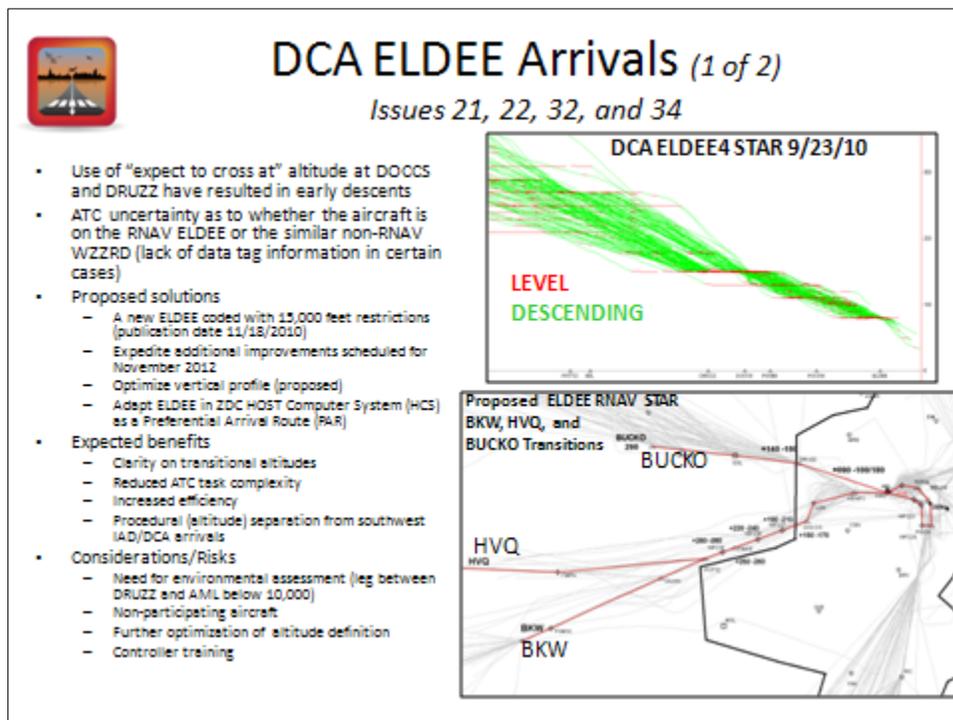
Optimization of the arrivals from the West included optimization of the ELDEE arrivals to DCA, the SHNON and ROYIL arrivals to IAD, and the Westminster (EMI) arrivals to BWI.

4.2.1.1 DCA ELDEE Arrivals

Issues 21, 22, 32 and 34

This issue is caused by pilot confusion on “expect to cross at” altitude at DOCCS and DRUZZ (both at 15,000 feet) and can result in unexpected descent to 12,000 feet (in conflict with westbound departures) even though there are additional 15,000 foot restrictions at REVUE and MORTY. The STAR is currently undergoing review by AVN for modifications to ensure altitude compliance. The ELDEE RNAV is essentially an overlay of the conventional WZZRD Arrival. There are occasions when aircraft file for the WZZRD even though they are RNAV equipped. The PCT scratch pad information included in the data tag does not indicate what procedure the aircraft is on, once ZDC has issued a “direct to” a fix instruction.

ZDC and PCT agreed to attempt to segregate the flows from the northwest and install OPD procedures to all three major airports. The graphic below depicts proposed modifications to the ELDEE STAR with OPD components and historical flight track data to DCA. The route over BUCKO is segregated from IAD flows, shifting the lateral track west of AML. The proposed IAD procedures are now located north of the ELDEE STAR.



The arrival procedures were where the majority of the estimated benefits were expected.

Utilizing the DCA ELDEE arrivals to demonstrate the process of determining the annual fuel savings on a given procedure, the operational counts associated with the proposed transitions were queried from the FAA’s ETMS flight messages. The baseline fuel burn estimates were determined by multiplying the length and altitudes associated with level-offs during current operations, and summing across all identified level-offs. The vertical profiles of the proposed routes/procedures were initially produced using MFAST and validated with subject matter expertise. The fuel burn savings associated with the new routes/procedures were then multiplied by the number of operations expected.

Fuel burn savings associated with reduced track length were also calculated and summed across the expected number of flights. In addition, the fuel burn savings associated the remaining aircraft not covered by the model (B73X-series, A319/A320, and RJs) were estimated by taking the average fuel savings across all modeled aircraft types and applying that gallons per flight savings to the un-modeled aircraft count.

Using this methodology, it was estimated that the proposed conceptual DCA ELDEE arrival would save \$745,000 to \$2,235,000 annually.



DCA ELDEE Arrivals *(2 of 2)*

Issues 21, 22, 32, and 34

- **Estimating benefits with BADA-based model**
 - Proposed ELDEE (BUCKO) potentially saves per flight:
 - 5.6 gallons of fuel burn for A320/B73Xs
 - 2.1 gallons of fuel burn for RJs
 - Proposed ELDEE (HVQ & BKW) potentially save per flight:
 - 9.5 gallons of fuel burn for A320/B73Xs
 - 3.1 gallons of fuel burn for RJs
 - Current ELDEE is utilized by 48,992 ops per year (41,414 covered by modeled aircraft)
 - Multiplying the fuel savings per flight by the number of ops per year on each transition to annualize the savings
 - Approx. \$609,000 in savings from only the A320/B73Xs and Regional Jets (RJs)
 - Approx. \$175,000 of those fuel burn savings associated with reduced track distance
 - Additionally, to estimate savings for the remaining 7,578 aircraft not covered by the modeling, an average range of fuel saving is applied
 - Approx. \$136,000 in savings for the other aircraft types
- **Estimated flight simulation maximum fuel benefit**
 - Annual cost savings of approx. \$2,235,000

Yearly Operations filed on ELDEE STAR		
	A320/B73Xs	RJs
ELDEE BUCKO	10,453	16,466
ELDEE BKW	3,699	5,826
ELDEE HVQ	1,930	3,040
Total	16,082	25,332

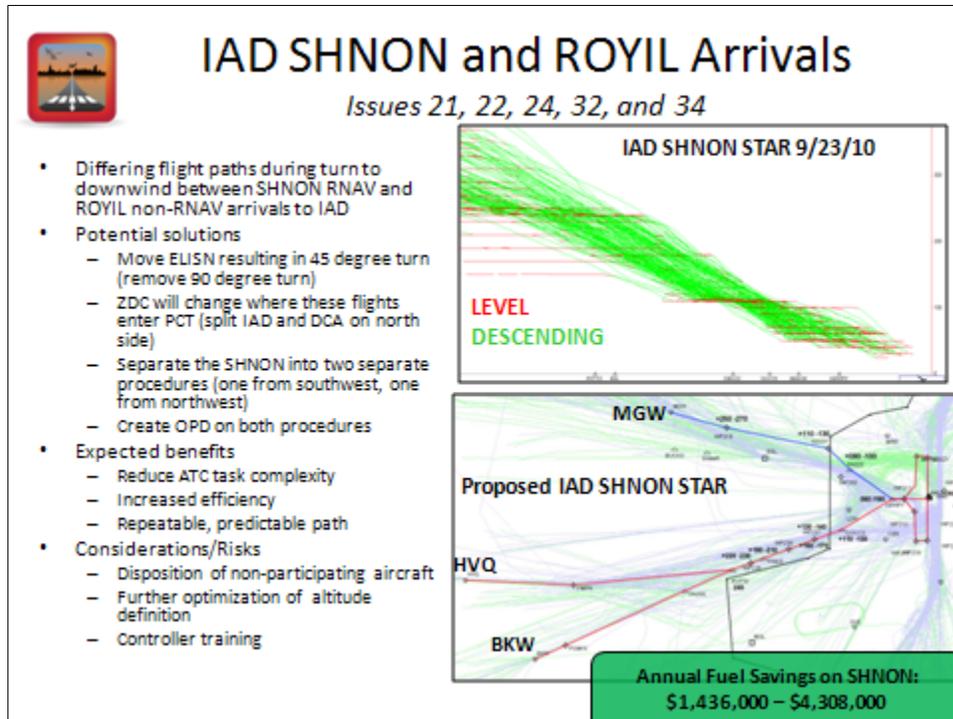
Comparative Track Length on ELDEE STAR (nm)			
	Baseline	Proposed	Difference
ELDEE BUCKO	154.6	153.6	-1.0
ELDEE BKW	231.1	231.1	0.0
ELDEE HVQ	255.0	253.5	-1.5

**Annual Fuel Savings on ELDEE:
\$745,000 – \$2,235,000**

4.2.1.2 IAD SHNON and ROYIL Arrivals

Issues 21, 22, 24, 32 and 34

PCT requested modifications to the SHNON and ROYIL STARs from the west. PCT and ZDC agreed the route from the northwest over MGW could be segregated from the DCA and BWI flows to incorporate OPD components.



4.2.1.3 BWI Westminster Arrivals

Issues 16, 32, 34 and 35

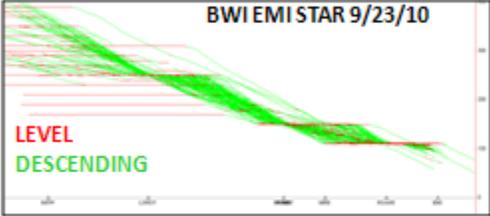
The EMI5 STAR to BWI is currently a conventional STAR. ZDC and PCT agreed the STAR would benefit from OPD components.



BWI Westminster Arrivals

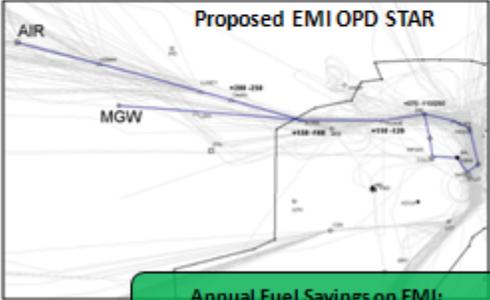
Issues 16, 32, 34, and 35

- The conventional Westminster (EMI) STAR needs transitions closer to the airport
- Jet aircraft level-off at BUBBI at 15,000 feet, and then at 11,000 feet over RUANE
- Potential solutions
 - Define STAR to near runway based on current procedures and convert to RNAV
 - Define altitudes on Runway 33L transition at 5,000 feet abeam to the airport
 - Define altitudes on Runway 10 transition at 4,000 feet to COLUM
 - Develop BWI OPD in ZDC15
- Expected benefits
 - Reduce ATC task complexity
 - Increased efficiency
- Considerations/Risks
 - Non-participating aircraft
 - Further optimization of altitude definition
 - Controller training



BWI EMI STAR 9/23/10

LEVEL
DESCENDING



Proposed EMI OPD STAR

AIR
MGW

Annual Fuel Savings on EMI:
\$529,000 – \$1,589,000

4.2.2 D.C. Metroplex Southern Arrivals

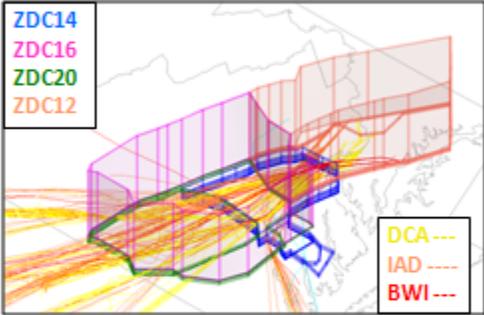
Depicted below are historical arrival tracks for BWI, DCA and IAD airports with the four sectors that would be affected by the proposed OPDs. The optimization of Southern Arrivals in the Washington D.C. Metroplex was considered the most complex proposal made by the PST. This is due to the modification of several flows along with changes to several sectors within ZDC. However, these proposed modifications were also felt to be some of the most beneficial to the overall operation. The proposed solutions impact the OJAAY arrivals to DCA, the BARIN arrivals to IAD, and the RAVNN arrivals to BWI.



D.C. Metroplex Southern Arrivals

Background Information

- Several potential stratification adjustments between ZDC16 and ZDC20 were analyzed to eliminate/reduce level-offs for D.C. Metroplex arrivals
- After analysis and discussions with ZDC, it was determined that further sectorization adjustments involving ZDC16, ZDC20, ZDC14 & ZDC12 would be necessary to accommodate OPDs to IAD, DCA and BWI
- ZDC agreed to address redesign of these sectors in the design and implementation process to integrate with the proposed RNAV STARS with OPD components to DCA, IAD, and BWI

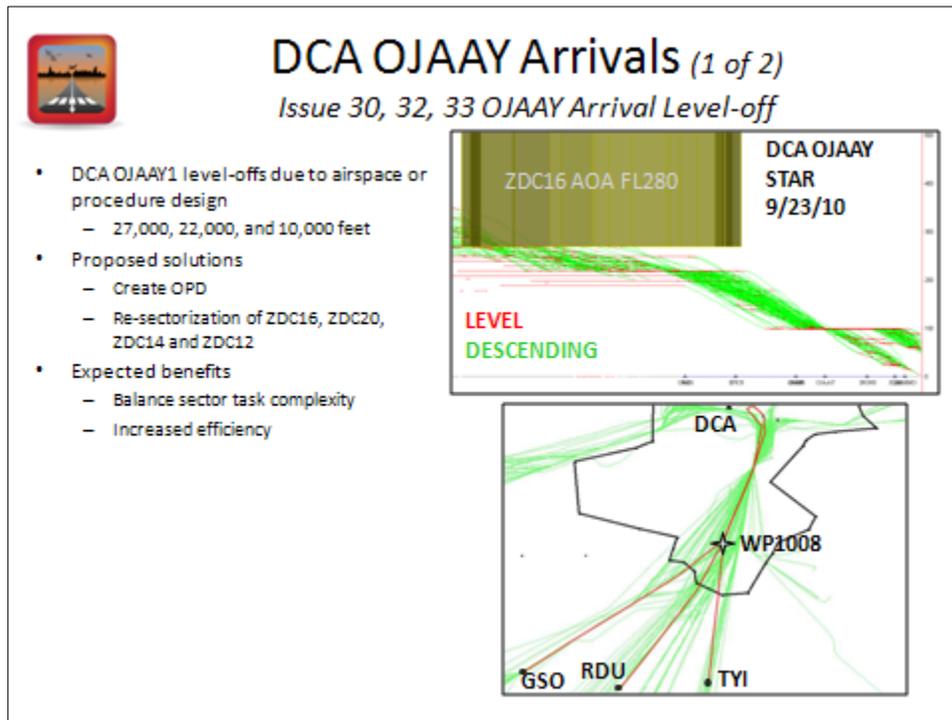


The diagram illustrates the arrival tracks for DCA, IAD, and BWI through the ZDC sectors. The sectors are color-coded: ZDC14 (blue), ZDC16 (pink), ZDC20 (green), and ZDC12 (orange). The arrival tracks are color-coded: DCA (yellow), IAD (red), and BWI (red). The tracks show the flow of aircraft from the south through the ZDC sectors towards the airports.

4.2.2.1 DCA OJAAY Arrivals

Issues 30, 32, and 33

Top right graphic depicts historical radar tracks showing aircraft being forced down early to avoid ZDC16 airspace. Number of level-offs occur due to airspace configuration. Bottom graphic depicts notional proposed OPD RNAV STAR with multiple en route transitions. Proposed RNAV STAR shortens the current filed route for most aircraft. Airspace redesign within ZDC would be necessary to implement this OPD procedure.



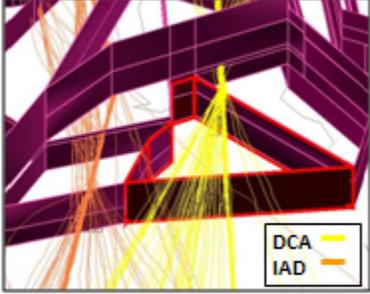
The graphic below depicts possible airspace transfer between James River and Mount Vernon areas in PCT to possibly alleviate the level-off at 10,000 feet at OJAAY.



DCA OJAAY Arrivals (2 of 2)

Issue 30, 32, 33 OJAAY Arrival Level-off

- Considerations/Risks
 - Re-sectorize to accommodate optimized procedures and current traffic flows
 - ZDC12
 - ZDC14
 - ZDC16
 - ZDC20
 - Minimize or eliminate level-offs
 - If ZDC16 floor is raised, ZDC20 would work additional PHL/EWR/LGA traffic, adding more coordination and communication
 - Possible realignment of airspace from PCT James River to Mount Vernon areas to allow more efficient DCA/ADW descents

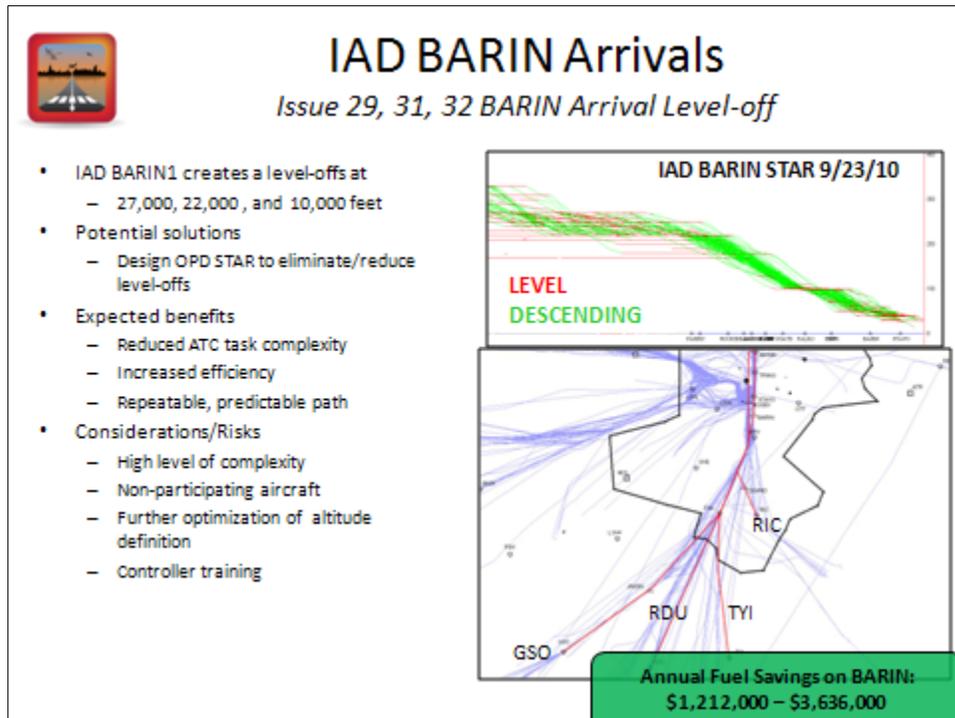


Annual Fuel Savings on OJAAY:
\$1,177,000 – \$3,531,000

4.2.2.2 IAD BARIN Arrivals

Issues 29, 31, and 32

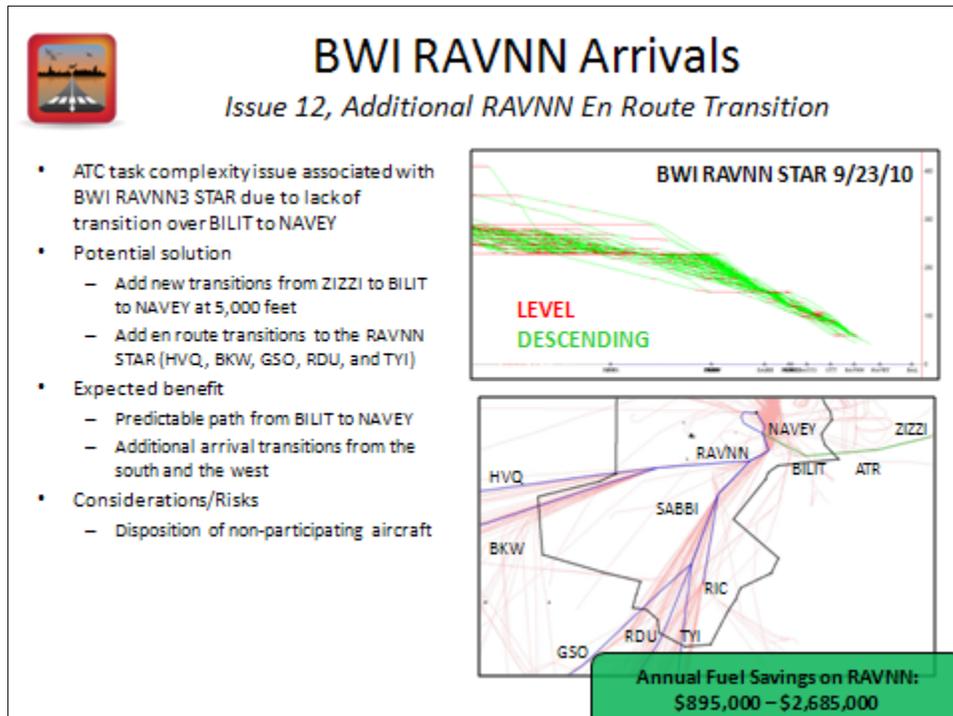
Associated OPD altitudes are included in the detailed packages. This proposal has a high level of complexity due to the interactions between multiple OPD procedures.



4.2.2.3 BWI RAVNN Arrivals

Issue 12

The PST optimized the descent profiles to BWI, which resulted in the fuel burn savings quantified in the graphic below. In addition, PCT requested an additional transition over BILIT to NAVEY for task complexity associated with the BWI RAVNN3 STAR. The graphic below depicts historical flight tracks and the proposed BILIT transition in green.



4.2.3 Additional Transitions and New (non-OPD) STARs

The PST proposed additional transitions for the RAVNN and BILIT STARs, as well as a new STAR routing aircraft from MXE to BELAY to BWI. The RAVNN STAR modification was discussed in Section 4.2.2.3.

4.2.3.1 DCA BILIT Arrivals

Issue 23

PCT requested an additional transition to the BILIT STAR from EDDGY to Runway 01 that would reduce current radar vectoring. The graphic below depicts the proposed route.



DCA BILIT Arrivals

Issue 23, Additional BILIT Runway Transition

- Lack of a DCA Runway 01 transition on the BILIT STAR
- Potential solution
 - Develop an additional transition on BILIT STAR from EDDGY for Runway 01
- Expected benefits
 - Reduce ATC task complexity
 - Repeatable, predictable path
- Considerations/Risks
 - Disposition of non-participating aircraft
 - ZDC unable to implement an optimized vertical profile due to other current traffic flows



4.2.3.2 BWI Arrivals over MXE

Issues 17 and 47

This proposal provides a new PBN arrival to replace routine use of radar vectors/direct-to clearances for arrivals to BWI via MXE (Issue 17). Issue 47 is also addressed since it calls for decreased reliance on ground-based NAVAIDS. Coordination with ZNY/PHL will need to be done prior to implementation of this procedure.



BWI Arrivals Over MXE

Issues 17 and 47

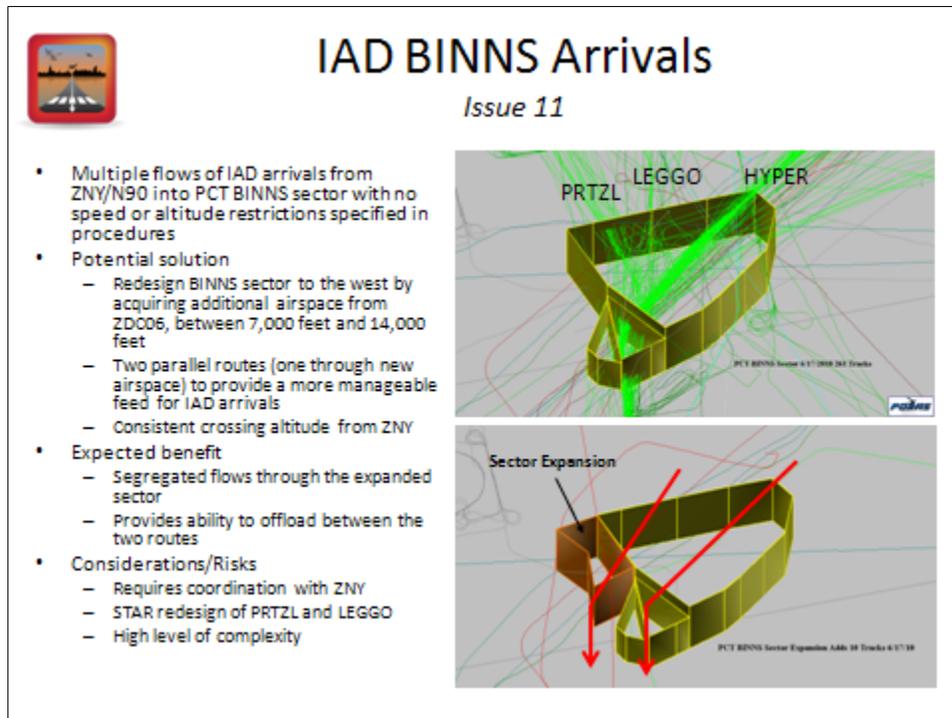
- BWI arrivals over MXE are vectored
- Potential solution
 - Develop RNAV STAR from MXE to TROYZ to BELAY
- Expected benefits
 - Reduce ATC task complexity
 - Increased efficiency
 - Repeatable, predictable path
- Considerations/Risks
 - Disposition of non-participating aircraft
 - OPD not investigated due to potential interactions with ZNY airspace plan
 - Potential for en route transition from DQO



4.2.4 IAD BINNS Arrival

Issue 11

The graphics in the figure below depict historical flight data for both current and proposed sectorization. If the airspace modification were available on the sample day (6/17/2010), 77 flights could have moved to the alternate STAR.



4.3 En Route Issues

Several issues identified by the PST involved operation in en route airspace. This includes the potential for optimizing jet routes, reducing en route sector complexity through redesign, and the provision of additional en route transitions on RNAV STARs. The list below captures the primary issues addressed by the PST.



En Route Issues List

- STAR from ZDC to TEB, MMU, CDW (Issue 51)
- HGR operations (Issue 53)
- ZDC04 Redesign (Issue 54)
- ZDC03 Complexity (Issue 37)
- Volume in ZDC31 and ZDC60 (Issue 49)
- Flows Over SBY..WIBID..CHS (Issue 52)
- J6 Alternative/Waypoint to Accommodate D.C. Metroplex Departures (Issues 42 and 55)
- Q-Route to Replace J149 between RAMAY and HACKS (Issues 42 and 56)
- HYPER, LEGGO, PRTZL RNAV Procedures (Issue 25)

4.3.1 STAR from ZDC to TEB, MMU, CDW

Issue 31

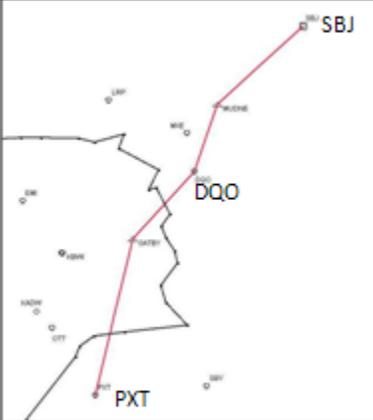
The proposed route could be a conventional STAR, since only 71% of the flights on the proposed route are RNAV equipped. Coordination with ZNY/N90/PHL would be required prior to implementation of this procedure.



STAR from ZDC to TEB, MMU, CDW

Issue 31

- Lack of a prop route from PCT airspace to TEB, CDW, MMU
 - Current routing
PXT023R..V433..DQO029R..V3..SBJ
- Proposed solutions
 - Create T-route below FL180
 - STAR (conventional) to TEB, MMU, CDW
- Expected benefits
 - Predictable flight path
 - Reduced ATC task complexity
- Considerations/Risks
 - Requires coordination with PHL TRACON and ZNY
 - 71 percent of aircraft along route were RNAV equipped*



* Based on arrivals to TEB, CDW, and MMU that filed in June 2010 PXT023R..V433..DQO029R..V3..SBJ

4.3.2 HGR Terminal Operations

Issue 53

Initial screening performed by the PST shows that radar coverage should be adequate for PCT to assume the HGR terminal functions. PCT should be able to assume the HGR terminal functions without any degradation in service.



HGR Terminal Operations

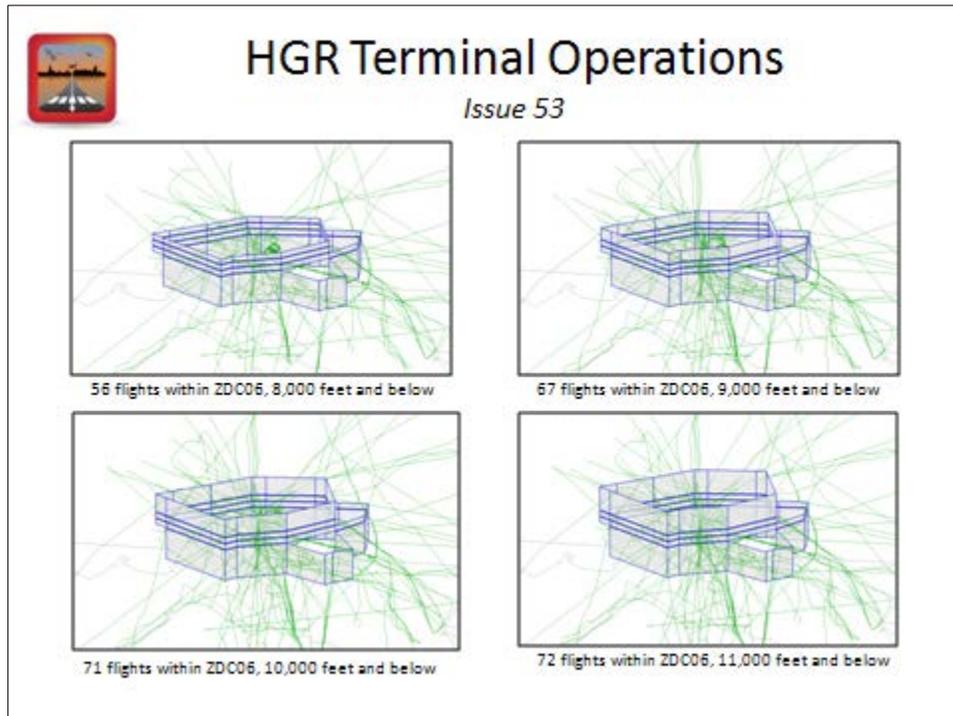
Issue 53

- ZDC06 working HGR approach control and high altitude operations
- Potential solution
 - PCT provides approach control operations
 - Apply terminal separation standards
- Expected benefits
 - Terminal functions in a terminal facility
 - Enable an en route sector to focus on high altitude operations
- Considerations/Risks
 - Radar coverage expected to be adequate as PCT will use the same radars as ZDC
 - PCT equipment and staffing

46 flights within ZDC06, 7,000 feet and below



The preferred option for ZDC is to relinquish 8,000 feet and below to PCT for HGR approach functions. Analysis was done for PCT acquiring airspace from the surface to altitudes between 8,000 feet and 11,000 feet.



4.3.3 ZDC Sector 04 Redesign

Issue 54

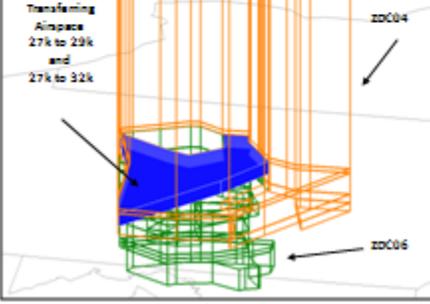
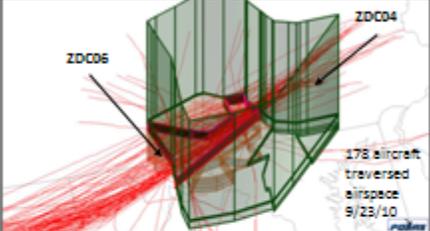
Redesign of ZDC04/06 will be enabled if HGR terminal functions are moved to PCT. This sector re-stratification will balance sector loading.



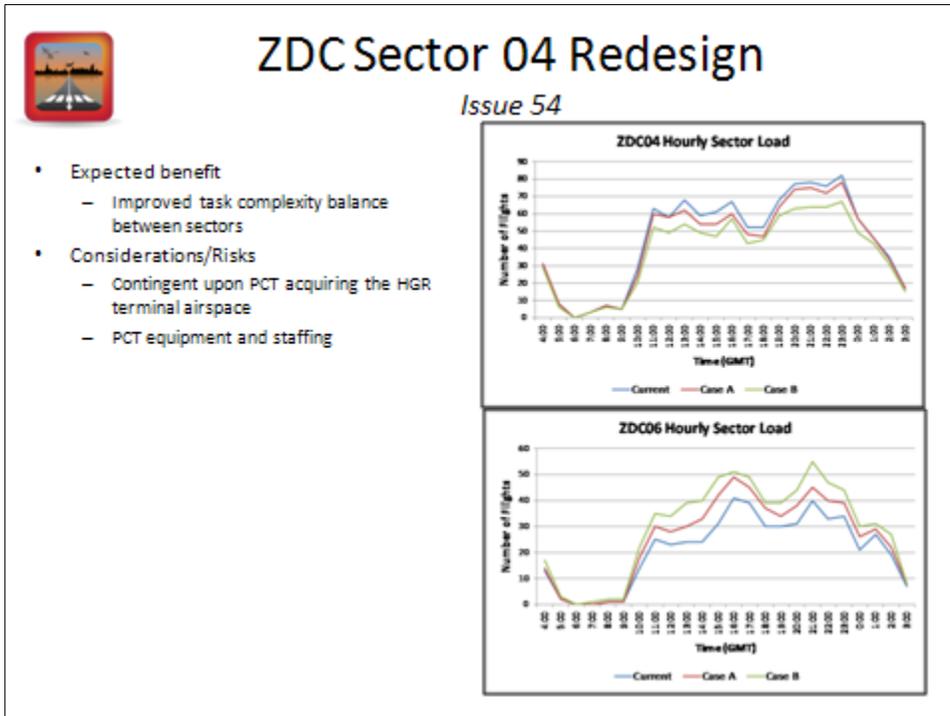
ZDC Sector 04 Redesign

Issue 54

- ZDC04 would require airspace redesign if PCT acquires HGR terminal functions (see Issue 53)
- Potential solution
 - ZDC04 acquires the floor altitudes from ZDC06 (primarily J6 traffic)
 - Case A: From FL270 to FL290
 - Case B: From FL270 to FL320



Moving the shelf of airspace from ZDC04 to ZDC06 improves the task complexity balance of the two sectors, with transfer of FL270 to FL320 (Case B) to ZDC06 as the preferred alternative. The graphs below depict hourly sector loading based on 6/17/10 traffic. Case B reduces ZDC04 traffic during the peak (2100 GMT) from approximately 80 to 65 aircraft per hour, and only increases ZDC06 traffic from 40 to 54 aircraft during the same time period.



4.3.4 ZDC Sector 03 Complexity

Issue 37

ZDC03 is a complex sector that blends Metroplex westbound departures and also handles north and southbound overflights. ZDC wanted to look at alternative sectorization to help balance the task complexity in this sector. Adjacent sectors ZDC01 and ZDC05 were analyzed to see the impact of re-sectorization to reduce the task complexity in ZDC03. The proposed solution is to re-stratify the floor of ZDC03 from FL250 to FL280. ZDC01 would absorb this airspace. In order to balance the impact on ZDC01, the lateral boundary between ZDC01 and ZDC05 would be adjusted to take airspace from ZDC01 above Clarksburg approach control and transfer it to ZDC05. Transitional separation between ZDC and PCT should be addressed in their SOPs/LOAs.



ZDC Sector 03 Complexity *(1 of 2)*

Issue 37

- Complexity in ZDC03 due to blending of D.C. Metroplex departure traffic
- Proposed solution
 - Re-stratify ZDC03
 - Change floor from FL250 to FL280
 - ZDC01 absorbs this airspace
 - Change lateral boundaries of ZDC01 and ZDC05 over Clarksburg approach
 - Transitional separation between PCT and ZDC
- Expected benefit
 - Balance in sector task complexity
 - Reduces point-outs from ZDC05 to ZDC01 on IAD departures
- Considerations/Risks
 - Spectrum analysis

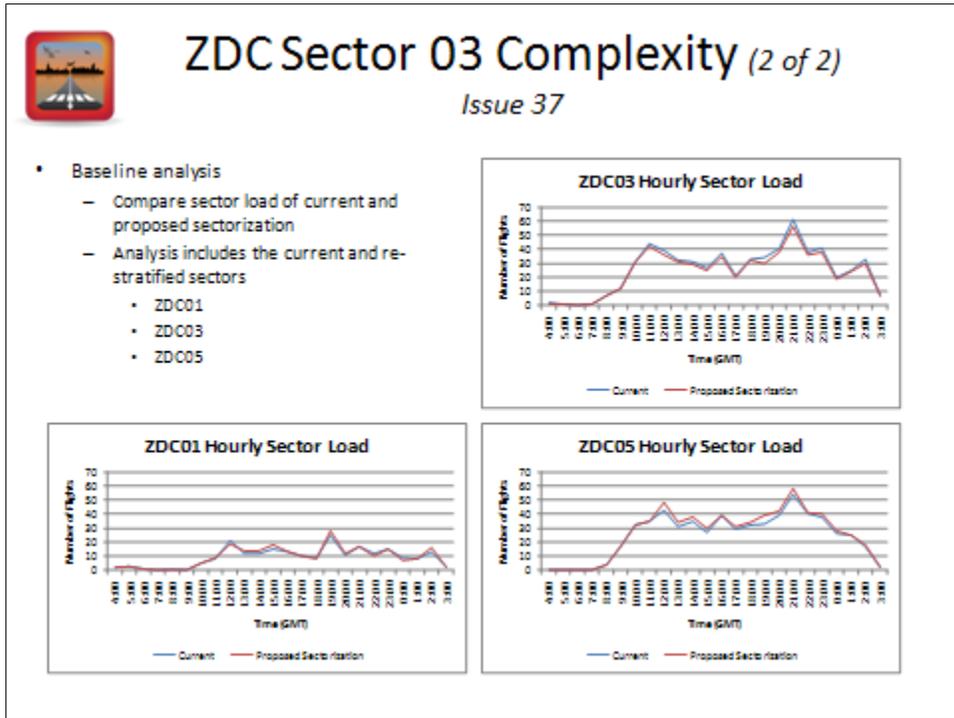
Current Sectorization



Proposed Sectorization



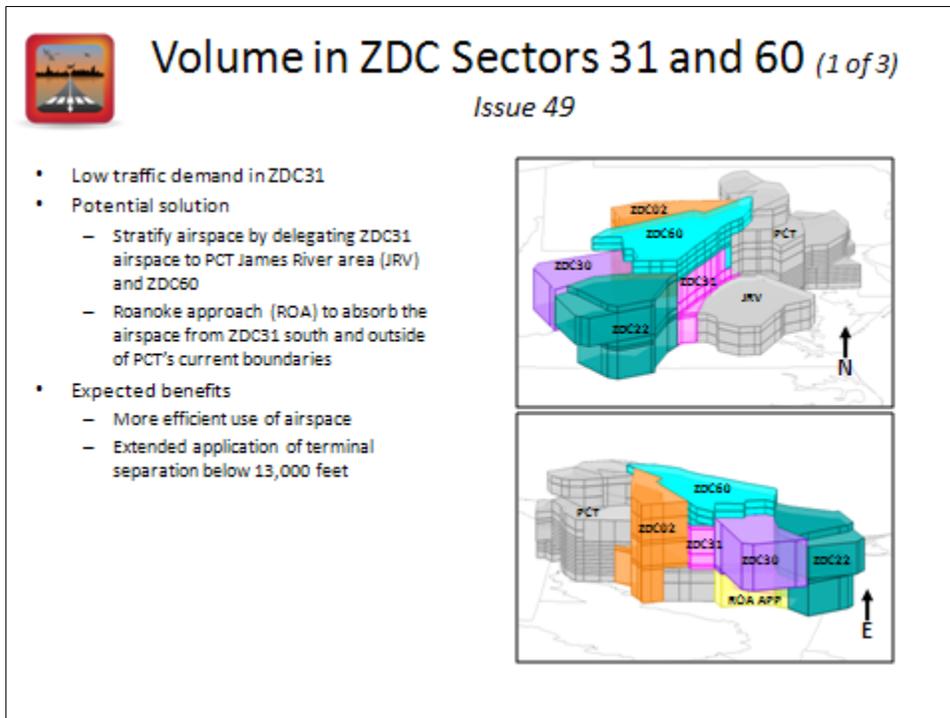
An analysis of hourly sector counts for the three affected sectors was conducted. The proposed sectorization did not have a large impact on these counts. The ZDC01 hourly counts remain below 30 flights. With the new sectorization at the peak hour (2100 GMT), ZDC03 hourly counts drop from 61 to 56, while the ZDC05 hourly counts increase from 54 to 58.



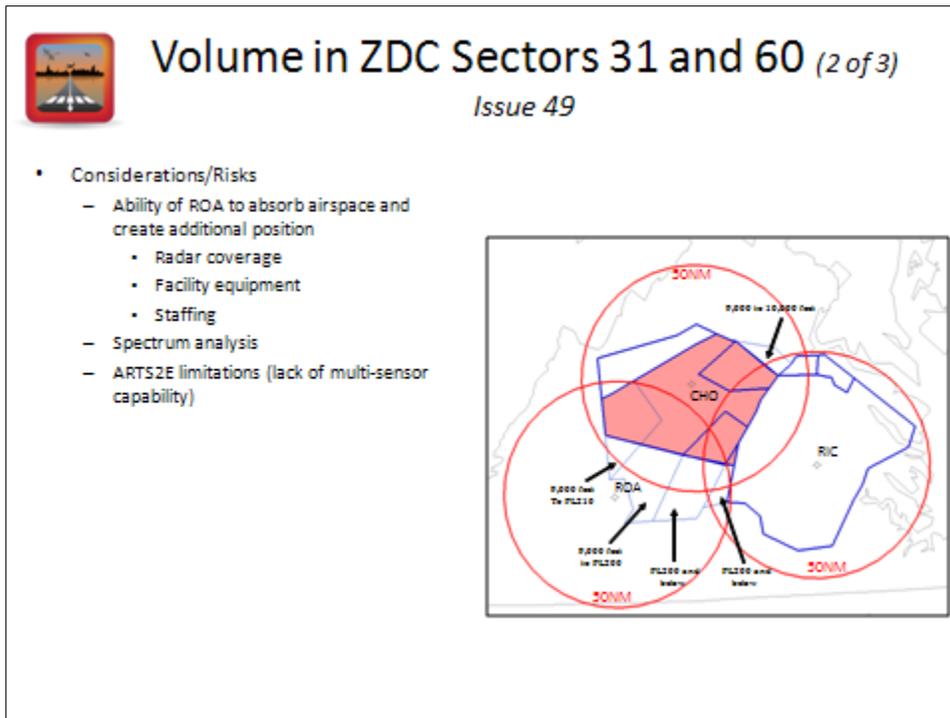
4.3.5 Volume in ZDC Sectors 31 and 60

Issue 49

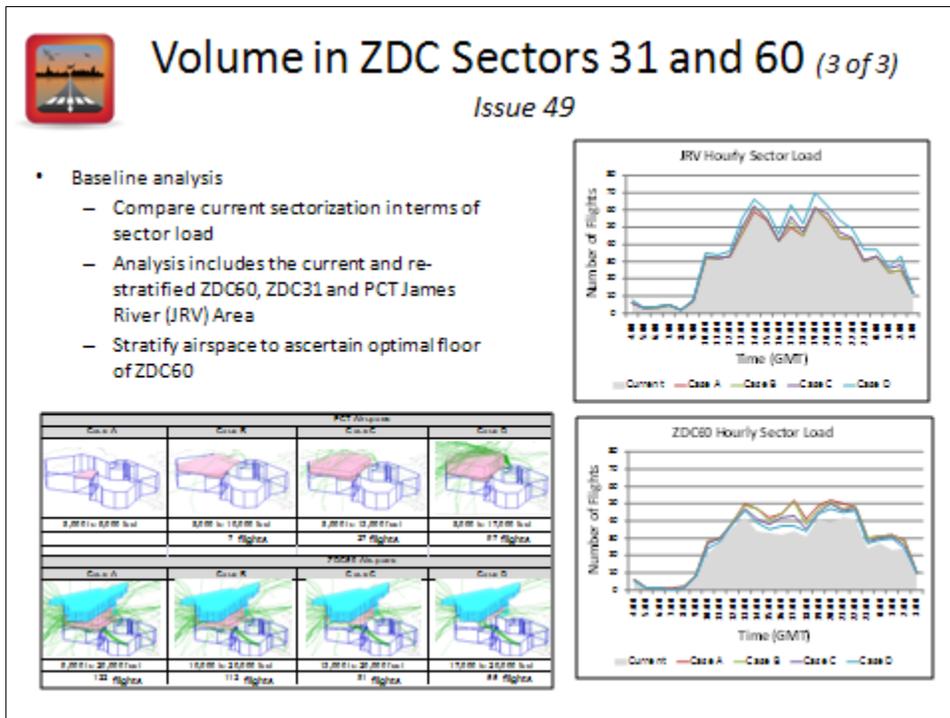
ZDC31 is combined with ZDC60 a majority of the time. One potential solution is for PCT and ZDC60 to absorb ZDC31 airspace. ROA approach would assume ZDC31 airspace outside of the PCT boundary.



ZDC proposes to have ROA/LYH approach absorb ZDC31 airspace outside of PCT's boundary at 13,000 feet and below. The area highlighted in red in the graphic below is the proposed airspace transfer from ZDC31 to PCT and ZDC60. Fifty mile range rings in the graphic show that the radar coverage should be sufficient.



Different stratification cases were analyzed. Case C is the preferred alternative by ZDC. In this case, PCT would acquire 13,000 feet and below from ZDC31 and ZDC60 would absorb ZDC31 airspace from 14,000 feet to FL200. With the new sectorization at the peak hour (1900 GMT), the JRV hourly count would go from 60 to 70 aircraft, while the ZDC60 hourly count would increase from 40 to 50.



4.3.6 Flows over SBY, WIBID, CHS

Issues 48 and 52

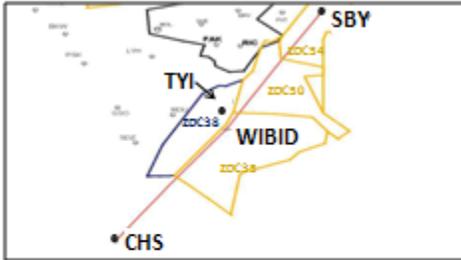
Currently, traffic from SBY to CHS encroaches on ZDC38 and TYI traffic. ZDC proposes to have traffic routed via a Q-route to move traffic out of ZDC38 into ZDC35. Because this issue proposes a Q-route which reduces reliance on the conventional jet route, Issue 48 is also indirectly addressed.



Flows Over SBY, WIBID, CHS

Issues 48 and 52

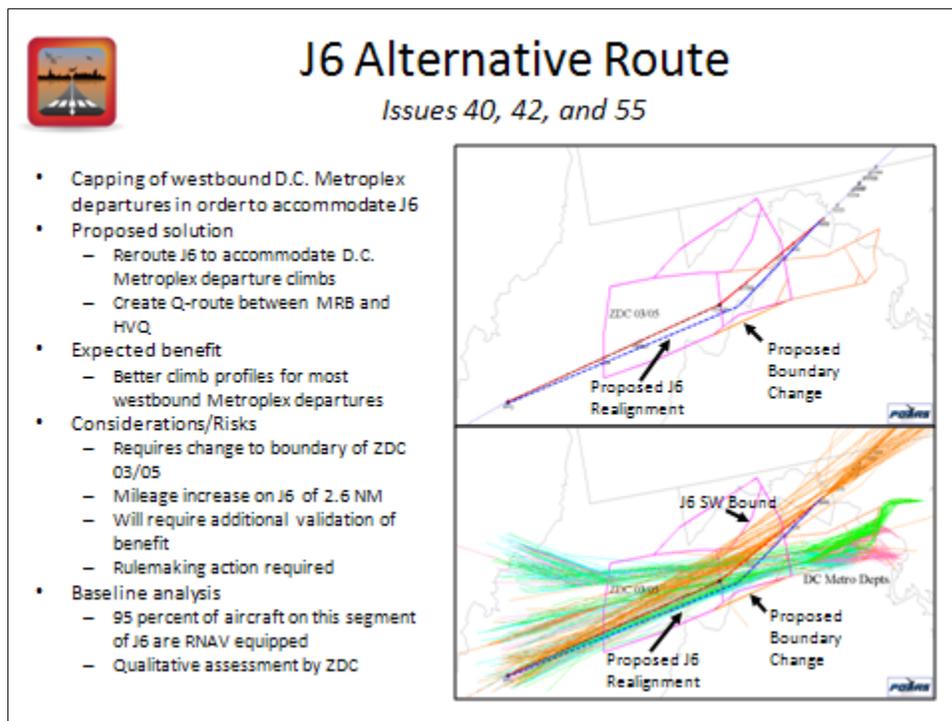
- D.C. Metroplex Arrivals conflict with SBY-TYI-CHS overflights at Top of Descent point (TOD) within ZDC38
- Proposed solution
 - Create Q-route from SBY to WIBID to CHS
- Expected benefits
 - Moves confliction south of TOD for D.C. Metroplex Arrivals
 - Predictable flight path
 - Reduced ATC task complexity
 - Traffic moved out of ZDC38
 - Shorter route than filed over ISO
- Considerations/Risks
 - 98 percent of aircraft on this route are RNAV equipped



4.3.7 J6 Alternative Route

Issues 40, 42 and 55

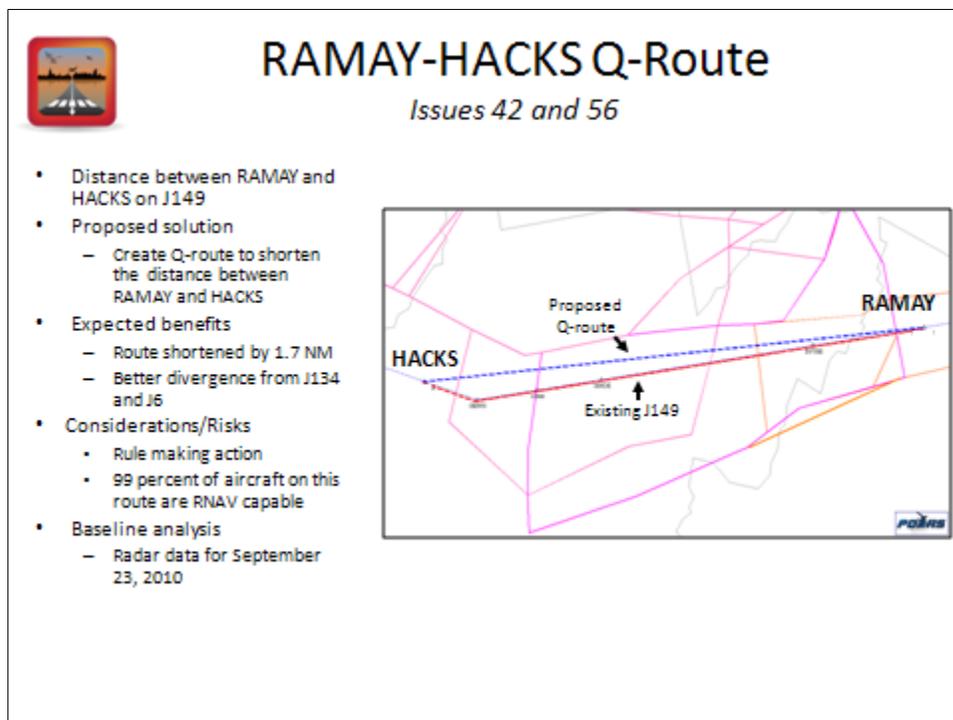
This ZDC proposal will allow J6 en route operations to diverge earlier from D.C. Metroplex departures filed over HNN and HACKS. This should provide for an improved climb for Metroplex departures on these routes. The proposed design does increase the distance flown between MRB and HVQ by 2.6 miles. However, the PST believes that the advantage provided to Metroplex departures will overshadow any additional fuel required by en route operations along J6. Issues 40 (impact of departure level-offs) and 42 (reduce reliance on conventional jet routes and airways) are also addressed by this proposed solution.



4.3.8 RAMAY-HACKS Q-Route

Issues 42 and 56

This ZDC proposal would shorten J149 between RAMAY and HACKS by 1.7 NM. Additionally, the divergence from J134 and J6 would be improved. Divergence between the proposed J6 Q-route alternative (Issue #55) and this proposed Q-route would increase as well. Issue 42 (reduce reliance on conventional jet routes and airways) is also addressed by this proposed solution. Ninety-nine percent of the aircraft that filed on J149 between RAMAY and HACKS in June 2010 were RNAV-capable. This percentage was determined by counting the flights that filed J149 and either GEFES, GINYA, AML, RAMAY, EYTEE, HACKS for June 2010, and then counting those with AC_TYPE E,F,G,R,J,K,L, or Q as RNAV-capable.



4.3.9 HYPER, LEFFO and PRTZL Arrivals

Issue 25

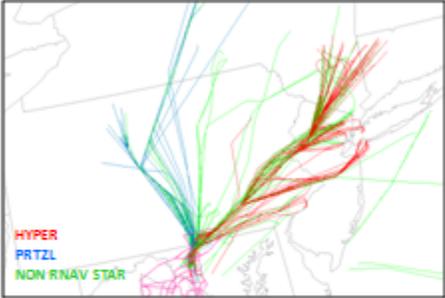
IAD arrivals from the north and northeast are often not assigned the available RNAV STARs even though they are capable of flying them. This is most likely due to lack of adaptation in the ZNY Host Computer System (HCS) of these RNAV STARs as preferential arrival routes (PARs). Additionally, the FAA's User Request and Evaluation Tool does not currently prioritize the RNAV STARs as the preferred routing.



HYPER, LEGGO, and PRTZL Arrivals

Issue 25

- PCT uncertainty as to whether IAD arrivals from the north and northeast are assigned the HYPER, LEGGO, and PRTZL (RNAV) procedures or a conventional procedure at handoff
 - Many RNAV-capable aircraft are delivered by ZNY on the conventional procedures
- Proposed solution
 - Ensure adaptation favors application of RNAV STARs
 - Ensure User Request and Evaluation Tool (URET) at ZBW and ZNY favors application of RNAV STARs
 - See issue #11 (BINNS sector)
- Expected benefits
 - Removal of uncertainty in route assignment
 - Advantages associated with RNAV routes over conventional procedures
- Considerations/Risks
 - Controller training
 - Shift in traffic volume



HYPER
PRTZL
NON RNAV STAR

4.4 Terminal Issues

For the terminal area, the PST again found that the lack of PBN/RNAV procedures resulted in additional ATC/pilot task complexity and reduced efficiency. The design of Class B airspace also resulted in arriving aircraft entering, exiting, and then reentering the designated airspace. PCT is currently examining the redefinition of Class B airspace, so no specific recommendations were made by the PST in this area. However, the PST noted that additional PBN procedures were needed to support satellite airport operations and PBN routes could be implemented to enhance efficiency. Additionally, the military indicated an interest in developing PBN procedures for Andrews Air Force Base (ADW).

4.4.1 Class B Excursions

Issues 8 and 33

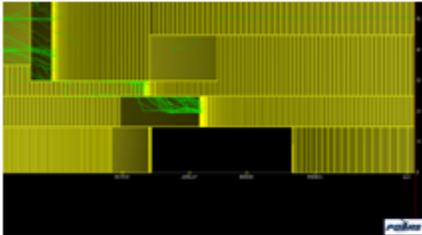
Currently, PCT Class B airspace is not adequate to contain all arrivals to BWI, DCA and IAD. However, all Visual Flight Rules aircraft within the Special Flight Rules Area (SFRA) must have an operational transponder, maintain radio communications and have acquired an ATC clearance into and out of the SFRA, which may mitigate some of the risks associated with Class B excursions. The data shown below on Class B excursions comes from the FAA's Performance Data Analysis and Reporting System (PDARS) Class B Safety Report.



Class B Excursions

Issues 8 and 33

- BWI arrivals exit Class B airspace on final to Runway 10
- IAD arrivals exit Class B airspace on base and final to Runways 01/19 L/C/R
- Baseline analysis
 - Radar tracks
 - AJS Class B safety report for September 23, 2010
- Potential solution
 - Re-evaluate Class B to contain arrivals
 - ATC clearance considerations
- Expected benefits
 - Enhanced operational safety
- Considerations/Risks
 - Operational requirements due to the SFRA may mitigate the risk of Class B containment



IAD RWY 19C Arrivals Exiting Class B Airspace

AJS Class B Safety Report: Summary Arrivals

[Click Here for an Explanation of this Report](#) Remarks: For PCT on 9/23/2010

Excursion Category	Excursions on Arrival					
DEP Airport	Count of Excursions	Total Arrival Excursion Aircraft	Total Excursion Flight Time	Total Excursion Flight Distance	Total Arrivals	Excursion %
DCA	20	18	0:11:23	40,482	424	4.25%
BWI	14	14	0:04:26	19,018	451	3.42%
IAD	67	61	1:34:05	336,923	577	10.57%
Grand Total	101	93	1:49:54	396,423	1452	6.59%

4.4.2 PBN Procedures for Satellites

Issue 14

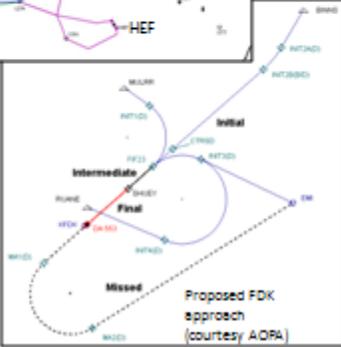
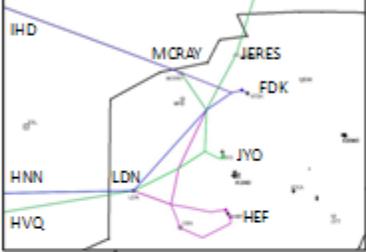
Adding PBN procedures to satellite airports will enable the segregation of flows between them and the major airports. Additionally, PBN approach procedures will provide improved access without requiring additional infrastructure. A baseline analysis for this proposal was not possible due to insufficient radar track data and lack of procedures published specifically for the airports being evaluated. The procedure proposed for FDK is intended to be a public procedure (rather than Special Aircraft and Aircrew Authorization Required [SAAAR]) which requires changes in current criteria.



PBN Procedures for Satellites

Issue 14

- Lack of PBN procedures at airports such as W32, VKX, FDK, CGS, HEF, JYO, W00, ADW, FME, 2W5, MTN, GAI and DMW
- JYO and FDK departures interact with IAD departures
- Proposed solutions would include the design and optimization of satellite
 - RNAV SIDS
 - RNAV arrivals
 - RNAV/GPS approaches to most runways
 - PCT considers departure procedures for airports within FRZ a priority
- Expected benefits
 - Improved access
 - Segregation from BWI/DCA/IAD procedures
- Considerations/Risks
 - PBN capability of GA fleet
 - Environmental assessment
 - Staffing satellite positions at PCT



Proposed FDK approach (courtesy AORA)

4.4.3 BWI RNP Approach Procedures

Issue 18

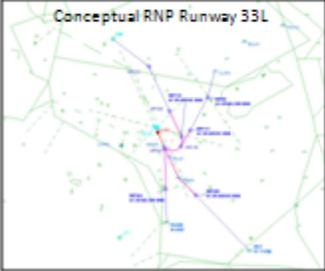
Industry is participating in the development of PBN approaches for BWI airport. Several concepts have been proposed, but there is a need to form an Industry/FAA working group to explore the potential of PBN approaches at BWI in detail. This should be a task for the Design and Implementation Team. Two conceptual examples of PBN approaches for BWI are shown below.



BWI RNP Approach Procedures

Issue 18

- BWI does not use RNP approach procedures
- Potential solution
 - Build BWI conceptual RNP approach procedures for Runways 33L and 10 that mimic existing visual approaches
 - Design and Implementation Team should partner with BWI lead carriers to develop and refine RNP approaches at BWI to mimic RNAV visual overlays
- Expected benefit
 - Leverages NextGen capabilities
 - Predictable, repeatable flight path to the runway
- Considerations/Risks
 - Disposition of non-participating aircraft
 - Controller training



4.4.4 Satellite Traffic in the SFRA

Issue 19

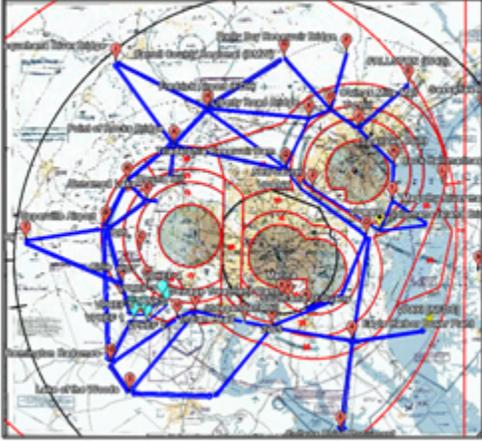
The provision of waypoints within and adjacent to the SFRA will assist pilots in avoiding restricted airspace and navigating the complex Class B and SFRA areas.



Satellite Traffic in the SFRA

Issue 19

- Satellite airport traffic from within the SFRA needs to be tracked by PCT
 - Airports within FRZ: CGS, VKX, W32, ADW, WOO, DAA
 - task complexity due to GA requirement to report landing time
- Proposed Solutions
 - 14 new VFR waypoints (currently in planning by PCT)
 - Allows users to file VFR flight plans
- Expected benefits
 - Improved ability for VFR flights to navigate beneath the complex Class B and SFRA airspace
 - Reduced need for coordination/task complexity
- Considerations/Risks
 - PBN capability of GA VFR fleet



VFR waypoint to assist navigation below Class B airspace
(Image courtesy of Lou Ridley, PCT)

4.4.5 V93 Tower En Route Clearance

Issues 27 and 42

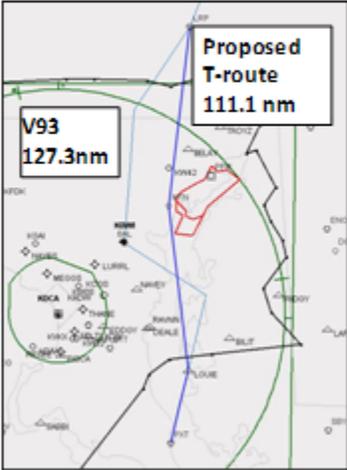
This proposed T-route would primarily benefit controllers by eliminating the need to manually clear aircraft assigned to this segment of V93 to the preferred routing.



V93 Tower En Route Clearance

Issues 27 and 42

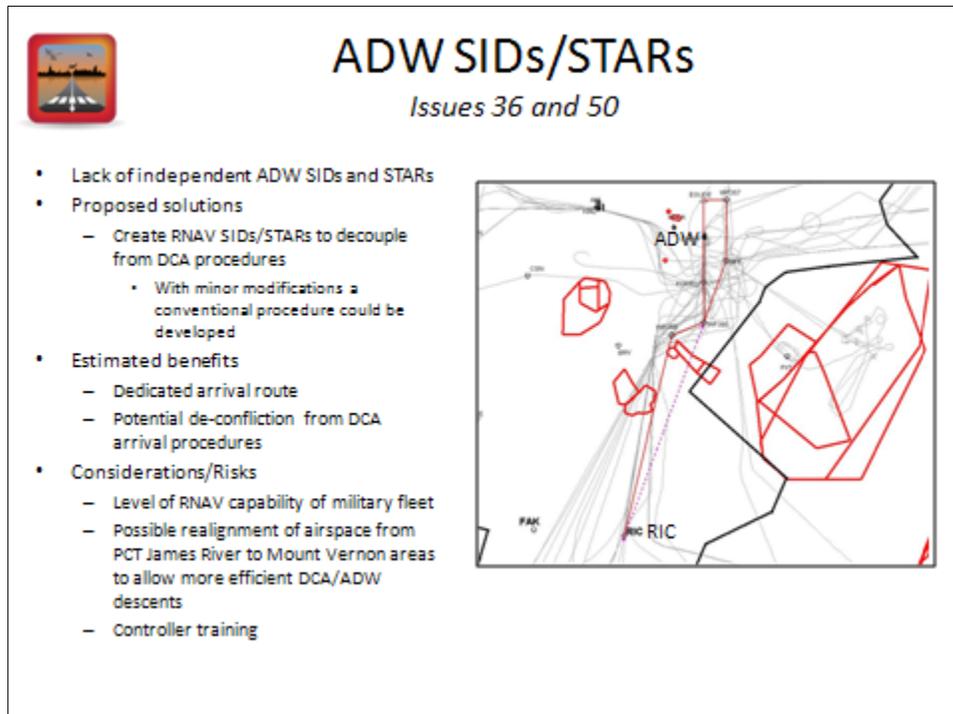
- Aircraft filed on V93 are re-routed via LRP..MTN..LOUIE..PXT since it is more direct and avoids overflight of the BWI radarsite
- Potential solution
 - Create T-route for preferred routing
 - 62 aircraft flew V93 over LRP to PXT in June 2010
 - 96 percent of aircraft using V93 are RNAV equipped
 - Maximum authorized altitude would be 14,000 feet
 - More than 80 percent flew below 14,000 feet in June 2010
- Expected benefits
 - Reduced ATC task complexity
 - Reduced mileage versus filed route (16 NM)
- Considerations/Risks
 - Only for traffic flying at or below 14,000 feet (ZDC owns 15,000 feet and above)



4.4.6 ADW SIDs/STARs

Issues 36 and 50

ZDC requested an independent ADW STAR from the RIC/FAK area. The graphic below depicts historical flight data and the proposed routing over RIC. The dashed line could be a separate procedure assigned by ATC to join the STAR at WP360 when the restricted area is inactive or in use below 10,000 feet.



5 Issues Identified, But Not Analyzed

The PST was presented with several issues that could not necessarily be addressed by PBN solutions or within the timeframe of the expected effort. These issues are listed below and will be forwarded to the Design and Implementation Team for future consideration.

- Altitudes designed to accommodate IAD triple, simultaneous ILS approaches do not allow turns to intercept inside of the intermediate fix (Issue 9 - currently under study by PCT)
- Impact of required Minimum Vectoring Altitude (MVA) changes (Issue 15)
 - Due to recent changes in criteria, MVAs are being updated across the National Airspace System (NAS)
 - These changes will primarily impact approach and missed approach procedures, but the Design and Implementation Team will need to be aware of them especially in cases where runway transitions are included in the PBN procedures
- Development of Instrument Flight Rules (IFR) helicopter routes within PCT (Issue 28)
 - Lack of specifics and limited time prevented the PST from specifically considering IFR helicopter routes
 - Given the state of PBN criteria for helicopters, and the level of support, the Design and Implementation Team may want to consider the development of such routes
- Procedures that are PBN compatible – without requiring SAAAR e.g., use of Radius-to-Fix legs on a STAR (Issues 39 and 44)
 - Establishment or modification of existing criteria was not considered to be an issue for which the PST could propose a mitigation
- Make use of Navigation Reference System (NRS) waypoints (Issue 41)
 - Current criteria does not allow the use of NRS waypoints on RNAV SIDs/STARs
 - For proposed Q-routes, no NRS waypoints were appropriately located
- Consolidate RNAV standards (Issue 43)
 - Currently an ongoing effort by FAA Aviation System Standards and Flight Standards lines of business
- Optimize ability to sequence RNAV and non-RNAV flows using tools such as Relative Position Indicator (RPI) (Issue 45)
 - Time horizon for RPI implementation (2-3 years) resulted in the PST applying only currently implemented tools and capabilities
- Improve planning during weather events (Issue 46)

- This specifically addressed coordination and planning between facilities which was considered an issue for which the PST could not propose a mitigation
- Reduce need for manual coordination between facilities (Issue 48)
 - This issue specifically addressed coordination and planning between facilities that could be addressed through automation and was considered an issue for which the PST could not propose a mitigation

6 Summary

The focus of the PST was to address identified issues through the application of PBN procedures and airspace changes that enable predictable, repeatable flight paths, reduce ATC task complexity, and maximize efficiency. The two phases of this approach consisted of:

- Collaboratively identifying and characterizing existing issues and then
- Proposing conceptual designs and airspace changes that will address the issue and optimize the operation

The expected benefits for the proposed solutions were derived primarily from the differences in fuel burn between the current operation and the conceptual changes. In all cases, the PST also identified considerations and risks that could be associated with each proposed change.

Adopting the changes proposed by the Washington D.C. Metroplex Prototype Study Team is estimated to result in an annual savings of between \$6.4 mil and \$19.0 mil per year in fuel savings primarily due to

- Use of OPDs
- Reduced track distances

Additional benefits include

- Reduced ATC task complexity and pilot/controller communications due to reduced radar vectoring
- Foundation for NextGen capabilities (e.g., use of Relative Position Indicator; Required Time of Arrival)
- Repeatable, predictable flight paths
- Reduced need for TMIs