Draft Environmental Assessment for Washington, D.C. Optimization of Airspace and Procedures in the Metroplex

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1 Introduction

The National Environmental Policy Act of 1969 (NEPA) (42 United States Code [U.S.C.] § 4321 et seq.), requires federal agencies to disclose to decision makers and the interested public a clear, accurate description of potential environmental impacts arising from proposed federal actions and reasonable alternatives to those actions. Through NEPA, Congress has directed federal agencies to include environmental factors in their planning and decision making processes and to encourage public involvement in decisions that affect the quality of the human environment. Furthermore, as part of the NEPA process, federal agencies are required to consider the environmental effects of a proposed action, reasonable alternatives to the proposed action, and a no action alternative (analyzing the potential environmental effects of not undertaking the proposed action). The Federal Aviation Administration (FAA) has established a process to ensure compliance with the provisions of NEPA through FAA Order 1050.1E, Change 1, Environmental Impacts: Policies and Procedures (FAA Order 1050.1E).

This Environmental Assessment (EA), prepared in accordance with FAA Order 1050.1E, documents the potential effects to the environment that may result from the optimization of Air Traffic Control (ATC) procedures that would standardize aircraft routing to and from airports. The Proposed Action, the subject of this EA, is referred to as the Optimization of Airspace and Procedures in the Washington D.C. Metroplex or “DC OAPM.” The procedures designed as part of the DC OAPM would support arriving and departing aircraft operating under Instrument Flight Rules (IFR) at the study area airports (“the Study Airports”), using currently available technology.

This EA consists of the following chapters and appendices:

- **Chapter 1: Introduction.** Chapter 1 provides basic background information on the air traffic system, the Next Generation Air Transportation System program, performance based navigation including area navigation technology, the FAA's OAPM initiative, and information on the Washington D.C. Metroplex and Study Airports.

- **Chapter 2: Purpose and Need.** Chapter 2 discusses the need (problem) and purpose (goal) for airspace and procedure optimization in the DC Metroplex area and identifies the Proposed Action that is the subject of this EA.

- **Chapter 3: Alternatives.** Chapter 3 discusses the Proposed Action and the No Action Alternatives analyzed as part of the environmental review process.

- **Chapter 4: Affected Environment.** Chapter 4 discusses existing conditions within the DC Metroplex area.

- **Chapter 5: Environmental Consequences.** Chapter 5 discusses the potential environmental impacts associated with the Proposed Action and No Action Alternatives.

- **Appendix A: Agency and Public Coordination.** Appendix A documents agency and public coordination associated with the EA process and includes any comments received during the public review period and responses to these comments.
1.1 Project Background

On January 16, 2009, the FAA asked the RTCA to create a joint government-industry task force to make recommendations for implementation of Next Generation Air Transportation System (NextGen) operational improvements for the nation’s air transportation system. In response, RTCA assembled the NextGen Mid-Term Implementation Task Force (Task Force 5), which included more than 300 members representing commercial airline, general aviation, military, manufacturer, and airport stakeholders. The NextGen Program is discussed in more detail in Section 1.2.4.

On September 9, 2009, RTCA issued the NextGen Mid-Term Implementation Task Force Report, which provided the Task Force 5 recommendations. One of these recommendations suggested that the FAA should undertake planning for the implementation of Performance-Based Navigation (PBN) procedures such as Area Navigation (RNAV) and Required Navigation Performance (RNP) procedures on a Metroplex basis. (RNAV and RNP procedures are further discussed in Section 1.2.4.) Based on this recommendation, the FAA created the OAPM initiative.

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1 RTCA, Inc. Executive Summary of the NextGen Mid-Term Implementation Task Force Report, September 9, 2009.
2 RTCA, Inc. is a private, not-for-profit corporation that develops consensus-based recommendations regarding communications, navigation, surveillance and air traffic management system issues. RTCA functions as a federal advisory committee and includes roughly 400 government, industry and academic organizations from the United States and around the world. Members represent all facets of the aviation community, including government organizations, airlines, airspace users, airport associations, labor unions, and aviation service and equipment suppliers. More information is available at http://www.rtca.org.
5 A Metroplex is a geographic area covering several airports, serving major metropolitan areas and a diversity of aviation stakeholders.
The purpose of the OAPM initiative is to optimize air traffic procedures and airspace on a regional scale. This would be accomplished by employing technological advances in navigation such as RNAV while ensuring that aircraft that are not equipped to use RNAV have access to terminal airspace. This approach addresses congestion and other factors that reduce efficiency in busy Metroplex areas and accounts for key operating airports and airspace in the Metroplex. Study Area airports are further discussed in Section 1.4. It also addresses connectivity with other Metroplex areas. The intent is to use the limited airspace as efficiently as possible for congested Metroplex areas.

1.2 Air Traffic Control and the National Airspace System

The following sections are intended to provide the reader with basic background knowledge of air traffic control and the National Airspace System (NAS). A description of the NAS, the role of Air Traffic Control (ATC), the methods used by air traffic controllers to manage the Air Traffic Control system, and the different phases of aircraft flight within the system. Following this discussion, information is provided on the FAA’s NextGen program and the OAPM initiative.

1.2.1 National Airspace System

Under the Federal Aviation Act of 1958 (49 USC § 40101 et seq.), the FAA is charged with the responsibility for controlling the use of the nation’s navigable airspace and regulating civil and military aircraft operations in the interest of maintaining safety and efficiency. To help fulfill this mandate, the FAA established the NAS. Within the NAS, the FAA manages aircraft takeoffs and landings and the flow of aircraft between airports through a system of infrastructure (e.g., air traffic control facilities), people (e.g., air traffic controllers, maintenance, and support personnel), and technology (e.g., radar, communications equipment, ground-based navigational aids (NAVAIDs), etc.) The NAS is governed by various FAA rules and regulations.

The NAS comprises one of the most complex aviation networks in the world. Accordingly, to fulfill its mission, the FAA is continuously reviewing the design of all NAS resources to ensure they are effectively and efficiently managed. When changes are proposed to the NAS, the FAA works to ensure that the changes maintain or enhance system safety and improve efficiency. One way to accomplish this mission is to employ emerging technologies to increase system flexibility and predictability. The FAA Air Traffic Organization (ATO) is the primary organization within the FAA responsible for optimizing airspace and flight procedures used in the NAS. In working to improve the NAS, the FAA must comply with NEPA and other applicable laws and regulations.

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6 Terminal Airspace: an area of airspace defined by boundaries and altitudes assigned to a radar control facility associated with an airport or group of airports. The facility that manages this airspace is referred to as the Terminal Radar Approach Control (TRACON). The boundaries and altitudes are based on factors such as traffic flows, neighboring airports and terrain. The primary traffic flows are arrivals and departures to the airport(s) located within the terminal airspace.


8 NAVAIDs are facilities that transmit signals that define key points or routes.

9 U.S. Department of Transportation, Federal Aviation Administration, Order JO 7400.2G, Change 3, Procedures for Handling Airspace Matters, Section 32-3-5(b) "National Airspace Redesign," April 10, 2008
1.2.2 Air Traffic Control within the National Airspace System

The combination of infrastructure, people, and technology used to monitor and guide or direct aircraft within the NAS is referred to collectively as ATC. ATC is responsible for separating aircraft (keeping minimum distances between aircraft) to maintain safety and expedite the flow of traffic operating in the NAS. Air traffic controllers are responsible for providing these air traffic services to aircraft operating in the airspace. This is accomplished through communications with pilots and by using various technologies such as radar.

Aircraft operate under two distinct categories of flight rules: Visual Flight Rules (VFR) and Instrument Flight Rules (IFR).\(^{10}\) These flight rules generally correspond with two categories of weather conditions: Visual Meteorological Conditions (VMC) and Instrument Meteorological Conditions (IMC).\(^ {11}\) VMC generally exist during fair to good weather with good visibility. IMC occur during periods when visibility falls to less than three statute miles or the ceiling (the distance from the ground to the bottom layer of clouds when the clouds cover more than 50 percent of the sky) drops to lower than 1,000 feet. Under VFR, pilots are able to fly whatever route they chose and are responsible to “see and avoid” other aircraft and obstacles such as terrain to maintain safe separation. Under IFR ATC is responsible for providing separation from other aircraft and terrain and pilots use cockpit instruments and radar to fly routes specified by ATC and to comply with ATC instructions. Pilots must follow IFR during IMC; however, due to various factors such as the general requirement for aircraft to operate under IFR in Class A airspace (i.e., enroute airspace between 18,000 feet MSL and 60,000 feet MSL)\(^ {12}\), the majority of commercial air traffic operate under IFR regardless of weather conditions.

Based on factors such as aircraft type and weather, air traffic controllers apply criteria to maintain defined minimum distances (referred to as separation) between aircraft.\(^ {13}\) These types of separations include:

- **Vertical or “Altitude” Separation:** separation between aircraft operating at different altitudes;
- **Longitudinal or “In-Trail” Separation:** the separation between two aircraft operating along the same flight route referring to the distance between a lead and a following aircraft; and,
- **Lateral or “Side-to-Side” Separation:** separation between aircraft (left or right side) operating along two separate but nearby flight routes.

Exhibit 1-1 depicts the three dimensions around an aircraft used to determine separation.

For aircraft operating under IFR, air traffic controllers maintain separation by monitoring and, as needed, directing pilots following standard instrument procedures. Standard instrument procedures define the routes along which aircraft operate. These procedures are intended to provide predictable, efficient routes to move aircraft through the airspace in an orderly manner. They also minimize the need for communication between the controller.


\(^{12}\) 14 C.F.R. § 91.135.

\(^{13}\) Defined in FAA Order 7110.65U, Air Traffic Control.
In its effort to modernize the NAS, the FAA is developing standard instrument procedures using new and alternate technologies. A primary technology being applied in this effort is RNAV. RNAV technology allows an RNAV-trained pilot operating an RNAV-equipped aircraft to fly a more direct route based on instrument guidance that references an aircraft’s position within the coverage of ground-based NAVAIDs or space-based navigational aids using Global Positioning System (GPS) technology. **Exhibit 1-2** compares an RNAV procedure to a conventional procedure.

If standard instrument procedures in the terminal airspace do not exist or are unable to accommodate demand due to air traffic congestion, ATC must maintain safety within the airspace it controls by using one or a combination of several management tools and coordination techniques. The more frequently this is done, the more complex pilot and controller workload becomes. The management tools and coordination techniques include:

- **Vectoring:** Controllers issue a series of headings to a pilot to route an aircraft. This can increase aircraft flight distance and flight time resulting in increased fuel burn, decreased flight route predictability, and increased air traffic controller/pilot communication requirements and workload.

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14 Ground-based distance measuring equipment (DME) can be used to establish an aircraft’s position.
Exhibit 1-2  Comparison of Routes Following Conventional versus RNAV Procedures

- **Speed Control**: Controllers direct aircraft to reduce or increase aircraft speed. A reduction in speed can increase aircraft flight time resulting in increased fuel burn, decrease flight route predictability, and increase air traffic controller/pilot communication requirements and workload.

- **Hold Pattern/Ground Hold**: Controllers assign aircraft to a holding pattern in the air or hold aircraft on the ground before departure. Holding an aircraft on the ground can result in delays and increased flight time. Assigning an aircraft to a holding
pattern in the air increases flight time resulting in greater fuel burn and air traffic controller/pilot communication requirements and workload.

- **Level-off:** Controllers direct an aircraft to level off during ascent or descent. This can increase flight time and distance, resulting in increased fuel burn, by disrupting a continuous ascent or descent and increasing air traffic controller/pilot communication requirements and workload.

- **Reroute:** Controllers reroute aircraft to terminal airspace entry or exit gates other than the preferred or most direct gate. This can increase flight time, distance, and fuel burn; decrease flight route predictability; and increase air traffic controller/pilot communication requirements, complexity, and workload.

- **Point-out:** Controllers point out, or notify a controller managing an adjacent sector of the proximity of an aircraft to the adjacent sector’s boundary (close to one and a half miles from the shared boundary). Point outs can be done verbally or electronically and can result in added complexity to air traffic controller communications and increased workload.

As an aircraft moves from origin to destination, ATC personnel function as a team and transfer control of the aircraft from one controller to the next and from one ATC facility to the next. Overall, managing the flow of departing aircraft (departure flow) tends to be less complicated. For example, if traffic conflicts or weather related issues are anticipated aircraft can be held on the ground to ensure safe management of the airspace. Managing the arrival flow tends to be more complicated because arriving aircraft are already airborne and thus require increased management to maintain a safe airspace environment.

### 1.2.3 Aircraft Flow within the National Airspace System

An aircraft traveling from airport to airport typically operates through six phases of flight (plus a “preflight” phase.) **Exhibit 1-3** depicts the typical phases of flight for a commercial aircraft. These phases include:

- **Preflight (Flight Planning):** The preflight route planning and checks in preparation for takeoff.

- **Push Back/Taxi/Takeoff:** The transition of an aircraft from push back at the gate to taxiing to an assigned runway and lift off from the runway.

- **Departure:** The in-flight transition of an aircraft from take-off to the enroute phase of flight, during which the aircraft climbs to its assigned cruising altitude following a standard instrument procedure (predefined set of guidance instructions that define a route for a pilot to follow) or a series of verbally issued instructions from an air traffic controller.

- **Enroute:** The generally level segment of flight (“cruising altitude”) between the departure and destination airports.

- **Descent:** The in-flight transition of an aircraft from the assigned cruising altitude to the point at which the pilot initiates the approach to a runway at the destination airport.
Exhibit 1-3 Typical Phases of a Commercial Aircraft Flight

- **Approach:** The segment of flight during which a pilot follows a standard procedure or series of verbal instructions from an air traffic controller to guide the aircraft to the landing runway.

- **Landing:** Touch-down of the aircraft at the destination airport’s runway and taxiing from the runway end to the gate or parking position.

### 1.2.4 Air Traffic Control Facilities

The NAS is organized into three-dimensional areas of navigable airspace (defined by a floor, a ceiling, and a lateral boundary), which are managed by different ATC facilities. These airspace areas are divided into specialized areas, which are further broken down into sectors. Air traffic controllers are assigned to specialized areas within the control of their ATC facility and assigned specific sectors within which they manage the aircraft operating under IFR. The three types of ATC facilities include:

- **Air Traffic Control Tower:** Controllers at an Air Traffic Control Tower (ATCT) located at an airport manage phases of flight associated with an aircraft taking off from and landing at an airport. ATCT typically controls airspace extending from the airport out to a distance of several miles.

- **Terminal Radar Approach Control:** Controllers at a Terminal Radar Approach Control (TRACON) facility manage aircraft as they transition between an airport and the enroute phase of flight. This includes the departure, climb, descent, and approach phases of flights. TRACON controllers are responsible for separating aircraft operating within the terminal airspace sectors. As an aircraft moves from sector to sector, responsibility for management of that aircraft is transferred from controller to controller. The terminal airspace in the DC Metroplex area is referred to as “the Potomac Consolidated TRACON” or “PCT” and is shown on Exhibit 1-4.
Air Route Traffic Control Centers: Controllers at Air Route Traffic Control Centers (ARTCCs or “Centers”) manage the flow of traffic to, from, and within the enroute airspace. Enroute airspace includes low-altitude routes called “victor airways”, high-altitude jet routes called “jet routes” (both defined by a series of ground-based NAVAIDS); low-altitude RNAV routes called “T-routes” and high-altitude RNAV routes called “Q-routes.” The RNAV routes provide a more direct path to a destination airport. Exhibit 1-4 shows how enroute airspace is delegated to different ARTCCs in the DC Metroplex area. Similar to terminal airspace, enroute airspace is divided into sectors.

The following sections discuss how air traffic controllers at these ATC facilities control the phases of flight for aircraft operating under IFR.
1.2.4.1 Departure Flow

As an aircraft operating under IFR departs a runway and follows its assigned heading, it moves from the ATCT airspace, through the terminal airspace, and into enroute airspace where it proceeds on a specific route or “jet route.” Once on a jet route, an aircraft flies along the route until it nears its destination airport.

Within the terminal airspace, TRACON controllers are responsible for controlling aircraft departing from the ATCT airspace to an exit gate. An exit gate represents an area along the boundary between terminal airspace and enroute airspace. Exit gates are generally established near jet routes to better facilitate transfer of aircraft between terminal and enroute airspace. When aircraft pass through the exit gate, control is passed from TRACON to ARTCC controllers as aircraft join a jet route.

To maintain safe distances between aircraft within the terminal airspace, TRACON controllers must maintain separation for departing aircraft (as well as between arriving and departing aircraft). Separation is further discussed in Section 1.2.3.3.

**Standard Instrument Departures**

Departing aircraft operating under IFR use an instrument procedure called a Standard Instrument Departure (SID). A SID provides pilots with defined lateral and vertical guidance to facilitate safe and predictable navigation from an airport through the terminal airspace to a jet route in the enroute airspace. A SID may be based on vectoring, following a route defined by ground-based NAVAIDs, or a combination of both. This is called a “conventional” SID. Because of the increased precision inherent in RNAV technology, an RNAV SID, which provides GPS-based navigation, defines a more predictable route through the airspace than does a conventional SID.

The portion of a SID that provides a path serving a particular runway at an airport is referred to as a “runway transition.” A SID may have several runway transitions serving one or more runways at one or more airports. From the common segment of the route, guidance may then be provided in the SID to one or more jet routes in the enroute airspace. This is referred to as an “enroute transition.”

1.2.4.2 Arrival Flow

A pilot will initiate the descent phase of flight within the enroute airspace. During descent, the aircraft will enter the terminal airspace for the destination airport at an entry gate. The entry gate represents a point along the boundary between terminal airspace and enroute airspace. When aircraft pass through the entry gate control of the aircraft is passed from ARTCC to TRACON controllers. To maintain safe distances between aircraft within the terminal airspace, TRACON controllers must maintain the same separation for arriving aircraft as those defined for departing aircraft. Separation is further discussed in Section 1.2.3.3.

**Standard Terminal Arrival Routes**

Aircraft arriving within the terminal airspace follow an instrument procedure called a Standard Terminal Arrival Route (STAR). A STAR proceeds from a route in the enroute airspace to the final approach to a runway. The final approach is the segment of flight when an aircraft is aligned with the landing runway and operates along a straight route at a constant rate of descent to the runway (an approximately three or slightly less degree angle).
A STAR can provide full guidance from enroute airspace through a terminal airspace entry gate, to a commonly used segment of the STAR in the terminal airspace, and then to the final approach to one or more runways at one or more airports. Guidance from the enroute airspace to the terminal airspace is called an “enroute transition” and from the common segment of the STAR in the terminal airspace to the final approach to a runway end is called a “runway transition.” A STAR can also provide only partial guidance through the terminal airspace and may not include runway transitions.

1.2.4.3 Aircraft Separation

As TRACON controllers manage the flow of aircraft into, out of, and within the terminal airspace, they maintain the following separations between aircraft:

- **Altitude separation (vertical):** when operating below 29,000 feet above mean sea level (MSL), two aircraft on separate routes that cross or converge, must be at least 1,000 feet above/below each other at the point the two routes intersect. When operating above 29,000 feet MSL and below 41,000 feet MSL, the two aircraft must be at least 1,000 feet from each other under reduced vertical separation minima (RVSM).

- **In-Trail separation (longitudinal):** Within a TRACON radar controlled area and within 40 miles of the radar site being used to track the aircraft, the minimum distance between two aircraft on the same route (or in-trail) is three miles. When aircraft are beyond 40 miles from the radar site, the minimum longitudinal separation of aircraft increases to five miles due to radar coverage capabilities. As aircraft proceed further from the radar, ATC must increase departure aircraft separation from three miles to five miles as the aircraft nears the exit gate. To ensure that the minimum five mile separation is maintained, ATC may separate aircraft by as much as seven miles.

- **Side-to-Side separation (lateral):** Similar to in-trail separation, the minimum side-to-side (left or right side of an aircraft) between aircraft in the terminal airspace must be at least three miles within 40 miles of the primary radar site, and at least five miles beyond 40 miles from the primary radar site.

1.2.5 Special Use Airspace

Special Use Airspace (SUA) is airspace with defined boundaries in which certain activities such as military flight training and air-to-ground military exercises must be confined. These areas either restrict other aircraft from entering or restrict the type of aircraft activity allowable within the airspace. There are six types of special use airspace:

- **Prohibited Area:** Prohibited areas contain airspace of defined dimensions within which aircraft are prohibited unless given prior authorization. Such areas are established for security or other reasons associated with the national welfare.

- **Restricted Area:** Restricted areas contain airspace identified by an area within which aircraft, while not wholly prohibited, are subject to restrictions when the area is being used. The area denotes the existence of unusual, often invisible hazards to

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15 Mean Sea Level: elevation (on the ground) or altitude (in the air) of any object, relative to the average sea level measured in 1991 (called the North American Vertical Datum of 1988).

16 Department of Transportation, Federal Aviation Administration, Order JO 7110.65U, Ch. 5, Sec. 5-5-1. February 9, 2012.
aircraft such as artillery firing, aerial gunnery, or guided missiles. Entering a restricted area without authorization may be extremely hazardous to the aircraft and its occupants. When the area is not being used, control of the airspace is released to the FAA and ATC can use the area for normal operations.

- **Warning Area:** Warning areas are airspace of defined dimensions, extending from three nautical miles (nmi) outward from the coast of the U.S. in which activity may occur that is hazardous to non-participating aircraft. The purpose of warning areas is to warn pilots of potential danger. A warning area may be located over domestic and/or international waters.

- **Military Operating Area:** Military Operating Areas (MOAs) consist of airspace with defined vertical and lateral limits established for the purpose of separating certain military training activities (e.g., air combat tactics, air intercepts, aerobatics, formation training, and low-altitude tactics) from IFR traffic. Whenever a MOA is being used, nonparticipating IFR traffic may be cleared through a MOA if IFR separation can be provided by ATC. Otherwise, ATC will reroute or restrict nonparticipating IFR traffic.

- **Alert Areas:** Alert areas are depicted on an aeronautical chart to inform pilots of areas that may contain a high volume of pilot training or an unusual type of aerial activity.

- **Controlled Firing Area:** Controlled Firing Areas (CFAs) contain activities which, if not conducted in a controlled environment, could be hazardous to an aircraft not participating in the activity. The distinguishing feature of a CFA, as compared to other special use airspace, is that its activities are suspended immediately when spotter aircraft, radar, or ground lookout positions indicate an aircraft might be approaching the area. This area does not impact or change an aircraft flight path; therefore, it is not depicted on aeronautical charts.

In addition to the six types of SUA described above, the DC Metroplex is subject to the Washington D.C. Metropolitan Area Special Flight Rule Area (DC SFRA) and a Flight Restricted Zone (DC FRZ). The DC SFRA and DC FRZ are areas of airspace where the ready identification, location, and control of aircraft are required in the interest of national security.

1.2.6 **Next Generation Air Transportation System**

The NextGen program is the FAA’s long-term plan to modernize the NAS through evolution from a ground-based system of air traffic control to a GPS-based system of air traffic management. The OAPM initiative’s objective is to accomplish this step in the overall process of transitioning to the NextGen system by 2018. A key step in achieving the NextGen ATC system is implementation of PBN procedures, such as RNAV and RNP procedures, which use GPS-based technology and aircraft “auto pilot” and Flight Management System (FMS) capabilities. RNAV and RNP capabilities are now readily available and, PBN can serve as the primary means aircraft use to navigate along a route.

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17 14 CFR § 93.335.

As of 2011, 92 percent of U.S. scheduled air carriers were equipped for some level of RNAV. The following sections describe PBN procedures in greater detail.

1.2.6.1 RNAV

Exhibit 1-5 shows a comparison of conventional and RNAV procedures. RNAV enables aircraft traveling through terminal and enroute airspace to follow more accurate and better defined, direct flight routes in areas covered by GPS-based navigational aids. This results in predictable routes with fixed locations and altitudes that can be planned ahead of time by the pilot and air traffic control. In addition, fixed routes help maintain segregation between aircraft by providing the ability to separate traffic both vertically and horizontally. As a result, some routes can be shortened and the need for level-offs can be eliminated.

Ground-based NAVAID routing is often limited by issues such as line-of-sight and signal reception accuracy. NAVAIDs such as, VHF Omnidirectional Range (VOR) are affected by terrain and other obstructions that can limit their signal accuracy. Consequently, routes using ground-based NAVAIDs require at least six nmi of clearance on either side of the route’s main path to account for potential obstructions. This clearance requirement increases the farther an aircraft is from the VOR. In comparison, RNAV signal accuracy requires only two nmi of clearance on either side of the procedure’s main path (called RNAV-1). RNAV procedures can mirror conventional procedures or provide routes within the airspace using satellite technology that were not previously possible with ground-based NAVAIDs. RNAV also provides routes that enable transition routes to multiple runways. These runway transition route options provide more flexibility in managing arrival traffic.

RNAV-based procedures facilitate more efficient design and use of airspace that collectively results in improved access, predictability, and operational efficiency while maintaining or enhancing safety and increasing opportunities to reduce fuel consumption. The predictability of routes following RNAV procedures can reduce the need for controllers to employ management tools, such as vectoring and holding, and therefore, reduce controller and pilot workload and airspace complexity.

1.2.6.2 RNP

RNP is an RNAV procedure that is flown with the addition of an onboard performance monitoring and alerting system. A defining characteristic of an RNP operation is the ability for an RNP capable aircraft navigation system to monitor the accuracy of its navigation (based on the number of GPS satellite signals available to pinpoint the aircraft location) and inform the crew if the required data becomes unavailable. Exhibit 1-5 compares conventional, RNAV, and RNP procedures and shows how an RNP capable aircraft navigational system provides a more accurate location (down to less than a mile from the intended path) and will follow an exact path, including turns. The enhanced accuracy and predictability makes it possible to implement procedures within a controlled airspace that were not possible under the current air traffic system.

1.2.6.3 Optimized Profile Descent

An Optimized Profile Descent (OPD) is a flight procedure that uses the aircraft FMS to fly continuously from the top of descent to landing without intervening level-off segments. **Exhibit 1-6** illustrates an OPD procedure compared to a conventional descent. Aircraft that fly OPD can maintain higher altitudes and lower thrust for longer periods. This results in lower fuel burn and corresponding reductions in emissions and noise. As level-off segments are eliminated, OPD also reduces the need for communications between controllers and pilots.

1.2.7 The OAPM Initiative

The FAA intends to design and implement RNAV procedures that will take advantage of the readily available technology in the majority of aircraft as part of the OAPM initiative. The OAPM initiative specifically addresses congestion, airports in close geographical proximity, and other limiting factors that reduce efficiency in busy Metroplex airspace. Efficiency is improved by expanding the implementation of RNAV-based standard instrument procedures and connecting the routes defined by the standard instrument procedures to high and low altitude RNAV routes. Efficiency would also be increased taking advantage of RNAV to maximize the use of the limited airspace in congested Metroplex environments.
### The DC Metroplex

The following sections describe the airspace structure and existing standard instrument procedures of the DC Metroplex that would be affected by the DC OAPM project.

#### DC Metroplex Airspace

Exhibit 1-4 depicts part of the airspace structure in the DC Metroplex. Air traffic controllers in the PCT TRACON facility control a portion of airspace designated as PCT that is located within the Washington ARTCC (ZDC) and New York ARTCC (ZNY) airspace. Surrounding ARTCC airspace includes Boston (ZBW), Atlanta (ZTL), Indianapolis (ZID), and Jacksonville (ZJX). While PCT airspace is located entirely within the DC Metroplex airspace, the DC Metroplex airspace also includes portions of ZDC enroute airspace.

The lateral boundary of the PCT airspace is irregularly shaped, extending from Ronald Reagan Washington National Airport (KDCA or DCA) to between approximately 28 to 68 nmi to the north, 63 to 113 nmi to the east, 83 to 116 nmi to the south, and 63 to 113 nmi to the west. Excluding airspace delegated to the ATCTs at controlled airports within PCT, PCT controllers currently manage the airspace within these boundaries from the surface to as high as 25,000 feet MSL over the DC Metroplex area and up to 9,000 feet MSL on the outer edges. ZDC controllers manage the airspace above and adjacent to the PCT airspace, and portions of the northeast PCT area adjacent to and above the PCT airspace are managed by ZNY controllers.
1.3.1.1 DC Metroplex SUA

The physical configuration of the PCT airspace is constrained by the close proximity of major airports and the existence of SUA. Four of the six types of SUA are found within the D.C. Metroplex area, primarily reflecting airspace areas and controlled airspace used by the military as delegated by FAA (e.g., Military Operations Area and Restricted Areas). In addition, the DC Metroplex is subject to the DC SFRA and FRZ. Exhibit 1-7 depicts the boundaries of SUA in proximity to PCT.

Exhibit 1-7 Special Use Airspace

Notes:
PCT – Potomac Consolidated TRACON
ZOB – Cleveland ARTCC
DCA – Ronald Reagan Washington National Airport
ZNY – New York ARTCC
ZDC – Washington ARTCC
ADW – Joint Base Andrews
IAD – Washington Dulles International Airport
RIC – Richmond International Airport

Legend
Potomac Consolidated TRACON Boundary
Study Airports
State Boundaries
FRZ
SFRA
Military Operations Area
Prohibited Area
Restricted Area
Warning Area
Water
ARTCC Boundary
US and Interstate Highways


1.3.2 Current STARs and SIDs

As of December 2011, 32 published STARs and SIDs served the airports within the DC Metroplex airspace. Of these, 19 are conventional procedures and 13 are RNAV procedures. Eight of the 13 RNAV procedures provide RNAV guidance from the enroute airspace to a runway final approach. Many of the RNAV STARs currently in place were developed over time as the availability of RNAV-technology in aircraft cockpits increased and RNAV design criteria was improved. Several of these procedures are overlays of conventional procedures designed as part of the Potomac Consolidated TRACON Redesign project. The purpose of that project was to increase efficiency and enhance safety by taking advantage of the benefits of combining the TRACON facilities in the Baltimore-Washington metropolitan area. However, the alternative selected did not include RNAV procedures.

1.4 DC Metroplex Airports

The focus of the proposed DC OAPM project is on the Study Airports which are connected to standard procedures subject to change. **Table 1-1** lists the Study Area airports, their locations, and their runways. **Exhibit 1-8** shows where the airports are located geographically.

<table>
<thead>
<tr>
<th>Airport Name</th>
<th>Code</th>
<th>Location</th>
<th>Runways</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dulles International Airport</td>
<td>IAD</td>
<td>Washington D.C.</td>
<td>01L,01C,01R,19L,19C,19R,01,04,15,19,22,33</td>
</tr>
<tr>
<td>Ronald Reagan Washington National Airport</td>
<td>DCA</td>
<td>Washington D.C.</td>
<td>01, 04, 15, 19, 22, 33</td>
</tr>
<tr>
<td>Joint Base Andrews</td>
<td>ADW</td>
<td>Camp Springs, MD</td>
<td>01L, 01R, 19L, 19R</td>
</tr>
<tr>
<td>Richmond International Airport</td>
<td>RIC</td>
<td>Richmond, VA</td>
<td>02, 07, 16, 20, 25, 34</td>
</tr>
</tbody>
</table>

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### Table 1-1  DC Metroplex EA Study Airports (2 of 2)

<table>
<thead>
<tr>
<th>Airport Name</th>
<th>Code</th>
<th>Location</th>
<th>Runways¹/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easton/Newnam Field Airport</td>
<td>ESN</td>
<td>Easton, MD</td>
<td>04, 15, 22, 33</td>
</tr>
<tr>
<td>Frederick Municipal Airport</td>
<td>FDK</td>
<td>Frederick, MD</td>
<td>05, 12, 23, 30</td>
</tr>
<tr>
<td>Leesburg Executive Airport</td>
<td>JYO</td>
<td>Leesburg, VA</td>
<td>17, 35</td>
</tr>
<tr>
<td>Montgomery County Airpark</td>
<td>GAI</td>
<td>Gaithersburg, MD</td>
<td>14, 32</td>
</tr>
<tr>
<td>Manassas Regional Airport/Harry P. Davis Field</td>
<td>HEF</td>
<td>Washington D.C.</td>
<td>16L, 16R, 34L, 34R</td>
</tr>
<tr>
<td>Eastern West Virginia Regional Airport/Shepherd Field</td>
<td>MRB</td>
<td>Martinsburg, WV</td>
<td>08, 26</td>
</tr>
<tr>
<td>Winchester Regional Airport</td>
<td>OKV</td>
<td>Winchester, VA</td>
<td>14, 32</td>
</tr>
<tr>
<td>Stafford Regional Airport</td>
<td>RMN</td>
<td>Stafford, VA</td>
<td>15, 33</td>
</tr>
<tr>
<td>Martin State Airport</td>
<td>MTN</td>
<td>Baltimore, MD</td>
<td>15, 33</td>
</tr>
</tbody>
</table>

**Notes:**
1/ A runway can be used in both directions, but is named in each direction separately. Runway number is based on the magnetic direction of the runway (e.g., Runway 09 points to the east direction). The two numbers on either side always differ by 180 degrees. If there is more than one runway pointing in the same direction, each runway number includes an ‘L’, ‘C’ or ‘R’ at the end. This is based on which side a runway is next to another one in the same direction.

**Source:**
Prepared by: ATAC Corporation, October 2012.

### 1.4.1 Major Study Airports

The DC Metroplex airports are divided into major Study Airports and satellite airports. The major Study Airports include the following:

**Washington Dulles International Airport (KIAD or IAD)** classified as a large-hub primary airport²¹ in the National Plan of Integrated Airport Systems (NPIAS), IAD is the primary commercial airport serving the DC Metroplex area.²² Accordingly, IAD receives scheduled commercial service and accommodates at least one percent of total U.S. enplaned passengers. IAD supports a mix of domestic and international passenger airlines, air cargo carriers, corporate aviation, and general aviation activity. The airport has four runways, described in **Table 1-1**. As of the end of 2011, an aircraft arriving at IAD may be assigned...

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²¹ “Primary airport” means a commercial service airport the Secretary determines to have more than 10,000 passenger boardings each year. (49 U.S.C. § 47102(16).) 
²² “Large hub airport” means a commercial service airport that has at least 1.0 percent of the passenger boardings. (49 U.S.C. § 47102(11).)
one of four RNAV STARs or one of four conventional STARs. A departing aircraft may be assigned one RNAV SID or one conventional SID.

Ronald Reagan Washington National Airport (KDCA or DCA) is located approximately 21 nmi southeast of IAD and accommodates a mix of commercial, corporate and general aviation activity. DCA is classified as a primary, large-hub airport in the NPIAS. The airport has three runways, described in Table 1-1. As of the end of December 2011, DCA IFR arrivals may be assigned one of five RNAV STARs or one conventional STAR


depending upon where they enter the terminal airspace. Departing aircraft may be assigned one RNAV SID or one conventional SID.25

**Baltimore/Washington International Thurgood Marshall Airport (KBWI or BWI)** is located approximately 40 nmi northeast of IAD and 26 nmi northeast of DCA. Similar to IAD and DCA, BWI is classified as a primary, large-hub airport under the NPIAS.26 BWI has four runways, described in Table 1-1. As of the end of 2011, BWI arrivals may be assigned one RNAV STAR or one of two conventional STARs. Departing aircraft may be assigned one RNAV SID, or one of two conventional SIDs.27

**Joint Base Andrews (KADW or ADW)** is located approximately 29 nmi southeast of IAD and primarily serves military activity. The airport has two runways, described in Table 1-1. As of the end of 2011, arriving IFR aircraft may be assigned to one conventional STAR, depending on where they enter the terminal airspace. Departing aircraft may be assigned one of the three conventional SIDs.28

**Richmond International Airport (KRIC or RIC)** is located approximately 94 nmi south of IAD. RIC is classified as a small-hub29 airport under the NPIAS.30 RIC has three runways, described in Table 1-1. As of the end of 2011, RIC did not have associated STAR procedures. Departing aircraft may be assigned one of two conventional SIDs.31

Approximately 88 percent of all IFR traffic within the DC Metroplex area operates at the major Study Airports. As shown in Table 1-2, in 2011, the combined major and satellite Study Airports accommodated 95 percent of all IFR traffic that departed or landed under FAA control in or out of the DC Metroplex area (specifically within the PCT TRACON and ZDC controlled airspace).

### 1.4.2 Major Study Airport Runway Operating Configurations

The major Study Airports often operate under several different runway operating configurations depending on conditions such as weather, prevailing wind, and air traffic conditions. As a result, it is possible for the runway ends used for arrivals and departures to change several times throughout a day. ATCT controllers at these airports generally use two different runway operating configurations, and each runway operating configuration may designate primary and secondary arrival and departure runway ends for that configuration.


28 Id.

29 "small hub airport" means a commercial service airport that has at least 0.05 percent but less than 0.25 percent of the passenger boardings. (49 U.S.C. § 47102(25).)


### Table 1-2 Distribution of 2011 IFR Traffic Among Study Airports in PCT

<table>
<thead>
<tr>
<th>Airport</th>
<th>IFR Operations</th>
<th>Percent of Total Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dulles International Airport (IAD)</td>
<td>359,608</td>
<td>31.1%</td>
</tr>
<tr>
<td>Ronald Reagan Washington National Airport (DCA)</td>
<td>282,618</td>
<td>24.4%</td>
</tr>
<tr>
<td>Baltimore/Washington International/Thurgood Marshall Airport (BWI)</td>
<td>272,908</td>
<td>23.6%</td>
</tr>
<tr>
<td>Richmond International Airport (RIC)</td>
<td>86,435</td>
<td>7.5%</td>
</tr>
<tr>
<td>Joint Base Andrews (ADW)</td>
<td>25,641</td>
<td>2.2%</td>
</tr>
<tr>
<td>Manassas Regional Airport/Harry P. Davis Field (HEF)</td>
<td>20,072</td>
<td>1.7%</td>
</tr>
<tr>
<td>Leesburg Executive Airport (JYO)</td>
<td>11,605</td>
<td>1.0%</td>
</tr>
<tr>
<td>Martin State Airport (MTN)</td>
<td>11,366</td>
<td>1.0%</td>
</tr>
<tr>
<td>Montgomery County Airpark (GAI)</td>
<td>9,758</td>
<td>0.8%</td>
</tr>
<tr>
<td>Frederick Municipal Airport (FDK)</td>
<td>6,570</td>
<td>0.6%</td>
</tr>
<tr>
<td>Easton/Newnam Field Airport (ESN)</td>
<td>5,217</td>
<td>0.5%</td>
</tr>
<tr>
<td>Eastern West Virginia Regional Airport/Shepherd Field (MRB)</td>
<td>3,616</td>
<td>0.3%</td>
</tr>
<tr>
<td>Winchester Regional Airport (OKV)</td>
<td>3,153</td>
<td>0.3%</td>
</tr>
<tr>
<td>Stafford Regional Airport (RMN)</td>
<td>2,893</td>
<td>0.2%</td>
</tr>
<tr>
<td><strong>Total IFR Operations</strong></td>
<td><strong>1,101,460</strong></td>
<td><strong>95.1%</strong></td>
</tr>
<tr>
<td><strong>Total PCT IFR Operations</strong></td>
<td><strong>1,157,617</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>

**Notes:**
(Sorted from Highest IFR Operations to Lowest)

**Source:**

**Prepared by:** ATAC Corporation, October 2012.

**Exhibits 1-9 through 1-13** illustrate the primary runway operating configurations at IAD, DCA, BWI, ADW, and RIC, respectively.
Exhibit 1-9  KIAD Runway Operating Configurations

KIAD: North Runway Operating Configuration – 48%

- Primary Arrival
- Primary Departure

KIAD: South Runway Operating Configuration – 52%

- Secondary Arrival
- Secondary Departure


Prepared By: ATAC Corporation, December 2012.
Exhibit 1-10  KDCA Runway Operating Configurations

KDCA: North Runway Operating Configuration – 57%
Primary Arrival
Primary Departure

KDCA: South Runway Operating Configuration – 43%
Secondary Arrival
Secondary Departure

Prepared By: ATAC Corporation, December 2012.
Exhibit 1-11 KBWI Runway Operating Configurations

KBWI: East Runway Operating Configuration – 29%
- Primary Arrival
- Primary Departure

KBWI: West Runway Operating Configuration – 71%
- Secondary Arrival
- Secondary Departure

Prepared By: ATAC Corporation, December 2012.
Exhibit 1-12  KADW Runway Operating Configurations

KADW: North Runway
Operating Configuration – 55%

Primary Arrival

Secondary Arrival

Primary Departure

Secondary Departure


Prepared By: ATAC Corporation, December 2012.
Exhibit I-13  KRIC Runway Operating Configurations

KRIC: North Runway Operating Configuration – 49%

Primary Arrival

Primary Departure

KRIC: South Runway Operating Configuration – 51%

Secondary Arrival

Secondary Departure


Prepared By: ATAC Corporation, December 2012.
2 Purpose and Need

As discussed in Chapter 1, the FAA Modernization and Reform Act of 2012 (“the Act”) was enacted in February 2012 to help modernize the nation’s air transportation system. Among other provisions, the Act requires the implementation of performance-based airspace procedure enhancements at 35 of the nation’s busiest airports and at any medium or small hub airports located within the same Metroplex area as determined by the FAA Administrator. The Act also requires that all performance-based procedures be certified, published, and implemented by June 30, 2015. Accordingly, the Federal Aviation Administration (FAA) proposes to increase the efficiency of the DC Metroplex airspace through the implementation of area navigation (RNAV) defined Instrument Flight Procedures (IFPs) that improve upon existing, but less efficient ground-based and/or radar vector procedures. The FAA Administrator has decided to implement the DC Metroplex enhancements before the June 30, 2015 deadline.

This EA is being prepared by the FAA to evaluate the potential environmental impacts associated with implementation of RNAV-defined IFPs for the DC Metroplex (Proposed Action). NEPA requires EAs to articulate the purpose of and need for the action being proposed. Identification of the need for an action provides the basis for identification of reasonable alternatives, including the Proposed Action, that can meet the purpose, and therefore, address the need or problem. The following sections discuss the need for and the purpose of the Proposed Action. Following this discussion, the Proposed Action is described in detail.

2.1 The Need for the Proposed Action

In the context of an EA, “need” refers to the problem that the Proposed Action is intended to resolve. The problem in this case is the inefficiency of the existing airspace structure and aircraft flight procedures in the DC Metroplex. This is due to the use of older NAVAID technology when newer RNAV technology is readily available. As described in Chapter 1, a majority of commercial aircraft operating in the DC Metroplex are RNAV equipped; however, most procedures currently used in the DC Metroplex are conventional and rely upon ground-based NAVAIDs. Because conventional procedures cannot provide more predictable controls inherent in RNAV procedures, such as specific speeds or altitudes, controllers use vectoring and speed adjustments to manage traffic. This leads to increased controller and pilot workload. RNAV procedures are free of the lateral and vertical flight path limitations typical of conventional procedures. This inefficient use of available technology impedes FAA’s ability to meet one of its primary missions as mandated by Congress – to provide for the efficient use of airspace. Furthermore, as discussed in Section 1.2.6.1, RNAV technology can add efficiency to an air traffic system with enhanced predictability, flexibility, and route segregation.

32 The 35 airports are identified under the Act as Operational Evolution Partnership (OEP) airports. OEP airports are commercial U.S. airports with significant activity. These airports serve major metropolitan areas and also serve as hubs for airline operations. More than 70 percent of U.S. passengers move through these airports.

33 Instrument Flight Procedures (IFP) - Instrument flight procedures specify standard routings, maneuvering areas, flight altitudes, and visibility minimums for instrument flight rules (IFR). These procedures include airways, jet routes, off-airway routes, Standard Instrument Approach Procedures (SIAP(s)), Standard Instrument Departure Procedures/ Departure Procedures (SID(s))/ DP(s)), and Standard Terminal Arrival Routes (STAR(s)). (FAA Order 8200.1C United States Standard Flight Inspection Manual).

34 “Procedure” is a predefined set of guidance instructions that define a route for a pilot to follow.
The following sections describe the problem in detail followed by a discussion of the causal factors that have contributed to the problem. A detailed explanation of the technical terms and concepts used in this chapter can be found in Chapter 1, Background.

2.1.1 Description of the Problem

Many existing Standard Instrument Departure (SID) and Standard Terminal Arrival Route (STAR) procedures require aircraft to use ground-based NAVAIDs to navigate to and from air carrier and General Aviation (GA) airports in the DC Metroplex. As discussed in Section 1.2.6.1, RNAV, conventional procedures are less accurate because of radio signal limitations that can arise between NAVAIDs and aircraft due to factors such as terrain. As a result, ground-based NAVAID procedures require large areas of clearance on either side of a route’s main path to account for potential obstructions. Furthermore, conventional procedures are dependent upon where ground-based NAVAIDs are located which can result in less efficient routing. Because conventional procedures are less accurate, the actual location of an aircraft both laterally and vertically, can be less predictable for both ATC and pilots.

The lack of accuracy and predictability requires ATC to use aircraft management tools and coordination techniques such as speed control, level flight segments, and vectoring to guide aircraft. These tools and coordination techniques are further discussed in Section 1.2.2., Air Traffic Control within the National Airspace System. Applying these tools and techniques without a more precise means to predict exactly where aircraft are located along an assigned procedure is complex. In most situations, these tools and techniques lead to less efficient aircraft operations and inefficient use of airspace. For example, Air Traffic Control (ATC) may issue instructions requiring an aircraft to level off during climb and descent to prevent conflicts with other aircraft. This leads to increased flight time and distance than would otherwise be necessary. Furthermore, increased communications between controller and pilot may result in less precise flight paths due to the time it takes the controller to issue an instruction to the pilot and for the pilot to read the instruction back to the controller for confirmation before the instruction can be executed. As a result, more airspace must be protected to allow aircraft the latitude to operate leading to less efficient and less flexible operations.

The lack of precision resulting from inefficient use of technology also contributes to reduced available airspace. In addition, the lower levels of predictability and accuracy associated with these procedures require ATC to issue additional instructions to pilots, increasing pilot workload and requiring constant monitoring by ATC. Combined, these factors form the basis for the problem within the DC Metroplex.

The lack of SIDs and STARS based on current RNAV technology adversely affects FAA’s ability to efficiently manage available airspace. Therefore, the problem is the inability to provide additional efficiency afforded by RNAV technology. Table 2-1 presents the number of standard instrument procedures dependent upon conventional navigation (radar vectors or ground-based NAVAIDs), the number of procedures dependent upon RNAV, and the total number of standard instrument procedures, unique and shared.
<table>
<thead>
<tr>
<th>Airport</th>
<th>Conventional Procedures</th>
<th>RNAV Procedures</th>
<th>Total Unique (Shared) Standard Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>KIAD</td>
<td>CAPITAL EIGHT, DELRO TWO, PHILIPSBURG TWO, SELSINGROVE THREE</td>
<td>STOIC TWO, BARIN ONE, LEGGO TWO, PRTZL THREE (HYPER FOUR, SHNON, ROYIL)</td>
<td>8</td>
</tr>
<tr>
<td>KDCA</td>
<td>NATIONAL TWO (IRONS FOUR)</td>
<td>LAZIR THREE, BILIT ONE, CLIPR ONE, OJAAY ONE, SKILS TWO (ELDEE FIVE)</td>
<td>6</td>
</tr>
<tr>
<td>KBWI</td>
<td>PALEO THREE, SWANN THREE (NOTTINGHAM SIX, WESTMINSTER FIVE)</td>
<td>TERPZ TWO (RAVNN THREE)</td>
<td>3</td>
</tr>
<tr>
<td>KRIC</td>
<td>COLIN FIVE, YEAST ONE</td>
<td>None</td>
<td>2</td>
</tr>
<tr>
<td>KADW</td>
<td>ANDREWS ONE, CAMP SPRINGS ONE, MORNINGSIDE ONE, WZZRD TWO (IRONS FOUR)</td>
<td>None (ELDEE FIVE)</td>
<td>4</td>
</tr>
<tr>
<td>KESN</td>
<td>None</td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>KFDK</td>
<td>None</td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>KGAI</td>
<td>None</td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>KHEF</td>
<td>ARSENAL TWO (COATT FOUR)</td>
<td>None (HYPER FOUR, SHNON, ROYIL)</td>
<td>1</td>
</tr>
<tr>
<td>KJYO</td>
<td>None (COATT FOUR)</td>
<td>None (SHNON, ROYIL)</td>
<td>0</td>
</tr>
<tr>
<td>KOKV</td>
<td>None</td>
<td>None (HYPER FOUR)</td>
<td>0</td>
</tr>
<tr>
<td>KMRB</td>
<td>TRIXY FOUR</td>
<td>None (HYPER FOUR)</td>
<td>1</td>
</tr>
<tr>
<td>KMTN</td>
<td>None (NOTTINGHAM SIX, WESTMINSTER FIVE)</td>
<td>None (RAVNN THREE)</td>
<td>0</td>
</tr>
<tr>
<td>KRMN</td>
<td>None</td>
<td>None (HYPER FOUR)</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15(4)</strong></td>
<td><strong>10(5)</strong></td>
<td><strong>25(9)</strong></td>
</tr>
</tbody>
</table>

Table Notes:
Counts in parentheses represent procedures shared by more than one airport.

Airports:
- KIAD: Dulles International Airport
- KDCA: Ronald Reagan Washington National Airport
- KRIC: Richmond International Airport
- KADW: Andrews Air Force Base
- KESN: Easton/Newnam Field Airport
- KFDK: Frederick Municipal Airport
- KGAI: Montgomery County Airpark
- KOKV: Winchester Regional Airport
- KHEF: Manassas Regional Airport
- KJYO: Leesburg Executive Airport
- KMRB: Eastern WV Regional Airport/Shepherd Field
- KMTN: Martin State Airport
- KRMN: Stafford Regional Airport

Prepared By: ATAC Corporation, June 2013.
To take full advantage of current RNAV technology, the number of RNAV procedures should be close to the total number of existing procedures. For the DC Metroplex, as of December 2011, there were 34 standard instrument procedures, 44 percent of which were RNAV based (10 unique procedures and five shared procedures). The conventional procedures do not segregate traffic efficiently due to dependence on conventional navigation using ground-based NAVAIDs or a mix of conventional and RNAV navigation. Section 2.1.3 describes the current factors that lead to limited means of providing additional efficiency.

It is important to note that a key design constraint is safety. Any proposed change to a procedure to resolve the problem must not degrade safety, and if possible enhance safety. Current procedures do not include any safety issues because published procedures must meet defined safety criteria; accordingly, the Proposed Action is not being proposed to address any safety issues.

### 2.1.2 Causal Factors

A problem (or need) is best addressed by examining the circumstances or causal factors that together serve as a foundation for the need. As previously described, the problem for the DC Metroplex is the prevalence of existing SID and STAR procedures dependent on older ground-based NAVAID technology leading to inefficiencies in the DC Metroplex airspace.

The need for the Proposed Action can be better understood and addressed based on the specific factors causing the problem. Addressing the causal factors that lead to the problem will ultimately facilitate development of a reasonable alternative designed to resolve the problem (or meet the purpose).

Three key factors were identified by the DC Metroplex Study Team as causes for the lower level of efficiency in the DC Metroplex:

- Lack of flexibility in the efficient transfer of traffic between the enroute and terminal area airspace;
- Complex converging interactions between arrival and departure flight paths; and,
- Lack of predictable standard routes defined by procedures to/from airport runways to/from enroute airspace.

The following sections describe these three causal factors in detail.

#### 2.1.2.1 Lack of Flexibility for the Efficient Transfer of Traffic Between the Enroute and Terminal Area Airspace

Flexibility allows ATC to plan and adapt to traffic demands, which change frequently within any given hour. Even though flights are scheduled, delays in other regions of the U.S. or severe weather along an aircraft’s route may cause aircraft to enter or exit the enroute and terminal area airspace at times other than those previously scheduled. Controllers require options to manage dynamic traffic demand.

Elements such as additional entry and exit points, individual procedures for each Study Airport, and the ability to diverge aircraft (turn aircraft on different headings away from each other) earlier reduces the amount of vectoring needed to merge traffic and maintain safe
Separation. These elements also provide additional options when one procedure is too busy to accommodate additional traffic.

The "four corner post" airspace design presents the most efficient way to transfer aircraft to an airport from an entry gate and from an airport to an exit gate. In a typical four-corner post system, aircraft depart the terminal airspace through exit gates to the north, east, south, and west. Aircraft arrive to the terminal airspace through entry gates to the northeast, southeast, southwest, and northwest. However, implementation of a four corner post system in the PCT terminal airspace is restricted by various factors including geographic location, close proximity among airports, runway geometry, traffic demand, and other constraints. Consequently, the transfer control areas for PCT are found in locations that best meet the unique characteristics of the DC Metroplex airspace.

The limited number of terminal airspace entry and exit points serving as offloads and/or separate traffic routes result in gaps in arrival and departure flows to and from Study Airports within the PCT terminal area airspace.\textsuperscript{35} For arrivals, the gaps between aircraft on a given procedure are large enough to fit another aircraft. Due to the need to merge flows that could otherwise operate independently with development of the appropriate procedures, the controller is not able to use the existing airspace as efficiently as possible.

The following sections further discuss flexibility issues specific to the terminal area airspace entry and exit points.

**Entry Points**

Exhibit 2-1 depicts the entry points where control is transferred from the Centers to the TRACON in the DC Metroplex airspace. These entry points are often shared by aircraft arriving at different Study Airports. Table 2-2 lists the STAR procedures and associated transition points for the major Study Airports.

\textsuperscript{35} Flow: multiple aircraft operations assigned to a procedure that operate along the same route, and includes variation in aircraft location over the ground. A traffic flow is typically defined by several days of radar flight tracks. Traffic flows may also be represented by corridors based on a frequently traveled area characterized by one or more well-traveled routes.
Exhibit 2-1   Terminal Airspace Control Transfer Areas - Arrivals

Notes:
PCT – Potomac Consolidated TRACON
ZOB – Cleveland ARTCC
ZDC – Washington ARTCC
ADW – Joint Base Andrews
BWI – Baltimore/Washington International Thurgood Marshall Airport
DCA – Ronald Reagan Washington National Airport
IAD – Washington Dulles International Airport
RIC – Richmond International Airport

Legend
- Potomac Consolidated TRACON Boundary
- Study Airports
- State Boundaries
- Water
- ARTCC Boundary
- US and Interstate Highways

Entry Gates:
- North Arrivals
- West Arrivals
- South Arrivals
- East Arrivals

Source: DC OAPM Metroplex Study Team, 2010
## Table 2-2  STAR Arrival Transitions

<table>
<thead>
<tr>
<th>Arrival Transitions</th>
<th>STAR Procedure</th>
<th>Airport</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIR</td>
<td>EMI5</td>
<td>KBWI</td>
</tr>
<tr>
<td>ALB</td>
<td>HYPER4 (RNAV)</td>
<td>KIAD</td>
</tr>
<tr>
<td>BAF</td>
<td>HYPER4 (RNAV)</td>
<td>KIAD</td>
</tr>
<tr>
<td>BKW</td>
<td>ROYIL2</td>
<td>KIAD</td>
</tr>
<tr>
<td></td>
<td>SHNON2</td>
<td>KIAD</td>
</tr>
<tr>
<td></td>
<td>ELDEE5 (RNAV)</td>
<td>KDCA</td>
</tr>
<tr>
<td></td>
<td>WZRRD2</td>
<td>KDCA</td>
</tr>
<tr>
<td>CSN</td>
<td>OTT6</td>
<td>KBWI</td>
</tr>
<tr>
<td></td>
<td>RAVNN3 (RNAV)</td>
<td>KBWI</td>
</tr>
<tr>
<td>ESL</td>
<td>ROYIL2</td>
<td>KIAD</td>
</tr>
<tr>
<td></td>
<td>SHNON2</td>
<td>KIAD</td>
</tr>
<tr>
<td>FAK</td>
<td>BARIN1 (RNAV)</td>
<td>KIAD</td>
</tr>
<tr>
<td></td>
<td>COATT4</td>
<td>KIAD</td>
</tr>
<tr>
<td></td>
<td>OTT6</td>
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<tr>
<td>FQM</td>
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</tr>
<tr>
<td></td>
<td>SEG3</td>
<td>KIAD</td>
</tr>
<tr>
<td>HVQ</td>
<td>ROYIL2</td>
<td>KIAD</td>
</tr>
<tr>
<td></td>
<td>SHNON2</td>
<td>KIAD</td>
</tr>
<tr>
<td></td>
<td>ELDEE5 (RNAV)</td>
<td>KDCA</td>
</tr>
<tr>
<td></td>
<td>WZRRD2</td>
<td>KDCA</td>
</tr>
<tr>
<td>KEMAN</td>
<td>EMI5</td>
<td>KBWI</td>
</tr>
<tr>
<td>LAFLN</td>
<td>BILIT1 (RNAV)</td>
<td>KDCA</td>
</tr>
<tr>
<td>LRP</td>
<td>SKILS2 (RNAV)</td>
<td>KDCA</td>
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<tr>
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<td>DELRO2</td>
<td>KIAD</td>
</tr>
<tr>
<td>LVZ</td>
<td>LEGGO2 (RNAV)</td>
<td>KIAD</td>
</tr>
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<td>SEG3</td>
<td>KIAD</td>
</tr>
<tr>
<td>MGW</td>
<td>EMI5</td>
<td>KBWI</td>
</tr>
<tr>
<td>MXX</td>
<td>CLIPR1 (RNAV)</td>
<td>KDCA</td>
</tr>
<tr>
<td></td>
<td>DELRO2</td>
<td>KIAD</td>
</tr>
<tr>
<td></td>
<td>HYPER4 (RNAV)</td>
<td>KIAD</td>
</tr>
<tr>
<td>PARKE</td>
<td>HYPER4 (RNAV)</td>
<td>KIAD</td>
</tr>
<tr>
<td>PSB</td>
<td>PSB2</td>
<td>KIAD</td>
</tr>
<tr>
<td></td>
<td>PRTZL3 (RNAV)</td>
<td>KIAD</td>
</tr>
<tr>
<td></td>
<td>SKILS2 (RNAV)</td>
<td>KDCA</td>
</tr>
<tr>
<td>RBV</td>
<td>HYPER4 (RNAV)</td>
<td>KIAD</td>
</tr>
<tr>
<td>RIC</td>
<td>IRONS4</td>
<td>KDCA</td>
</tr>
<tr>
<td></td>
<td>RAVNN3 (RNAV)</td>
<td>KBWI</td>
</tr>
<tr>
<td></td>
<td>OJAAY1 (RNAV)</td>
<td>KDCA</td>
</tr>
<tr>
<td></td>
<td>OTT6</td>
<td>KBWI</td>
</tr>
<tr>
<td>RIDGY</td>
<td>BILIT1 (RNAV)</td>
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</tr>
<tr>
<td>SHAAR</td>
<td>ELDEE5 (RNAV)</td>
<td>KDCA</td>
</tr>
<tr>
<td></td>
<td>WZRRD2</td>
<td>KDCA</td>
</tr>
</tbody>
</table>

**Table Notes:**
- **Bold** indicate shared transitions.
- Ground-based NAVIADS
  - ALB: Albany VORTAC
  - BAF: Barnes VORTAC
  - BKW: Beckley VORTAC
  - CSN: Casanova VORTAC
  - ESL: Kessel VOR/DME
  - FAK: Flat Rock VORTAC
  - FOM: Williamsport VOR/DME
  - HVO: Charleston VORTAC
- LRP: Lancaster VORTAC
- LVZ: Wilkes-Barre VORTAC
- MGW: Morgantown VORTAC
- MXX: Modena VORTAC
- PSB: Philipsburg VORTAC
- RBV: Robbinsville VORTAC
- RIC: Richmond VORTAC
The limited number of well-defined entry points results in challenges that affect the efficient management of aircraft traffic. Because of the geographic location of the DC Metroplex area, the majority of aircraft enter the terminal airspace from the west, north, and south. Approximately 45 percent of traffic enters from the west, 25 percent from the north, and 17 percent from the south. As a result, airspace congestion occurs during periods of high demand at each of these locations. The resulting congestion requires the issuance of air traffic instructions such as vectoring, controlling speed, holding aircraft, leveling off aircraft, or rerouting aircraft to other entry points, which, as described in Section 2.1.1, increases pilot and controller workload, increases complexity for both controllers and pilots, and can result in delays.

Exhibit 2-2 illustrates how aircraft arrivals are sequenced in the enroute airspace and then merged to enter terminal airspace at a single point.

Aircraft arriving from different enroute flows must be merged into a single arrival flow at an entry point to terminal airspace. This is similar to traffic in multiple freeway lanes merging into one lane which can cause congestion prior to the merge. To maintain safe separation between aircraft, controllers must create sufficient gaps between aircraft along the route to safely line up aircraft from multiple streams. This may require ATC to issue instructions directing a pilot to take actions that can result in slower air traffic and increased congestion. This also results in increased workload for both the controller and pilot. Aircraft destined for each of the Study Airports share standard instrument arrival procedures that enter the

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terminal airspace on a single arrival flow through one of the entry points. Aircraft are then split from a single arrival flow and issued instructions to the final approaches to the various runways at the different Study Airports. Gaps in the flow to the individual Study Airports can develop after aircraft are sequenced and directed to the final approaches to the respective airport runways.

**Exit Points**

Exhibit 2-3 depicts the exit points where control is transferred from the TRACON to the ARTCCs for aircraft departing the DC Metroplex airspace.

**Exhibit 2-3 Terminal Airspace Control Transfer Areas - Departures**

<table>
<thead>
<tr>
<th>Notes:</th>
<th>PCT – Potomac Consolidated TRACON</th>
<th>ZOB – Cleveland ARTCC</th>
<th>ZDC – Washington ARTCC</th>
<th>ZNY – New York ARTCC</th>
</tr>
</thead>
</table>

**Table 2-3** lists the transitions for each SID that serves the four major study area airports. During peak periods of departure to the west, south, and north, controllers must merge departing aircraft from the Study Airports into single departure flows that pass through the terminal area exit points. Merging departing aircraft into departure flows can lead to delays.
Accordingly, controllers must frequently employ management tools such as holding departing aircraft on the ground before takeoff to control air traffic volume in the surrounding airspace. This directly affects departure efficiency at the Study Airports.

In addition to holding aircraft on the ground, controllers may also assign vectors and level-offs to aircraft during their departure climbs to provide adequate separation as aircraft are gradually merged into a departure route. The need to merge aircraft into departure routes increases the complexity of managing the terminal airspace and can decrease the efficiency of the airspace volume. Vectoring can also increase flight distances and reduce predictability, as aircraft are assigned less direct routes which they must continue to follow as they proceed further away from an airport.

<table>
<thead>
<tr>
<th>Departure Transitions</th>
<th>SID Procedure</th>
<th>Airport</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACY</td>
<td>PALEO3</td>
<td>KBWI</td>
</tr>
<tr>
<td>BUFFR</td>
<td>LAZIR2 (RNAV)</td>
<td>KDCA</td>
</tr>
<tr>
<td></td>
<td>NATNL2</td>
<td>KDCA</td>
</tr>
<tr>
<td></td>
<td>TERPZ2 (RNAV)</td>
<td>KBWI</td>
</tr>
<tr>
<td></td>
<td>CPTAL8</td>
<td>KIAD</td>
</tr>
<tr>
<td>COLIN</td>
<td>COLIN5</td>
<td>KRIC</td>
</tr>
<tr>
<td>CSN</td>
<td>LAZIR2 (RNAV)</td>
<td>KDCA</td>
</tr>
<tr>
<td></td>
<td>NATNL2</td>
<td>KDCA</td>
</tr>
<tr>
<td></td>
<td>CPTAL8</td>
<td>KIAD</td>
</tr>
<tr>
<td>DAILY</td>
<td>STOIC2 (RNAV)</td>
<td>KIAD</td>
</tr>
<tr>
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<td>LAZIR2 (RNAV)</td>
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<tr>
<td>DQO</td>
<td>SWANN3</td>
<td>KBWI</td>
</tr>
<tr>
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<td>KRIC</td>
</tr>
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</tr>
<tr>
<td>ENO</td>
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<td>KBWI</td>
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<td>KIAD</td>
</tr>
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<td>HAFNR</td>
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Table 2-3  SID Departure Transitions (2 of 2)

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<td>KRIC</td>
</tr>
<tr>
<td>MOL</td>
<td>YEAST1</td>
<td>KRIC</td>
</tr>
<tr>
<td>MRB</td>
<td>CPTAL8</td>
<td>KIAD</td>
</tr>
<tr>
<td>OOD</td>
<td>SWANN3</td>
<td>KBWI</td>
</tr>
<tr>
<td>OTT</td>
<td>CPTAL8</td>
<td>KIAD</td>
</tr>
<tr>
<td>PALEO</td>
<td>LAZIR2 (RNAV)</td>
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</tr>
<tr>
<td></td>
<td>NATNL2</td>
<td>KDCA</td>
</tr>
<tr>
<td></td>
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<td>KIAD</td>
</tr>
<tr>
<td>PAUKI</td>
<td>LAZIR2 (RNAV)</td>
<td>KDCA</td>
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<tr>
<td></td>
<td>NATNL2</td>
<td>KDCA</td>
</tr>
<tr>
<td></td>
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<td>KBWI</td>
</tr>
<tr>
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<td>COLIN5</td>
<td>KRIC</td>
</tr>
<tr>
<td>RAMAY</td>
<td>LAZIR2 (RNAV)</td>
<td>KDCA</td>
</tr>
<tr>
<td></td>
<td>NATNL2</td>
<td>KDCA</td>
</tr>
<tr>
<td></td>
<td>TERPZ2 (RNAV)</td>
<td>KBWI</td>
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<tr>
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<td>KRIC</td>
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<tr>
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<td>SWANN</td>
<td>LAZIR2 (RNAV)</td>
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<td></td>
<td>NATNL2</td>
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<td></td>
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<td>KIAD</td>
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<tr>
<td>WOOLY</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>STOIC2 (RNAV)</td>
<td>KIAD</td>
</tr>
<tr>
<td></td>
<td>NATNL2</td>
<td>KDCA</td>
</tr>
</tbody>
</table>

Table Notes:

**Bold** indicate shared transitions.

Ground-based NAVAIDS

ACY: Atlantic City VORTAC  GVE: Gordonsville VORTAC  MOL: Montebello VOR/DME  BUFFR  GINYA  RAMAY
CSN: Casanova VORTAC  HCM: Harcum VORTAC  OOD: Woodstown VORTAC  COLIN  HAFNR  SANNY
DQO: Dupont VORTAC  LDN: Linden VORTAC  OTT: Nottingham VORTAC  DAILY  JERES  SWANN
EMI: Westminster VORTAC  LYH: Lynchburg VORTAC  PXT: Patuxent VORTAC  DRAIK  PALEO  WOOLY
ENO: Smyrna VORTAC  MRB: Martinsburg VORTAC  SIE: Sea Isle VORTAC  FLUKY  PAUKI

Source:  NFDC, accessed 05/31/2012.
Prepared By:  ATAC Corporation, December 2012.

There are several consequences that result from all instrument arrivals and departures to and from the Study Airports using common standard instrument procedures and terminal airspace entry and exit points. These consequences include:

- The need to merge arriving aircraft into a single arrival flow at each entry point can increase flight time and distances.
- Gaps in the final arrival flows do not allow for the formation of a constant stream of aircraft to the Study Airports. This prevents the full use of the potential arrival throughput at the Study Airports.
- Merging aircraft from all Study Airports into single departure streams for each exit point requires controllers to create greater separations between subsequent departures from the same airport than would otherwise be required if the routes were separated or there were only a single airport in operations. Dedicated departure routes for each airport or runway would reduce the needed separation.
- Holding aircraft on the runway to create the necessary gaps in the departure routes leads to departure delays at all Study Airports, especially during peak travel periods. This prevents full use of the potential departure throughput at the Study Airports.
The need for additional controller-to-pilot communication to issue the variety of instructions required to merge and desegregate the flow of aircraft adds to the workload of both controllers and pilots.

Options for controllers to re-direct aircraft to avoid bad weather or more efficiently handle sequencing are limited when the pilot does not have the runway in sight due to low visibility.

Exhibit 2-4 shows the multiple routes DCA RNAV departures use for one SID, the LAZIR2 RNAV. Inefficiencies arise as the conventional departure SID for DCA shares the same routes. This procedure does not allow for efficient segregation of the departure routes and requires extensive radar vectoring. This contributes to ATC task complexity and flight path variability. The lack of additional departure procedures also reduces efficiency for aircraft.

Exhibit 2-4  LAZIR2 RNAV SID – DCA

Legend
- Study Airports
- State Boundaries
- District of Columbia
- Maryland Counties in Study Area
- Virginia Counties in Study Area
- Water
- US and Interstate Highways
- LAZIR SID Departure Tracks

Notes:
2.1.2.2 Complex Converging Interactions Between Arrival and Departure Flight Paths

This section describes three general examples of complex converging interactions between arrival and departure flight routes in the DC Metroplex airspace. The airspace in the DC Metroplex can be very complex, particularly because of the close proximity of three busy commercial service airports (DCA, IAD, and BWI) and the presence of restricted area of airspace such as the Flight Restriction Zone (FRZ) around central Washington D.C. (The FRZ is discussed further in Section 1.2.5, Special Use Airspace.) These following three examples are followed by discussion of how these types of interactions function in the DC Metroplex.

1. Many arrival and departure routes converge or cross. This is necessary to move aircraft to an airport from the appropriate entry point and from an airport to the appropriate exit point. To maintain appropriate separation between aircraft, the controller issues altitude assignments that rely on vertical distances of 1,000 feet or more. Crossing routes include level flight segment “bridges” where at key points aircraft stop their descent or climb and level off to allow arrivals or departures to cross and descend or climb away from another aircraft’s path. Aircraft may then fly at this altitude until they have moved away from other aircraft crossing the same area.

2. ATC typically splits arrival and departure control responsibilities. Control of aircraft is passed on from one controller to the next as the aircraft progress through airspace. Vertical separation between aircraft arrivals and departures is maintained primarily through defined ceiling and floor altitudes. An arriving aircraft cannot descend until the aircraft is clear of the dimensional airspace reserved for departures. When an aircraft clears one airspace area, it is transferred by a controller to the next airspace area controlled by another controller. During the time between handoff and transfer of control between controllers, aircraft may have to level off until the next controller acknowledges control and the aircraft is able to resume its climb. The amount of time necessary to transfer control may be directly affected by the extent of controller workload.

3. Controllers may need to alert aircraft or another controller responsible for a neighboring airspace sector of the proximity of other aircraft (point-outs). Aircraft must be separated laterally by at least three nautical miles (nmi) within the terminal airspace and generally by at least five nmi in the enroute environment. This is achieved in the terminal environment by keeping an aircraft at least 1.5 nautical miles from the airspace boundary assigned to a specific controller. In the enroute portions of the DC Metroplex airspace, separation is maintained at 2.5 nmi. As conventional navigation is not as accurate as RNAV, two to three nautical mile buffers from the boundary are used to ensure the 1.5 and 2.5 nmi distances are always kept. These accuracy limitations result in areas of unusable airspace.

All the scenarios described above require additional verbal communication between controllers or between controllers and pilots. This can take extra time resulting in unnecessary system complexity and increased pilot and controller workload. In addition,
Vectoring and level-offs can reduce airspace efficiency and flight efficiency by adding time and distance to flights as aircraft enter/exit to/from the terminal airspace.

The following sections provide two specific examples of how these interactions function within the DC Metroplex area.

**West DCA Arrivals (ELDEE 5) and West IAD Departures (CAPITAL 8)**

Exhibit 2-5 shows how current arrival routes for DCA (blue flight tracks) cross with several westbound IAD departure routes (orange flight tracks). Due to the altitudes at which aircraft on these routes cross there are several issues that prevent optimized approaches to the airport, including crossing restrictions and leveling off requirements. These issues can result in extended flight time and distance.

**Exhibit 2-5 DCA Departures – IAD Arrivals Conflicts**

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**IAD and BWI Departure Conflicts**

The IAD STOIC departure procedure requires that the initial fix be located 15 nmi from the runway complex to ensure avoidance of the Flight Restricted Zone (FRZ) surrounding DCA.
The BWI TERPZ2 departure route conflicts with the IAD STOIC departure route due to this IAD STOIC initial fix location. The DCA SKILS and CLIPR arrival routes also conflict with the IAD STOIC departure route. Exhibit 2-6 shows where the IAD and BWI departures conflict. Exhibit 2-7 shows where the DCA and IAD departures conflict. These conflicts can cause level-offs resulting in extended flight time and distance.

Exhibit 2-6 IAD Departure – BWI Departure Conflicts

Notes:
ADW – Joint Base Andrews
BWI – Baltimore/Washington International Thurgood Marshall Airport
DCA – Ronald Reagan Washington National Airport
IAD – Washington Dulles International Airport
Source: ATAC (PDARS radar data), June 2011.

2.1.2.3 Lack of Predictable Standard Procedures to/from and in Enroute Airspace

Predictability provides pilots and controllers the ability to know ahead of time how, where, and when an aircraft should be operated along a defined route allowing them to better plan airspace use and the control of aircraft in the given volume of airspace. A predictable route may include expected locations (where), altitudes (where and how high), and speeds (how
A procedure that provides these elements results in a more predictable route for the pilot and controller.

Aircraft performance and/or piloting technique can vary, and as a result, may also play a factor in reducing predictability. Because conventional procedures are less precise than RNAV procedures and less predictable, controllers will use vectoring as well as instructions governing speed and altitude level-offs to ensure safe vertical and lateral separation between aircraft. As discussed in Section 1.2.6.1, RNAV procedures enable aircraft to follow more accurate and better defined, direct flight routes in areas covered by GPS-based navigational aids. This allows for predictable routes with fixed locations and altitudes that can be planned ahead of time by the pilot and air traffic control. Fixed routes help maintain segregation between aircraft by allowing defined vertical and horizontal separation of traffic. As a result, some routes can be shortened and the need for level-offs can be eliminated. This allows for improved use of the airspace. Therefore, the greater the number of RNAV procedures in a Metroplex the greater the degree of predictability.
Table 2-4 summarizes current availability of conventional and RNAV-based procedures for the four major study airports as of December 2011.

The following sections describe the three areas - ground path, vertical path, and runway transitions - in which conventional procedures in the DC Metroplex result in less predictable air traffic management as compared to RNAV-based procedures. The following sections describe the conditions that reduce predictable air traffic management.

**Ground Path**

Airports with a significant volume of aircraft operating under Instrument Flight Rules (IFR) need SID and STAR procedures to direct air traffic flows and various runway configurations to achieve optimal efficiency. The intention of SID and STAR procedures is to maintain a predictable flow of aircraft to/from an airport. This is achieved by establishing consistent flight route expectations, reducing the need for communications between controllers and pilots. These procedures also reduce the need to hold aircraft on the ground or in the air, or to make use of other aircraft management tools and coordination techniques to satisfy aircraft separation requirements.

Several STAR and SID procedure designs use ground-based NAVAIDs. As discussed in Section 2.1.1, navigation based on ground-based NAVAIDs can be hindered by line-of-site issues and signal degradation that limits where conventional procedure routes can be located. In addition, because they are less precise, conventional procedures require additional lateral airspace to protect aircraft flying on neighboring routes. Due to these factors, it can be difficult for a non-RNAV equipped aircraft to follow an accurate ground path. The ground path is the track or trace along the surface of the earth directly below the aircraft which represents where the aircraft should be flying. Because these procedures cannot provide more predictable controls such as specific speeds or altitudes, controllers use vectoring and speed adjustments to manage traffic. This leads to increased controller and pilot workload. **Table 2-4** shows the current number of procedures for the five major study airports as of December 2011.

<table>
<thead>
<tr>
<th>Airport</th>
<th>STAR</th>
<th>SID</th>
<th>Conventional</th>
<th>RNAV</th>
<th>SID</th>
</tr>
</thead>
<tbody>
<tr>
<td>KADW</td>
<td>IRONS FOUR</td>
<td>ANDREWS ONE, CAMP SPRINGS ONE, MORNINGSIDE ONE</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>KBWI</td>
<td>NOTTINGHAM SIX, WESTMINSTER FIVE</td>
<td>PALEO THREE, SWANN THREE</td>
<td>RAVNN THREE</td>
<td>TERPZ TWO</td>
<td></td>
</tr>
<tr>
<td>KDCA</td>
<td>IRONS FOUR</td>
<td>NATIONAL TWO</td>
<td>BILIT ONE, CLIPR ONE, ELDEE FIVE, OJAAY ONE, SKILS TWO</td>
<td>LAZIR THREE</td>
<td></td>
</tr>
</tbody>
</table>
### Table 2-4: Existing STAR and SID Procedures for ADW, BWI, DCA, IAD, and RIC (2 of 2)

<table>
<thead>
<tr>
<th>Airport</th>
<th>Conventional STAR</th>
<th>Conventional SID</th>
<th>RNAV STAR</th>
<th>RNAV SID</th>
</tr>
</thead>
<tbody>
<tr>
<td>KIAD</td>
<td>COATT FOUR, DELRO TWO, PHILIPSBURG</td>
<td>CAPITAL EIGHT</td>
<td>BARIN ONE, HYPER FOUR, LEGGO TWO, PRTZL THREE, SHNON TWO</td>
<td>STOIC TWO</td>
</tr>
<tr>
<td>KRIC</td>
<td>NONE</td>
<td>COLIN FIVE, YEAST ONE</td>
<td>NONE</td>
<td>NONE</td>
</tr>
</tbody>
</table>

Table Notes:
- Procedures listed in table include RNAV SIDs and STARs implemented in 2012.
- Prepared By: ATAC Corporation, April 2013.

### Vertical Path

Aircraft climb or descend when instructed by a controller. The point when an aircraft reaches an assigned altitude may vary depending upon a combination of factors, including aircraft performance, weather conditions, and/or piloting technique. Aircraft arriving to or departing from the Study Airports are frequently required to level off during descent/climb to maintain vertical separation from other arriving and departing aircraft. Flight time and distance can be increased for traffic flows with interrupted climbs and descents as the aircraft exit/enter the terminal airspace or transition to/from the runway approach environment. Unpredictable vertical guidance resulting from conflicting traffic leads to increased controller workload and inefficient aircraft operation.

There are routes in the DC Metroplex that require climbing or descending aircraft to level-off to accommodate aircraft crossing above or below. In these instances, aircraft efficiency suffers due to: 1) power variability during leveling-off; 2) power variability in reinitiating the climb or descent; and 3) increased fuel consumption. The level-off in the climb phase typically results in aircraft taking longer to reach the altitude necessary to exit the terminal airspace. During the descent phase, the level-off requires application of thrust for aircraft preparing to land to maintain appropriate approach speeds and altitude. This results in extended fuel burn.

**Exhibit 2-8** shows the vertical profile for current DCA/IAD departure flight tracks. Once over the PALEO fix, departures in this area must level-off at 23,000 feet MSL. This location is referred to as “flight level” 230 and abbreviated FL230. The extended level-off is noted by the collection of dark blue flight tracks circled in red. An additional level-off can also be noted at 9,000 feet MSL by the collection of orange flight tracks circled in red. This situation involves additional controller-pilot communications, including additional point-outs. This adds to complexity (e.g., higher controller workload, the number of times controller-to-pilot communication occurs, and inefficient use of aircraft performance capabilities during a descent or climb) and reduces airspace efficiency. Accordingly, the STAR or SID does not offer a predictable route. The procedure does not take full advantage of RNAV capabilities.

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37 While the aircraft is in a climb or descent, controllers may need to alert adjacent aircraft or another controller, who is responsible for a nearby airspace sector, of the proximity of a nearby aircraft. This notification is called a “point-out” and adds to the airspace complexity, because of the communication requirement and time taken to provide the point-out and receive confirmation from the recipient. Reducing point-outs improves efficiency in communications.
including the ability to use the current technology to reduce the complexity of the terminal airspace system and allow for more efficient use of the airspace.

**Runway Transitions**

As discussed in Section 1.4.3, Study Airports use different runway operating configurations based on factors like weather, wind direction, and the amount and type of air traffic. At a Study Airport with a high level of air traffic, particularly during peak periods, operational efficiency is improved by the availability of STARs for each runway that can be used for the various runway operating configurations. STARs with one or more runway transition route (i.e., the route that leads aircraft to a final approach that typically ends at an Initial Approach Fix) enhance efficiency by minimizing the need for controller-to-pilot communication when aircraft transition to the final approach of the runway from the enroute transition route. The enroute transition route begins in enroute airspace, converging into a single route that ends at a point prior to the runway transition route. Standard instrument arrival procedures also make it easier for controllers to monitor the flow of traffic to the runways and to maintain a constant and predictable routing of aircraft.

Of the 10 RNAV STARs for the major airports in the DC Metroplex, eight include runway transitions to the final approach to a runway end. Including runway transitions in the RNAV STARs can reduce pilot and controller workload, increase flight route predictability, and minimize the need for controller-to-pilot communication. After issuing control instructions to follow an RNAV STAR that contains a runway transition, the controller knows how the pilot will maneuver the aircraft to the final approach. Thus, there is no need for further controller-to-pilot communication unless unusual circumstances arise, such as the need to call out the proximity of other traffic.

**Satellite Airports**

In addition to issues with existing procedures, system efficiency is affected by the lack of more predictable STAR and SID procedures at DC Metroplex satellite Study Airports. These airports serve as reliever or alternate airports in the event destination airports are
closed due to unexpected conditions such as bad weather. The existing procedures for the satellite Study Airports do not allow for predictable segregation of routes between air traffic arriving to or departing from these Study Airports and the major Study Airports in the DC Metroplex. Specifically, the need for predictable SID and STAR procedures to and from the satellite Study Airports are exemplified by interactions between IAD routes and departures from Leesburg Airport (JYO) and Frederick Municipal Airport (FDK), as well as DCA routes and operations at U.S. Air Force operated Joint Base Andrews (ADW).

2.2 Purpose of the Proposed Action

The purpose (goal) of the Proposed Action is to take advantage of the benefits of performance based navigation by implementing RNAV procedures that will help improve the efficiency of the airspace in the DC Metroplex. Implementing RNAV procedures will also comply with direction issued by Congress in the Modernization and Reform Act of 2012. To meet this goal, the Proposed Action would optimize procedures serving the DC Metroplex Study Airports while maintaining or enhancing safety in accordance with FAA's mandate under federal law. This would be achieved by reducing dependence on ground-based NAVAID technology in favor of more efficient satellite-based navigation, such as RNAV. Specifically, the objectives of the Proposed Action are as follows:

- Improve the flexibility in transitioning traffic between enroute and terminal area airspace and between terminal area airspace area and the runways;
- Improve the segregation of arrivals and departures in terminal area and enroute airspace; and
- Provide RNAV arrival and departure enroute transitional and terminal area airspace procedures for each individual runway with the intent to provide a more predictable ground and vertical path.

Air traffic controller workload and controller-to-pilot communication would be expected to decrease, reducing both workload and airspace complexity. Improvements in arrival and departure segregation among the DC Metroplex Study Airports would reduce the need for vectoring and level flight segments, resulting in shorter, more predictable flows.

Each objective of the Proposed Action is discussed in greater detail below.

2.2.1 Improve Flexibility in Transitioning Aircraft

As discussed in Section 2.1.2.1, the limited number of entry and exit points and associated procedures, constrain the efficiency of the air traffic routes in the terminal and enroute transitional airspace. This results from the need to merge multiple routes prior to arrival to and departure from terminal airspace. One objective of the Proposed Action is to minimize the need for merging by increasing the number of entry/exit points and procedures dedicated to specific Study Airports. This objective can be measured with the following criteria:

- Where possible, increase the number of entry and exit points compared with the No Action Alternative (measured by number of exit/entry points).
- Segregate major Study Airport traffic from other major Study Airport and/or satellite Study Airport traffic to/from Study Airports (measured by count of RNAV STARs and/or SIDs that can be used independently to/from Study Airports).
2.2.2 Segregate Arrivals and Departures

As discussed in Section 2.1.2.2, arrival and departure flight routes frequently cross, converge, or are located within close proximity of each other in some portions of the enroute and terminal airspace. This requires controllers to actively manage the traffic using the tools available to them to ensure that safe vertical and lateral separation between aircraft is maintained. Another objective of the Proposed Action is to implement procedures that would achieve better segregation of arrivals and departures within the terminal airspace. This objective can be measured with the following criterion:

- Where possible, increase the number of RNAV STARs and SIDs compared with the No Action Alternative (measured by total count of RNAV STARs and RNAV SIDs for the DC Metroplex.)

2.2.3 Improve the Predictability of Air Traffic Flow

As discussed in Section 2.1.2.3, current procedures in the DC Metroplex do not take full advantage of RNAV capabilities. RNAV procedures can increase predictability by taking better advantage of aircraft performance capabilities (e.g., speed control and altitude restrictions) and by designing procedures that reflect these capabilities. These enhancements would provide for more predictable, repeatable, and efficient routes than is currently possible with most conventional procedure designs.

In addition, RNAV procedures with runway transitions provide for a more predictable flow of air traffic through the airspace and require less controller-to-controller coordination and controller-to-pilot communications to manage air traffic flows. Additional runway transitions to and from each runway would provide controllers more flexibility to balance demand, maintain runway departure separations, and segregate routes without the need for controller intervention.

This objective can be measured with the following criteria:

- Ensure that the majority of STARs and SIDs to and from the Study Airports are based on RNAV technology (measured by count of RNAV STARs and SIDs for an individual Study Airport);

- Increase the number of runway transitions in the RNAV STARs and SIDs in comparison to the No Action Alternative. (measured by count of procedures that include runway transitions to/from runways); and,

2.3 Criteria Application

The Proposed Action is evaluated to determine how well it meets the purpose and need based on the measurable criteria for each objective described above. The evaluation of alternatives will include the No Action Alternative, under which the existing (2011) air traffic procedures serving the Study Airports would be maintained, along with approved procedure modifications already planned and approved for implementation. The criteria are intended to aid in comparing the Proposed Action Alternative with the No Action Alternative.

2.4 Description of the Proposed Action

The Proposed Action considered in this study would include the implementation of optimized RNAV SID and STAR procedures that would reduce reliance on conventional
procedures. The primary components of the Proposed Action are to the extent possible, redesign standard instrument arrival and departure procedures to more efficiently serve the Study Airports and to improve the flexibility and predictability of air traffic routes. The Proposed Action is described in detail in Chapter 3, Alternatives.

Implementation of the Proposed Action would not result in an increase in the number of aircraft operations at the Study Airports. However, inefficiencies in the air traffic routes currently serving the Study Airports would be reduced. The Proposed Action does not involve physical construction of any facilities, such as additional runways or taxiways, and does not require any state or local actions. Therefore, the implementation of the proposed changes to procedures in the DC Metroplex would not require any physical alterations to environmental resources identified in FAA Order 1050.1E.

2.5 Required Federal Actions to Implement Proposed Action

Implementation of the Proposed Action requires the following actions to be taken by the FAA:

- Controller training; and,
- Publication of new or revised STARs, SIDs, and transitions.

2.6 Agency Coordination

On December 19, 2012, the FAA distributed an early notification letter to 437 federal, state, regional, and local officials as well as to 17 tribes. FAA sent the early notification letter to provide notice of the initiation of the EA; request background information related to the EA study area; and to gain an understanding of issues, concern, policies, and/or regulations that may affect the environmental analysis. A subsequent notification letter was sent to an additional 56 federal, state, and local officials on March 25, 2013. The FAA sent the early notification letter to:

1. To advise agencies and tribes of the initiation of the EA study;
2. To request background information regarding the study area established for the EA; and
3. To provide an opportunity to advise the FAA of any issues, concerns, policies or regulations regarding the environmental analysis that will be undertaken in the EA.

Appendix A, Agency Coordination, Agency Consultation, and Public Involvement, includes a copy of the early coordination letter (and attachments) as well as a list of the receiving agencies and tribes.