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Meeting Summary, October 5, 2016

NextGen Advisory Committee (NAC)

The nineteenth meeting of the NextGen Advisory Committee (NAC) was held on October 5, 2016 at JetBlue University, Orlando, FL. The meeting discussions are summarized below.

List of attachments:

- Attachment 1 – Attendees
- Attachment 2 – Presentations for the Committee meeting - (containing much of the detail on the content covered during the meeting)
- Attachment 3 – Approved June 17, 2016 Meeting Summary
- Attachment 4 – Approved Terms of Reference (effective October 2016)
- Attachment 5 – Approved Terms of Reference (effective November 2016)
- Attachment 6 – NAC Chairman's Report
- Attachment 7 – FAA Report from The Honorable Michael Huerta, FAA Administrator and Victoria Wassmer, Acting FAA Deputy Administrator
- Attachment 8 – PBN Time, Speed, Spacing Task Group – Final Report
- Attachment 9 – Joint Analysis Team – Final Report: Performance Based Navigation Procedures: North Texas Metroplex, Denver Established on RNP

Welcome and Introductions

Chairman Anderson opened the meeting at 8:33 a.m. by thanking JetBlue for hosting the meeting and welcoming the NAC members and others in attendance and introduced one new Committee member:

- Angie Heise, President of Civil, Leidos (formerly Lockheed Martin)

All other NAC members and attendees from the public are identified in Attachment 1.

Designated Federal Official Statement

The DFO, Victoria Wassmer (Acting FAA Deputy Administrator) read the Federal Advisory Committee Act notice, governing the public meeting.

Approval of June 17, 2016 Meeting Summary and Revised Terms of Reference

Chairman Anderson asked for consideration of the written Summary of the June 17, 2016 meeting. By motion, the Committee approved the Summary (Attachment 3). By motion, the Committee also approved two versions of the revised Terms of Reference for the Committee – one effective for October 2016 that revises the FAA's DFO to Ms. Wassmer (Attachment 4) and the other effective November 2016 that establishes Dave Bronczek, President, FedEx Express, as the Chair of the Committee (Attachment 5).

Chairman's Remarks

The following is a summary of the remarks made by Chairman Anderson (Attachment 6):

He thanked the FAA and Administrator Michael Huerta for the foresight to establish the NAC in 2010. Since its inception, the NAC has provided numerous recommendations that have and can lead to demonstrable improvements in the efficiency and capacity of the aviation system.

Collaboration and Commitments – there is a need to continue to build on the strong foundation of collaboration with the FAA - 8 years (Task Force 5 and NAC); it is important for FAA and industry to commit to specific dates and locations.

Goal – the NAC has set an overarching goal of NextGen to achieve VMC performance in IMC conditions, leading to increased predictability along with reduced delays and flying time.

Keep it simple – a simple, quick, transparent measurement system for NextGen implementation must be in place for all undertakings, and this must be focused on the system delivering operational benefits and not simply tracking program milestones.

Risk Management, Safety Assessments – the NAC needs to do a better job of managing risk associated with the introduction of new operational capabilities into the NAS.

Next Big Thing – for NextGen to succeed, we need to solve New York - nothing will move the needle on performance like fixing New York; if we don't have northeast regional undertaking, we are not deploying NextGen.

Going Forward – we need to follow through on current taskings, setting priorities and continuing with some stretch goals and evaluating implementations – Joint Analysis Team. Crucial to communicate the successes, reporting results and communicating builds support for work that should be funded, proof of success will be required to garner confidence.

Concluding his remarks, Chairman Anderson emphasized the need to continue close, consensus based, transparent collaboration between the FAA and the aviation industry, with investment priorities being driven by the operators. "Stay at the NAC table, make change

happen. RTCA's collaborative, consensus-building process is the best approach to modernizing the Air Transportation System."

FAA Report – Michael Huerta, Administrator; Victoria Wassmer, Acting Deputy Administrator; Lynn Ray, Vice President Mission Support, Air Traffic Organization

The following captures points from Mr. Huerta and Ms. Wassmer's remarks. The details are contained in the FAA report (Attachment 7).

Administrator Huerta introduced Victoria Wassmer as the Acting Deputy Administrator/Chief NextGen Officer and thanked Chairman Anderson for his leadership as his two-year term concludes. Ms. Wassmer emphasized the business of NextGen – delivering benefits from technology and capabilities and the importance of industry-FAA collaboration in this effort.

Lynn Ray, Vice President Mission Support, Air Traffic Organization, presented the Agency's response to the Community Outreach recommendation stating that overall, the FAA concurred with the NAC recommendation approved during the June 2016 NAC meeting. She emphasized the focus on cultural change, including how the FAA and the aviation community engage the broader community and partner differently inside and outside the aviation industry. The bottom line is that communication will occur earlier in the process and more frequently. There is also a concentration on communicating with the public in a manner that is understandable and relevant to their interests and concerns. Community workshops is part of the strategy that the FAA is implementing to address this area. This includes the use of visuals that translate technical issues and explanations of why aircraft operate in a specific manner.

Ms. Wassmer commented that it is important for the industry to be involved, "it is not just about the FAA" for PBN to be successfully implemented.

The Administrator introduced Dave Bronczek, President, FedEx Express, who will assume the chair role in November 2016 for the 2017/2018 term. Mr. Bronczek commented that he is looking forward to working with the professionals at the FAA and the industry in continuing to move forward with implementing NextGen capabilities and the work of the NAC.

Value of NextGen Capabilities Ad Hoc

Ed Bolen, President and CEO, National Business Aviation Association, explained that the purpose of the Ad Hoc is to develop high-level messaging that conveys the value of NextGen

capabilities being deployed. A part of this is to determine why current messaging is not resonating as we would like.

The Committee discussed the draft working definition:

"NextGen is the Aviation community working together to modernize technologies, policies and procedures in the national airspace system in order to increase capacity, reduce delays and cancellations, reduce our environmental footprint, and enhance safety, for all segments of aviation with bad weather performance equal to good weather performance"

Committee members commented that there is a need to cover the bigger picture, the "higher calling," the macro goals of NextGen so that those outside the industry, including Congress, can understand. The discussion also covered the challenges associated with a long-term program. One suggestion was to link statements of progress with the value achieved and the potential for the future.

Members of the Committee stressed the need for this topic to be a reoccurring agenda item and agreed that Unmanned Aircraft Systems (UAS) should be a part of this initiative representing a new user and perspective.

The Ad Hoc will report back to the Committee at the next meeting.

Airline C/N/S Fleet Plans—United, American, SkyWest

Tracy Lee, Vice President Network Operations, United Airlines; Tim Campbell, Senior Vice President Air Operations, American Airlines; and Chip Childs, President & CEO, SkyWest, presented a briefing on their respective C/N/S fleet plans--ADS-B, PBN and DataComm. These briefings are an on-going agenda item for the Committee to better understand aircraft operator equipage. Alaska Airlines and UPS are being requested to present at the next meeting.

United Airlines overall principle for equipage:

United Airlines NextGen Vision

Our focus is to modernize our fleet using technologies which will safely and efficiently improve schedule integrity and reliability

- **Equipage should benefit our customers with a goal of delivering ceiling and visibility performance approaching that of clear weather days**
- **CNS projects and programs must deliver financial value and effectively utilize United's capital resources while complying with mandates**
- **United actively leverages manufacturers, suppliers, and industry partners to accelerate the demonstration of technology and reduce time to market and adoption**

Goal: Turn bad days into good days

35

UNITED

American Airlines overall principle for equipage:

Guiding Principles for NextGen Equipage for AA

1. Ensure our fleet is ready to capture the safety and efficiency benefits of NG capabilities that are cost justified
2. Continue to demonstrate willingness to partner with FAA and suppliers on proof-of-concept proposals
   - A330 ADS-B IN demo with with CAVS FAA and ITP
   - 737 FANS program with Harris Corp
3. Advocate for leveraging existing avionics and infrastructure to its fullest before considering fleet changes
4. Encourage FAA to expand, wherever possible, use of performance based standards to meet requirements vs. hardware-specific mandates, e.g. Equip 2020 (2025)
5. Ensure impacts to regional partners are fully included in all equipage impact analyses
6. Promote new and creative uses of EFB's or related portable, certified devices to minimize the cost and time associated with fleet modifications

NAC Briefing 2016-10.05 FINAL

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SkyWest's overall principle for equipage:

SkyWest Philosophy on NextGen

- SkyWest is fully engaged and committed to NextGen, and has developed a comprehensive solution and timeline to have our current fleet equipped with ADS-B-Out no later than Q3 2019.
- SkyWest is among the first regionals to develop and plan implementation of LPV and RNP-AR.
- SkyWest remains an active participant and supports both industry and the FAA's Equip 2020 working groups in pursuit of this critical NextGen initiative.
- Beyond ADS-B-Out, additional NextGen components may be driven by RJ manufacturer capability for specific fleet types, economics, major partners and fluid flying contracts.

SkyWest, Inc. Operating Fleet	# in Fleet	Est. Equip (ADS-B)
E175	63	Equipped
CRJ900	64	5/2019
CRJ700	131	7/2019
CRJ200	224	9/2019
ERJ145/135	168	9/2019
Total	650	

Following the presentation, in response to Chairman Anderson's question, Mr. Merritt affirmed that United should be able to meet its internal deadline to have its fleet fully equipped with ADS-B by the 3rd qtr. of 2019. An FAA representative expressed a broader concern about the availability of repair station capacity to perform ADS-B installation as the 2020 deadline for equipping approaches. Currently there is not an issue, but this could change as the date becomes closer. It was also requested by the Committee that the status of repair station capability be included in future NAC ADS-B Equip 2020 reports. While most large air carriers have internal capabilities to perform installations, repair station availability is crucial for regionals, other air carriers and the business/general aviation community.

Regarding the regional operators, Mr. Childs stated that 75% of RAA member airlines have submitted equipage plans to MITRE accounting for 89% of the total regional fleet. He explained the broader equipage outlook for their industry is complicated to project because of the variables of partnerships with major carriers, availability of pilots, fixed revenue structures that require additional planning for economic feasibility and the need for larger carrier partner collaboration.

ADS-B Update

Bruce DeCleene, Manager, Flight Technologies and Procedures Division, FAA, gave a status update about the latest equipage statistics and reinforced (along with Administrator Huerta) that the 2020 deadline is firm. The focus of the Equip 2020 activity is to obtain information from the regional operators and other air carriers that have not yet provided compliance plans.

A Committee Member noted that there is a need to determine ADS-B requirements and an equipage path for Unmanned Aircraft Systems (UAS). It was suggested that this be an initial request of the new Drone Advisory Committee (DAC) because ADS-B equipage is crucial for integrating UAS into the NAS. It was noted that the Drone Advisory Committee (DAC) will not be able to address this for some time. The Committee requested that UAS ADS-B equipage for the 2020 mandate be evaluated, tracked and reported back to the NAC.

Mr. DeCleene stated there may have been some initial miscommunication or mixed messaging regarding the FAA ADS-B equipping incentive program; the intent was to incentivize repair stations to increase capacity and throughput. In response to a question from a committee member, Mr. DeCleene stated that there would not be an extension of the 60-day window for general aviation aircraft equipage approval, explaining how the reservation system for repair stations was expected to work.

There was a discussion related to repair stations and the need to ensure the entire supply chain could provide the needed equipment and associated support necessary to make the 2020 goal. The Committee requested that Embraer, Bombardier, Honeywell, Rockwell Collins, Thales and other OEMs make presentations from the manufacturer and supply chain perspectives. The briefings should address the standards, technologies and pathways for the retrofit of existing aircraft.

NextGen Integration Working Group (NIWG) 2017-2019 Rolling Plan

The NIWG Executive Team Members Teri Bristol, FAA Air Traffic Organization, Steve Dickson, Delta Air Lines, Jim Eck, FAA NextGen, and Melissa Rudinger, AOPA, opened the NIWG discussion noting that the NextGen Priorities Joint Implementation Plan was developed in response to the NAC's June 2016 recommendations.

The Industry-FAA Teams developed recommendations for implementing NextGen capabilities at specific sites in the 2017-2019-time frame for:

- DataComm
- Multiple Runway Operations – Wake ReCat
- PBN
- Surface

The FAA plan contains additional details on implementing the joint FAA-Industry recommendations approved in June. Both Ms. Bristol and Mr. Dickson acknowledged the hard work and collaboration of the NIWG teams to reach agreement on the commitments for the next three years. Mr. Dickson noted that initial NIWG plans (in 2014) were program milestones, but now they are more focused on stretch goals and implementation of capabilities. Industry has been forced to become more cohesive and continues to want to help the FAA prioritize implementations, leveraging existing equipment while encouraging continued equipage. NIWG teams will focus on where they need the NAC's help for setting priorities, getting resources, making decisions, and providing guidance.

The Industry Leads and the FAA Subject Matter Experts (SMEs) for each of the four focus areas presented reports on the existing commitments (the names of the presenters are highlighted):

DataComm

FAA SMEs: Paul Fontaine (ANG), Jessie Wijntjes (ATO)

Industry Leads: John O'Sullivan (Harris Corporation), Chuck Stewart (United Airlines)

Mr. Wijntjes reported that the Departure Clearance Services are operational at nearly 50 towers and the program is 24 months ahead of schedule. The Full Services baseline was achieved with a reduced number of services. The DataComm Team is now pivoting to focus on En Route Services. Mr. Stewart shared that as of 9/7/16, 1,792 DataComm aircraft were operating in the National Airspace System.

The FAA and industry provided a sample of weather events resulting in time savings benefits for DataComm flights. Time saved per flight is determined by comparing DataComm flights that received revisions to Non-DataComm flights that received revisions.

Day	Site	Length (hrs.)	Time Savings per Flight: Data Comm vs. Non Data Comm	Total Time Saved
2/16/2016	KEWR	7.5	Average 23.7 min less gate delay and 5 min less taxi delay	195 minutes
4/1/2016	KJFK	24	Average 9 min less gate delay and 7.8 min less taxi delay	299 minutes
4/3/2016	KEWR	24	Average 16.3 min less gate delay and 11 min less taxi delay	274 minutes
6/28/2016	KEWR	9.5	Average 21.5 min less gate delay and 5.3 min less taxi delay	208 minutes
6/29/2016	KEWR	9	Average 8.2 min less taxi delay	63 minutes
7/28/2016	KJFK	24	Average 6 min less taxi delay	60 minutes
8/13/2016	KBWI	9	Average 26.5 min less gate delay and 9.1 min less taxi delay	398 minutes
9/10/2016	KIAH	7	Average 2.3 min less gate delay and 1.5 min less taxi delay	38 minutes
9/19/2016	KLAX	31	Average 2.8 min less gate delay and 10.7 min less taxi delay	105 minutes

Multiple Runway Operations (MRO)

FAA SMEs: Jack Allen (ATO), Paul Strande (ANG)

Industry Leads: Glenn Morse (United Air Lines), Jon Tree (The Boeing Company)

Mr. Allen and Mr. Morse reviewed the status and the plan commitments including:

- Amend Dependent Runway Separation Order 7110.308A (SFO)
- Amend Dependent Runway Separations for Runways Greater than 4,300 Feet (CVG, MEM, PHX, SDF)
- Amend Standards for Simultaneous Independent Approaches, Triples (ATL, IAD)

They noted that the FAA is working to amend the national standards for vertical navigation (VNAV) for simultaneous independent parallel approaches as quickly as possible to allow operators to achieve even more benefits in capacity and arrival/departure rates. A Committee Member asked if the FAA's noise model is being updated for NextGen improvements and separation improvements made under Wake ReCat and the concentrated tracks for PBN. In response, Ms. Ray commented that the thresholds for measuring noise remain the same. Administrator Huerta requested that NIWG teams receive a noise briefing from FAA aviation noise measurement Subject Matter Experts.

Surface

FAA SMEs: Mike Huffman (ATO) and Susan Pfingstler (ATO)

Industry Leads: Rob Goldman (Delta Air Lines), Steve Vail (Mosaic ATM, Inc.)

Ms. Pfingstler and Mr. Goldman provided an update on Terminal Flight Data Manager (TFDM) which is the surface management solution for NextGen that will provide an integrated tower flight data automation system to improve controllers' common situational awareness. The FAA awarded the contract to Lockheed Martin (Leidos) with Saab Sensis as a

sub-contractor on June 29th. The FAA has also accepted the NAC recommendation for ongoing industry engagement throughout the various stages of the TFDM deployment which will be a combination of the Surface Collaborative Decision Making (S-CDM).

In response to a question, Mr. Goldman explained that data sharing is crucial to achieve benefits. The FAA and American, as the lead operator, will provide the lessons learned from data sharing under the Airspace Technology Demonstration 2 (ATD-2) project demonstration in Charlotte, NC. Ms. Pfingstler stated that there must be a critical mass of operator participants for a predictive tool to be effective.

A Committee Member shared that in Europe better databases of surface information is helping Euro control more effectively manage traffic flows and balance capacity.

Other members agreed that in the US, it is critical to ensure that regional partners participate in the exchange of data, pointing out that in some airports the regional operators represent a majority of the operations. Chairman Anderson requested that American, Delta and United support their regional partners need to be accounted for and participate in data exchange to achieve the benefits of surface departure management.

A discussion ensued about the importance of keeping this simple and avoiding attempts to gather too much data that is not being used. Operator representatives emphasized the use of existing data that would result in benefits in the near-term and lay the foundation for future expansion as more participate and the FAA's ability to use the information expands. It was also noted that expanding airport participation in CDM and their providing data is a critical step.

The Surface Team was asked to include metrics and lessons learned in early data exchange via the Traffic Flow Management System at the next NAC Subcommittee meeting (December 2016) to inform predictability performance analyses.

Performance Based Navigation (PBN)

FAA SMEs: Donna Creasap (ANG), Josh Gustin (ATO)
Industry Leads: Steve Fulton (Sandel Avionics), Brian Townsend (American Airlines)

Mr. Fulton described the work of the PBN Team since the approval of the recommendation by the NAC in June as "spirited but useful" conversations that led the PBN Team to agreement on the new milestones in the NextGen priorities plan. The Team worked to identify specific time frames that were TBD in the June document. The next two years have a heavy emphasis on pre-implementation commitments and implementation of Established on

Required Navigation Performance (EoR). During a discussion about the engagement of the industry in the PBN implementation process, a NAC member noted that the maintenance community has used lead operators in studies and demonstration projects for some time and that the operators might benefit from the lessons learned from this community as they worked on their NextGen commitments. Ms. Creasap committed to follow-up with the FAA's Aviation Safety organization to better understand FAA-Industry collaboration used for development of minimum equipment lists (MELs).

PBN Time, Speed, Spacing Task Group

The Task Group Co-Chairs Dan Allen, FedEx Express, and Steve Fulton, Sandel Avionics, presented the final report based on the following Key Policy Statements:

- A transition to a time-based system is necessary to enable higher percentages of PBN operations with the goal of keeping aircraft on an optimal path.
- VMC in IMC conditions
- Large cultural change for controllers, pilots, dispatchers and others involved in the operation of aircraft
- Decision support tools for air traffic controllers are critical
- Implementation must be integrated

The specific recommendations are that the FAA:

- Create an agency-wide vision for changing to a time-based system and develop and implement a plan to communicate the vision.
- Incorporate the roadmap outlined throughout this document for 2016-2020; 2021-2025; and 2026-2030 for decision support tools and aircraft capabilities.
- Adopt change management principles as part of their implementation process to gain the acceptance and culture change to realize the benefits of time-based enhancements.

Mr. Allen presented the following overview of the three times frames requested to be covered by the FAA:

- Near-Term (2020)
    - Policy, procedures and training to enable initial PBN capabilities and using existing tools and systems for a better integrated system

    - Infusing time-based metering into the culture; deploying traffic flow management decision support tools for controllers
- Mid-Term (2021-2025)
    - Focuses on continued deployment of available NextGen capabilities consistent with meeting the goal of PBN TSS in an integrated manner
    - Begins the process of integrating aircraft trajectory data with ground systems
- Far-Term (2026-2030)
    - Further enhances, increasing resilience of ground-based tools
    - Integrates the stand-alone capabilities described in the mid-term
    - Leverages FIM demonstration for potential full NAS implementation
    - Based on experiences from Near- and Mid-Term, begins implementing advanced DataComm capabilities defined by Special Committee (SC)-214, Standards for Air Traffic Data Communication Services

Following the presentation of the final report, a Committee Member emphasized the criticality of industry commitment to successfully transition to a time-based system. Chairman Anderson expressed the need for a coordinated, integrated plan for Time, Speed, Spacing, and the other components of NextGen – including the NIWG priority areas to answer what NextGen means. Several members stated that there will be challenges to replace the current system with a time-based system, but it is essential for the industry.

This was followed by a discussion of the need for analyzing the safety issues associated with a transition to a time-based system. Others stated that this will be done in phased manner and several operators explained that this will require changes for pilots. Modeling and human in the loop analysis are an important part of this process. It was also noted that this transition should help to optimize the ATC system.

A Committee Member emphasized that in Europe, simulation and flight trials are underway to evaluate impacts. The goal under SESAR is to intensify sharing of trajectory by the aircraft with the ground.

During the discussion, it was noted this plan doesn't have to be completed tomorrow; "walk before you run". Benefits can be realized along the way but the real benefits are farther out.

Chairman Anderson asked for a motion to consider the PBN Time, Speed, Spacing Task Group – Final Report that was subsequently approved by the NAC (Attachment 8). The Committee also requested that the FAA's NextGen office provide a presentation of the larger Integrated

Plan for NextGen as a follow-up to the discussion that will improve the understanding of the more comprehensive implementation plan and provide context for each piece.

Enhanced Surveillance Task Group

The Task Group Co-Chaired by Steve Brown, NBAA and Captain Bart Roberts, JetBlue Airways, was established to evaluate the need and benefit of enhanced surveillance capabilities for oceanic airspace controlled by the FAA.

Mr. Brown reviewed the work to date and discussed the following emerging issues that must be addressed to develop the final report by June 2017:

- Three Unique Geographic Areas
    - North Atlantic
    - WATRS
    - Pacific
- Operator Equipage
- Clearly Defining Benefits
- Costs and Who Pays

Chairman Anderson encouraged Mr. Brown to request any additional resources or other assistance from the NAC necessary for the Task Group to complete its work.

PBN Implementation-Feature location: Denver, CO

Gary McMullin, Southwest Airlines, and Ron Renk, United Airlines, discussed the history of Denver approaches and usage rates that are being derived from the use of Established on Required Navigation Performance approaches. The overall Benefits of RNP reviewed are:

- Operator Benefits:
    - Fuel Reduction in IMC
    - Time Reduction in IMC
    - Schedule Reliability: The schedule is not affected when operations change from VMC to IMC because the same path is flown.
    - Safety

        - Pilot workload relocation (move work to EnRoute).
        - Increased pilot situational awareness.
        - Stabilized instrument approaches vs visual approaches.
- ATC Benefits:
    - Reduction in pilot-controller communications (cleared for approach on downwind)
    - Repeatable, reliable ground tracks in both VMC and IMC
        - No excursions through final approach coarse (FAC)
        - No need to get on 30-degree intercept
    - Safety
        - Controller workload – Monitor vs Active Commands
        - Stabilized instrument approaches vs visual approaches.

According to information presented by Mr. McMullin, participating airlines are saving two minutes and approximately 100 pounds of fuel at Denver through the user of Established on RNP in visual conditions. The additional benefits that can be derived using the procedures in IMC was evaluated by the Joint Analysis Team and was discussed following this briefing.

A Committee Member emphasized the importance of publicizing the availability of RNP approaches using the Automatic Terminal Information Services (ATIS) to enhance greater utilization of these high-value procedures. This is a recommendation made previously by the NAC. Mr. McMullin agreed that the ATIS message has had a big impact on pilots utilizing RNP.

Joint Analysis Team (JAT) – Final Report: Performance Based Navigation Procedures: North Texas Metroplex, Denver Established on RNP

The Co-Chairs, Ilhan Ince, American Airlines, and Dave Knorr, FAA, reviewed the findings of the analysis of PBN in Denver and the Metroplex in North Texas.

<u>Established on RNP (EoR) in Denver</u>

- EoR increased utilization of RNP AR approaches from 5.8% of arrivals to 6.6% of arrivals to Denver, an increase of 12%
    - Time saved from efficient approaches increased from 211 to 282 hours annually

- If an additional waiver is granted, EoR is expected to enable an increase up to 7.1% of arrivals executing RNP AR approaches.
    - Time saved expected to increase to 360 hours annually
- EoR is an important enabler to future growth of utilization of efficient PBN approaches.

North Texas (NT) Metroplex

- Many external factors challenged pre-vs post Metroplex analysis
    - DFW/AAL re-banking, CRO, over-the-top elimination, Wright amendment at DAL, use of flow metering, change in wind patterns, and WN Cost Index change (speed increase)
- Changes in city pair block times driven by winds, not by the implementation of procedures due to Metroplex
- The Team recognized the importance of system impacts of the Metroplex and, after analysis, determined to focus on flight trajectory changes within 300 nm as it best approximates effects of the North Texas Metroplex and allows for better isolating external factors pre/post implementation
- Metroplex has…
    - Segregated arrival routes between DFW and DAL
    - Added route structure where flights previously vectored off-route
        - Enabler for increased TBFM forecasting accuracy, infrastructure for new tools and improved safety per SMEs
    - Slightly increased flight distance within 300nm but slightly reduced time
    - Clearly reduced level segments and increased continuous descents, particularly for DFW

The lessons learned based on the analysis are:

EoR

- EoR, in conjunction with terminal sequencing tools and growing aircraft equipage, should further grow the percent of arrivals executing efficient PBN approaches

Metroplex

- Developed a robust Metroplex methodology that effectively accommodates for variety of pre/post implementation changes and may be used in future
- Additional work required: need to document the Metroplex analysis process and determine a joint approach to measure fuel impacts/changes

- Metroplex efforts should continue to ensure they are cognizant of impacts on flight time and distance

Chairman Anderson asked for a motion to approve the Joint Analysis Team – Final Report: Performance Based Navigation Procedures: North Texas Metroplex, Denver Established on RNP that was subsequently approved by the NAC (Attachment 9). The JAT will complete its fuel analysis.

Based on a request made by Ms. Bristol, the NAC also requested the JAT to perform additional analysis as requested in the original tasking of the following areas:

- Fuel Analysis for North Texas
- PBN
    - EOR DEN IMC
    - Optimized Profile Descents - Boston, MA and Gary, IN
- Wake ReCat 2.0
    - Los Angeles, CA
    - Indianapolis, IN
- DataComm Benefits Review

The time frames and priority will be developed in conjunction with the NACSC.

Summary of the Meeting and Next Steps

The NAC Secretary summarized the following actions from the meeting and follow-up items:

Action Item	Responsible Entity	Completion Date
Enhanced Surveillance – tasking to examine its application in US-controlled oceanic airspace from spaced-based ADS-B.	RTCA	Interim February 2017 Final June 2017
Present a report from an operator of a local PBN implementation to highlight benefits of implementation and what occurred – "what worked, what didn't and what can we do going forward?" Set up a plan going forward to have PBN briefings at subsequent NAC meetings.	FAA/RTCA TBD	February 2017 and future NAC meetings
Equipage • ADS-B avionics supply chain being ready for 2020 mandate – • Manufacturer(s) briefing on NextGen equipage plans – standards, technologies and	RTCA Avionics-Honeywell, Rockwell Collins, Thales, etc. Manufacturers-	February 2017 and future NAC meetings

pathways for the retrofit of existing aircraft	Embraer, Bombardier	
Equip 2020 updates – Standing agenda item for update on operator equipage For February include: • UAS applicability and compliance path • Installation facility capacity	FAA AVS	February 2017 and future NAC meetings
Ad Hoc tasked with developing a unified, crystalized message – demonstrating the value of NextGen capabilities being deployed as a result of the government-industry collaboration on the NAC. • Add Ryan Hartman, Insitu, representing UAS perspective	RTCA	Final February 2017
Presentation of the Integrated Plan for NextGen – follow-up discussion and approval of the Time, Speed, Spacing Task Group recommendation	FAA ANG & NACSC	February 2017
Briefing for the Committee on Airline C/N/S fleet plans—ADS-B, PBN, DataComm Using standard template for equipage.	RTCA Alaska, UPS	February 2017 and future NAC meetings
Joint Analysis Team requested to perform additional analysis as requested in the original tasking	PBN - EOR DEN IMC, OPD – BOS and Gary, IN Wake ReCat 2.0 – LAX/ IND DataComm Benefits Review	February 2017 and future NAC meetings based on program plan
Surface Data Exchange – regionals, other non-CDM members (i.e. airports and other operators) as well as examining benefits from the provision of data by operators	RTCA/ANG-1 Surface NIWG	February 2017

DFO and Chairman Closing Comments

Ms. Wassmer and Chairman Anderson both thanked the members for their participation in the meeting. Ms. Wassmer also thanked Chairman Anderson for his leadership of the Committee.

Other Business

No items were requested or discussed.

Adjourn

By motion, Chairman Anderson concluded the meeting of the Committee at 1:58 p.m.

Next Meeting

The next meeting of the NAC is February 22, 2017 location TBD.

Attendees:
October 5, 2016 Meeting of the NextGen Advisory Committee
Orlando, FL

Name	Company
Anderson, Richard	***Delta Air Lines, Inc.***
Wassmer, Victoria	***Federal Aviation Administration***
Allen, Dan	FedEx Express
Allen, Jack	Federal Aviation Administration
Allen, Mark	Federal Aviation Administration
Angeles, Eduardo	*Federal Aviation Administration*
Baker, Mark	*Aircraft Owners and Pilots Association*
Ball, Mike	Northrup Grumman
Batchelor, David	SESAR Joint Undertaking
Benich, Christopher	Honeywell International, Inc.
Bertapelle, Joe	JetBlue Airways
Black, Faye	Regional Airline Association
Bolen, Ed	National Business Aviation Association
Bouchard, Adam	Tampa International Airport
Bowman, Jim	*FedEx Express*
Bradley, Mark	Delta Air Lines
Brenner, Frank	EUROCONTROL
Bristol, Teri	*Federal Aviation Administration*
Bronczek, David	FedEx Express
Brown, Lee	Landrum & Brown
Brown, Steve	National Business Aviation Association
Bunce, Peter	*General Aviation Manufacturers Association*
Campbell, Timothy	American Airlines, Inc.
Canoll, Tim	*Air Line Pilots Association*
Cass, Lorne	American Airlines
Cebula, Andy	RTCA, Inc.
Challan, Peter	Harris
Childs, Chip	*Regional Airline Association*
Cranor, Bill	United Airlines
Creasap, Donna	Federal Aviation Administration
D'Alessandro, Carl	*Harris Corporation*
Dalton, Rick	Southwest Airlines
DeCleene, Bruce	Federal Aviation Administration
Denning, Jana	Leidos
Diaz, Mario	*City of Houston, Texas*
Dickson, Steve	Delta Air Lines, Inc.

Donovan, Colleen	Federal Aviation Administration
Drew, Craig	Southwest Airlines
Dumont, Pete	*Air Traffic Control Association (ATCA)*
Eck, Jim	*Federal Aviation Administration*
Engola, Paul	Leidos
Esposito, Carl	*Honeywell International, Inc.*
Evans, Ginger	*City of Chicago*
Flaishans, Terry	ACSS LLC
Fulton, Steve	Sandel Avionics
Gallo, Tracy	SkyWest, Inc.
Goldman, Robert	Delta Air Lines
Gomez, Pamela	Federal Aviation Administration
Gross, Marc	American Airlines
Guillermet, Florian	*SESAR Joint Undertaking*
Hamy, Marc	Airbus
Hanlon, Dan	Raytheon
Harris, John	*Raytheon*
Hartman, Ryan	*Insitu Inc.*
Heise, Angie	*Leidos*
Henig, Jens	General Aviation Manufacturers Association (GAMA)
Hickey, John	*Federal Aviation Administration*
Hill, Fran	Leidos
Huerta, Michael	Federal Aviation Administration
Ince, Ilhan	American Airlines
Jarrette, Judith-Ann	Greater Orlando Aviation Authority
Jenny, Margaret	*RTCA, Inc.*
Johnson, Sasha	United Airlines, Inc.
Joly, Pascal	Airbus
Kast, Christian	UPS
Kefaliotis, John	Metron Aviation
Kenagy, Randy	Air Line Pilots Association (ALPA)
Land, Robert	JetBlue Airways
Lee, Tracy	United Airlines
Martin, Jeff	*JetBlue Airways*
McArtor, Allan	*Airbus*
McDuffee, Paul	Insitu
McMullin, Gary	Southwest Airlines
Melcher, David	*Aerospace Industries Association*
Mercer, Roosevelt	Federal Aviation Administration
Merkle, Michele	Federal Aviation Administration
Merritt, Jon	United Airlines, Inc.

Meserole, Chip	The Boeing Company
Morse, Glenn	United Air Lines, Inc.
Muhs, Bob	The Boeing Company
Nolen, Billy	Airlines for America
O'Keefe, Rush	FedEx Express
O'Sullivan, John	Harris
Pennington, Darrell	Air Line Pilots Association
Perrone, Mike	*Professional Aviation Safety Specialists*
Pfingstler, Susan	Federal Aviation Administration
Pierce, Brad	*NOISE*
Planzer, Neil	The Boeing Company
Quigley, Bryan	United Air Lines
Ray, Lynn	Federal Aviation Administration
Renk, Ron	United Airlines
Rinaldi, Paul	*National Air Traffic Controllers Association*
Robinson, Cortney	Aerospace Industries Association
Rocheleau, Chris	Federal Aviation Administration
Rodgers, Mark	CSSI
Rosenbloom, Scott	DoD NextGen Lead Service Office
Rozansky, Christopher	City of Naples Airport Authority
Rudinger, Melissa	Aircraft Owners and Pilots Association (AOPA)
Ryals, Lillian	*The MITRE Corporation*
Shellabarger, Nan	Federal Aviation Administration
Shin, Jaiwon	*NASA*
Smiley, Dan	Federal Aviation Administration
Speir, Ken	Delta Air Lines, Inc.
Stewart, Chuck	United Air Lines
Stone, Rocky	United Air Lines, Inc.
Swayze, Rich	Delta Air Lines
Teel, Brandi	RTCA, Inc.
Townsend, Brian	American Airlines, Inc.
Tree, Jon	Jeppesen
Ulmann, Jim	NATCA
Van De Walker, Wayne	Department of Transportation OIG
Warren, Christie	JetBlue Airways
Wijntjes, Jesse	Federal Aviation Administration
Woods, Jeff	NATCA

RTCA

THE GOLD STANDARD FOR AVIATION SINCE 1935

Welcome to the Meeting of the NextGen Advisory Committee

October 5, 2016
JetBlue University
Orlando, FL

RTCA

THE GOLD STANDARD FOR AVIATION SINCE 1935

Welcome & Introductions

PUBLIC MEETING ANNOUNCEMENT
Read by: Designated Federal Official Michael Whitaker
NextGen Advisory Committee
October 5, 2016

In accordance with the Federal Advisory Committee Act, this Advisory Committee meeting is OPEN TO THE PUBLIC.

Notice of the meeting was published in the Federal Register on:

September 15, 2016

Members of the public may address the committee with PRIOR APPROVAL of the Chairman. This should be arranged in advance.

Only appointed members of the Advisory Committee may vote on any matter brought to a vote by the Chairman.

The public may present written material to the Advisory Committee at any time.

RTCA

THE GOLD STANDARD FOR AVIATION SINCE 1935

Review and Approval of:

*June 17, 2016 - Meeting Summary
*Oct Terms of Reference
*Nov Terms of Reference

NAC Agenda Topics

- Value of NextGen and NAC AdHoc Task Group
- Airline C/N/S Fleet Plans and ADS-B Update
- NIWG Status Reports & Rolling Plan
- PBN Time, Speed, Spacing Task Group – Final Report
- PBN Implementation – Denver Established on RNP
- Joint Analysis Team – Final Report: Performance Based Navigation Procedures: North Texas Metroplex, Denver Established on RNP
- Enhanced Surveillance Task Group – Interim Report

RTCA

THE GOLD STANDARD FOR AVIATION SINCE 1935

Chairman's Report
Richard Anderson, NAC Chair

Community Engagement for PBN and Metroplex

FAA | NextGEN

PBN Blueprint Outreach Recommendations

- The FAA concurs with the recommendations of the NAC PBN Blueprint for Community Outreach.
- Based on these recommendation the FAA has begun a new process to educate and communicate the changes to the airspace.
- Based on the recommendation that we have a holistic nationwide strategic focus, we have named Julie Marks as the ATO Community Involvement Manager.

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FAA | NextGEN

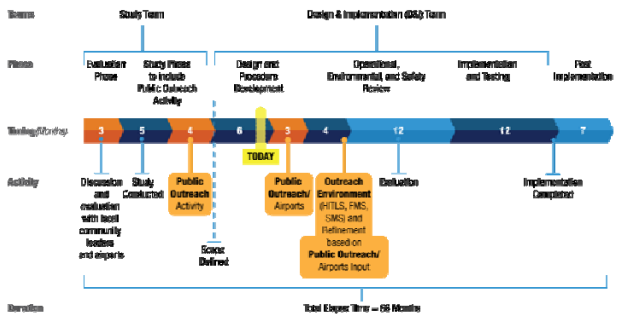
New Way to Communicate

- Expanding our process to introduce multiple layers of engagement
- Making the collaborative process of Airspace redesign more transparent to:
  - Airports
  - Local, state and federal governments
  - Community organizations
  - General public

FAA | NextGEN

Integrating Communication into the Process

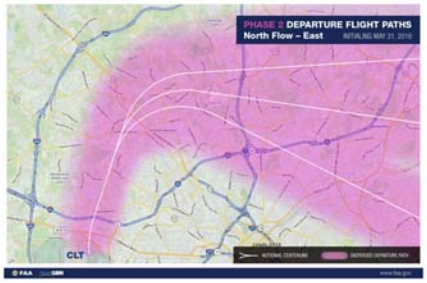
PBN and Metroplex Timeline



Workshop Format

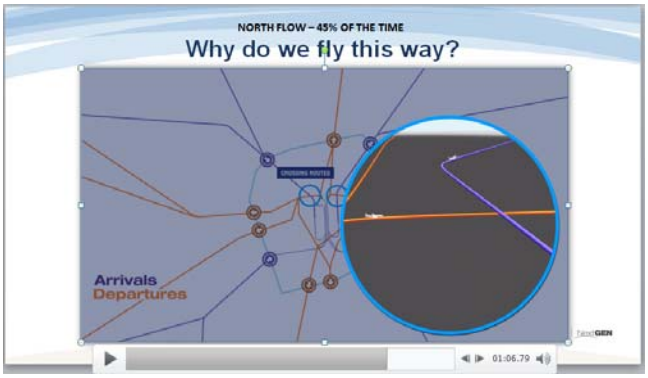
- One on One opportunity to educate and communicate about changes to the airspace
- Communicate how the environmental process works
- Give the community an opportunity to provide feedback

Use Visuals to Translate Technology



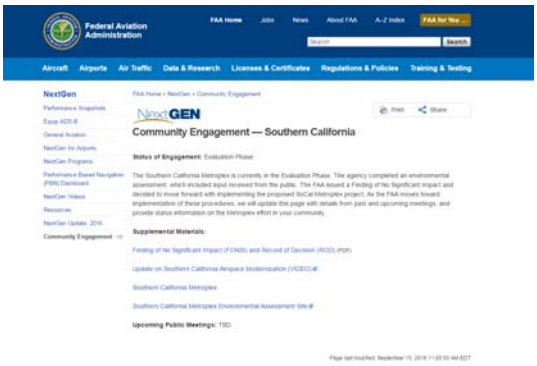
FAA | NextGEN

Explanation of Why We Fly This Way



FAA | NextGEN

Community Engagement Website



FAA | NextGEN

RTCA

THE GOLD STANDARD FOR AVIATION SINCE 1935

The Value of NextGen and NAC Ad Hoc

AdHoc Chair:

Ed Bolen, NBAA

The Tasking

- Develop High-Level Messaging that Conveys Value of NextGen Capabilities being Deployed
  - *Determine Why Current Message is Not Resonating*

Working Definition of NextGen

"Aviation community working together to modernize technologies, policies and procedures in the national airspace system in order to increase capacity, reduce delays and cancellations, reduce our environmental footprint, and enhance safety, for all segments of aviation with bad weather performance as good as good weather performance"

What Is Changing with NextGen?

- Increased Capacity or Throughput
  - Without new concrete
- Increased Reliability, Predictability
  - **Marginal weather = good weather**
- Increased Efficiency
- Reduced Delays
- Reduced Cancellations
- Reduced Environmental and Noise impact
- Enhanced Safety

High Level, Simple, Compelling Message

DISCUSSION

RTCA

THE GOLD STANDARD FOR AVIATION SINCE 1935

Airline C/N/S Fleet Plans and ADS-B Update

American Airlines

American Airlines' CNS Equipage Plan
NextGen Advisory Committee Briefing

10/05/2016 - MCO

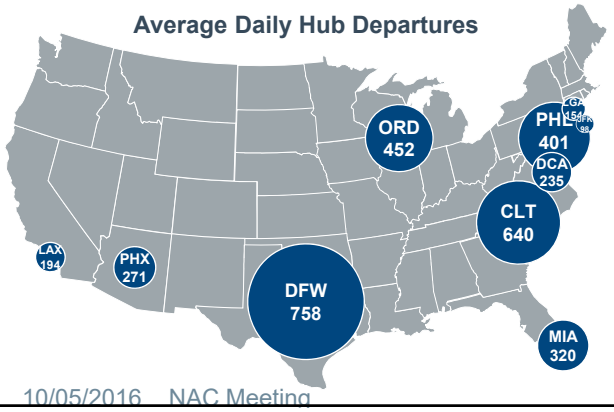
Guiding Principles for NextGen Equipage for AA

1. Ensure our fleet is ready to capture the safety and efficiency benefits of NG capabilities that are cost justified
2. Continue to demonstrate willingness to partner with FAA and suppliers on proof-of-concept proposals
   - A330 ADS-B IN demo with with CAVS FAA and ITP
   - 737 FANS program with Harris Corp
3. Advocate for leveraging existing avionics and infrastructure to its fullest before considering fleet changes
4. Encourage FAA to expand, wherever possible, use of performance based standards to meet requirements vs. hardware-specific mandates, e.g. Equip 2020 (2025)
5. Ensure impacts to regional partners are fully included in all equipage impact analyses
6. Promote new and creative uses of EFB's or related portable, certified devices to minimize the cost and time associated with fleet modifications

American Airlines Background

- AA's post-merger network is both extensive and complex:
  - Serves ~525,000 passenger enplanements per day with 6,700 flights to more than 330 destinations in 54 countries
  - Extensive operations in Central / South America and Europe with a growing network in Asia
  - With ten hub / domestic gateway airports, seasonal weather patterns could have an impact on 3-4 hubs/gateways at the same time

Average Daily Hub Departures



Proportion of Daily Departures		
Hub	Mainline	Regional
DCA	33%	**67%**
PHL	35%	**65%**
ORD	40%	**60%**
CLT	46%	**54%**
LGA	48%	**52%**
DFW	59%	41%
PHX	61%	39%
LAX	64%	36%
JFK	75%	25%
MIA	79%	21%
Hubs	**52%**	**48%**

Majority are regional

YTD thru 9/29

Our current fleet is diverse and modernizing

Mainline

Twin-aisle	B777	67
	A330	24
	A350	-
	B787	21
	B767	31
	Sub-Total	143
Single-aisle	B757	51
	A320F	375
	B737	284
	MD80	53
	E190	20
	Sub-Total	783
	Total	**926**

Mainline

DASH 8	32
E-140	13
E-145	118
CR200	111
CR700	79
CR900	118
E-175	124
Total	**595**

Prop	32
50 seats	242
70 seats	79
76 seats	242

NAC Briefing 2016-10.05 FINAL

~ 300 new deliveries planned for 2017 and beyond

- We began welcoming nearly 500 new aircraft into the fleet starting in 2013, including 127 in 2015. Almost two new aircraft were delivered per week in 2016
- In 2017, we'll begin taking delivery of the Boeing 737 MAX, and in 2018 we will get our first Airbus A350 XWB. We begin taking delivery of Airbus A320neo Family aircraft in 2019.
- New aircraft, in combination with recent and planned retirements results in the youngest fleet age in the industry (9.8 yrs by YE '17)

	2016	2017	2018	2019	2020	2021 and beyond	Total
Airbus							
A320 Family	25	20	–	–	–	–	45
A320neo	–	–	–	25	25	50	100
A350 XWB	–	–	2	5	5	10	22
Boeing							
737-800	20	20	–	–		–	40
737 MAX	–	3	17	20	20	40	100
777-300 ER	2	–	–	–	–	–	2
787 Family	8	13	8	–	–	–	29
Bombardier							
CRJ900[1]	18		–	–	–	–	18
Embraer							
E175[1]	24	12	–	–	–	–	36
Total	97	68	27	50	50	100	392

NAC Briefing 2016-10.05 FINAL

Key Messages — Mainline Fleet

- AA's mainline fleet (currently ~925 aircraft) is well-positioned to take advantage of operational efficiency enhancements made possible by successful implementation of NextGen.
  - All mainline aircraft are already equipped[1], and all twin-aisle aircraft are also authorized. Currently ~70% of single-aisle aircraft are authorized
    - Single-aisle RNP AR capability would increase to 100% if Airbus reduces pricing for the necessary authorizing paperwork for the legacy A32F[2] fleet
  - The industry's largest fleet renewal and a strategy that relies more on "performance based" standards mitigates the capital outlay for NG-specific equipage
    - The MD-80 and E-190 fleets will be retired before 2020 and over 260 new deliveries 737/ 737 MAX / A32F / A32F neo aircraft will continue
- A very large portion of AA's fleet is already NG capable, thus we support the position of other operators that FAA should expand efforts to expedite program implementation and rationalization.
  - This will accelerate efficiency benefits to the majority of Part 121 operators who are similarly equipped.
  - This will likely require different business practices for FAA (ATO, Flight Standards, and NG)
  - Rationalization entails continuous review of individual program to ensure their scope and spend is appropriate in a dynamic, multi-year life cycle

[1] Equipage stats are focused on RNP, CPDLC, and ADS-B and exclude M80 and E190 fleets that will be retired by 2020
[2] A320F = A320 Family (A319 / A320 / A321)

Key Messages — Regional Fleet

- AA's regional fleet (currently ~595 aircraft), like other operators of RJ's, will be less capable.
  - The issue is most acute for 50 seat RJ's than larger/newer RJs. This reflects the lack of an approved product offering or one that is prohibitively expensive
  - RJ compliance would significantly improve if Embraer offered any certified option for the EMB 140/145. These aircraft represent ~20% of the American Eagle portfolio
- American Eagle's current structure of operating partners highlights the complexity of managing a consistent equipage strategy across all partners
  - Roughly half of regional aircraft are currently operated by wholly-owned subsidiaries and ~40% of AE's fleet are flown by contract partners operating their own aircraft. The remaining 10% of aircraft are owned by AA, but operated by a partner.
  - RAA could be a valuable source of aggregate regional industry stats

Capability Detail

PBN / RNP

- AAL invested over $300 million to retrofit Boeing fleets for RNP AR
  - *MD-80 – GPS and glass displays retrofit*
  - *757/767 – Pegasus FMS retrofit to support FAA stated intent of having RNP 2 above FL280 in US NAS in 1Q2012.*
    Note – program ultimately cancelled
- Roughly 240 legacy US A320F aircraft are equipped RNP AR, but lack ops approval. Airbus' current pricing for the authorizing paperwork is not cost effective.
  - This represents ~30% of the single aisle fleet
- All new deliveries have RNP AR capability
  - *The on-going fleet renewal, including previously announced retirement of a portion of the A330 fleet, will further enhance fleet capability*

Navigation	2016	2020	>2025
777	0.11 AR	0.11 AR	0.11 AR
A350	N/A	0.1 AR	0.1 AR
A330	0.3 non-AR	0.3 non-AR	0.3 non-AR
787	0.1 AR	0.1 AR	0.1 AR
757/767	0.15 AR	0.15 AR	0.15 AR
A320F(1)	0.1 AR	0.1 AR	0.1 AR
737	0.1 AR	0.1 AR	0.1 AR
MD-80	0.3 non-AR	*Retired*	*Retired*
E190	0.15 AR	*Retired*	*Retired*

(1) Approximately 130 of 365 A320F are RNP AR

Capability Detail

Data Comm

- All twin-aisle aircraft (and 757's) use SATCOM and CPDLC in support of international operations
- 220 737 aircraft are being equipped with CPDLC under FAA data comm program. New deliveries also equipped with CPDLC.
- VDLM2 equipage on new aircraft deliveries
  - VDLM2 retrofits are non-economical

Data Comm	2016	2020	>2025
777(1)	SATCOM / VDLM0/2 CPDLC	→	→
A330	SATCOM / VDLM0 CPDLC	→	→
A350		SATCOM / VDLM2 CPDLC	→
787	SATCOM / VDLM2 CPDLC	→	→
757/767(2)	SATCOM / VDLM0/2 CPDLC	→	→
A320F	VDLM0/2		
737(3)	VDLM0/2 / CPDLC	→	→
MD-80	VDLM0	Retired	Retired
E190	VDLM0	Retired	Retired

(1) VDLM2 on 777-300
(2) SATCOM on TATL aircraft. Non-SATCOM a/c in the process of retirement
(3) (4) VDLM0 on 1st 76 aircraft and VDLM2 subsequent; CPDLC on 220+ aircraft

Capability Detail

Surveillance / ADS-B

- ADS-B OUT plan:
  - DO-260B transponders and associated wiring
  - SA Aware MMRs
  - Will need SAPT for operations post-2025
  - "Wait-and-see on" SA Aware performance and potential benefits of multi-constellation / multi-frequency MMR (2022-2023 timeframe)
- ADS-B IN plan:
  - A330 fleet is equipped and participating in trials with CAVS FAA and ITP on the NATS tracks
  - Future equipage plans will depend on further information about requirements and program capabilities

Surveillance	2016	2020	>2025
777	✗	✓	✓*
A330	✓	✓	✓*
A350	✗	✓	✓*
787	✓	✓	✓*
757/767	✗	✓	✓*
A320F	✗	✓	✓*
737	✗	✓	✓*
MD-80	✗	Retired	Retired
E190	✗	Retired	Retired

(*) Evaluate need for SBAS relative to SA Aware based on performance history

In summary…..

- American Airlines is well-positioned to capture the safety and efficiency benefits of NextGen program enhancements, now and in the future
- We look forward to continued close collaboration with the FAA and all other stakeholders to ensure the program is focused on delivering the maximum benefit, at the lowest cost possible, in the shortest amount of time

Supporting NextGen

Communications, Navigation and Surveillance Programs Strategy

October 5, 2016

UNITED

United Airlines NextGen Vision

Our focus is to modernize our fleet using technologies which will safely and efficiently improve schedule integrity and reliability

- Equipage should benefit our customers with a goal of delivering ceiling and visibility performance approaching that of clear weather days
- CNS projects and programs must deliver financial value and effectively utilize United's capital resources while complying with mandates
- United actively leverages manufacturers, suppliers, and industry partners to accelerate the demonstration of technology and reduce time to market and adoption

Goal: Turn bad days into good days

UNITED

United Airlines at a glance

B767	51
B777	75
B747	20
B787	30
Wide-body	176

B737	325
A319/A320	158
B757	77
Narrow-body	560

37-Seat	21
50-Seat	241
70-Seat	117
76-Seat	114
Regional	493

- 1,200+ Aircraft in Operating Fleet
- 50+ Countries Served
- 330+ Destinations Served
- 4,500+ Daily Departures
- 140 Million Passengers

Source:
Company's YE2016 fleet plan, as of July 19, 2016, as reported on ir.united.com

UNITED

Data Communications

Communications | Navigation | Surveillance

- In 2014 UA partnered with Harris, FAA, on the DataComm Implementation Services initiative
  - FANS 1/A+ and VDLM2
- In 2015 UA launched CPDLC DCL at EWR
  - We continue to see taxi out minutes saved on each accepted re-route
- Our strategy and efforts are designed to take advantage of the ongoing DataComm Roadmap
- Chief Technical Pilot, Captain Chuck Stewart is currently the DataComm NIWIG co-chair

Fleet	FANS 1/A+ VDLM0	FANS 1/A+ VDLM2	FANS 1/A+ Over SATCOM
B787	-	70% all by '19	100%
B747	100%	-	100%
B777			
-200AB/300	-	55% all by '19	100%
-200Y	100%	-	100%
B767	-	75% all by '19	100%
B757			
-200A/B	-	0% all by '19	100%
-200K	-	-	-
-300	-	66% all by '19	Evaluating
B737			
-7/8/9/Max	-	28% all by '19	Evaluating
-7/8/9	7%, GUM fleet	-	-
A350	-	Planned	Planned

UNITED

SATCOM

Communications | Navigation | Surveillance

- **Preparing to leverage the safety and efficiency benefits of flight planning, weather, and charting applications across our operation**
- **Support our crews and operation through dual SATCOM configurations for polar operations**
- **Want to use technology to complement any deficient HF/VHF performance**

Fleet	Inmarsat	Iridium
B787	Aero H+	*awaiting Boeing SB
B747	Aero H+	SatLink Classic (voice only)
B777 *-200* *-300*	Aero H+ Aero H+	SatLink Max RC ICS
B767 *-300* *-400*	Aero H+ Aero I	SatLink Max (1 a/c) -
B757 *-200* *-300*	- Aero H+	SatLink Classic -
B737 *(Guam)*	-	SatLink Classic (4 a/c) SatLink Max (7 a/c)
A350	Aero H+	-

UNITED

Performance Based Navigation

Communications | Navigation | Surveillance

- **United is active in the PBN arena, taking the lead both with Metroplex and 7100.41 projects**

United As Lead Carrier	Phase
IAH	Complete
DC	Complete
SoCAL	Implementation
NorCAL	Complete
CLE/DTW	Evaluation
DEN	Evaluation

- **Recently demonstrated the benefits of the Ground based Augmentation System (GBAS) at SFO**
  - **Precision approach capability allows for tighter aircraft spacing, more approach options and the ability to maintain efficiency during unfavorable weather**
- **Chief Technical Pilot – Navigation, Ron Renk, is a member of:**
  - **FAA Performance Aviation Rulemaking Committee (PARC)**
  - **RTCA NextGen Integration Working Group (NIWG)**

UNITED

PBN Navigation Equipage

Communications | Navigation | Surveillance

Fleet	RNP		RF	GLS	
	Current	2025		Current	2025
B787-*8/9*	RNP (10,4,2,1) / RNP **AR** (.10)	No Change	YES	100%	100%
B747	RNP (10,4,1)	No Change	NO	NO	Retired
B777	RNP (10,4,2,1) / RNP **AR** (.11)	No Change	YES	Some provisioned	100%
B767	RNP (10,4,2,1) / RNP **AR** (.15)	No Change	YES	NO	100%
B757	RNP (10,4,2,1) / RNP **AR** (.15)	No Change	YES	NO	100%
B737	RNP (10,4,2,1) / RNP **AR** (.11)	No Change	YES	41%	100%
A319/320	RNP (10,4,1)	RNP (10,4,2,1) / RNP **AR** (.15)	YES (Authorized by 2025)	NO	80%
A350		RNP (10,4,2,1) / RNP **AR** (.10)	*YES*	-	100%

Notes:
- A350 planned for future deliveries. All data shown as future state
- All aircraft are equipped with GPS and RNAV 1 / RNAV APPR

UNITED

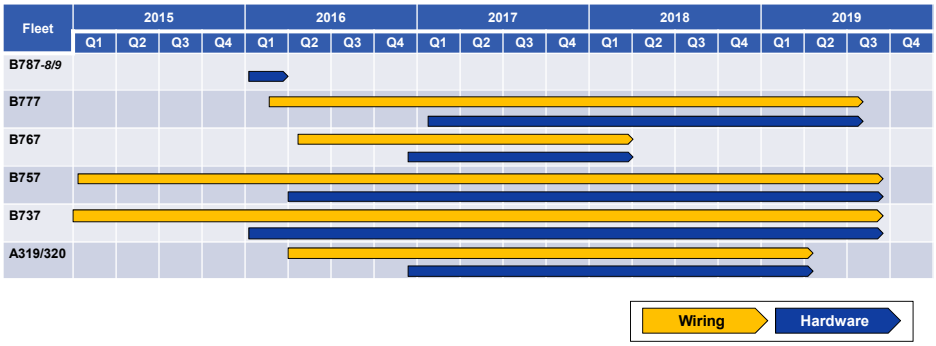
Surveillance

Communications | Navigation | Surveillance

- **2014 United was awarded FAA/Boeing/Rockwell Collins ADS-B Out 737 Operational Benefits Validation (OBV)**
  - **Demonstrating the benefits of ADS-B Out with new routes over the Gulf of Mexico and improved access to routes off the east coast between New York and Florida**
- **ADS-B In: Partnering with NASA, Boeing, Honeywell, FAA on Air Traffic Management Technology Demonstration-1 initiative (ATD-1)**
  - **Exploring the benefits case for ADS-B In applications**
  - **Flight deck Interval Management (FIM)**
    - **Maintaining visual meteorological conditions (VMC) arrival rates during instrument meteorological conditions (IMC)**
    - **Use FIM to maximize arrival throughput**
- **Chief Technical Pilot; Captain Rocky Stone; Chair, RTCA Special Committee 186 (DO-260B)**

UNITED

ADS-B Out Phased Implementation



Notes:
- 747's are planned for retirement
- A350 will be delivered equipped as required

UNITED

PARTNER OF CHOICE | EMPLOYER OF CHOICE | INVESTMENT OF CHOICE

SkyWest, Inc. Equipage Strategy
NextGen Advisory Committee

Chip Childs
President & CEO

SKYWEST INCORPORATED

SkyWest Philosophy on NextGen

- SkyWest is fully engaged and committed to NextGen, and has developed a comprehensive solution and timeline to have our current fleet equipped with ADS-B-Out no later than Q3 2019.
- SkyWest is among the first regionals to develop and plan implementation of LPV and RNP-AR.
- SkyWest remains an active participant and supports both industry and the FAA's Equip 2020 working groups in pursuit of this critical NextGen initiative.
- Beyond ADS-B-Out, additional NextGen components may be driven by RJ manufacturer capability for specific fleet types, economics, major partners and fluid flying contracts.

SkyWest, Inc. Operating Fleet	# in Fleet	Est. Equip (ADS-B)
E175	63	Equipped
CRJ900	64	5/2019
CRJ700	131	7/2019
CRJ200	224	9/2019
ERJ145/135	168	9/2019
Total	**650**	

Equipage Summary

SkyWest is making major investments in NextGen and is on track to be equipped before FAA mandate.

- Communication: E175 fleet is DataComm ready; we are currently mapping plans for CRJ and ERJ145 fleets.
- Navigation: SkyWest is engaged and preparing for implementation of Localizer Performance with Vertical Guidance (LPV) and Required Navigation Performance – Authorization Required (RNP-AR) capabilities.
- Surveillance: SkyWest is one of the first airlines participating in the ADS-B program with our E175 fleet. These aircraft come completely configured and compliant upon receipt. Remaining fleet will be equipped prior to 2020.

Communications – FANS/CPDLC/DCL (DataComm)

DataComm Overview

- E175 is DataComm ready; requires simple software upgrade via Service Bulletin (SB).
- CRJ200, 700, 900 and ERJ145 capability requires investment and upgrade; fleet and partner collaboration will drive implementation possibilities.

Type	Summary	Est. Completion
E175	E175 is Datacomm ready; requires simple software upgrade via Service Bulletin (SB).	2018
CRJ900	Requires multiple component upgrades or replacements in addition to wiring modification via STC or SB; significant investment.	2025
CRJ700	Requires multiple component upgrades or replacements in addition to wiring modification via STC or SB; significant investment.	2025
CRJ200	Requires multiple component upgrades or replacements in addition to wiring modification via STC or SB; significant investment.	2025
ERJ145	Requires multiple component upgrades or replacements in addition to wiring modification via STC or SB; significant investment.	2025

Navigation – LPV & RNP (AR)

- SkyWest is engaged in and preparing for implementation of Localizer Performance with Vertical Guidance (LPV) and Required Navigation Performance – Authorization Required (RNP-AR) capabilities.

Type	Summary	Est. Completion
E175	• No upgrades required/aircraft ready • SB not required for RNP • Simple software upgrade via Service Bulletin (SB) for LPV	2018
CRJ900	• Requires multiple component upgrades or replacements in addition to wiring modification via STC or SB	2025
CRJ700	• Requires multiple component upgrades or replacements in addition to wiring modification via STC or SB • Certain aircraft not eligible for upgrade	2025
CRJ200	• Requires multiple component upgrades or replacements in addition to wiring modification via STC or SB • Certain aircraft not eligible for upgrade	2025
ERJ145	• Requires minimal component upgrades in addition to minor wiring modification via STC or SB. • STC is available for WAAS/LPV	2025

Surveillance – ADS-B

- SkyWest is participating in the ADS-B program with our E175 fleet. These aircraft come completely configured and compliant upon receipt.
- SkyWest, in joint efforts with FAA, Bombardier and Rockwell Collins, has successfully installed LPV/WAAS on four CRJ900 Aircraft with only minor component and wire modifications.
- Currently reviewing ERJ145 fleet to finalize solution and future installation of LPV/WAAS.
- CRJ fleets will soon begin the necessary systems installations.
  - Plan ready since Jan. 2016

Type	Summary	Est. Completion
E175	No modification required. Aircraft received compliant from factory.	2016
CRJ900	• Requires multiple component upgrades or replacements in addition to wiring modification via STC • Labor intensive with an estimated 50 man-hours per aircraft • Some ADS-B requirements also support communication and/or navigation upgrades	Q2 2019
CRJ700	• Requires multiple component upgrades or replacements in addition to wiring modification via STC • Labor intensive with an estimated 50 man-hours per aircraft • Some ADS-B requirements also support communication and/or navigation upgrades	Q2 2019
CRJ200	• Requires multiple component upgrades or replacements in addition to wiring modification via STC • Labor intensive with an estimated 50 man-hours per aircraft • Some ADS-B requirements also support communication and/or navigation upgrades	Q3 2019
ERJ145	• Requires multiple component upgrades or replacements in addition to wiring modification via STC and Component Service Bulletins. • Labor intensive with an estimated 40 man-hours per aircraft • Some ADS-B requirements also support communication and/or navigation upgrades	Q3 2019

Regional Industry Overview

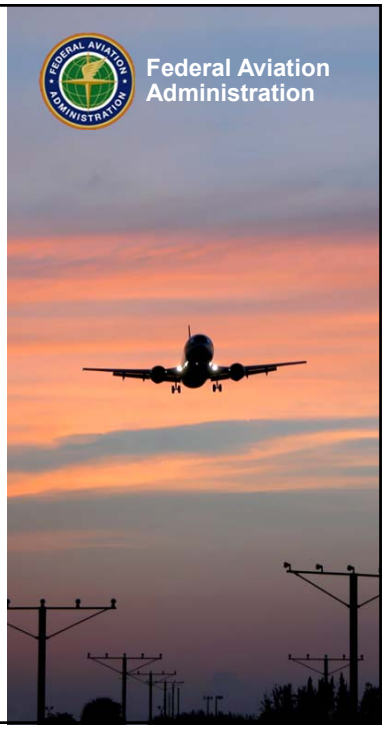
- 75% of RAA member airlines have submitted equipage plans to MITRE accounting for 89% of the total regional fleet
  - Together, SkyWest, Inc. carriers (SkyWest and ExpressJet), represent 30% of the regional industry fleet
- Evolving industry fleet
- Fixed revenue structure requires additional planning for economic feasibility
- Equipage requires partner collaboration

PARTNER OF CHOICE | EMPLOYER OF CHOICE | INVESTMENT OF CHOICE

SKYWEST INCORPORATED

Equip 2020
FAA Update

Federal Aviation Administration



Date: Bruce DeCleene, AFS-400
October 5, 2016

Summary

- **No New Air Carrier Plans (88%)**
- **Equip 2020 Update**
  - GPS Receiver Selection
  - Privacy Concept of Operations
  - Incorrect Flight Identification
- **GA Rebate Status**

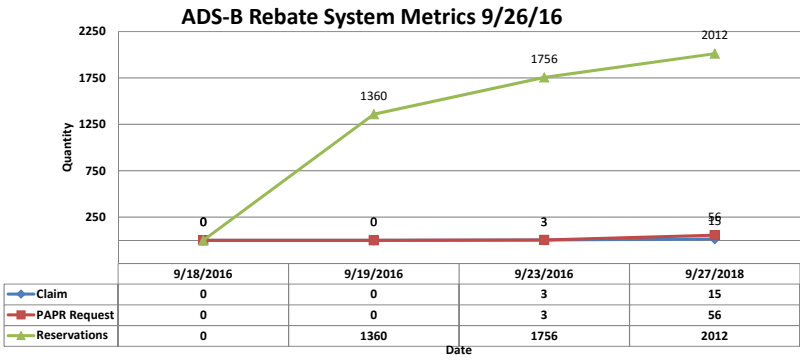
General Aviation Rebate

ADS-B REBATE

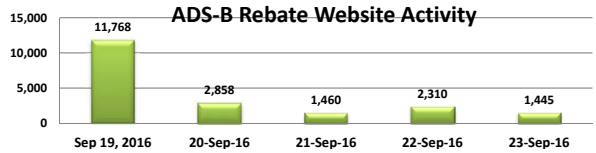
The FAA launched the ADS-B Rebate Program on Monday, September 19th delivering on its commitment to incentivize general aviation aircraft owners to equip with the required avionics that comply with the ADS-B Out rule that will take effect Jan. 1, 2020.

- The agency will offer $500 rebates to eligible aircraft owners for one year or until a total of 20,000 rebates have been claimed.
- **Eligible aircraft:** Defined as U.S.-registered, fixed-wing, single-engine piston aircraft whose operation requires an onboard pilot, first registered before Jan 1, 2016.
- **Eligible equipment:** Avionics that are certified to FAA Technical Standard Orders and meet the program rules (software upgrades of existing equipment are not eligible). Rebates are not available for aircraft already equipped with rule compliant ADS-B or for aircraft the FAA has previously paid or committed to pay for upgrade(s) to meet the ADS-B mandate.

General Aviation Rebate Metrics

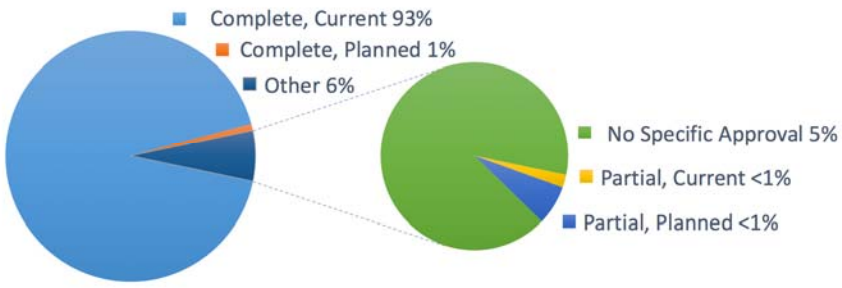


	9/18/2016	9/19/2016	9/23/2016	9/27/2018
Claim	0	0	3	15
PAPR Request	0	0	3	56
Reservations	0	1360	1756	2012



Back-up

Availability of ADS-B Out Solutions Mapped to IFR Flight Plan Derived Fleet

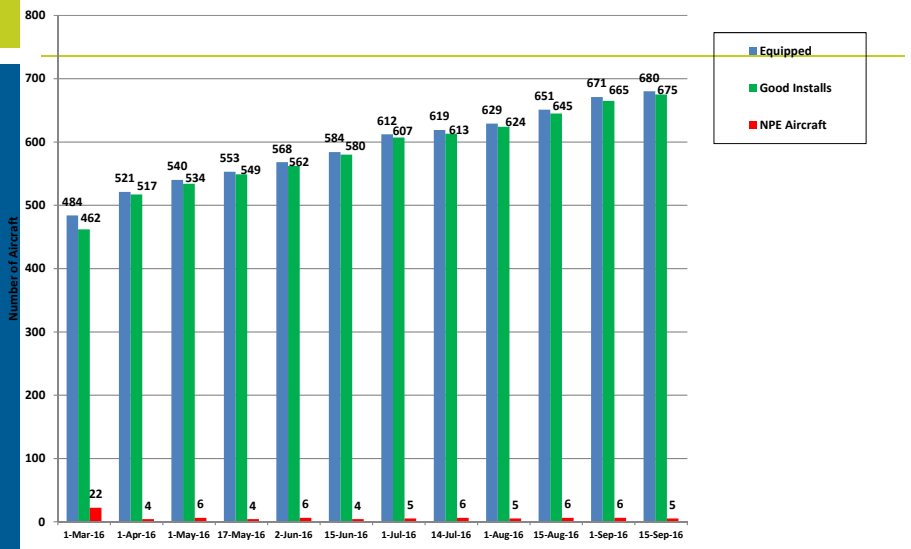


- **Suppliers that provided data for second round data collection:**
  - ACSS, Aspen Avionics, CMC, CMD, Embraer, FreeFlight Systems, Garmin, Gulfstream, Honeywell, Prostar L-3/Lynx, Rockwell Collins, Textron Aviation, United, Universal Avionics, UPS
- **Current solution database contains 5,549 solutions mapping to 2,031 unique make model combinations**

Data current as of 09/16/2016

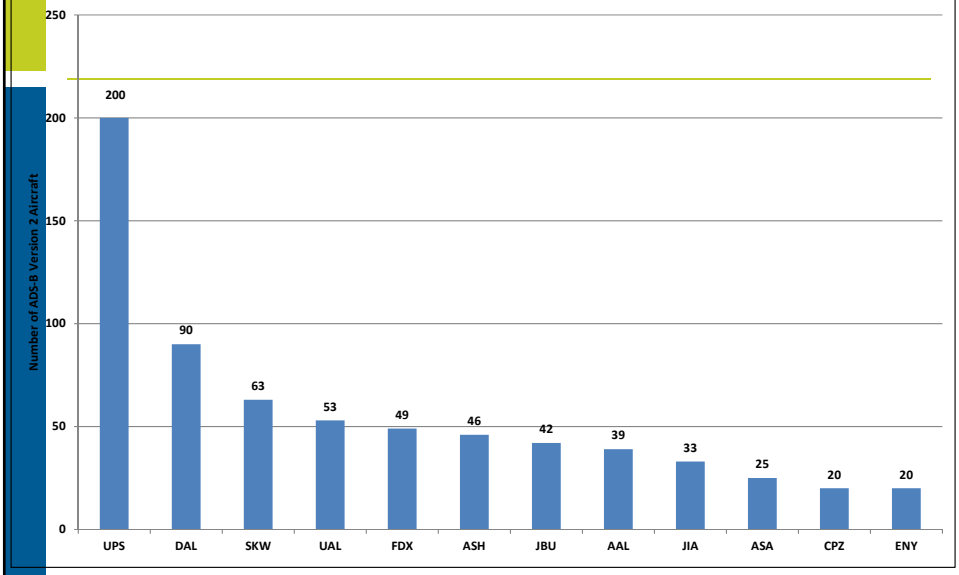
MITRE

US Air Carrier Equipage & Avionics Performance



MITRE

Equipage by US Air Carrier

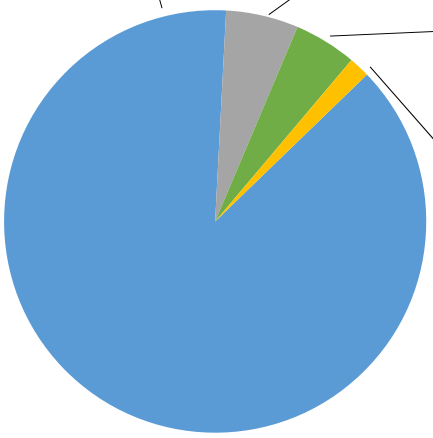


MITRE

US 14 CFR Part 121 Operator ADS-B Out Equipage Plans Mapped to FAA Forecasted 2020 Fleet

Operator Plans Received (24 Airlines) 88%

- Air Wisconsin
- Alaska
- American
- CommutAir
- Compass
- Delta
- Empire
- Endeavor
- Envoy
- ExpressJet
- FedEx
- GoJet
- Great Lakes
- Horizon
- JetBlue
- Piedmont
- PSA
- Republic
- Shuttle America
- Skywest
- Southwest
- Trans States
- United
- UPS



Remaining Operators (49 Airlines) 6%

5 Largest Operators Without Submitted Plan 4%

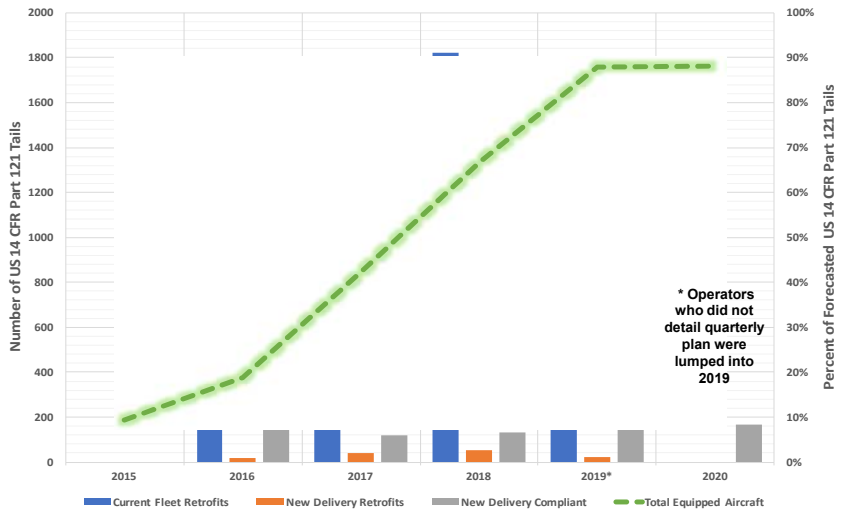
- Allegiant Air
- Hawaiian
- Mesa
- Spirit
- Virgin America

Forecasted New Delivery 2%

Data current as of 09/16/2016

MITRE

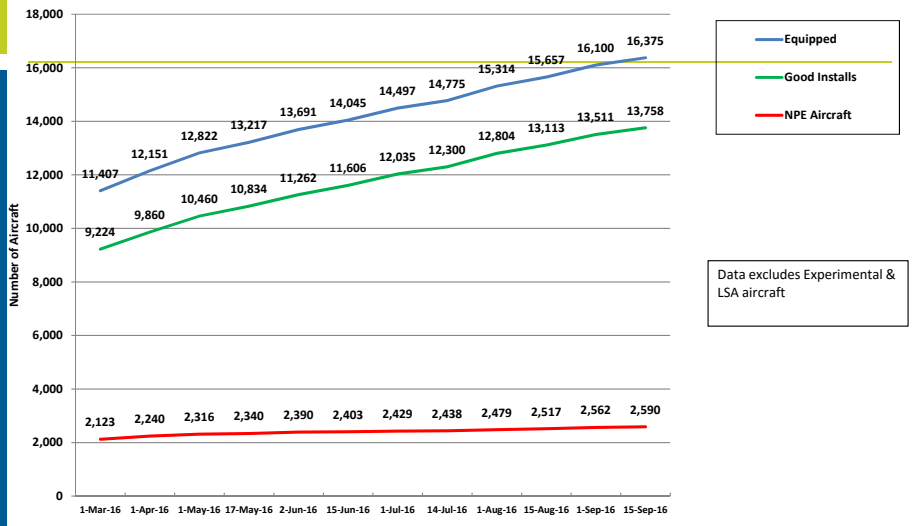
US 14 CFR Part 121 Operator ADS-B Out Equipage Plans Mapped to FAA Forecasted Fleets



Data current as of 09/16/2016

MITRE

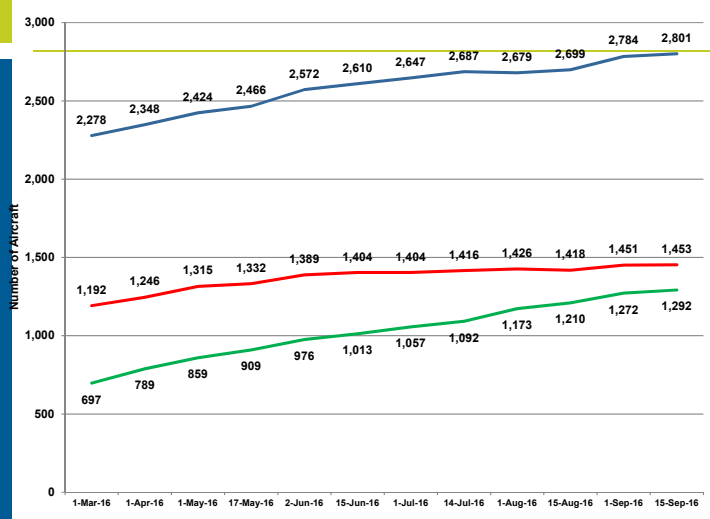
US GA Fixed-Wing Equipage and Avionics Performance



Data excludes Experimental & LSA aircraft

MITRE

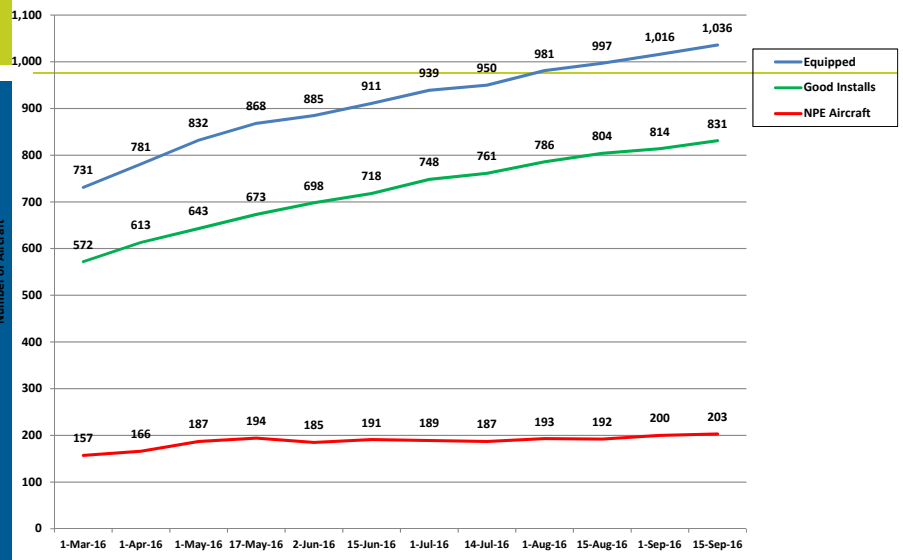
USA Exp and LSA Aircraft Equipage and Avionics Performance



The small dip in equipped aircraft in early August is due to a change in the Performance Monitor from a 2-year to a 1-year rolling window. Aircraft not seen in over a year were removed from the data on Aug 1, 2016.

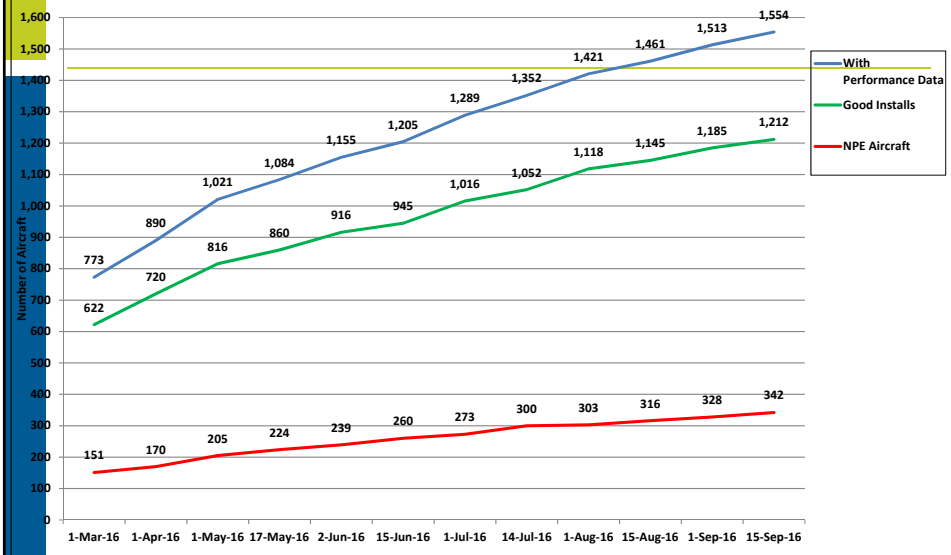
MITRE

US Rotorcraft Equipage & Avionics Performance



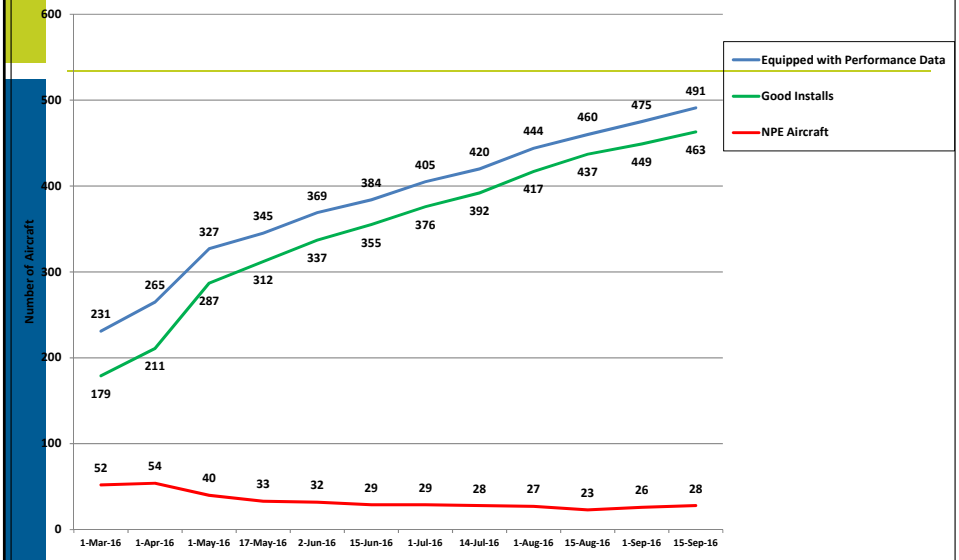
MITRE

International GA Equipage & Avionics Performance



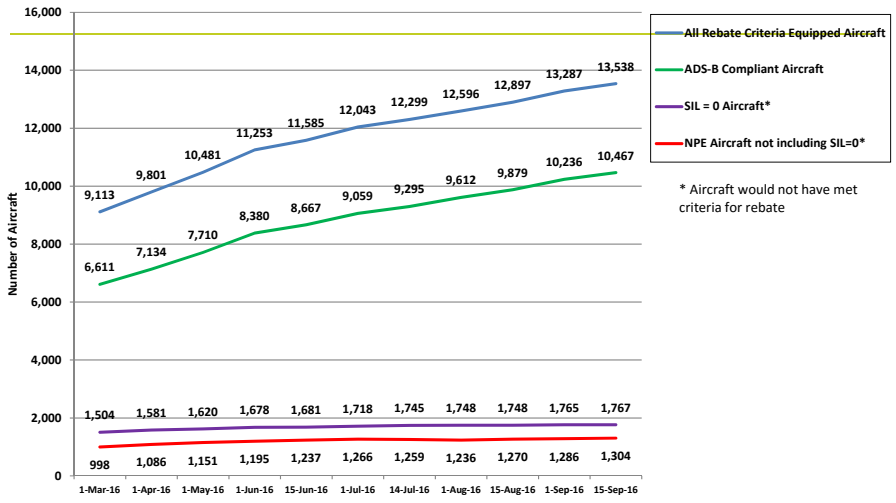
MITRE

International Air Carrier Equipage and Avionics Performance



MITRE

US Fixed-Wing Single-Engine (rebate) Aircraft Equipage & Performance

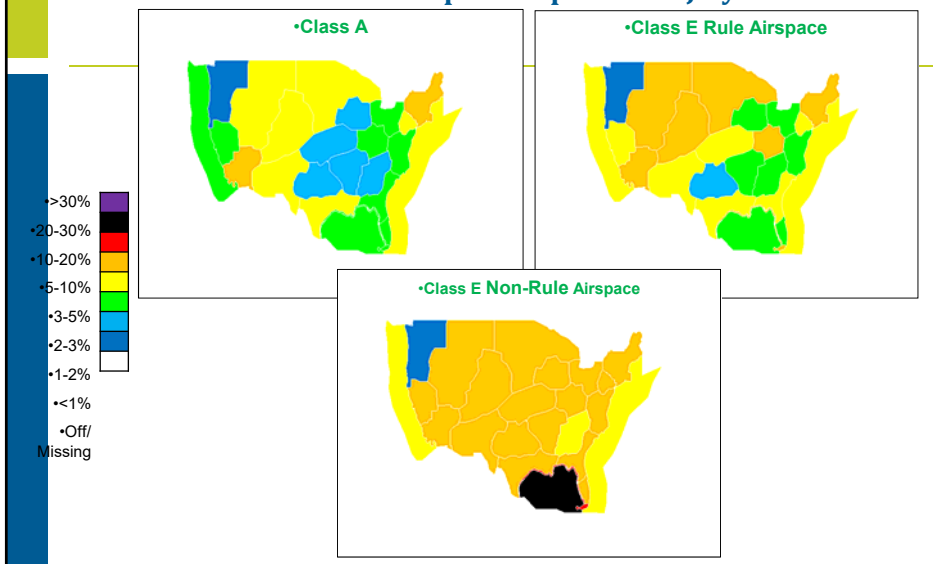


* Aircraft would not have met criteria for rebate

MITRE

Equipage Heat Maps

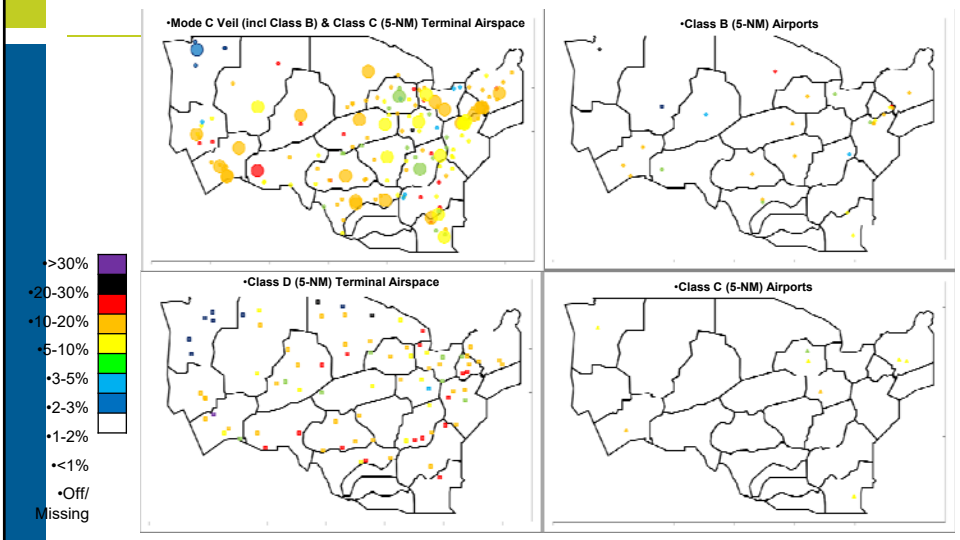
Percent of ADS-B Out V2 Compliant Operations July 2016



MITRE

Equipage Heat Maps

Percent of ADS-B Out V2 Compliant Operations July 2016



MITRE

DISCUSSION

BREAK

NextGen Integration Working Group
(NIWG)
Reports & Discussion

Jim Eck, Teri Bristol, John Hickey
Steve Dickson, Melissa Rudinger

RTCA

THE GOLD STANDARD FOR AVIATION SINCE 1935

Data Comm

Industry Leads:
Chuck Stewart, United Airlines
John O'Sullivan, Harris Corporation
FAA SME:
Jesse Wijntjes, ATO

Data Comm Accomplishments

- Tower Controller Pilot Data Link Communications (CPDLC) Departure Clearance (DCL) implementation 24 months ahead of schedule
  - Data Comm service available at 45 towers - approximately 24 months ahead of APB Baseline schedule
  - Conducting over 13,000 operations per week
- Baselined En Route Full Services at Final Investment Decision
  - Reduced set of services due to budget reductions
  - Set of services coordinated with operator stakeholders
  - Met NAC NIWG milestone
- Developed proposed framework for approving media beyond VDL-2, to include VDL-0, for use in En Route airspace
  - Briefed PARC CWG and DCIT on framework
- Transitioning into operations evaluations and integration and test for En Route Initial Services

Data Comm Implementations

Key Sites			
Site Name	Site ID	ARTCC ID	IOC
Boise (Non-CPDLC)	BOI	ZLC	08/10/16
ZLC: Salt Lake City	SLC	ZLC	08/10/16
ZHU: Houston Intcl	IAH	ZHU	09/09/15
ZHU: Houston Hobby	HOU	ZHU	09/10/15
NAP – NAP Integ Compl	N/A	ZNY/ZT	09/30/15

Group A			
Site Name	Site ID	ARTCC ID	IOC
New Orleans	MSY	ZHU	07/21/16
Austin	AUS	ZHU	07/28/16
San Antonio	SAT	ZHU	07/19/16
Los Angeles	LAX	ZLA	03/10/16
Las Vegas	LAS	ZLA	03/25/16
San Diego	SAN	ZLA	04/07/16
John Wayne	SNA	ZLA	04/21/16
Burbank	BUR	ZLA	05/05/16
Ontario	ONT	ZLA	05/19/16
San Francisco	SFO	ZOA	06/09/16
Oakland	OAK	ZOA	06/23/16
San Jose	SJC	ZOA	07/07/16
Sacramento	SMF	ZOA	07/21/16
Reno (Non-CPDLC)	RNO	ZOA	07/25/16
Phoenix	PHX	ZAB	08/10/16
El Paso (Non-CPDLC)	ELP	ZAB	08/25/16
Portland	PDX	ZSE	09/14/16
Seattle	SEA	ZSE	09/15/16
Albuquerque	ABQ	ZAB	09/29/16
Dallas Love	DAL	ZFW	10/10/16
Dallas FTW	DFW	ZFW	10/24/16
Will Rogers (Non-CPDLC)	OKC	ZFW	10/24/16
Honolulu (Non-CPDLC)	HNL		11/03/16
Anchorage (Non-CPDLC)	ANC		11/30/16

Group B			
Site Name	Site ID	ARTCC ID	IOC
Louisville	SDF	ZID	07/21/16
Cincinnati (Non-CPDLC)	CVG	ZID	07/28/16
Indianapolis	IND	ZID	08/07/16
Columbus (Non-CPDLC)	CMH	ZID	08/11/16
Memphis	MEM	ZME	03/25/16
Nashville	BNA	ZME	04/13/16
Atlanta-Hartsfield (Non-CPDLC)	ATL	ZMA	04/27/16
Denver	DEN	ZDV	05/03/16
Arkansas	ATL	ZTL	05/19/16
Charlotte	CLT	ZTL	06/02/16
San Francisco (Non-CPDLC)	SFO	ZTL	06/07/16
Orlando	MCO	ZJX	06/30/16
Miami	MIA	ZMA	07/29/16
Ft Lauderdale	FLL	ZMA	08/12/16
Tampa	TPA	ZMA	08/29/16
St Louis	STL	ZKC	10/03/16
Kansas City	MCI	ZKC	10/17/16
Tulsa (Non-CPDLC)	TUL	ZKC	10/17/16
Minn-St Paul	MSP	ZMP	11/01/16
Eppley Field (Non-CPDLC)	OMA	ZMP	11/07/16
Jacksonville (Non-CPDLC)	JAX	ZJX	11/07/16
Palm Beach (Non-CPDLC)	PBI	ZMA	11/14/16
San Juan	SJU	ZMA	12/12/16

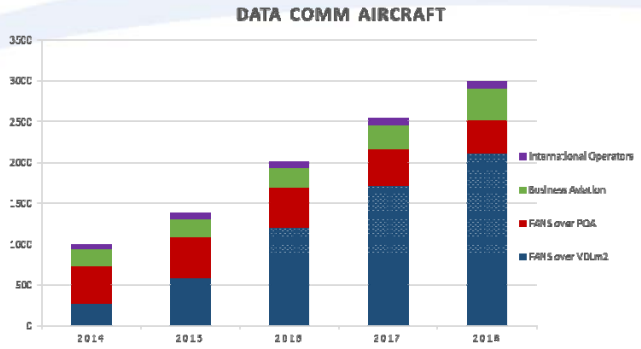
Group C			
Site Name	Site ID	ARTCC ID	IOC
Newark	EWR	ZNY	02/11/16
JF Kennedy	JFK	ZNY	02/25/16
LaGuardia	LGA	ZNY	03/14/16
Teterboro	TEB	ZNY	03/24/16
Westchester	HPN	ZNY	04/12/16
Philadelphia	PHL	ZNY	04/22/16
Boston	BOS	ZBW	05/12/16
Providence (Non-CPDLC)	PVD	ZBW	05/13/16
Bradley	BDL	ZBW	05/19/16
Albany (Non-CPDLC)	ALB	ZBW	05/17/16
Detroit	DTW	ZOB	06/30/16
Cleveland	CLE	ZOB	07/13/16
Pittsburgh	PIT	ZOB	07/29/16
Buffalo (Non-CPDLC)	BUF	ZOB	07/29/16
Balt/Wash	BWI	ZDC	08/16/16
Dulles	IAD	ZDC	08/30/16
Reagan	DCA	ZDC	09/14/16
Andrews (Non-CPDLC)	ADW	ZDC	10/05/16
Chicago Midway	MDW	ZAU	10/24/16
Chicago O'Hare	ORD	ZAU	11/07/16
Milwaukee	MKE	ZAU	11/07/16
Raleigh/Durham	RDU	ZDC	11/07/16

TDLS Sites Color Key	
CPDLC DCL Site	
Enhanced PDC Only Site	
Site Operational	
Site Operational (PDC Only)	

- Waterfall reflects **challenge** schedule dates (calendar year)
  - Baseline schedule Tower deployment dates are 2016-2019
- Tower Phase provides infrastructure for En Route starting in 2019

FAA NextGEN

Data Comm–Equipage Status



- **1,792 Data Comm equipped aircraft operating in the NAS as of September 7, 2016**
  - Includes FANS/VDL-2, FANS/POA, business jets, and international aircraft
- **972 aircraft have been equipped through the Data Comm equipage initiative**

FAA NextGEN

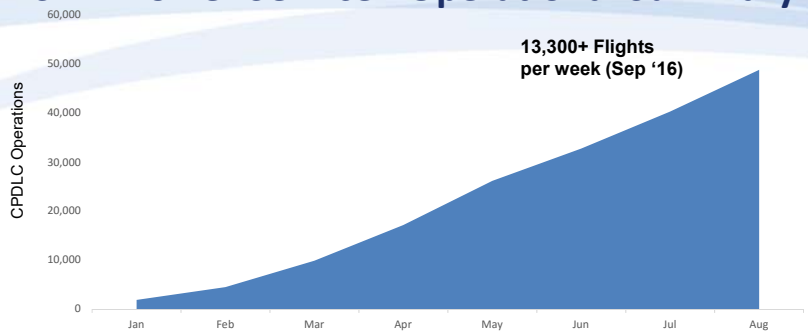
Data Comm
New Rolling Plan Implementation Commitments

- Departure Clearance Tower Services Baseline Waterfall
  - Complete remaining 10 sites in implementation waterfall
- En Route Initial Services
  - Completed detailed design for En Route Initial Services
  - Services to be delivered are: Transfer of Communications, Initial Check-In, Altimeter Settings, Altitudes, Speeds (Limited), Crossing Restrictions (Limited), Airborne Reroutes/Go Button, Controller Initiated Reroutes (Limited), Direct-to-Fix (Initial)
  - Vetting proposed implementation waterfall with stakeholders
  - Working towards a 2019 initial capability at first ARTCC

Data Comm
New Rolling Plan Pre-Implementation Commitments

- Make Investment Decision for En Route Full Services
  - Completed August 2016
  - Baselined services are Controller Initiated Routes (Full), Crossing Restrictions (Full), Direct-to-Fix (Full), Advisory Messages, Holding Instructions
- Develop Implementation Framework for Non-VHF Digital Link (VDL) Mode 2 Media
  - Developed proposed framework for approving media beyond VDL-2, to include VDL-0, for use in En Route airspace
  - Briefed PARC CWG and DCIT on framework

S1P1 Tower Service - Operational Summary



9 US Mainline Air Carriers

American Airlines · UNITED · FedEx · Hawaiian Airlines · Southwest · DELTA · Alaska · ups · Virgin America

DoD

32 Aircraft Types

BOEING · AIRBUS · BOMBARDIER · Gulfstream · DASSAULT FALCON

19 International Air Carriers

AirBridgeCargo · AIR NEW ZEALAND · Air India · AirTahitiNui · Austrian · BRITISH AIRWAYS · brussels airlines · cargolux · Emirates · ETIHAD · Aerolineas Argentinas · LATAM CARGO · KOREAN AIR · SAS · SINGAPORE AIRLINES · swissair · QATAR

Business Jet Operators

CJG · EXECUTIVE JET MANAGEMENT · ExcelJet · PRESTER AVIATION · JETLINX · JET AVIATION · NETJETS · SOLAIRUS AVIATION

FAA

NextGEN

Benefits & Metrics

Day	Site	Length (hrs.)	Time Savings per Flight: Data Comm vs. Non Data Comm	Total Time Saved
2/16/2016	KEWR	7.5	Average 23.7 min less gate delay and 5 min less taxi delay	195 minutes
4/1/2016	KJFK	24	Average 9 min less gate delay and 7.8 min less taxi delay	299 minutes
4/3/2016	KEWR	24	Average 16.3 min less gate delay and 11 min less taxi delay	274 minutes
6/28/2016	KEWR	9.5	Average 21.5 min less gate delay and 5.3 min less taxi delay	208 minutes
6/29/2016	KEWR	9	Average 8.2 min less taxi delay	63 minutes
7/28/2016	KJFK	24	Average 6 min less taxi delay	60 minutes
8/13/2016	KBWI	9	Average 26.5 min less gate delay and 9.1 min less taxi delay	398 minutes
9/10/2016	KIAH	7	Average 2.3 min less gate delay and 1.5 min less taxi delay	38 minutes
9/19/2016	KLAX	31	Average 2.8 min less gate delay and 10.7 min less taxi delay	105 minutes

- The above are a sample of weather events resulting in time savings benefits for Data Comm flights
- Time saved per flight is determined by comparing Data Comm flights that received revisions to Non Data Comm flights that received revisions
  - Gate Delay values for flights that received revisions before pushback
  - Taxi Delay values for flights that received revisions after pushback

FAA

NextGEN

Benefits – Controller Feedback

- "During SWAP this equipment is amazing! We routinely see Data Comm enabled aircraft who require a re-route due to weather never stop their taxi for take off. Aircraft not participating in Data Comm, must stop taxi, contact tower for new route, then sit and contact airline dispatch until everything is coordinated and approved for takeoff. This can take a long time, and blocks an active taxiway. During SWAP, Data Comm users are simple to process, and receive no delay waiting." – NYC Area Controller
- "Got a full route clearance to Asia somewhere and it was with a foreign carrier that had a thick accent and is already a struggle to understand during basic shortened clearance readbacks. Controller told me he was so relieved to be able to send that clearance via CPDLC and have the pilot wilco it without any voice exchanges and confusion/frustration." – LAX Controller

Benefits – Controller Feedback

- "In MIA a 777 got a reroute number 1 in line for takeoff, he was routed offshore away from the storms, center put the reroute in, controller sent the clearance via CPDLC and 3 minutes later they were rolling down the runway, that would have been at least 10-20 min traditionally, if they needed more fuel up to an hour."– National Controller SME
- "So I happened to be working clearance last night during a weather reroute. The only CPDLC I had to reroute worked like a charm! All other I had to read and wished they were FANS equipped." – IAH Controller

Operator Feedback - UPS

- UPS advanced flight systems manager Christian Kast said the cargo airline saves 15 gallons of fuel for each minute reduced in the departure process.
- “In the express cargo business, seconds matter,” he said. “So when you talk about minutes saved, this becomes a game changer for us.”
- “I have easily seen [Data Comm] save me 7 to 15 minutes” in getting clearance for takeoff, UPS MD-11 captain Gregg Kastman told *ATW*. “For UPS, we really have a time-critical sort. Every minute I’m delayed could affect the transfer of packages onto 40 aircraft waiting [at UPS Airlines’ global headquarters facility] in Louisville.”

Operator Feedback – Delta Air Lines

- Delta estimates that Data Comm can shave one minute off the time it takes a plane to taxi for takeoff. Spread over Delta’s fleet of planes, the airline says that adds up to a savings of about $20 million a year.
- The savings in fuel mean greater profitability. Delta can save tens of millions of dollars a year
- “As quick as we can get out to the end of the runway and into the air, (the better),…The benefit is really going to be tremendous,” Jim Graham Delta Airlines
- “It is better for the environment, too, because it reduces the amount of time commercial jets sit on tarmacs with engines running. It leaves a smaller carbon footprint”, said Delta Capt. Jim Graham.

Data Comm Risks

- Training
  - Development and acceptance of training materials
  - Timing of training to support initial operations at a site
  - Operator flight crew training to support waterfall
- Operator commitment and coordination to support the implementation waterfall
  - Equipped aircraft needed to support Data Comm site IOCs
  - Support to FAA testing and air-to-ground interoperability
- Coordination of the delivery and integration of the component subsystems
  - ERAM/TDLS/DCNS/FTI/Aircraft
- Site coordination
  - Coordinating across multiple facilities and operators to transition to Data Comm
- Air-to-Ground interoperability
  - Issue resolution between air and ground systems can be complex

FAA NextGEN

DISCUSSION

RTCA

THE GOLD STANDARD FOR AVIATION SINCE 1935

Multiple Runway Operations

Industry Leads:
Glenn Morse, United Airlines
Jon Tree, The Boeing Company
FAA SMEs:
Jack Allen, ATO
Paul Strande, ANG

Multiple Runway Operations Accomplishments

- **Wake RECAT Phase 1.5 static wake categories**
  - Now implemented at 23 airports and 12 TRACONs
- **Wake RECAT Phase II optimized wake categories**
  - Pre-implementation assessment completed in March
  - Order is approved and training is complete for key site
  - IOC at SCT, LAX, SAN, ONT, and BUR on September 26, 2016
- **Simultaneous Independent Procedures**
  - Standards for independent triple approaches and independent approaches using offsets were authorized and are implemented at ORD and DTW
- **Dependent Procedures**
  - 1.0 NM dependent stagger authorized NAS wide and implemented at commitment sites
  - 7110.65 publication planned for November 10, 2016 will include authorization of 1.5 NM stagger for runways between 3600' and 8300', and implementation will follow
  - Safety analysis is on schedule to meet commitment for 7110.308A stagger reduction at SFO

FAA NextGEN

Multiple Runway Operations
New Rolling Plan Implementation Commitments

- Amend Dependent Runway Separation Order 7110.308A (SFO)
- Amend Dependent Runway Separations for Runways Greater than 4,300 Feet (CVG, MEM, PHX, SDF)
- Amend Standards for Simultaneous Independent Approaches, Triples (ATL, IAD)
- Amend National Standards for Vertical Navigation (VNAV) for Simultaneous Independent Parallel Approaches (dependent on pre-implementation commitment)
- Wake RECAT Additional Sites

FAA NextGEN

Multiple Runway Operations

Pre-Implementation Commitments

- Assessment of Time Based Separation concept for use in the NAS (Research)
- Analysis of upgrading current Wake RECAT Sites to Phase II
- Technical report on Vertical Navigation Requirement for Simultaneous Independent Parallel Instrument Approaches to Closely Spaced Parallel Runways

Industry Commitments

- Joint Analysis Team (JAT) Performance Analysis Participation

FAA NextGEN

Multiple Runway Operations Risks

- Program interdependencies with other FAA projects
- Collision and wake hazard safety analysis results
- Unforeseen runway issues
- Environmental concerns

FAA NextGEN

DISCUSSION

RTCA

THE GOLD STANDARD FOR AVIATION SINCE 1935

Surface Team

Industry Leads:
Rob Goldman, Delta Air Lines
Steve Vail, Mosaic ATM, Inc.
FAA SMEs:
Susan Pfingstler, ATO
Mike Huffman, ATO

Surface Accomplishments

- Implemented Traffic Flow Management System (TFMS) Release 13 to enable the addition of new surface data elements as part of an early Terminal Flight Data Manager (TFDM) implementation activity
  - Implemented April 2016
- Installed electronic flight strip systems in Newark, Las Vegas and San Francisco
- Made Key Investment Decision for TFDM
  - Restored TFDM Funding
  - Achieved the Final Investment Decision on June 15th
    - Planned development and deployment to 89 Sites
  - The contract was awarded to Lockheed Martin on June 29th.
    - Sub-contractor, Saab Sensis
  - Prioritize implementation of TFDM in the NY area
    - Required acceleration of Departure Spacing Program system replacement

FAA NextGEN

Surface Management - TFDM

TFDM is the surface management solution for NextGen. TFDM will provide an integrated tower flight data automation system, which will improve controllers' common situational awareness to support the NextGen Concept of Operations. TFDM will improve efficiencies on the airport surface and terminal airspace by providing:

Electronic Flight Data TFDM will provide an improved Electronic Flight Data (EFD) exchange and Electronic Flight Strips (EFS) in the tower to replace printed flight strips. This functionality will be integrated with Flight Plans for automatic updating.	**Collaborative Decision Making for the Surface** TFDM will provide a departure scheduler with live data provided by Air Traffic systems/controllers and Flight Service Providers. The system will provide a departure metering capability, runway balancing and other surface management tools, improving surface traffic flow management.
Traffic Flow Management TFDM will enhance the traffic flow management data integration with Time Based Flow Management (TBFM) and Traffic Flow Management System (TFMS) to enable airlines, controllers and airports to share and exchange real-time data. This will result in improved surface traffic management as well as improve the products produced by TFMS and TBFM.	**Systems Consolidation** TFDM will replace multiple unsupportable systems in the National Airspace System through integration of their functionality into TFDM. This achieves technology modernization, improved data sharing and lower maintenance costs. The systems to be consolidated include ARMT, DSP, EFSTS, AEFS, and SMA.

FAA NextGEN

Surface
New Rolling Plan Implementation Commitments

- Increased Data Sharing among FAA, Flight and Airport Operators
  - The FAA commits to providing surface surveillance multilateration (MLAT) Category (CAT) 10 data (movement area and incidental non-movement area) to industry via SWIM in Q4 CY 2017
- Surface Departure Management
  - The FAA and NASA in partnership with American Airlines are moving forward with the Phase 1 of the ATD-2 demonstration at Charlotte - Planned start in Q4 CY17

FAA NextGEN

Surface Management
Rolling Plan Pre-implementation Commitments

- TFDM Meaningful Engagement
  - Identify a forum for ongoing industry engagement throughout the various stages of the TFDM deployment
- Deployment
  - ✓Plan to deliver capabilities as early as possible
  - ✓Prioritized implementation of TFDM in the NY area
    - Required acceleration of Departure Spacing Program system replacement

FAA NextGEN

Surface
New Rolling Plan Industry Commitments

- Data Sharing: Flight Operators' Roles in increased data sharing among FAA, Flight and Airport Operators:
  - As part of a two-way data-sharing agreement, industry commits to providing the FAA with Surface Data Elements by Q4 CY16
  - Several CDM members have started the process of transitioning their individual data exchange capabilities that will enable provision of the Surface Data Elements to be submitted
  - Four Airports have volunteered as "pilot" airports for data sharing
- Meaningful Inclusion in Terminal Flight Data Manager Program (TFDM)
  - Leverage current groups' capabilities
  - Define swim lanes
  - Track data exchange
  - Ensure ATD-2 learning transfer

FAA NextGEN

Why ‘meaningful inclusion’ is important

What Operational Concepts, Validation, and Requirements (AJV-7) suggested

What Investment Planning and Analysis approved (JRC)

As designed by the Project Management Office (PMO AJM-22)

What the contractor manufactured

As Tech Ops installed it

What industry wanted

Benefits to Early Data Provision

- Better Traffic Management Initiatives (TMI’s) in the form of more accurate start and end times, Ground Stops (GS), Ground Delay Programs, and Airspace Flow Programs, improved go/no-go decisions for GS, and reduction in TMI revisions
- Increased predictability, specifically through the reduction in the number of time-out delays, cancellations and improved Expect Departure Clearance Times compliance
- Better trajectory predictions through reduced Monitor Alert Parameter errors and reduction of departure Miles In Trail restrictions
- Improved demand predictions and more accurate and stable information will allow Flight Operators as well as FAA Traffic Management Units to make better planning decisions throughout the day
- Support TFDM system testing starting in 2018

FAA NextGEN

Surface Risks

- Data Sharing
- Collaborative Decision Making (CDM) Governance (Airport Operators and Others)

FAA NextGEN

DISCUSSION

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Performance Based Navigation

Industry Leads:
Steve Fulton, Sandel Avionics
Brian Townsend, American Airlines
FAA SMEs:
Donna Creasap, ATO
Josh Gustin, ATO

PBN Accomplishments

- Developed a two-year forward schedule with heavy emphasis on pre-implementation commitments and Established on Required Navigation Performance (EoR)
  - Industry provided recommendations in June
  - FAA aligned work with existing and new program plans and schedules
  - Re-engaged and modified work plans to better reflect industry priorities
  - Agreed to continuing engagement to fully consider the variety of methods available to ensure safe/successful transition to duals/triples EoR operations

PBN
New Rolling Plan Implementation Commitments

- **Metroplex Projects** - Atlanta – Q4 CY2016
  Charlotte – Q1 CY2017
  Las Vegas Design Start– Q1 CY2017

- **Single Site Implementations**
  - RNAV STAR
    - Gary (Indiana) – Q3 CY2016
    - Boston – Q3 CY2016
    - Austin – Q4 CY2017
  - RNAV SID
    - Henderson (Nevada) Executive Airport – Q4 CY2017

Time Based Flow Management

- **TBFM Ground-Based Interval Management–Spacing (GIM-S)**
  - 3 Sites Q4 CY2016, 3 Sites Q4 2017
- **TBFM Integrated Departure Arrival Capability (IDAC)**
  - 3 Sites Q4 2016, 1 Site Q4 CY2018, 4 Sites Q4 2019
- **TBFM Terminal Sequencing and Spacing (TSAS) – Q4 CY2019**

PBN
New Rolling Plan Pre-Implementation Commitments

- Established on Required Navigation Performance (RNP) (EoR)
- Established on Departure Operations (EDO)
- Enhanced Flight Vision Systems (EFVS)
- Advanced RNP (A-RNP)
- New Vertical Guidance
- RNP 1 Departures

PBN
Rolling Plan Industry Commitments

- **Several operators will work with the FAA to complete lead operator redefinition**
- **These lead operators have committed to represent industry should an implementation decision be made for these locations:**
- Implementation Commitments
  - American for Charlotte Metroplex
  - Delta for Atlanta Metroplex
  - Boeing for Gary Single Site Optimized Profile Descent (OPD)
  - Jet Blue and American for Boston Single Site OPD
  - Southwest for Austin Single Site OPD
  - NBAA for Henderson Executive Single Site RNAV Standard Instrument Departure

FAA NextGEN

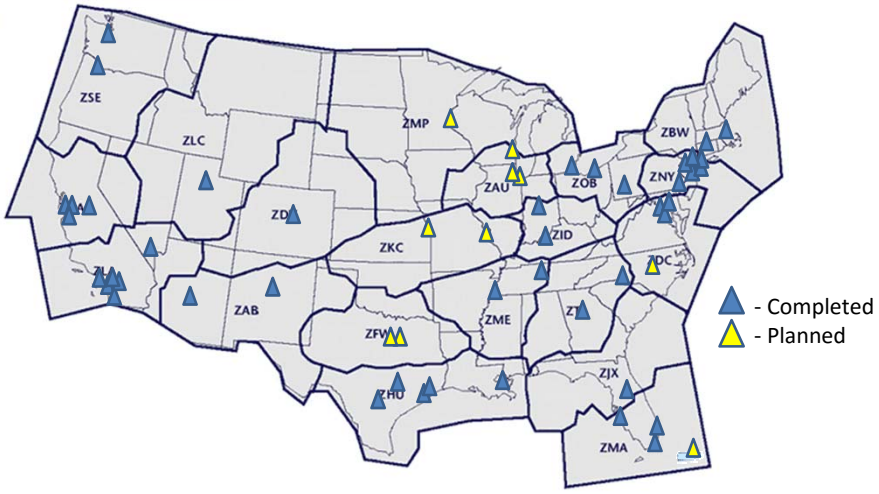
PBN Risks

- Environmental outreach will continue to have an impact to FAA schedules for the foreseeable future
  - Need to be aware and flexible as required to allow necessary outreach to achieve objectives
- Facility resource demands are fluid which adds risk to integration of program schedules
- Expectations for near-term EoR operational benefits may not be achievable
- The transition to a time-based extended metering in hybrid operation (use of miles and minutes) is complex and requires additional focus - GIM-S/TBFM programs are taking proactive actions to mitigate

FAA NextGEN

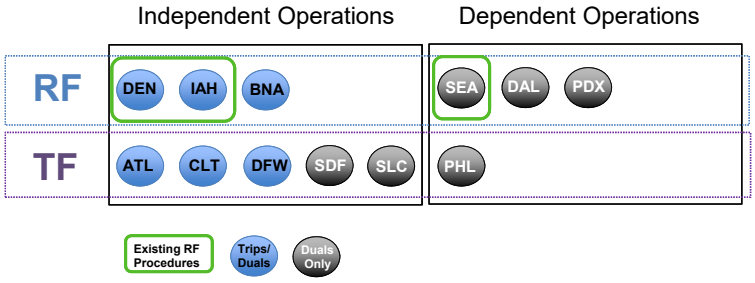
DISCUSSION

Data Comm Tower Services (DCL) Implementation Map

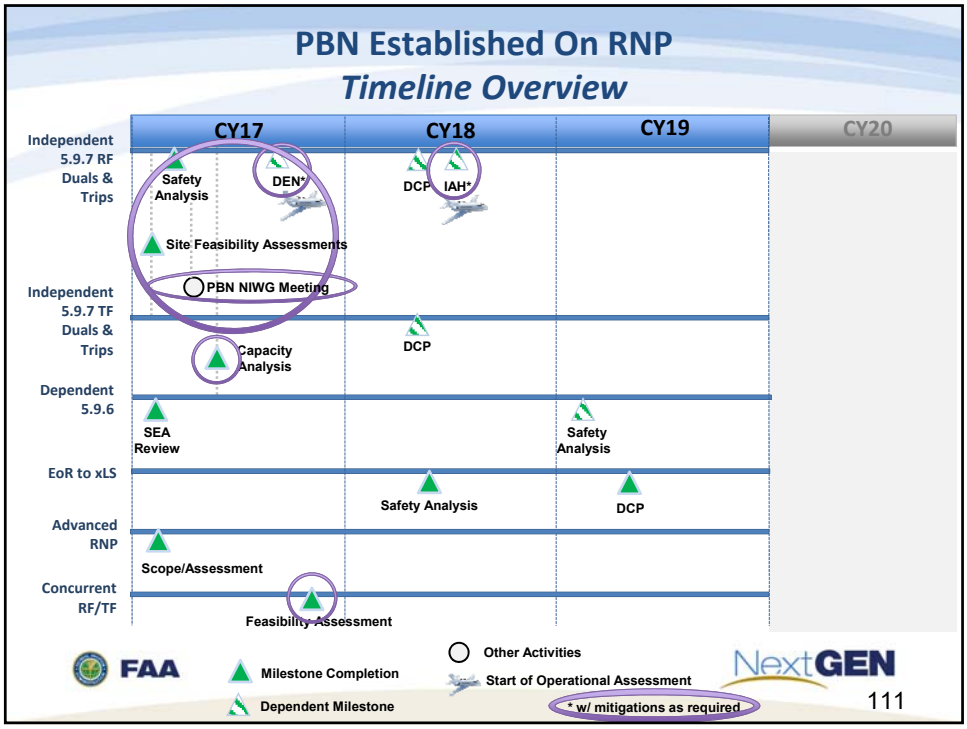


FAA NextGEN

PBN Established on RNP Site Recommendations



FAA NextGEN



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PBN Time, Speed, Spacing Task Group

Co-chairs:
Dan Allen, FedEx
Steve Fulton, Sandel Avionics

Goal of the Task Group

- ***"Keep the aircraft on the PBN procedure from En Route to the runway while maintaining or increasing throughput"***
- Candidate Capabilities Criteria
  - Current state of the capability (maturity, life cycle)
  - Necessary investment
  - Investment timing
  - Benefits- Evaluated Based on Key Performance Indicators (KPI) (efficiency, throughput, predictability)
- Leverage existing and future tools for controllers and aircraft

Participating Organizations

- Air Line Pilots Association
- Airbus
- Alaska Airlines
- American Airlines, Inc.
- City of Houston, Texas
- Delta Air Lines, Inc.
- Federal Aviation Administration
- FedEx Express
- GE Aviation
- Harris Corporation
- HMMH (DP)
- Honeywell International, Inc.
- JetBlue Airways
- Landrum-Brown
- Leidos
- Metron Aviation, Inc.
- National Air Traffic Controllers Association
- National Business Aviation Association
- Professional Aviation Safety Specialists
- Raytheon
- Regulus Group
- Rockwell Collins, Inc.
- RTCA, Inc.
- Sandel Avionics, Inc.
- SESAR Joint Undertaking
- Southwest Airlines
- Tetra Tech
- The Boeing Company
- The MITRE Corporation
- U.S. Air Force
- United Airlines, Inc.

Key Policy Statements

- A transition to a time based system is necessary to enable higher percentages of PBN operations with the goal of keeping aircraft on an optimal path.
- VMC in IMC conditions
- Large cultural change for controllers, pilots, dispatchers and others involved in the operation of aircraft
- Decision support tools are critical
- Implementation must be integrated

Findings

- FAA has increased efforts associated with Time Based Flow Management implementation and use, **overarching / system culture change is needed.**
- **FAA has a leading role to play in implementing ground based decision support tools**, **time, speed and spacing is highly dependent on aircraft FMS capability** and as such requires all stakeholders to fulfill their respective roles and responsibilities in a **collaborative and coordinated manner throughout the entire 15-year roadmap.**
- Increasingly integrated air to ground capabilities requires **alignment between FAA investments** and aircraft investments for cost avoidance and adequately timed and optimized benefits.

Recommendations

- **The NAC recommends that the FAA:**
- Create an agency-wide vision for **changing to a time-based system** and develop and implement a plan to communicate the vision.
- **Incorporate the roadmap** outlined throughout this document for 2016-2020; 2021-2025; and 2026-2030 for decision support tools and aircraft capabilities.
- **Adopt change management principles** as part of their implementation process to gain the acceptance and culture change to realize the benefits of time-based enhancements.

Time Frames

- Near Term (2020)
  - Policy, procedures and training to enable initial PBN capabilities and using existing tools and systems for a better integrated system
  - Infusing time based metering into the culture
- Mid Term (2021-2025)
  - Focuses on continued deployment of available NextGen capabilities consistent with meeting the goal of PBN TSS in an integrated manner
  - Begins the process of integrating aircraft trajectory data with ground systems
- Far Term (2026-2030)
  - Further enhances, increasing resilience of ground based tools
  - Integrates the stand alone capabilities described in the mid-term
  - Leverages FIM demonstration for potential full NAS implementation
  - Based on experiences from Near and Mid-Term, begins implementing advanced Data Comm capabilities defined by SC-214 Standards for Air Traffic Data Communication Services

Back-up

Time Frames

- Near Term (2020)
  - Policy, procedures and training to enable initial PBN capabilities and using existing tools and systems for a better integrated system
  - Infusing time based metering into the culture
  - GIM-S
  - TSAS
  - FIM Gateways
- Mid Term (2021-2025)
  - Focuses on continued deployment of available NextGen capabilities consistent with meeting the goal of PBN TSS in an integrated manner
  - Begins the process of integrating aircraft trajectory data with ground systems
  - GIM-S/TSAS expansion
  - RTA
  - FIM Demonstration

Far Term (2026-2030)

- Further enhances, increasing resilience of ground based tools
- Integrates the stand alone capabilities described in the mid-term
- Leverages FIM demonstration for potential full NAS implementation
- Based on experiences from Near and Mid-Term, begins implementing advanced Data Comm capabilities defined by SC-214 Standards for Air Traffic Data Communication Services

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LUNCH

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PBN Implementation
Denver Established On RNP

Ron Renk, United Airlines

Gary McMullin, Southwest Airlines

Denver Established on RNP – NAC

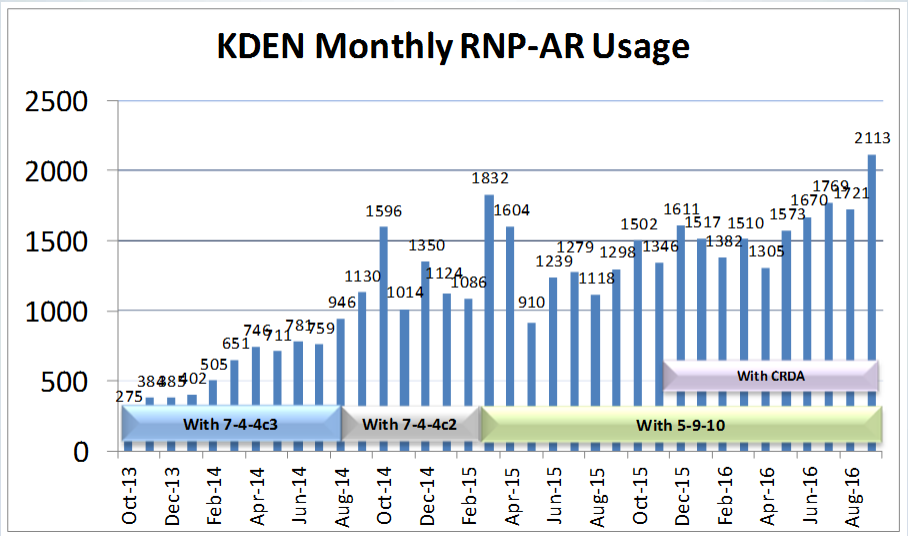
Captain Gary McMullin, Manager Airspace and Navigation

October 5, 2016

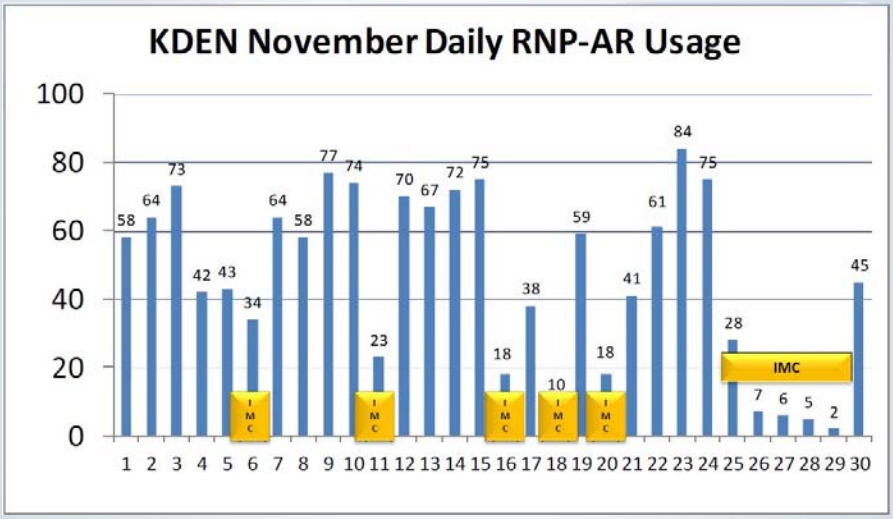
Denver RNP History

- **Denver RNP AR approaches published November 2012**
- **Fly it date was October 7, 2013**
  - Denver TRACON and Industry developed an implementation plan
  - Needed an interpretation on the 30 degree rule (7110.65, paragraph 7-4-4 c3).
    - This ruling allowed RNP AR operations to all runways except 16L and 16R
- **On August 22, 2014, RNP AR operations began on 16L and 16R**
  - Runways 16L and 16R are a dependent operation (7-4-4 c2)
- **In early 2015, FAA amended 7110.65, paragraph 5-9-10**
  - Change allowed RNP AR operations from both sides of the airport
  - The impact was a huge increase in the usage of RNP AR procedures
- **Waiting on a change to 7110.65, paragraph 5-9-7 to allow IFR operations**
  - Dual and Triple simultaneous approaches in IFR conditions
  - Estimated usage will increase 50-75 approaches per day
- **RNP AR capable aircraft are increasing**
  - Southwest will retire Classic fleet in September 2017
  - Skywest is nearing approval for RNP AR operations

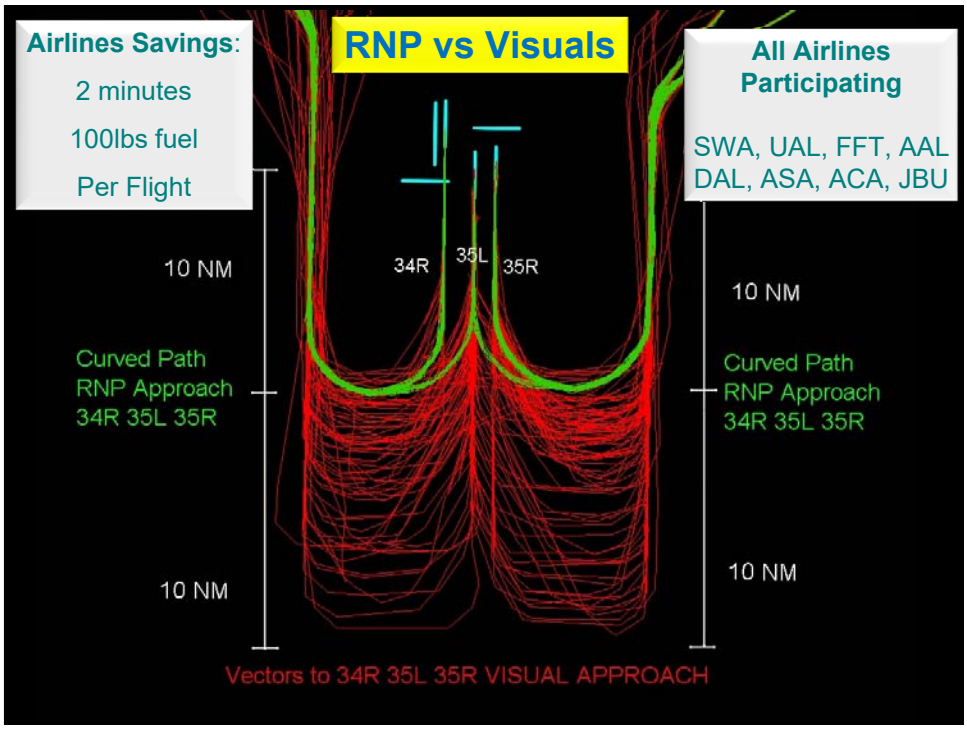
Denver RNP AR History

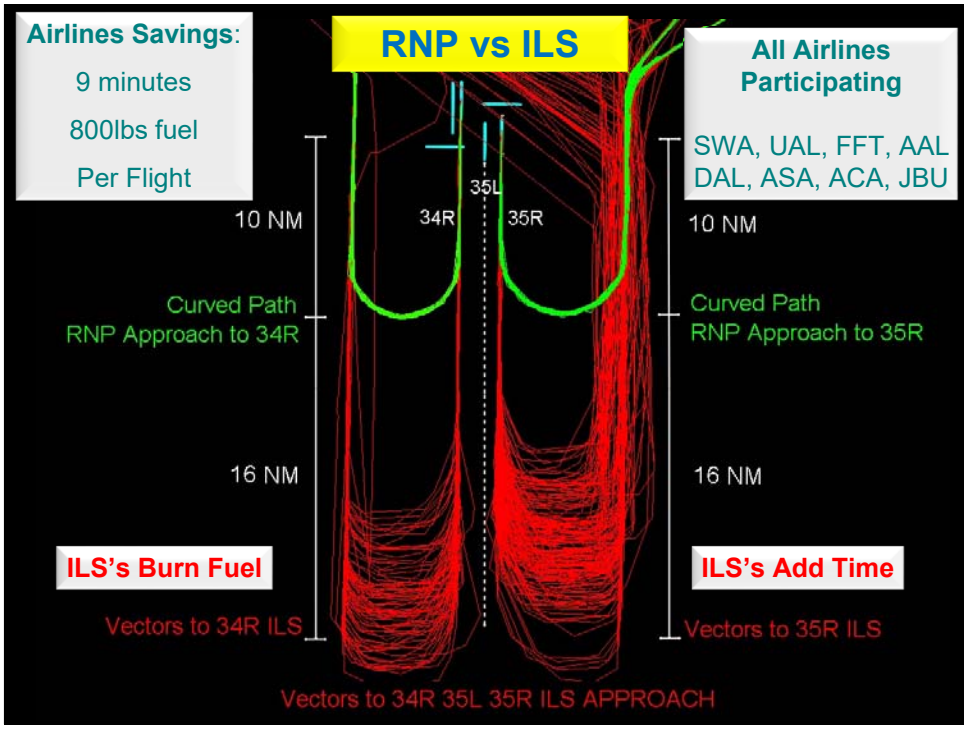


Importance of 5-9-7 Change



Southwest





RNP EOR Benefits–
NextGen Advisory Committee

Ron Renk
Chief Technical Pilot – Navigation
United Flight Operations

5 OCT 2016

UNITED

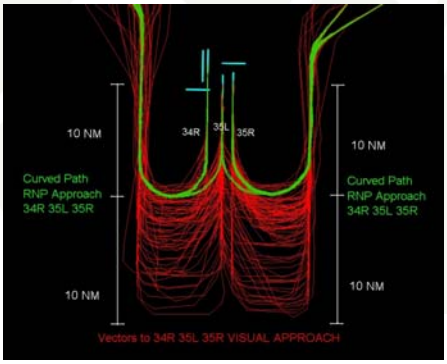
Fundamental Definition of RNP

- Approach with containment both in straight and curved legs
- Where is RNP beneficial:
  - o Terrain constrained airports (GUC)
  - o Airspace constrained airports (DCA)
  - o Redundancy to ground based approaches
  - o Efficiency
    - One ground track for VMC and IMC

UNITED

Fundamental Definition of EOR

- Ability to have RNP approaches/feeders, establishing the aircraft on the approach prior to final approach course (FAC)
  - o Removes need for vectoring approaches to final
  - o Allows similar turn on points to parallel runways



UNITED

Benefits of RNP

- Operator Benefits:
  - Fuel Reduction in IMC
  - Time Reduction in IMC
  - Schedule Reliability: The schedule is not affected when operations change from VMC to IMC because the same path is flown.
  - Safety
    - Pilot workload relocation. (move work to enroute)
    - Increased pilot situational awareness.
    - Stabilized instrument approaches vs visual approaches.

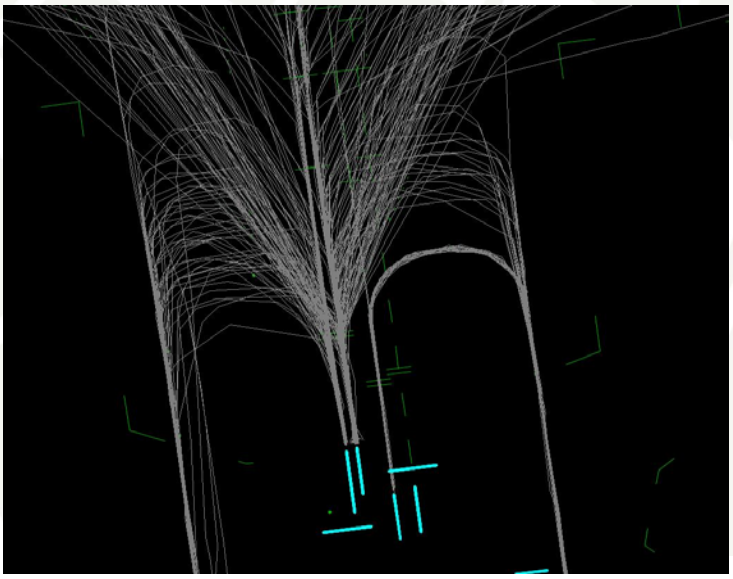
UNITED

Benefits of RNP

- ATC Benefits:
  - Reduction in pilot-controller communications (cleared for approach on downwind)
  - Repeatable, Reliable ground tracks in both VMC and IMC
    - No excursions through final approach coarse (FAC)
    - No need to get on 30 degree intercept
  - Safety
    - Controller workload – Monitor vs. Active Commands
    - Stabilized instrument approaches vs visual approaches.

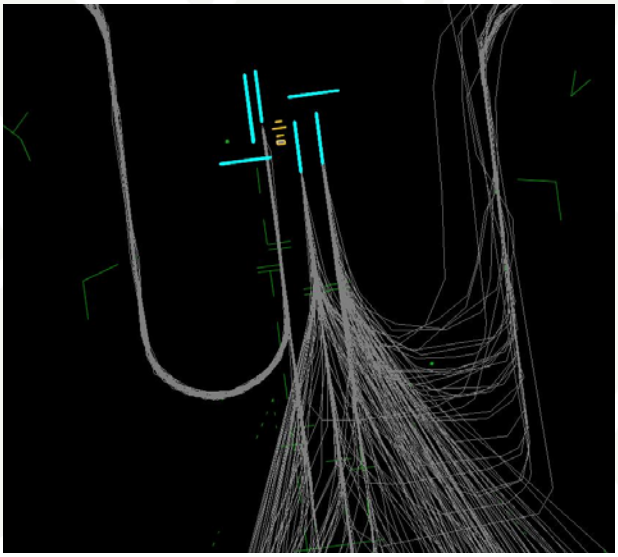
UNITED

RNP Usage



UNITED

RNP Usage



UNITED

Real-World Benefits

- Frontier, Southwest and United participated in a simulator study to find real-world fuel and time benefits
- **Scenario**:
  - Compare an ILS Rwy 34R from HIMOM waypoint to an RNP Rwy 34L from HIMOM
- **Conditions:**
  - Wind Calm
  - Heavy Landing Weight
  - ISA
  - Starting Fuel 10,000 lbs
- **Measurements:**
  - Ending fuel
  - Time in flight (from HIMOM) and taxi to apron

UNITED

Airline's Anticipated Savings

Per Flight

RNP vs ILS Simos

Data Collected In Simulators

RNP Z 34L vs. ILS 34R

UAL Efficiency Gained RNP Z 34L

Fuel: 700 lbs saved
Time: 9 minutes saved

RNP Z 34L vs. ILS 34R

FFT Efficiency Gained RNP Z 34L

Fuel: 940 lbs saved
Time: 10 minutes saved

RNP Z 34L vs. ILS 34R

SWA Efficiency Gained RNP Z 34L

Fuel: 800 lbs saved
Time: 10 minutes saved

Next Steps

- In DEN, EoR with triple parallel approaches
- EoR is not just for DEN, SEA. Other locations coming online:
  - IAH – November 2016
  - LAX – March 2017
- Increase utilization with Advanced RNP
- Implement TF designs in ATL
- Help controllers with decision support tools (CRDA, TSAS)
- Work on ways to have TF and RF designs on one procedure

UNITED

DISCUSSION

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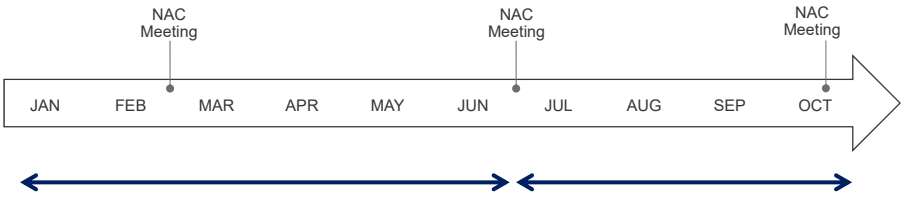
Joint Analysis Team Final Report: Performance Based Navigation Procedures: North Texas Metroplex, Denver Established on RNP

Ilhan Ince, American Airlines, Inc.
Dave Knorr, FAA

Joint Analysis Team (JAT)

- Goal: develop common statement of facts on NAS performance attributable to NextGen
- Analytical experts from industry and FAA. Participating organizations include:
  - Airlines 4 America
  - ACI North America
  - American Airlines
  - Cessna Aircraft Corp.
  - DFW International Airport
  - Delta Airlines
  - FAA
  - FedEx Express
  - JetBlue Airways
  - Jetcraft Avionics LLC
  - Landrum and Brown
  - MITRE
  - NATCA
  - PASSUR Aerospace
  - Southwest Airlines
  - United Airlines
  - UPS

JAT Schedule and Status



Wake ReCat Assessment
- CLT
- ORD/MDW

PBN Assessment
- Denver Established on RNP (EoR)
- North Texas Metroplex

FOCUS FOR TODAY

JAT Findings – Established on RNP

- EoR increased utilization of RNP AR approaches from 5.8% of arrivals to 6.6% of arrivals to Denver, an increase of 12%
  - Time saved from efficient approaches increased from 211 to 282 hours annually
- If an additional waiver is granted, EoR is expected to enable an increase up to 7.1% of arrivals executing RNP AR approaches
  - Time saved expected to increase to 360 hours annually
- EoR is an important enabler to further future growth of utilization of efficient PBN approaches

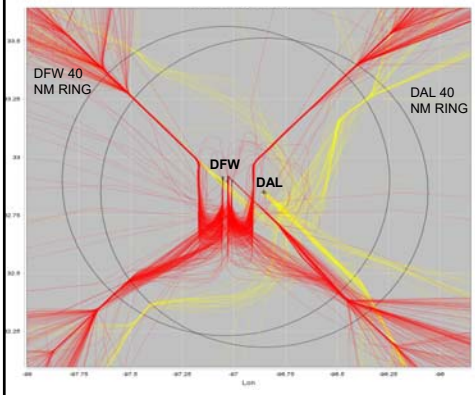
Annual Benefits from RNP AR with EoR

RNP AR benefit	RNP AR Pre-EOR	RNP AR with EOR	RNP AR EOR adjst IMC
Utilization (% of all arrivals)	5.8%	6.6%	7.1%
Avg. Distance Saving (nm/flight)	2.5	2.9	1.5 – 18.3
Overall Arrivals in 2015 (flights)		272,685	
Total Distance Savings (nm)	39,178	52,385	66,757
Avg. Speed at Intercept (kts)	185.3	185.6	185.6
Total Time Savings (hr)	211.5	282.3	359.7

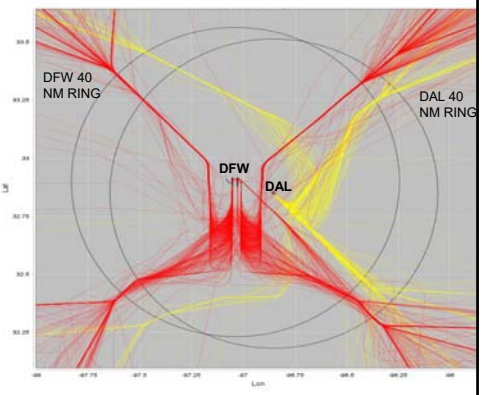
Data Sources:
- ASPM, for annual arrivals and occurrence of IMC
- PDARS, for utilization, distance and time calculations

North Texas Metroplex

Pre Metroplex Arrival Flows
Oct 2013 – Feb 2014



Post Metroplex Arrival Flows
Oct 2015 – Feb 2016



JAT Findings – NT Metroplex (1 of 2)

- Many external factors challenged pre vs. post metroplex analysis
  - DFW/AAL re-banking, CRO, over-the-top elimination, Wright amendment at DAL, use of flow metering, change in wind patterns, and WN Cost Index change (speed increase)
- Changes in city pair block times driven by winds, not Metroplex
- Team recognized importance of system impacts of the Metroplex and, after analysis, determined to focus on flight trajectory changes within 300 nm as it best approximates effects of NT Metroplex and allows for better isolating external factors pre/post implementation

JAT Findings – NT Metroplex (2 of 2)

- Metroplex has…
  - Segregated arrival routes between DFW and DAL
  - Added route structure where flights previously vectored off-route
    - Enabler for increased TBFM forecasting accuracy, infrastructure for new tools and improved safety per SMEs
  - Slightly increased flight distance within 300nm but slightly reduced time
  - Clearly reduced level segments and increased continuous descents, particularly for DFW

Lessons Learned

EoR

- EoR, in conjunction with terminal sequencing tools and growing aircraft equipage, should further grow the percent of arrivals executing efficient PBN approaches

Metroplex

- Developed a robust Metroplex methodology that effectively accommodates for variety of pre/post implementation changes and may be used in future
- Additional work required: need to document the Metroplex analysis process and determine a joint approach to measure fuel impacts/changes
- Metroplex efforts should continue to ensure they are cognizant of impacts on flight time and distance

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Enhanced Surveillance Task Group

Co-Chairs:

Steve Brown, NBAA

Bart Roberts, JetBlue

Request from the FAA

- Evaluate the need and benefit of enhanced surveillance capabilities
  - Examine the potential benefits to operators of reduced oceanic separation minima using space-based ADS-B or other improvements to surveillance
  - Potential funding mechanisms might be used and at what cost
- Evaluate the business case
  - Input to help capture the benefits of services possible, above and beyond current operations
  - US-controlled airspace
  - Challenges being solved
- Timeline: Final Recommendations June 2017

Enhanced Task Group Members & SME Organizations

- ALPA
- Airbus
- Aireon, LLC
- Airlines for America
- Alaska Airlines
- American Airlines
- DFW
- Delta Air Lines
- FAA
- FedEx Express
- GAMA
- Harris Corporation
- Honeywell
- INMARSAT
- IATA
- Iridium Satellite LLC
- JetBlue Airways
- Leidos
- NATCA
- NBAA
- NAV CANADA
- Northrop Grumman
- Rockwell Collins
- RTCA, Inc.
- Sensurion Aerospace
- SESAR
- Thales Group
- Boeing
- MITRE
- United Airlines
- UPS

Task Group Actions

- August Start-up
- YTD – Three meetings
- Level setting & info gathering
- ConOps & Benefits
  - FAA
  - NAV Canada
  - NATS
- Launched Operations and Benefits Subgroup
- Future Meetings – Oct/Nov/Dec
- NAC Feb Deliverable: Interim – Opns & Benefits

Summarized Assumptions

- Reduced separation is the predominant goal
- Changes should provide **safety enhancements, reduced risk to aviation, enhanced capacity and/or improved operational efficiency that are cost and environmentally beneficial**
- Maximize the use of current equipage that is compliant with current FAA C/N/S standards with no broad-based fleet upgrades required
- Will not affect the current FAA ADS-B Out 2020 mandate, and not add to the mandate
- May require comprehensive training of controllers, pilots and dispatchers, updating automation, and decision support tools

Summarized Guiding Principles for Recommendation

- Must address closing the business case for operators and the FAA
- US operators should not be financially or operationally penalized
- Transitions between air service providers should be considered as part of the integration
- Enhanced Surveillance services will be introduced by regions or routes
- Might require reducing budget allocation for lower priority initiatives or capabilities.
- Entities with a direct financial gain are limited to serve as SMEs

Emerging Issues

- Three Unique Geographic Areas
  - North Atlantic
  - WATRS
  - Pacific
- Operator Equipage
- Clearly Defining Benefits
- Costs and Who Pays

Backup

Assumptions

- Any changes in Oceanic services should provide safety enhancements, reduced risk to aviation, enhanced capacity and/or improved operational efficiency that are cost and environmentally beneficial to the aviation community.
- Delivery of performance based separation (or ATM) capabilities should maximize the use of current equipage that is compliant with current FAA C/N/S standards with no broad-based fleet upgrades required, although minor upgrades to systems could be considered to make it more robust.

Assumptions (cont.)

- A clear statement of requirements (e.g. desired separation standards, etc.) should be established with appropriate performance references to guide the assessment of implementation alternatives.
- Deployment of enhanced surveillance services over the ocean will not affect the current FAA ADS-B Out 2020 mandate, and not add to the mandate.
- Delivery of benefit may require comprehensive training of controllers, pilots and dispatchers, updating automation, and decision support tools.
- Reduced separation is the predominant goal of enhanced surveillance.

Guiding Principles

- The resulting set of recommendations will be transparent and objective, clearly laying out the methodology that the group employed to reach consensus on the specific recommendations.
- The final recommendation must address closing the business case for operators and the FAA.
- US operators should not be financially or operationally penalized under the final recommendation.
- Transitions between air service providers should be considered as part of the integration.

Guiding Principles (cont.)

- Enhanced Surveillance services will be introduced by regions or routes based on a assessment of needs, benefits and costs.
- FAA implementation of recommendations might require reducing budget allocation for lower priority initiatives or capabilities.
- Provider/Supplier input is important in the process of information gathering and understanding of issues, operational concepts, technologies and potential benefits, but entities with a direct financial gain are limited to serve as SMEs and not in the development of the final recommendation as well as any meetings/data sharing of specific cost/benefits calculations.

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Summary of Meeting and Next Steps

DFO and NAC Chairman Closing Comments

Concluding Items

- Action Items
- Other Business
- 2017 Meetings
  - February 24th
  - June 30th
  - October 6th

RTCA

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Adjourn

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RTCA Paper No. 155-16/NAC-041

June 24, 2016

Meeting Summary, June 17, 2016

NextGen Advisory Committee (NAC)

The eighteenth meeting of the NextGen Advisory Committee (NAC) was held on June 17, 2016 at The Boeing Company, Arlington, VA. The meeting discussions are summarized below.

List of attachments:

- Attachment 1 - Attendees
- Attachment 2 - Presentations for the Committee meeting - (containing much of the detail on the content covered during the meeting)
- Attachment 3 - Approved February 25, 2016 Meeting Summary
- Attachment 4 - NAC Chairman's Report
- Attachment 5 - FAA Report from The Honorable Michael Whitaker, FAA Deputy Administrator
- Attachment 6 – presentation

Welcome and Introductions

Chairman Anderson opened the meeting at 8:55 a.m. by thanking Boeing for hosting the meeting and welcoming the NAC members and others in attendance, and introducing three new Committee members:

- Carl Burleson, Acting Director, FAA Aviation Policy, Planning & Environment
- Jim Eck, Assistant Administrator, FAA NextGen
- Ginger Evans, Commissioner, City of Chicago

All NAC members and attendees from the general public were asked to introduce themselves (attendees are identified in Attachment 1).

Designated Federal Official Statement

The DFO, The Honorable Michael Whitaker (FAA Deputy Administrator) read the Federal Advisory Committee Act notice, governing the public meeting.

Approval of February 25, 2016 Meeting Summary

Chairman Anderson asked for consideration of the written Summary of the February 25, 2016 meeting. By motion, the Committee approved the Summary (Attachment 3).

Chairman's Remarks

The following is a summary of the remarks made by Chairman Anderson (Attachment 4):

He thanked Deputy Administrator Mike Whitaker for his service as FAA Designated Federal Official and his leadership in engagement with the industry in the consensus based process as the NAC seeks to implement NextGen capabilities. RTCA President Margaret Jenny also recognized him with a plaque.

He covered the three specific recommendations that the Committee would be asked to approve that day:

1. NextGen Integration Working Group 2017-2019 Rolling Plan Recommendation

The Industry-FAA Teams built upon the current industry-FAA collaborative work in the four priority areas to identify specific recommendations for implementing NextGen capabilities at specific sites in the 2017-2019-time frame. The plans include all necessary components of each capability including industry and FAA commitments necessary to implement the capabilities for:

- DataComm
- Multiple Runway Operations – Wake ReCat
- PBN
- Surface

2. PBN Blueprint Community Outreach Task Group

The Task Group developed recommendations for community outreach to assist the FAA and industry with the growing environmental challenges associated with PBN implementations.

3. Joint Analysis Team Performance Assessment of Wake Recategorization (Wake ReCat) at Charlotte and Chicago

The JAT industry-FAA team is evaluating the performance improvements attributable to the implementation of selected NextGen capabilities at specific locations. The Team, using data from FAA, individual operators and an industry-funded database developed by Passur

Aerospace will report on the methodology and results from an analysis of Wake ReCat at CLT, ORD and MDW airports.

He also pointed out that the NAC process means that members of the Committee support the recommendations once they are approved. Since 2010, this body has delivered nearly 40 recommendations to the FAA that cover:

- Prioritization of NextGen Implementation Investments & Locations
- Industry-FAA Joint Implementation Plans
- Metrics – What to Measure & How to Measure Implementation of Capabilities
- PBN – Metroplex, Single Sites, Overcoming Technical/Non-technical Barriers
- ADS-B Out Equipage
- Environmental Review Process, PBN Community Outreach

He concluded that we are all here because we believe our work is making a difference, but it is not clear that our message is getting out, and asked members to think about how they could do a better job of communicating the value of the NAC and the investments being made.

FAA Report - Mike Whitaker, Deputy Administrator, FAA

The following captures points from Mr. Whitaker's remarks. The details are contained in the FAA report (Attachment 5).

He acknowledged Ed Bolton's outstanding leadership as the head of the FAA's NextGen Office and the momentum that has been built through this collaborative work. He introduced Jim Eck, Mr. Bolton's successor, noting his significant contributions to NextGen, and assured the NAC that this will be a smooth transition.

Mr. Eck noted the need for a comprehensive plan to move forward and that the NAC was briefed on the CONOPS, which he encouraged everyone to read as it sets the guiderails for the FAA plans.

Mr. Whitaker also explained the new $500 rebate program for GA ADS-B equipment (20,000 aircraft) to encourage early equipage.

Related to ADS-B, he asked that the NAC be prepared to address the reasons and rationale for pursuing an enhanced surveillance capability in the context of the priorities they have already given, and in light of the tradeoffs that may be required. Teri Bristol explained that while the FAA has a good handle on the technology of space-based ADS-B, the FAA will be seeking recommendations from the NAC on cost/benefit and prioritization. She asked that a task group be formed to examine a requirement for enhanced surveillance in oceanic

airspace; what mechanisms might be used and at what cost; what the tradeoffs might be; and what funding models might be possible if enhanced surveillance is deemed of sufficient value.

Several Committee expediting the results of this work, reflecting industry's belief that new technologies should not be legislated but identified through collaborative processes. In response to a question about equipage, a NAC Member from an Original Equipment Manufacturer (OEM) commented that an ADS-B transceiver is sufficient for "space-based ADS-B, however additional communications equipment may be necessary depending on the existing capabilities of the aircraft."

Mr. Whitaker emphasized a key component of this work will be assessing the cost-benefit of space-based against other NextGen investments. During a discussion on need for the capability one commenter asked if capacity in the North Atlantic is an issue, and another commented that preferred altitudes is definitely a need in this airspace. It was also noted that there is a lack of ground-based Nav aid's in the Caribbean.

In conclusion, the NAC agreed that forming a Task Group is an appropriate way to proceed. The FAA is preparing an official tasking to RTCA.

The following organizations were identified as initial participants, in addition to others who might be identified from the NAC Subcommittee:

- FAA AVS & ATO
- FedEx Express
- Boeing
- MITRE
- JetBlue
- American Airlines
- United Airlines
- Lockheed Martin (Leidos)
- Harris Corporation
- IATA
- NATCA

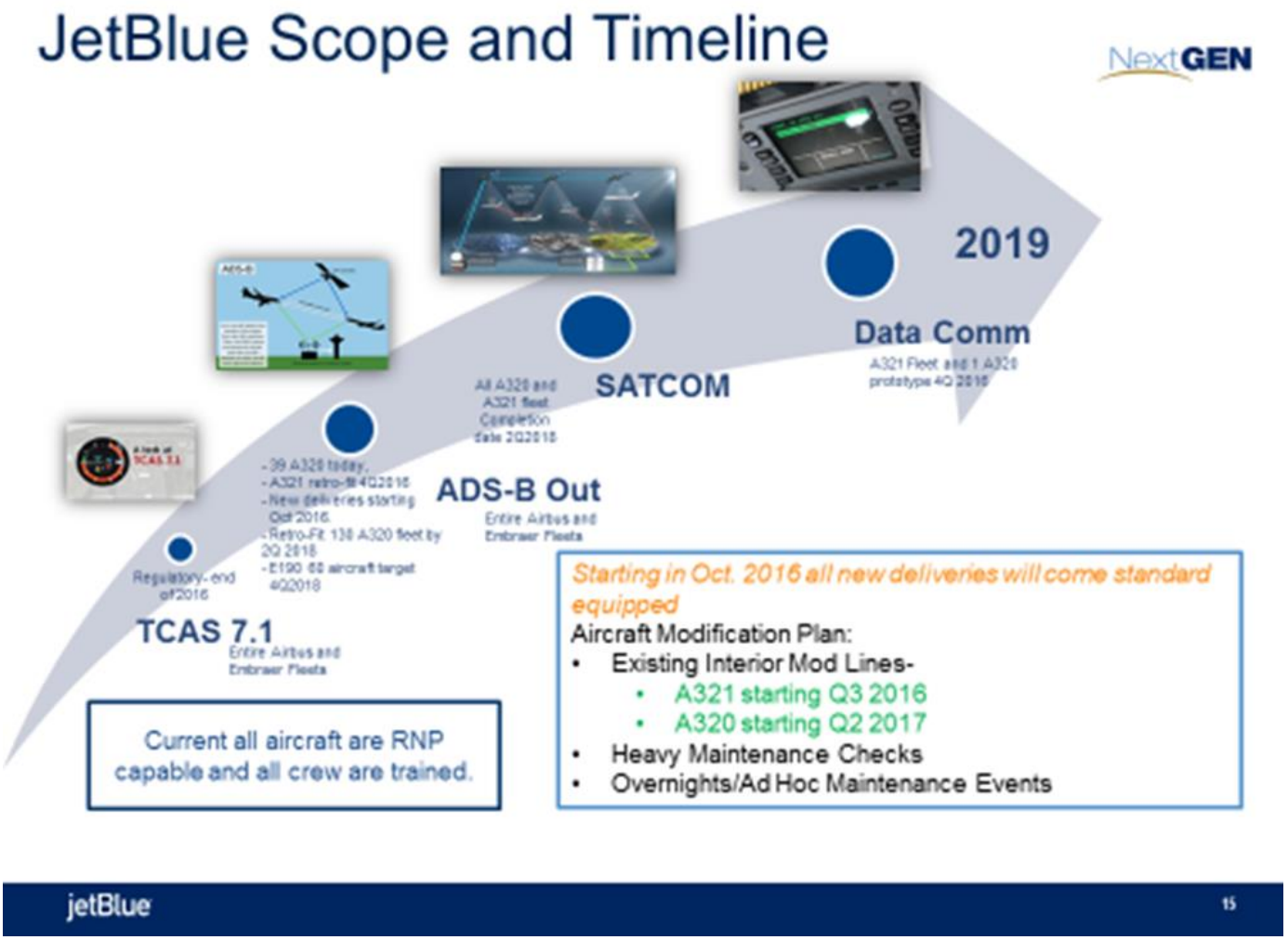
Airline C/N/S Fleet Plans—JetBlue Equipage

Bart Roberts, Vice President Flight Operations, JetBlue, presented a briefing on its C/N/S fleet plans--ADS-B, PBN and DataComm that was requested by the NAC at the February meeting.

Summary of JetBlue Equipage:

- Retrofit all Airbus 321s 2Q2017, 320's with ADSB out and Sat Comm and FANS 4Q2018
- Retrofit all Airbus 320's with ADSB out and Sat Comm 4Q2018
- Retrofit one Airbus 320 for cost/complexity evaluation 4@2016
- Update MMR's to enable situational monitoring per regulatory compliance 4Q2018
- Update Traffic Collision Avoidance System with 7.1 per regulatory compliance

Capital spending spread across 2016 to 2018 will make JetBlue a 100% RNP equipped fleet.



Mr. Roberts emphasized the importance of collaboration between the FAA and the industry as NextGen capabilities are implemented. He pointed out the benefits of DataComm and has led his company to make investments in this technology.

Chairman Anderson asked the operator community what they are doing with equipage investments beyond ADS-B 2020 compliance? He expressed the need for the NAC to better understand where the industry stands on equipage. A committee member emphasized the importance of being able to accommodate a mixed equipped fleet. Another committee member noted special challenges for Regional Airlines: pilot availability and new training requirements that is driving fleet and fleet equipage strategies.

Based on the discussion, RTCA was requested to develop list for briefings at future meetings by operators and OEMs on their fleet plans. This includes United Airlines to present at the October meeting and a regional operator representative as well.

In addition, Airbus was also requested to present at next meeting, followed by Honeywell and other OEMs.

As the discussion concluded, a Committee Member stated that operators and OEMs should communicate how the capability equipage leads to specific results.

How do we demonstrate the value of NextGen and the NAC?

Picking up on earlier comments, Chairman Anderson asked how the achievements and message about the NAC and NextGen could be more clearly conveyed to Congress and the public. He then led a discussion on focusing more attention on public relations and communication.

An initial comment from a Committee Member stated that the focus on the "what" and "how" of implementing NextGen can cause the industry to lose track of the "why"? It is important to emphasize how the implementation helps achieve the goals of NextGen. Goals includes more access to airports/airspace, improved safety, a reduced environmental footprint, which means getting the most out of system/capabilities. Essentially, why does what we are doing matter and how is it affecting our desired goals? Are we moving more aircraft through the system? Is it safer? Is there less environmental impact? Can operators run a more predictable operation?

Some in the industry and on Capitol Hill have asked, "what is the next big thing?" We should consider concentrating on "fixing" a large Metroplex and build support with a compelling story for NextGen. A Committee Member stated that in the metropolitan areas, the industry is running out of space to build more runways. NextGen adds capacity without the requirements of time, environmental approvals, investments needed for new concrete. A

follow-on comment expressed the need for ways to better communicate that people are benefiting is to make it relevant to them—direct benefits, increased numbers of people flying, more options for flights, locations, capacity – all without new runways.

Chairman Anderson noted the constraint of geography, pointing out that, New York goes so quickly to the National Airspace System (NAS). Mr. Whitaker suggested that rather than picking a site, we should let an airport or Metroplex pick us. They should line of support for a location and get a community to line up support?

Progress was summarized by a participant as a transformation of the NAS and implementation of NextGen that comes from evolution—you have to evolve to transform, it is not a big bang.

Other comments made include:

- Predictability is key for the passenger – working towards making IFR like VFR
- Need for the community to step forward, and explain how infrastructure in the sky may not be as tangible as roads and railroads, but it is just as important to the Nation's economy.
- It's important to have unified message about performance metrics – train people to communicate the message
- People living near airports want to know what will happen to them
- It's important for the work of the AdHoc to include what FAA has been communicating/saying; there is no need to reinvent information
- Operators are already harvesting benefits – aircraft turns system benefits
- Caution against painting too rosy a picture of implementations, and potentially raise questions about future investments.
- Air Traffic Controllers need decisions support tools to make NextGen capabilities such as PBN deliver benefits
- It is informative to look at the impact of NextGen from a Cruise-to-Cruise perspective rather than Gate-to-Gate.

Concluding the discussion, Chairman Anderson stated that the industry must tell the story of the benefits by focusing on three key points: 1) safety first – and we have never been safer; 2) environment – we are the only airspace system with a 2% reduction in emissions per year with a goal of carbon-neutral growth; 3) operational performance – airlines are running at 99% completed flights nearly every day.

An AdHoc of the following entities was identified to work on promotion and report back at the October NAC meeting: NBAA, NOISE, FAA (ATO, ANG, ARP), AIA, ATCA, PASS, NATCA, MITRE, American Airlines (NACSC Leadership).

ADS-B Update

Bruce DeCleene, Manager, Flight Technologies and Procedures Division, FAA, gave a status update about the latest equipage statistics and noted that the status of supplier-solution availability is good. He noted that attention is moving beyond just asking if planes are equipped, to determining if they are operating in compliance. GA numbers are well below where they should be, which has led to the rebate program. He noted the NAC attention has also led to increased equipage and compliance numbers for commercial operators. A Committee Member noted that there is a need to determine ADS-B requirements and an equipage path for Unmanned Aircraft Systems (UAS). It was suggested that this be an initial request of the new Drone Advisory Committee because ADS-B equipage is crucial for integrating UAS into the NAS.

Another NAC Member thanked the FAA for the rebate program, anticipating that it will make a difference in increasing equipage for General Aviation operators.

NextGen Integration Working Group (NIWG) 2017-2019 Rolling Plan

The Industry-FAA Teams have developed specific recommendations for implementing NextGen capabilities at specific sites in the 2017-2019-time frame for:

- DataComm
- Multiple Runway Operations – Wake ReCat
- PBN
- Surface

The NIWG Executive Team Members Teri Bristol, FAA Air Traffic Organization, and Steve Dickson, Delta Air Lines, opened the NIWG discussion noting the hard work of the teams that was necessary to arrive at a consensus-driven set of. Ms. Bristol announced that the FAA reached a positive final investment decision (FID) for Terminal Flight Data Manager (TFDM) on June 16. She reminded the NAC of three different types of recommendations:

1. Implementation capabilities where industry agreed on recommendations for specific capabilities to be implemented at specific locations in a specific timeframe

2. Pre-implementation capabilities where we all agree we want to take action but do not have the necessary information to make a firm commitment – in these cases the groups are recommending studies be undertaken to determine what is possible
3. Industry commitments—operators stepping up to serve as lead operators as we work to implement these capabilities

The FAA will respond with a final decision on commitments and document these in an executive report to the NAC Subcommittee in August and the NAC in October.

Mr. Dickson reinforced the need for flexibility, adaptability, and stretch goals. He emphasized the tension between transformation and evolution of the system—lining up improvements with longer-term goals. We have also included stretch goals. The industry with the FAA will learn from success and failure.

The Industry Leads and the FAA Subject Matter Experts (SMEs) for each of the four focus areas presented reports on the existing commitments (the names of the presenters are highlighted):

DataComm

FAA SMEs: Paul Fontaine (ANG), Jessie Wijntjes (ATO)

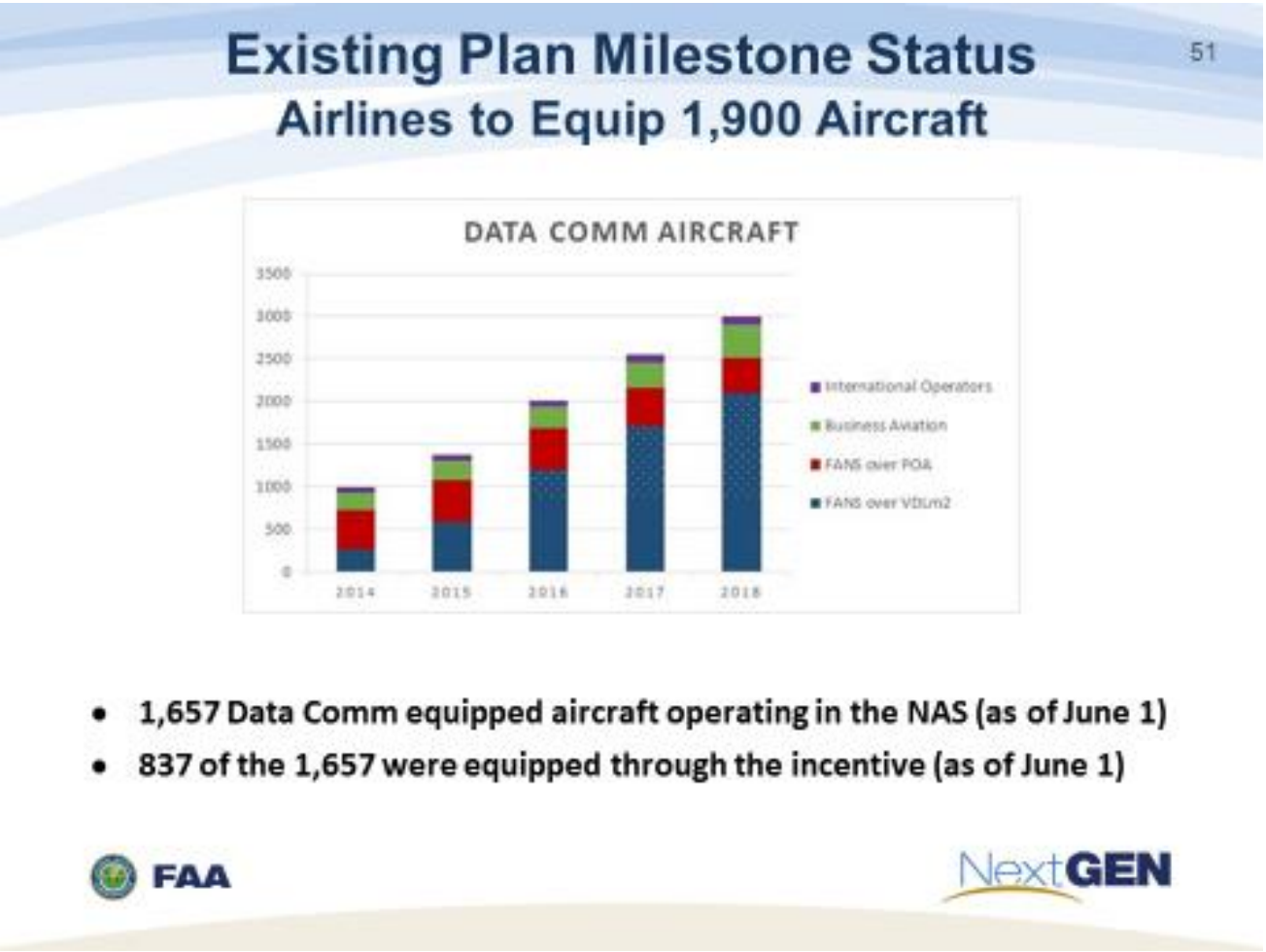
Industry Leads: John O'Sullivan (Harris Corporation), Chuck Stewart (United Airlines)

Mr. Wijntjes reported that the departure clearance tower services installations in the current NIWG plan are 20 months ahead of schedule with more than half of the waterfall finished.

Mr. Stewart presented the rolling plan components for DataComm:

- Continue accelerated DataComm tower services deployment
- Continue deployment of current baselined EnRoute initial services
- Develop baseline for currently budgeted full EnRoute services
- Develop baseline for remaining EnRoute full services
- Consider FANS 1/A over VDL Mode 0 as a viable medium for DataComm EnRoute
- Ensure operators are equipping at least 1,900 aircraft

Chairman Anderson commented that the industry must be ready to use this capability and asked that the DataComm equipage chart be shared at each meeting.



Multiple Runway Operations (MRO)

FAA SMEs: Jennifer Post (ATO), Paul Strande (NG)

Industry Leads: Glenn Morse (United Air Lines), Jon Tree (The Boeing Company)

Prior to covering the rolling plan, Ms. Post explained that the Wake ReCat assessment was completed and that the team is looking at operational impacts and benefits to determine sites where the FAA-industry gets the best return on implementations. Wake ReCat was implemented in SFO (NorCal TRACON) and is on track for ANC and LAX (SoCal TRACON).

The rolling plan presented by Mr. Morse is comprised of the following:

- Continue Wake ReCat 1.5 and 2.0 implementations at additional sites
- Continue safety analyses and publication of new separation standards and pursue supporting RNAV procedure development
- Complete analysis of Vertical Navigation Requirement (VNAV) for Simultaneous Independent Parallel Instrument Approaches to Closely Spaced Parallel Runways

- Complete assessment of potential benefits and facility requirements for upgrade of existing Wake ReCat Phase 1.5 sites to Phase 2.0
- Complete assessment of Time Based Separation (TBS) on final approach for use in the NAS as a transition to dynamic pair-wise wake turbulence separation standards

Surface

FAA SMEs: Ben Marple (ANG) and Susan Pfingstler (ATO)

Industry Leads: Rob Goldman (Delta Air Lines), Steve Vail (Mosaic ATM, Inc.)

Ms. Pfingstler provided an update on current plans, explaining that that the Advanced Electronic Flight Strips (AEFS) prototype installations in CLE and PHX continue to be operational and will remain so until replaced by TFDM. She also noted that there have been some stability issues, so SFO and LAS will go operational in new towers with paper strips. They will monitor new builds and revisit implementation in early 2017.

Mr. Goldman shared the following components of the Surface Team rolling plan, noting that the just-announced FID for TFDM is a crucial step towards surface capabilities.

- Implement Capabilities outlined in the Surface Collaborative Decision Making CONOPS & Terminal Flight Data Manager (TFDM) Program
    - Complete demonstration of departure metering at Charlotte Douglas International Airport (CLT) through the Airspace Technology Demonstration 2 (ATD-2) project
    - Electronic flight strips
    - Departure queue management
    - Traffic Flow Management system integration
- Increased data sharing
    - FAA – Surveillance information sharing
    - Flight Operators – Data elements
    - Airports – Pilot airports expanding participation in collaborative decision making
- Establish on-going industry engagement with FAA TFDM/Surface decision support tools, processes, procedures & policies

The importance of continuing to move forward on the ATD-2 work at CLT was emphasized by a Subcommittee leader.

Performance Based Navigation (PBN)

FAA SMEs: Donna Creasap (ANG), Josh Gustin (ATO)
Industry Leads: Gary Beck (Alaska Airlines), Steve Fulton (Sandel Avionics)
Providing a brief update on existing work, Mr. Gustin noted that all Metroplex work is on track and that the public workshop in CLT was key to moving that work forward. The Established on RNP (EOR) waiver in DEN led to the national standard, which was just wrapped up and is about a year earlier than planned. Mr. Fulton then shared the components of the PBN rolling plan.

- Established on Required Navigation Performance (EoR) – EoR w/ Radius-to-fix (RF), EoR w/ Track-to-fix (TF), assessment of TF/RF Concurrent Operations
- Metroplex – tracking milestones at three locations
- Established on Departure Operations (EDO) – FAA assessing concept viability
- RF to xLS (RF/TF) – Assessment/identification of pre-implementation milestones
- Optimized Profile Descents (OPD) - Area Navigation (RNAV) Standard Terminal Arrivals (STARs)
- Enhanced Flight Vision Systems (EFVS) – implementation of new capability
- Advanced RNP (A-RNP)
- New Vertical Guidance
- Departures – RNP and RNAV
- Seattle Greener Skies - Actions TBD after assessment

Chairman Anderson asked for a motion and obtained approval of the recommendations for the NIWG rolling plan. He noted that the FAA will respond with an executive report and will present it to the NAC in October. The plan will also be communicated to Congress.

PBN Implementation

Bruce DeCleene, FAA, and Jeff Woods, National Air Traffic Controllers Association (NATCA), updated the analysis of the Seattle Greener Skies PBN implementation in response to the action item from the last meeting. The purpose is to determine what is necessary to bring Greener Skies improved benefits to fruition. “What went wrong with Greener Skies and how do we fix it?”

Mr. DeCleene shared the results of FAA research into the status of the Greener Skies work at Seattle, noting that it was a three-part project: 1) design procedures and coordinate with the community; 2) determine how to use them to look at changes in separation standards; 3) implement changes. DeCleene shared that Seattle had three runway closures in a row, which limited use and therefore impacted controller and pilot desire to use it. Additionally, there were some deviations that led controllers to be skeptical of using the procedures.

Procedures have been adjusted and will be published next month to address these deviations and utilization is expected to increase.

A discussion was prompted related to change management critical to successful PBN implementation, not just fielding procedure- post operational implementation to evaluate use, achievement of intended purpose, use by controllers, pilots, availability of necessary ATC decision support tools, etc.

Mr. Woods explained that the key to Greener Skies was collaboration between controllers, pilots and FAA in identifying solutions. He also noted that it is important to recognize that the more automated we get the more complicated we get.

A Committee Member also highlighted the importance of working through the issues associated with workload in the cockpit.

In concluding the conversation, another Committee Member expressed the need to incorporate the Greener Skies next steps into the tracking of PBN NIWG.

Joint Analysis Team (JAT)

The JAT industry-FAA team is evaluating the performance improvements attributable to the implementation of selected capabilities at specific locations to develop a common statement of facts on NAS performance attributable to NextGen. The Team is supported by data from FAA, individual operators and an industry-funded database being developed by Passur Aerospace. Co-Chairs Ilhan Ince, American Airlines, and Dave Knorr, FAA, reviewed the findings from the Team on operational performance changes as a result of implementing Wake ReCat in CLT and Chicago.

They explained that the JAT agreed on a methodology to determine Wake ReCat impacts and benefits, and validated the consistency of data sources among the FAA, American and United Airlines, and PASSUR. Agreement was reached on findings and statements of facts, which built trust and confidence among the team members. The findings conclude that fleet mix and demand levels are critical drivers of Wake ReCat impact. Additionally, operational data demonstrates that Wake ReCat achieves changes in separation as expected. Finally, the before-and-after empirical analyses of terminal area, taxi times, and throughput are inconclusive due to exogenous factors. PASSUR data has been compared to FAA and industry data and may be used for Wake ReCat analysis.

The Co-Chairs reviewed the following specific findings:

- Fleet mix and demand levels are critical drivers of Wake ReCat impact

- Operational data demonstrates ReCat achieves changes in separation as expected
    - Before and after empirical analysis of terminal area and taxi times, as well as throughput, inconclusive due to exogenous factors, e.g. changes in demand, weather, airport construction, etc.
- **Airborne and taxi-out savings** expected for ReCat-impacted flights on runways experiencing pressure
    - Includes propagation of changes in separation onto subsequent aircraft when pressure/queueing is present

Implications of Wake ReCat		Airports		
		CLT	ORD	MDW
Estimated total annual savings in Airborne and Taxi Out Time due to ReCat[2]	Airborne	$180K	$590K	-$2K
	Taxi Out	$57K	$360K	-$32K
	Total	***$237K***	***$950K***	***-$34K***

- **Throughput improvement** expected when ReCat-impacted flights operate in peak airport demand
    - Modeled throughput based on actual separation changes suggests improvement in throughput
    - Throughput improvements empirically observed at ORD for IMC peaks when ReCat pairs exist, but not sustained enough to justify increase in called rate

Implications of Wake ReCat		Airports		
		CLT	ORD	MDW
Modeled Potential Change in Throughput During Peak Periods due to ReCat (Operations per hour)	Arrivals	0.5	1.8	0.1
	Departures	0.6	1.5	-0.4

At the conclusion, it was noted that the JAT's Wake ReCat methodology will be leveraged by the FAA and industry to prioritize future Wake ReCat implementations.

The JAT will make their next assessment of North Texas Metroplex and will explain their current plans for conducting this assessment at the October NAC meeting.

Chairman Anderson asked for a motion to approve the recommendation that was subsequently approved by the NAC.

PBN Blueprint Community Outreach Task Group

Co-Chairs Jim Crites, DFW International Airport, and Brian Townsend, American Airlines, presented for NAC approval a comprehensive recommendation for the FAA with the following major elements:

- Establish specialized Community Outreach Team(s)
- Develop a standard Community Outreach Toolkit
- Develop specific Local Community Outreach Toolkits
- Establish ongoing and scalable Community Outreach Programs in collaboration with local airports

The Co-Chairs emphasized the findings from the work of the Task Group that identified the need for outreach. Failure to have a coordinated effort has led to significant problems in certain locations. They also explained the importance of having FAA experts trained to conduct outreach, along with engagement by airport and aircraft operators.

A Committee Member agreed with the recommendations, emphasizing that early engagement is the most important aspect to local communities. An FAA NAC member also commented that outreach is the "right thing to do," but everyone involved must recognize that real engagement will take more time on the front end, but accomplish a better result.

Chairman Anderson asked for a motion and obtained approval of the PBN Blueprint Community Outreach Task Group recommendation.

PBN Time, Speed, Spacing Task Group

Task Group Co-Chairs Dan Allen, FedEx Express, and Steve Fulton, Sandel Avionics, provided an interim report on work to develop a 15-year plan for deployment of PBN in 5-year increments: near-term, 2016-2020; mid-term, 2021-2025; and far-term, 2026-2030. The report identifies and prioritizes tools and technologies ground vs. aircraft. The first two time frames are ground based metering/decision support tools for terminal, TRACON and EnRoute, with longer-term questions about aircraft based metering.

Picking up on the theme from the earlier presentation on Greener Skies, a Committee Member stressed the importance of the cultural issues associated with transitioning to time-based spacing responsibilities of controllers. The Member also questioned the additional investment for aircraft capabilities and the increased responsibilities for the pilot. Another commented that the cultural issues of controllers and pilots is crucial, along with the tools and operational relationships and division of responsibilities.

Mr. Allen committed to cover the cultural aspects in the final recommendation.

Another Committee Member asked about the tools for synchronizing and coordinating trajectories among automation platforms and whether they share a single trajectory model. Mr. Fulton replied that Time Based Flow Management (TBFM) has a central scheduling function, harmonizing between ground-aircraft. Mr. Allen also commented that every decision support tool is fed by the same TBFM engine.

Chairman Anderson asked about the end-state goals for the NAS. Mr. Fulton explained that predictability is enhanced by tools, along with PBN efficiency, fuel savings, and reductions in overall time. The final comments from a Member stressed the need to consider how airport capacity and capabilities are in-line with potential increases in traffic from TSS.

The task group will provide a final report in October.

Summary of the Meeting and Next Steps

The NAC Secretary summarized the following actions from the meeting and follow-up items:

Action Item	Responsible Entity	Completion Date
Enhanced Surveillance – a pending tasking to examine its application in US-controlled oceanic airspace from spaced-based ADS-B. Specifically, the group will examine the following: • The cost and benefits of deploying and equipping for this capability • What problem it will solve • It's priority relative to other NextGen capabilities	RTCA	Interim October 2016 Final February 2017

Initial group to include: ○ FAA AVS & ATO ○ FedEx Express ○ Boeing ○ MITRE ○ United Airlines ○ Lockheed Martin (Leidos) ○ Harris Corporation ○ IATA ○ NATCA		
Present a report from an operator of a local PBN implementation to highlight benefits of implementation and what occurred – "what worked, what didn't and what can we do going forward?" Set up a plan going forward to have PBN briefings at subsequent NAC meetings.	FAA/RTCA Southwest/United brief - DEN EOR Oct 2016	October 2016 and future NAC meetings
Manufacturer briefing on NextGen equipage plans – standards, technologies and pathways for the retrofit of existing aircraft.	RTCA Airbus	October 2016
Ad Hoc tasked with developing a unified, crystalized message – demonstrating the value of NextGen capabilities being deployed as a result of the government-industry collaboration on the NAC. NAC Member participants to include: ○ NBAA ○ NOISE ○ FAA ATO, ANG, ARP ○ AIA ○ ATCA ○ PASS ○ NATCA	RTCA	Interim October 2016 Final February 2017

○ MITRE ○ American Airlines (NACSC Leadership)		
Briefing for the Committee on Airline C/N/S fleet plans—ADS-B, PBN, DataComm. List of operators being developed as well as a matrix of equipage.	RTCA United & SkyWest (Regional Operator)	October 2016 and future NAC meetings
Carryover from June meeting - Presentations on future of the National Airspace System:	1. NASA 2. DoD	TBD

DFO and Chairman Closing Comments

Mr. Whitaker and Chairman Anderson both thanked the members for their participation in the meeting, and the continued work on the NIWG priorities and metrics.

Other Business

No items were requested or discussed.

Adjourn

By motion, Chairman Anderson concluded the meeting of the Committee at 2:42 p.m.

Next Meeting

The next meeting of the NAC is October 2016 in Orlando, FL, hosted by JetBlue.

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TERMS OF REFERENCE

NextGen Advisory Committee

Committee Leadership:

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Designated Federal Official	Victoria Wassmer, FAA Acting Deputy Administrator	FAA	(202) 267-8111	victoria.wassmer@faa.gov
Secretary	Andy Cebula	RTCA	(202) 330-0652	acebula@rtca.org

Background: NextGen offers the United States the unprecedented opportunity to increase the safety, predictability and environmental performance of aviation. The FAA seeks to establish an ongoing venue and process to enable stakeholders to advise the FAA on issues related to near- and mid-term implementation by providing a shared vision of NextGen for domestic and international arenas.

Purpose and Scope: The NextGen Advisory Committee will develop a common understanding of NextGen priorities in the context of overall NextGen capabilities and implementation constraints, with an emphasis on the near-term and mid-term (through 2018). The Committee provides a venue where the FAA can solicit a consensus-based set of recommendations on issues that are critical to the successful implementation of NextGen. It is also a forum to obtain a commitment of resources and/or synchronized planning between government and industry that will support and, when necessary, identify opportunities for industry participation in NextGen implementation. In conducting its work, the Committee will foster a common understanding of success with joint performance objectives and development milestones to be reviewed as implementation progresses. The Committee will primarily focus on implementation issues including prioritization criteria at a national level, joint investment priorities, location and timing of capability implementation. The Committee will provide a venue for the FAA as well as industry partners to report on progress on the implementation of NextGen operational capabilities and associated airspace performance improvements.

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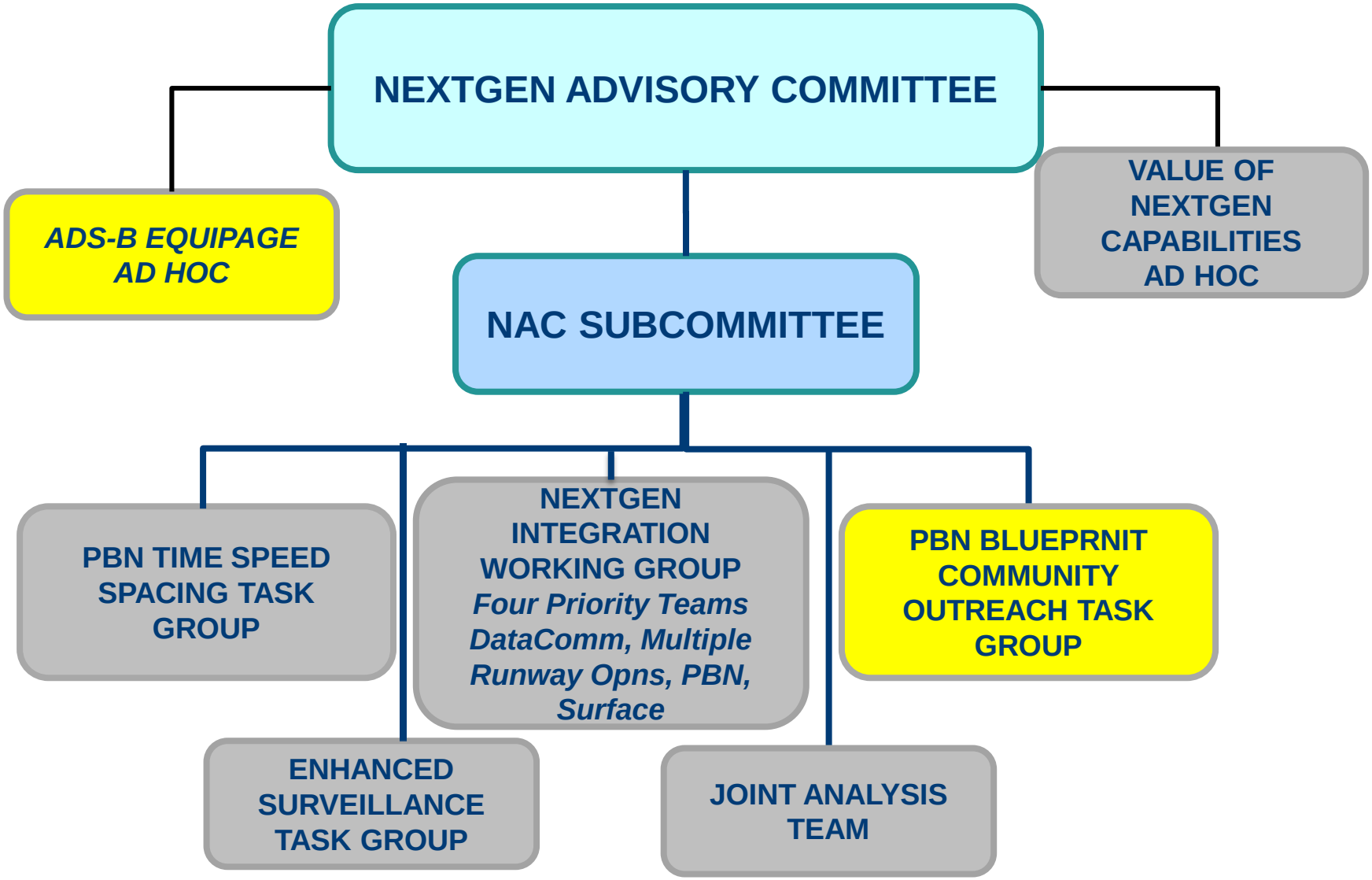

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RTCA Paper No. 242-16/NAC-043
October 5, 2016

TERMS OF REFERENCE

NextGen Advisory Committee

Committee Leadership:

Position	Name	Organization	Telephone	Email
Chairman	Richard Anderson	Delta Air Lines	(404) 715-1247	Richard.Anderson@delta.com
Designated Federal Official	Victoria Wassmer, FAA Acting Deputy Administrator	FAA	(202) 267-8111	victoria.wassmer@faa.gov
Secretary	Andy Cebula	RTCA	(202) 330-0652	acebula@rtca.org

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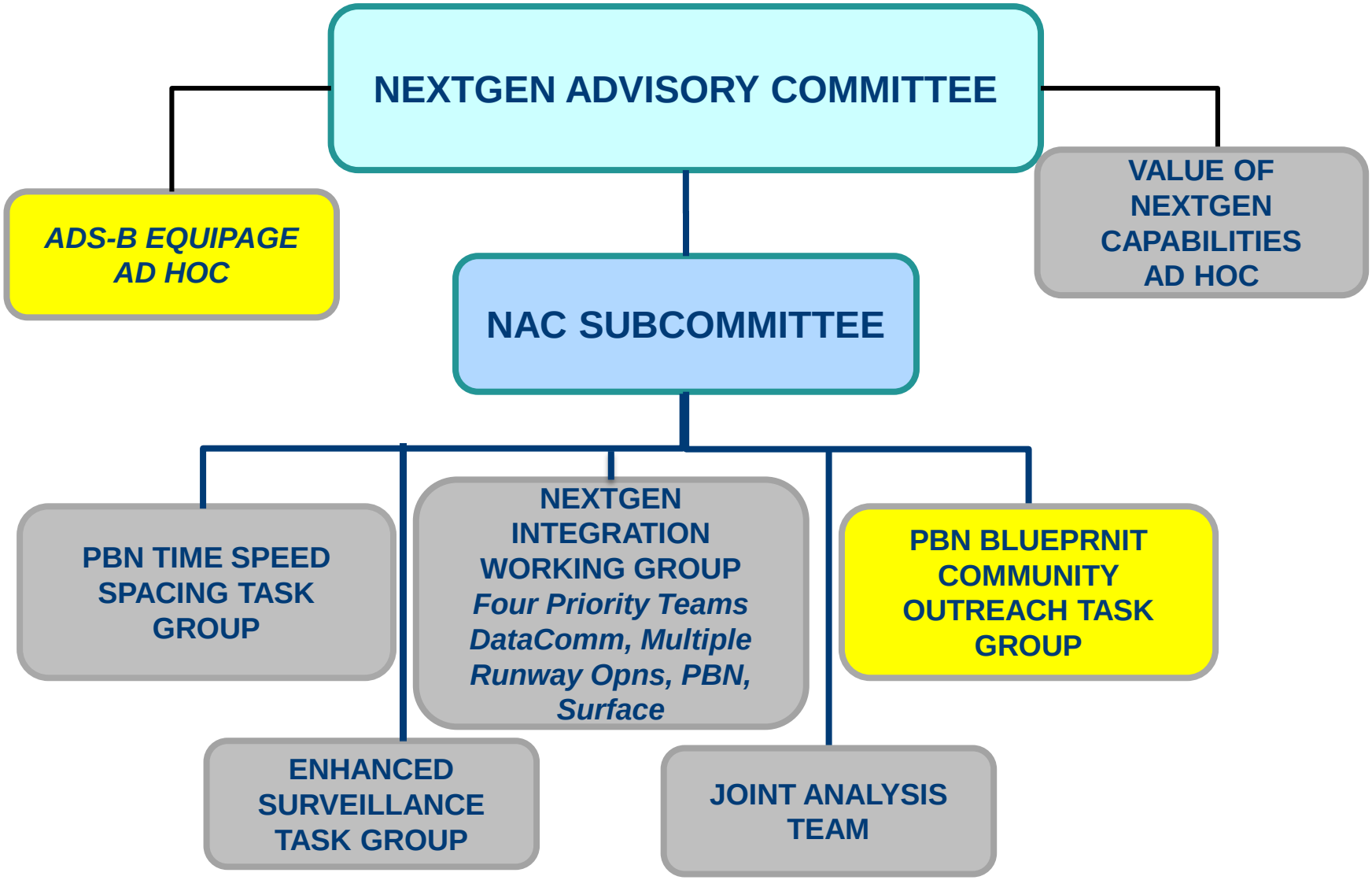

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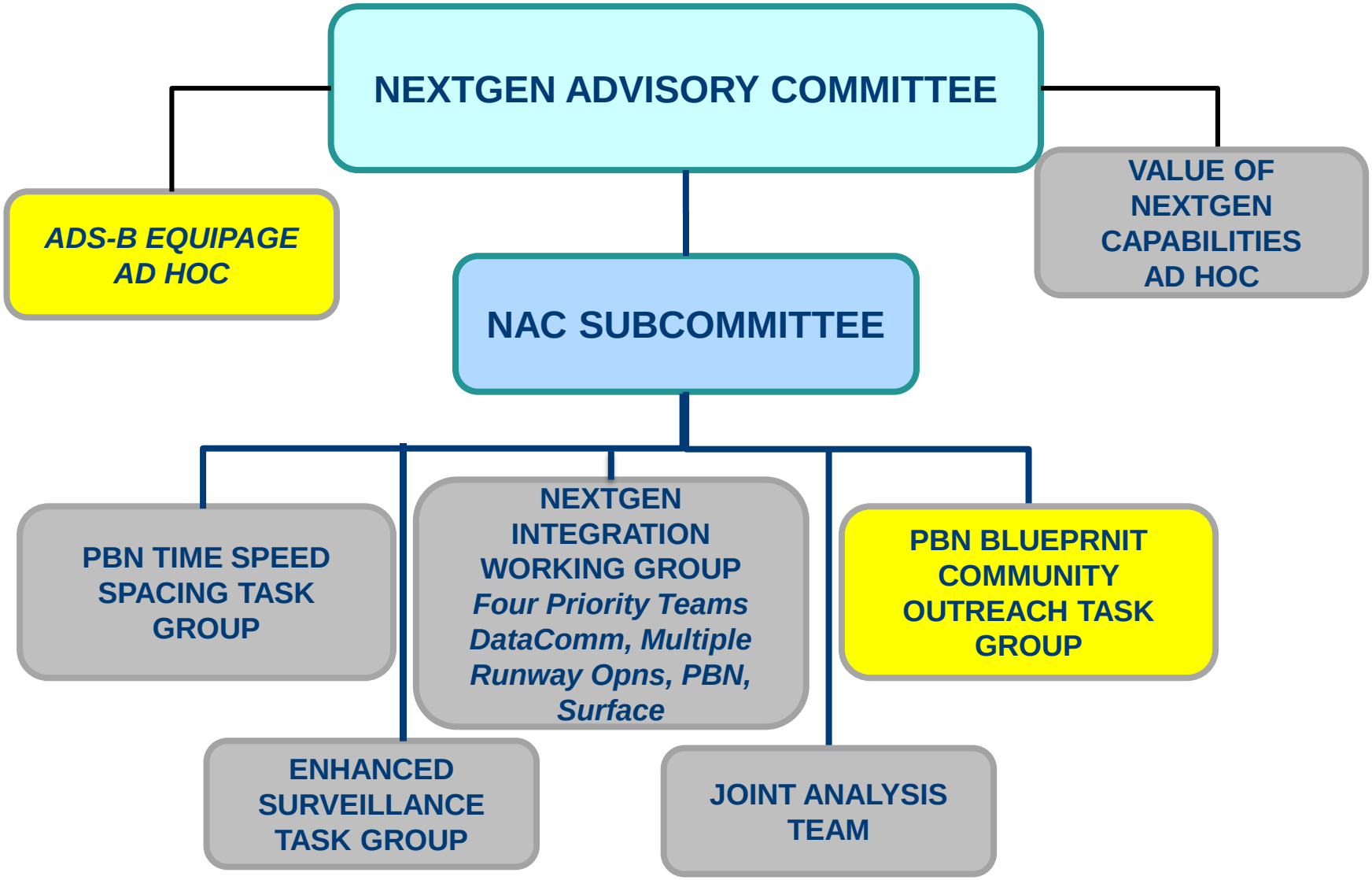


NextGen Advisory Committee Chair, Richard Anderson
Chair Report, NAC Meeting- October 5, 2016

Thanks to FAA – Administrator Huerta

- Foresight to establish the NAC in 2010
- NAC has provided numerous recommendations that can lead to demonstrable improvements in the efficiency and capacity of the aviation system

Collaboration and Commitments

- Need to continue to build on strong foundation of collaboration with FAA - 8 years (Task Force 5 and NAC)
- Important for FAA to be open to industry inputs/priorities
- Important for FAA to commit to specific dates and locations
- Important for Industry to make commitments and be accountable
    - Executive level commitment to collaboration
- Industry must continue to work together –
    - Operators—airports—automation providers—controllers—pilots—DoD
- A major constraint to NextGen is equipage, but it is a DUAL constraint, a chicken-and-egg. The operators will equip if they are confident that the FAA will deliver on its commitments. FAA relies on operators to equip to take advantage of NG capabilities
- Way to do that is to have broader/deeper participation from industry. More airlines, more stakeholders

Goal: IFR=VFR

- The NAC has set an overarching goal of NextGen to achieve VMC performance in IMC conditions leading to increased predictability along with reduced delays and flying time.
- The ATC system should operate the same as a VFR day when the weather conditions are CAT I IFR. If we could accomplish this goal, we will have vastly improved the ATC system efficiency.

Keep it simple

- Look at high level metrics. See BTS data for carriers.
- A simple, quick measurement system for the Next Gen implementation must be in place for all undertakings.
- This must be focused on the system delivering operational benefits not simply tracking program milestones.
- Transparency of data and quick methods to evaluate results are basic requirements.
- The industry and the FAA must avoid time consuming efforts and complicated negotiations to devise and put in place basic metrics.
- The Joint Analysis Team is providing a venue to foster this effort.

Risk Management, Safety Assessments

- We need to do a better job of managing risk associated with the introduction of new operational capabilities into the NAS.
- Measurement like we do for maintenance and creating of the Minimum Equipment List (MEL)
- Good (or bad) recent example is EOR. Risk should be managed more like the Maintenance Study group (MSG). Safety does not rely 100% on automation and safety cases need to broaden their perspective. There are multiple ways to mitigate risk, and we need to employ a multi-tiered safety system. Decisions should take all those systems and layers into account.

Next Big Thing

- For NextGen to succeed, we need to solve New York - nothing will move the needle on performance like fixing New York.
- A major problem is noise.
- If we don't have North East regional undertaking, we are not deploying NextGen.
- Recognize challenges up front and work to mitigate them.

NAC accomplishments

- Priorities – Top 4 capabilities being deployed
- Metrics (Keep it Simple!)
- Industry commitment to equipage
- Part 121 operators have never run as well as now (see BTS stats)

Going Forward

- Follow through on current taskings –
    - Setting priorities and following through – with some stretch goals
    - Evaluate implementations – Joint Analysis Team
    - Time Speed Spacing (ground-based controller traffic flow management decision support tools fully deployed as soon as possible, leading to ultimate cockpit-based capabilities) - See this through.
    - Enhanced Surveillance, (Space-based ADS-B)
    - Communicating the successes - reporting results and communicating builds support for work that should be funded, proof of success will be required to garner confidence
- Continue close, consensus based, transparent collaboration between the FAA and the aviation industry, with investment priorities being driven by the operators. Stay at the NAC table, make change happen. RTCA's collaborative, consensus-building process is the best approach to modernizing the Air Transportation System

Victoria Wassmer and Michael Huerta
NextGen Advisory Committee
Washington, D.C.
October 6, 2016

Michael Huerta starts the meeting:

Thank you, Richard, (*Anderson, NAC Chairman*) for that introduction and good morning everyone.

I'm happy to be joining you today so that I may officially introduce Victoria Wassmer to you. I recently asked Victoria to step into the role of Acting Deputy Administrator.

Victoria brings more than 20 years of experience of leadership in both the private and public sectors, most recently as the FAA's Assistant Administrator for Finance and Management, where she directed the agency's budget and a workforce of 3,500 employees.

She has more than 10 years of experience working at the FAA, which has enabled her to step into her new position and hit the ground running.

One of the most important responsibilities in her new job is serving as the FAA's Chief NextGen Officer.

She has already immersed herself in the day-to-day activities of our dynamic NextGen organization.

Victoria also has taken over former Deputy Administrator Mike Whitaker's role as Designated Federal Official for the NextGen Advisory Committee.

I know you will welcome her and, like me, you'll enjoy working with her.

Over the past several weeks, I've had the privilege of talking quite a bit about the successes of NextGen.

After so many years of doing foundational work, it's a pleasure to see how quickly we are fielding key technologies and capabilities.

When I spoke to the Aero Club of Washington a couple of weeks ago, I described NextGen as being nothing less than the reinvention of the way we manage air traffic.

One of my predecessors compared it to changing the tire on a moving car. But I amended that that slightly. It's like changing the engine on a moving jetliner. At altitude.

The nice thing about where we are with NextGen now is that it's no longer a "someday" project. Thanks to this committee's efforts and our continued collaboration, we are delivering results every day.We all have much at stake in the success of this effort, and it is a tribute to the collective collaboration with industry that we are seeing these positive results.

I think it's a testament to the work of this group that we -- and the industry as a whole -- consider the NextGen Advisory Committee as an example of how a regulator should work with stakeholders to solve challenging issues.

We are now using a similar collaborative approach with the recently formed a Done Advisory Committee, or DAC, which met last month for the first time.

The DAC is comprised of a wide variety of interested parties from across all of aviation.

In the coming months, the members will establish their priorities and begin to tackle the many policy and operational challenges before us as we continue the safe integration of drones into the National Airspace System.

Before I hand over the podium to Victoria for the balance of our NextGen report, I'd like to acknowledge our outgoing chairman, Richard Anderson.

Richard, as many of you know, is a "detail" guy.

I recall the summer before last, we had a couple of construction projects in Newark and San Francisco that were going to significantly cut capacity

Air Traffic asked me to call the CEOs of the affected airlines and explain the situation. Richard immediately asked for a meeting.

When he came into our office, he had the schedule for SFO broken down into 15-minute increments. "Now, where exactly do we have the problem?" he asked.

Richard brought that same level of attention to the NAC, and I think we all can agree that his energy and enthusiasm is of great value.

Richard's efforts -- specifically to bring all of the operators together to meet the ADS-B mandate and to talk about the various operational challenges before us – inspired all of us to roll up our sleeves.

Thank you for your leadership.

Now I'll turn it over to Victoria.

Victoria now delivers the rest of the FAA Report.

Thank you, Michael. I am delighted to be here, and honored to have been selected as the FAA's Acting Deputy Administrator and Chief NextGen Officer.

"When I was wearing a different hat as the head of finance and management for the FAA, I knew that

modernizing our national airspace required large capital investment and that a positive return on that investment was necessary.

Collaboration

It is always exciting to join a new team, but to join one like the NAC that has a clearly established culture of hard work and collaboration is very special.

I want to mention how pleased we are with an event that Industry hosted as part of AIA's (Aerospace Industries Association) Aerospace Week on Capitol Hill a couple of weeks ago.

This special display was sponsored and then run by our NextGen program partners – AIA, Aireon, Boeing, Harris, Leidos, Rockwell Collins, Raytheon and Thales (pronounced TAL-ES).

Members of the House and Senate plus their staffs were invited to board NextGen Flight 101, an interactive

exhibit that allowed people to sit in an airline seat and view videos showing where NextGen is providing value and benefits – today - in every phase of flight.

The demonstration provided the opportunity for our congressional members and other government stakeholders to see firsthand how NextGen translates into a safer and more efficient flying experience.

The Hill day brought home what NextGen means to passengers. It was also an important opportunity to show the Hill how invested the aviation industry is in the success of NextGen.

We also condensed these NextGen videos into a message on social media. During a 24 hour period, we hit an Instagram record for the FAA with 2,200 views. All told, 64,000 people viewed the post across all of our social media platforms.

The next stop for NextGen Flight 101 is the Air Traffic Control Association's Annual Meeting next week. But we

envision this display making many stops as an important tool in conveying the NextGen message.

Progress we've made

I think it's always a good idea to take a breath and look back on all that we have accomplished so we don't lose sight of how far we have come.

Since the time of the JPDO vision document to today's NAC, we've made remarkable progress as a community.

In the two years since we agreed on the NextGen priorities, we have seen accelerated progress in every area.

We have completed more than 90 milestones ranging from large-scale Metroplex airspace redesigns to tasks as targeted as merging data streams between the FAA and airline operators.

Whether it's Wake Recat or Performance Based Navigation procedures that are getting your aircraft to their

destinations through optimized airspace, the air traffic system is more predictable and efficient than ever.

Hardly a week goes by now that we don't bring some new capability online.

I want to focus for just a minute on Data Comm because it's one of this committee's most visible successes.

Engaging with stakeholders – and getting them on board with the technology and its benefits – was one of our NextGen priorities.

We launched trials at Newark and Memphis International Airports to test equipment and develop flight deck and tower procedures.

And we worked closely with partners like United Airlines, FedEx, and UPS to measure the fuel and time savings Data Comm could provide.

It wasn't long before we heard from our airline partners on the NAC. You all asked us to prioritize Data

Comm so the industry could take advantage of its capabilities more quickly and in more locations.

We had originally created a plan that would widely deploy Data Comm at airports over the course of three years. Instead we used the lessons learned in Newark and Memphis to accelerate the schedule and condensed deployment to *one* year.

Think about that: At the beginning of this year, Data Comm was operational at five airports.

Today, it's up and running at 46 air traffic control towers nationwide, including major markets like New York, Los Angeles, and in Washington, DC.

And we are on track to have this capability at more than 50 towers by the end of the year -- *23 months* ahead of schedule.

Equipage

We're also encouraged by the way industry has equipped for Data Comm. More than 900 aircraft have been equipped through the Data Comm incentive. We are well on the way towards our initial goal of 1,900 aircraft equipped by the end of 2019 to meet the benefits case.

We estimate that Data Comm will save operators more than $10 billion over the next 30 years – along with saving the FAA about $1 billion.

Data Comm will also benefit the public that we serve by saving them time as they travel to different destinations and as goods move throughout the country in more efficient ways.

I've also been impressed by the way we've worked together to get on track for compliance with the ADS-B mandate. Two weeks ago we launched a financial incentive for general aviation aircraft owners to equip early.

We've have had a strong initial response, in large part due to the partnership of AOPA (Aircraft Owners & Pilots Association), GAMA (General Aviation Manufacturers Association_ and AEA (Aerospace Electronics Association) who helped us develop and execute the program.

The incentive program was based on feedback that **cost** is the primary barrier for fixed wing single-engine piston owners.

Thanks to the NAC discussions and exposure, we have gathered aircraft equipage plans for 90% of the air carrier fleet, and we are working with the international community as well as other federal departments and agencies to prepare them to comply with the 2020 mandate.

I understand that you are also beginning to provide more visibility into your Communication, Navigation and Surveillance (CNS) fleet plans. The NAC's emphasis on this is critical to achieving all of the benefits of NextGen.

I see that United, American and SkyWest are on the agenda to provide equipage plans today. This transparency will be a tremendous aid to future discussions about priorities and operational integration. It will help us manage expectations and perhaps reveal opportunities we might not have seen otherwise.

Response to June Recommendations

Now I'd like to discuss what we've done since the last meeting in June when we received three recommendations from the NAC.

First, we received the Joint Analyses Team's Performance findings on Wake Recat in Chicago and Charlotte. Our intent with this important work is to develop a common understanding.

We also want to make sure we're on the same page about the data we should use and the methods we should employ to make these assessments.

We've developed a common approach on how to evaluate the very complex system that is the NAS, and we maintain respect even when we disagree. Our representatives on the JAT have had some very frank and detailed conversations.

And as a result, we are in a better position as an aviation community to describe the benefit collectively. We concur with these recommendations and have made this information publicly available on our NextGen website.

Second, we've received your recommendations on NextGen Priorities through 2019. Hopefully you've had a chance to review the read-ahead Executive Report outlining our response.

I am happy to say that we've come to agreement on a joint implementation plan. And later this morning the NextGen Priorities Integration Working Group teams are going to outline our joint commitments for the next three years.

This isn’t a layup; this plan is going to require effort on all of our parts.

What does it look like now? We’ll see airspace improvements with more advanced PBN procedures that are aligned with the PBN Navigation Strategy. The NAC endorsed this strategy at its meeting in February and we recently released it publically.

As you know, some of the greatest efficiencies can be gained while an aircraft is still on the ground and at the gate and when connecting the surface to the en route airspace.

We’ll be implementing surface improvements through the deployment of Terminal Flight Data Manager (TFDM) by exchanging more data with more stakeholders. The goal is to increase predictability and provide actionable and measurable gains in surface efficiency.

For NextGen, the overarching objectives for the future remain the same — maximizing airspace capacity with more sophisticated and seamlessly integrated information about the future position of aircraft at a given time.

The PBN time-based flow management initiatives included in this plan will be a big step in getting us there.

Finally, we also received your recommendations on the PBN Blueprint for improving community engagement.

I'd like to turn it over to Lynn Ray, our ATO vice president for Mission Support, to update you on our community engagement efforts.

Lynn Ray [briefing]

Victoria continues:

Thank you, Lynn.

I'd like to add that that we understand how important it is to our combined success that we engage with the communities –the local and community leaders, airports and the neighborhoods.

Everybody in this room knows that, as a whole, aviation has a good story to tell, including an impressive safety record.

Over the years, the industry has made exponential leaps in engine technology, which has resulted not only in fuel savings but much quieter engines as well.

Nevertheless, we've seen increases in the number of operations, particularly at night, and in the number of people living around airports.

So, while NextGen procedures are more efficient and precise, that also means some areas of communities are experiencing a greater concentration of flights along very narrow tracks.

As Lynn mentioned, we've held a number of meetings with the public in recent weeks and months.

One thing has become very clear: The FAA cannot solve this problem alone.

It’s up to all of us here — government, industry and labor — to communicate the importance of aviation to our local communities.

But it’s also vital that we listen to people’s concerns and make an earnest effort to find solutions that work for everyone.

Aviation provides thousands of jobs and brings goods, business travelers and tourists safely to our local communities, providing the foundation for commerce and prosperity.

The more we can communicate these benefits -- and the more we can work with our local communities to foster their support -- the better off we will be in both improving our nation’s airspace and strengthening our communities.

Conclusion:

All of this represents excellent progress.

But we continue to face the challenge of how to translate this progress into a seamless flow of air traffic that moves us to the next level of safety and efficiency.

One of the tasks before us includes Enhanced Surveillance. We are happy to be engaged with the NAC on examining Space Based ADS-B and Enhanced Surveillance.

We understand that reduced separation is the predominant goal of enhanced surveillance in oceanic airspace. Ultimately, it must be cost beneficial to the aviation community and it must be measured against other NextGen priorities.

Last December we also took positive steps in the areas of policy and training to address transitioning to a Time-Based Scheduling and Management paradigm.

This is dependent upon multiple systems, such as Time-Based Flow Management (TBFM) Traffic Flow Management System (TFMS), ERAM, and STARS.

TBFM enables us to manage air traffic flows using time instead of distance, which will make the system more predictable.

The effect will be transformative, and it will help us create a system that minimizes delays due to weather or facility outages.

I am looking forward to hearing the recommendations today on these issues.

Now I'd like to ask Michael to offer a few closing words.

Michael resumes.

Thank you, Victoria.

I hope you've all noticed that we are changing the way we do things at the FAA to allow innovation to flourish.

I've encouraged our employees to step back and really take a look at how they do their jobs. I want them to make sure that we're not only asking questions, but the *right* questions.

It’s through consultations with more diverse experiences and viewpoints to help us address important issues.

I hope you’ve noticed a change in responsiveness as we’ve used this experience to help us redefine how we interact with industry on a number of fronts.

We’re not all the way there yet, and it means that in our engineering-based culture that we need to get comfortable with always being a little uncomfortable.

My hope is that this approach will make the FAA more nimble and able to embrace opportunities as they arise, whether that’s adopting a new technology or rethinking operational strategies.

As with everything else NextGen, we look forward to the assistance and advice of the NAC.

Before I conclude, I’d like to take this opportunity to welcome Dave Bronczek, President and of FedEx Express, who will be the next chairman of the NAC.

(He was recently named to the newly created post of Chief Operating Officer of parent company Fed Ex Corp. beginning in 2018.)

This is not Dave's first foray into public service. I had the pleasure of working with Dave while he served on the FAA's Management Advisory Committee.

I want to thank him for stepping in once again to work with us in a collaborative way. Would you like to say a few words, Dave?

[DAVE GIVES BRIEF REMARKS]

Thanks, Dave.

I'd like to conclude by saying that the United States has always been a global aviation leader. I firmly believe that NextGen is going to be one of those contributions that we'll all reflect on someday and say, "I helped do that."

It will work because it represents the best we all have to offer. It will work – it ***is*** working – because of the assistance and collaboration the NextGen Advisory Committee.

Thank you very much.

RTCA

THE GOLD STANDARD FOR AVIATION SINCE 1935

Approved by the NextGen Advisory Committee October 2016

PBN Time, Speed, Spacing Task Group

Final Report of the NextGen Advisory Committee in Response to a Tasking from The Federal Aviation Administration

October 2016

Contents

Background/Introduction

In December 2015, the Federal Aviation Administration (FAA) tasked the NextGen Advisory Committee (NAC) with developing a 15-year roadmap for Performance Based Navigation (PBN) and Traffic Flow Management (TFM). The NAC has been instrumental in working with the FAA to address these and other complexities inherent in moving to greater use of (PBN) procedures.

The request included reviewing the FAA's current plans for traffic flow management scheduling, sequencing and spacing tools and developing a 15-year deployment strategy that complements the FAA's National Airspace System (NAS) Navigation Strategy 2016 that was approved by the PBN Operations Aviation Rulemaking Committee PARC).[1] The FAA request stated that, "The goal of the PBN strategy is to combine the flight efficiency of visual meteorological conditions with the predictability and stability of instrument operations. Operators have implemented a number of capabilities that enable them to fly predictable paths, laterally and vertically, enhancing the ability for air traffic management (ATN1) automation to predict the flow of traffic at airspace constraints, such as runway capacity."

The FAA's PBN strategy outlines near-term (2020), mid-term (2025) and far-term (2030) initiatives in the following focus areas:

- Implement PBN throughout the NAS with the right procedures to meet capacity, efficiency, and throughput needs;
- Provide navigation structure where beneficial, and flexibility where possible;
- Continue transition from distance-based to time-based and speed-based air traffic management;
- Deliver resilient navigation services;
- Modernize the FAA navigation service delivery;
- Enable lower visibility access to airports and airspace; and
- Innovate and continuously improve.

The strategy for the time, speed and spacing assignment will address what types of tools are appropriate in various operating conditions, what tools should be identified as high priority, and how the various capabilities can be integrated into efficient traffic flow management. There is also the need to determine the role of cockpit-based and ground-based Traffic Flow Management Systems/tools.

The efforts of the Task Group are complimentary to the NextGen Implementation Working Group (NIWG) which is considering the pre-2020 implications of PBN implementation. The NIWG is focused on prioritization of activities for the next three years.

Executive Summary

A transition to a time-based system is necessary to enable higher percentages of PBN operations with the goal of keeping aircraft on an optimal path. Managing the flows requires leveraging existing and future tools for the controllers and aircraft, and it also requires a large cultural change.

The FAA's NextGen Segment Implementation Plan (NSIP) states that, "the overarching objectives for the future remain the same — maximizing airspace capacity with more sophisticated and seamlessly integrated information about the future position of aircraft at a given time — while maintaining the

[1] Letter from Michael Whitaker (FAA Deputy Administrator) to Margaret Jenny (RTCA President) dated December 2, 2015.

safest air travel possible." The NAC has emphasized the need for NextGen to result in achieving visual meteorological conditions (VMC) performance in instrument meteorological conditions (IMC). Decision support tools are critical in the timing and evolution of this transition dependent on the technological capabilities that will enable functionality, particularly the expanding set of metering tools and applications, being operational in air traffic control facilities across the NAS.

The implementation must be integrated, fielding any single technology that has not been considered as part of an integrated system may sub-optimize the system. The system has air and ground components as well as human contribution, and accelerating any one technology in isolation may have unintended consequences.

The goal of the Task Group effort is to ***"keep the aircraft on the PBN procedure from EnRoute to the runway while maintaining or increasing throughput".*** To meet that goal there are candidate capabilities that need to be considered based on a set of criteria. These criteria include, but are not limited to, the following:

- Current state of the capability (maturity, life cycle)
- Necessary investment
- Investment timing
- Benefits - Key Performance Indicators (KPI) – such as – efficiency, throughput, predictability

The strategic roadmap embraces the following concepts:

- Near Term (2020)
    - Focuses on policy, procedures and training to enable initial PBN capabilities and using existing tools and systems for a better integrated system
    - Infusing time-based metering into the culture
- Mid Term (2021-2025)
    - Focuses on continued deployment of available NextGen capabilities consistent with meeting the goal of PBN Time, Speed, and Spacing in an integrated manner
    - Begins the process of integrating aircraft trajectory data with ground systems
- Far Term (2026-2030)
    - Further enhances, increasing resilience of ground based tools
    - Integrates the stand-alone capabilities described in the mid-term
    - Leverages Flight Deck Interval Management (IM) demonstration for potential full NAS implementation
    - Based on experiences from Near and Mid-Term, begins implementing advanced Data Comm capabilities defined by RTCA Special Committee 214, Standards for Air Traffic Data Communication Services

One of the most critical aspects for this successful transition is a comprehensive and collaborative change management plan for all operationally responsible parties. The concept of change management encompasses all those disciplines involved in the operation of aircraft and the ATC system. While the

current system provides safe, efficient, and reliable processes to control and manage aircraft, the ability to evolve the NAS is dependent on all stakeholders embracing change and acknowledging the potential benefits of those changes.

Flight Operators, as well as the FAA must constantly refine a change management plan that responds to an ever-changing environment, systems and work force. As collaborative stakeholders in the NAS, we are all compelled to adapt to the evolution that goes along with improved technology and procedures. Inclusive of that evolution is the concurrent adaptation of tools and applications--in this case, time-based methodologies that support those technological and procedural improvements. The results of that collaboration will be a measurably successful transition that allows for optimization in a PBN-based system.

The solution space is large. In order to ensure that the goals are met, a performance-based approach has been taken to evaluate the strategic alternatives. First, an understanding of the end-to-end system requirements will be identified. Then the performance will be allocated to the different solution domains. These allocations may evolve over time as new capabilities are made available. This is not a "clean sheet" design space, so a combined top down and bottom up approach will be taken. This ensures that investments already made are considered in the timing of the solution space.

As the FAA moves forward with the implementation of decision support tools and other time, speed, spacing capabilities there is the need to evaluate the benefits and evaluate alternatives-when appropriate. There needs to be sufficient flexibility in making adjustments to programs and projects based on assessments of performance. There may be times when the FAA and industry determine that the best path forward may be to change or even eliminate a project based on changes in operations, technology and other factors that determine the value of the capabilities.

Methodology

The Time, Speed, Spacing Task Group (Appendix A) is comprised of representatives from a cross-section of stakeholder groups who have been engaged in planning and implementing various aspects of NextGen capabilities. This includes operators, airports, pilots, controllers, automation providers, technical advisors and a diverse set of FAA Subject Matter Experts who have provided leadership in NextGen planning, pilot and demonstration programs, and PBN implementations.

The Task Group took the following steps in creating the recommendations:

1. Determined and reached consensus agreements on the scope of the task that guided the process of deliberations and subsequent outcome of Task Group recommendations. This included a set of assumptions and guiding principles.

2. Reviewed a library of reports and abstracts related to the complex aspects of time, speed and spacing that covered FAA, NASA and industry business case/needs assumptions as well as R&D efforts.

3. Developed a baseline, high level understanding of FAA plans for the three planning time frames, and reached a general consensus of the prioritization for the ground and aircraft based initiatives. This included a "Demo Day" held at The MITRE Corporations facilities that featured a series of briefings, lab demonstration and open discussions with individuals experienced in FAA infrastructure and PBN implementation efforts.

4. Captured the proposed solution alternatives and the ranking criteria. There is a recognition that priorities may change over time as systems and solutions evolve. Elements that may be necessary for access to early benefits may be discontinued in the future. Additionally, overall performance and allocation of performance to different system components may evolve as improved information sharing is enabled.

To complete this step, there were candidate capabilities that needed to be considered based on a set of criteria. These criteria include, but are not limited to, the following:

- Current state of the capability (maturity, life cycle)
- Necessary investment
- Investment timing
- Benefits - Key Performance Indicators (KPI) – such as – efficiency, throughput, predictability

5. Developed recommendations.

Key observations and findings from each step of the work of the Task Group are identified in the following sections of this Report.

Assumptions & Guiding Principles

The overall purpose of the PBN Time, Speed, Spacing work group is to develop strategies for time, speed, and spacing assignment and should address what types of tools are appropriate in various operating conditions, what tools should be prioritized, and how the various capabilities can be integrated into efficient traffic flow management. These will deliver operational capabilities that will provide a timing infrastructure to truly enable PBN. The assumptions and guiding principles adopted by the Task Group to meet this goal are summarized below:

- The Task Group's set of recommendations will be as transparent and as objective as possible, clearly laying out the methodology that the group employed to reach consensus on the specific recommendations.
- Implementation timelines are deliverables in the 5 to 15-year time frame.
- In order to understand the strategic need to identify the candidate solutions, each of the components needs to be considered. These components are all interdependent and include:
    - The air traffic automation (including both command and control automation and flow management tools, and the operator)
    - The airborne capabilities (including on-board decision support tools)
    - The human component of each
- The human component of candidate solutions is especially important. As performance is allocated to the different automation and human elements, complexities arise. The performance assessment will include technical and human components. As timing becomes a key performance attribute, care must be taken to ensure that there is a balance in how the timing is allocated to the automation and to the human. An over-allocation of time to the human will drive cost into the solution space. An under-allocation of time to the human component may impact overall system safety.

- Near-term Technology and concept of operations plans must be sufficiently mature to support the recommendations. New tools to improve system flow or terminal spacing and sequencing will be introduced through the planning period.
- There are FAA programs (enablers) currently underway that are fundamental to PBN. The PBN Strategy depends on the development and application of expanded and more mature scheduling, sequencing and pacing tools and automation.
- Mixed equipage will remain– it is an on-going process and a reality that must continually be addressed.
- Delivery of capabilities should maximize the use of existing aircraft equipage when possible, with no broad-based fleet upgrades required-recognizing that the FAA's PBN Strategy anticipates a progressively more capable fleet of aircraft able to fly more precise PBN procedures as outlined in the Strategy. The PBN Strategy should also leverage the purchase of new generation aircraft and the equipage modernization consistent with the PBN Strategy roadmap. Automation is expected to evolve over the planning period. Lessons learned as PBN operations increase and improve may re-allocate performance attributes to the different domains.
- The mixed equipage fleet has broad attributes with a continuously evolving "mixed fleet" of capabilities. Even the most modern A350 or B787, with all of their PBN capabilities may not have considered all of the future needs. Legacy aircraft will continue operating in the airspace and will bring a variety of tools and capabilities that need to be integrated into the solution space.
- Performance-based requirements will be used to manage the allocation of performance and balance complexity to benefits.
- The business case justification for NextGen equipage will be strengthened by the near-term delivery of capabilities. Aircraft operators continue to invest in updated aircraft/equipage based on a positive ROI and anticipate the removal of barriers to gain their return on investment in these new capabilities.
- The timing reference or desired point of timing is the approach end of the runway.
- Timing to the runway threshold must be accurate to +/- 10 seconds in order maintain or enhance current throughput rates.
- International Harmonization - Airborne equipment requirements should be compatible with the technology and dates of the ICAO Aviation System Block Upgrade plan. Where appropriate, the recommendation should be consistent with SESAR and other ATC modernization plans for aircraft equipage.
- Projects should be carefully scoped to balance complexity and benefits. "Scope creep" should be minimized.

Transitioning to a Time-Based System

The tasking from the FAA and the NAC is to provide a strategic roadmap for greater use of PBN procedures through time, speed and aircraft spacing. While it is tempting to focus on specific solutions, we need to focus on developing a vision of how we would prefer the future to evolve. That said, investment decisions have already been made on several of the candidate solutions and, for others, investment decisions are in process. These elements, along with airborne avionics investment decisions made in the past, will be considered as part of the evolving infrastructure.

An overarching principle is the endorsement of transition to time referenced airspace. The timing of this transition is dependent on the necessary metering tools being operational in the EnRoute, TRACON and

Terminal facilities. Also critical is the change management/cultural issues for controllers, pilots, dispatchers and others involved in the operation of aircraft and the ATC system.

There is consensus desire from industry to utilize time-based spacing systems in order to achieve the routine use of PBN, allowing them to capitalize on investments made to equip fleets. The efficiency gains of a time-based system, versus the traditional spatial system are well documented. However, the time, speed, spacing strategies must include controller and pilot understanding and acceptance to fully realize those benefits. The FAA has taken positive steps to address the barriers that have prevented moving the NAS to a time-based system, but additional emphasis is needed to truly change the entrenched habits and culture embedded in today's operation.

Individual ATC facilities tend to focus on resolving local problems and, at times, fail to see or consider the "bigger picture" system when applying solutions to those problems. Often facilities fall back to "tried and true" methods of spacing using miles-in-trail rather than a more system-oriented time-based approach due to some combination of a lack of understanding of the purpose or value of time-based system, a lack of confidence in the tools, or a lack of shared vision and common goals in managing the effectiveness of the NAS. Today this is evidenced in the fact that there are varying degrees of use and acceptance of the available time-based tools. There are a few locations in the NAS where time-based tools are being fully applied as intended (e.g. Many facilities that utilize TBFM have morphed its intended use to fit their own version of how the tool should be used and determined what level of use is acceptable). These local decisions to either reject or repurpose TBFM are well intentioned and often made in an effort to improve the operation in the facility's area of influence. However, these facilities fail to understand the implications these local "work-a-rounds" have on the overall success of the tools and the toll they take on realizing system-wide benefits.

The agency must focus on taking the necessary steps to standardize time-based and operational policies that drive NAS benefits. We understand this task is outside the norm of routine delivery of new capabilities and moves into an area of change management. The FAA must incorporate a change management function as part of the implementation strategy and make it a priority to reduce the risk for both industry and the agency in delivering the promises of NextGen.

To be clear, subject matter experts, including the DOT Inspector General, US General Accountability Office and the MITRE Corporation, have pointed out that there are critical dependencies underpinning a successful cultural change. They include a finely "tuned" and operationally managed automation system that will lead controllers to have a high level of confidence in the output provided and that supports the ability of aircraft to accurately comply. Training for controllers that includes the vision, philosophy and objectives of the enhancements must be included in the rollout to new facilities. At facilities where the tools have already been deployed, yet are not being utilized properly, intensive education efforts must be made that stress the benefits to the NAS. The agency has efforts underway to address system concerns and should continue to focus on time-based automation as a critical component of the NAS.

With the goal of moving to the routine use of time to manage the NAS, we must consider the following difficult principles that if not adhered to would lead to failure from industry's perspective:

- Add predictability without penalty to either industry or ATC. A predictable schedule should not compromise throughput.
- A system based on time must not adversely affect performance. Schedule integrity must be maintained.

- The use of time-based tools must meet the original objectives: PBN use while maintaining or improving throughput.
- Layered implementations provide an incremental path that assists in the successful transition.
- Ground-based decision support tools must be developed and implementation accelerated to achieve the benefits.
- A collaborative development and implementation process with all stakeholders is critical to ensure cooperation and understanding.
- The system cannot be so rigid that the aircraft or airport efficiency is adversely impacted.
- To ensure maximum benefits, metrics developed by the NAC (including the industry-FAA work of the Joint Analysis Team) and recommended to the FAA must be jointly monitored to verify intended results are achieved. In instances where performance doesn't match intended results these can guide potential corrections to the plan.

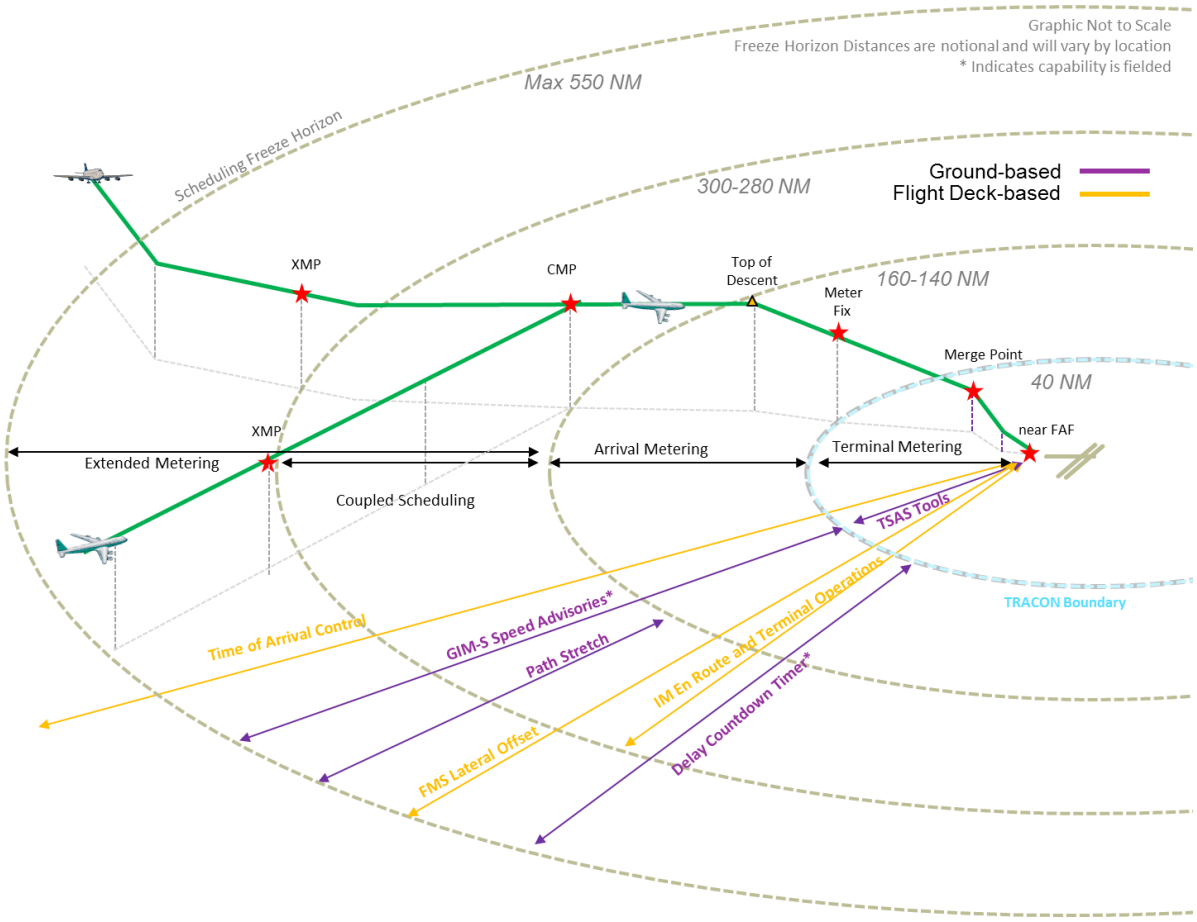
With agreement on the need to move to a time-based culture, success will be anchored by leadership continuing to reinforce the change and setting expectations for achievement of the common vision and goals.

Recommendation: The agency adopts change management principles as part of their implementation process to gain the acceptance and culture change to realize the benefits of time-based enhancements.

The following sections describe the capabilities and associated changes to aircraft, ATC automation, TFM automation, ATC decision support tools, TFM decision support tools, pilot tools as well as changes to Comm, Nav and Surveillance components for each of the three time frames. Each increment addresses costs and benefits to the extent possible.

Candidate Systems

The FAA has provided a notional graphic representing a collection of strategic elements and candidate systems to be considered for these operations.



Within this graphic representation both strategic elements and candidate solutions are considered. For reference, the strategic thread would include:

- Departure Scheduling
- Arrival Metering
- Extended Metering
- Coupled Scheduling
- Terminal Metering

The candidate solution components fall into the airborne and ground components. These include:

- Airborne
    - Time of Arrival Control
    - Flight Deck Interval Management (IM) EnRoute and Terminal operations
- Ground Based
    - Speed Advisories

- Path Stretch
- Terminal Spacing and Sequencing Tools

Near-term 2016-2020

Time Based Flow Management (TBFM) (foundational scheduling function)

Time Based Flow Management (TBFM) is an existing system that develops the schedule that is communicated to the various capabilities and tools identified in the near, mid and far time frames. It is the core tool that provides spacing and sequencing information and must be able to bear the weight of being a foundational element for NAS scheduling, sequencing and spacing moving forward. Accuracy and stability are critical to timing success. Conversely, instability or poor performance can create uncertainty and loss of workforce confidence in movement to a time-based NAS.

Advancements in the TBFM system have increased the reliability and accuracy of time-based operations where applied. Improved algorithms, surveillance data and ingestion of high definition wind modeling has improved the trajectory accuracy of TBFM and are, in most cases, producing reliable scheduled times.

The NAC recommends continued TBFM system improvements to ensure a strong foundation to build upon for future capabilities that will address the sequencing and spacing necessary for routine use of PBN in all domains. Particular attention and emphasis should be placed on site adaptation and issue resolution. Although improvements in TBFM trajectory modeling have occurred, excellence in site adaptation is crucial to producing desired results.

Additionally, the FAA should expand and standardize the use of TBFM in the NAS to meet the goals contained in operational use policy that covers EnRoute, TRACON and Tower airspace. Providing quality change management processes, including early training of the workforce, is a key aspect of continued implementation of TBFM. The FAA must have a commitment to have resources necessary for staffing, training and support and sustain this significant change.

Alternative use of CRDA (Flow Merging and Spacing)

Converging Runway Display Aid (CRDA) is an existing automation tool designed to assist controllers with spacing arrivals on the final straight approach segment to converging runways. By utilizing the foundational design principles of CRDA, the tool can be extended to provide its familiar visualization of the relative distance of aircraft to a merge point from converging streams anywhere in the terminal area, including PBN and non-PBN approaches. The opportunity to extend CRDA should be pursued, especially given the higher cost and longer time frame of other solutions that involve system-of-systems development and integration. An Extended CRDA capability would be integrated within the Standard Terminal Automation Replacement System (STARS), independent from other systems, and would be available at all sites, independent of Terminal Sequencing and Spacing (TSAS) deployment. Merging and Spacing Tools may also be used in harmony with time-based tools such as TSAS. A relevant example is the existing spacing tool for Automated Terminal Proximity Alert (ATPA). The utility of ATPA is not diminished by TSAS, nor is the utility of TSAS diminished by ATPA. The same is true for the extension of CRDA relative to use of TSAS. The overall goal should be to provide a suite of controller decision support tools that can be utilized depending on facility traffic volumes, airspace and airport configuration,

system deployment/integration, and the needs of different operational positions (e.g. feeder position versus final).

The NAC recommends that alternate use of CRDA should be evaluated and pursued given the extended period of time before the more complete solutions that are currently in development are available. It must be emphasized that the use of existing tools is only seen as a means to provide partial capability during the transition period.

Ground-based Interval Management – Spacing (GIM-S)

GIM-S is an EnRoute tool, resident in the TBFM and ERAM systems, that extends the time-based solution to 400-500 miles from the arrival airport and provides EnRoute controllers speed queues to keep aircraft on the appropriate time schedule. Timing accuracy at the meter fix is expected to be within 30 seconds of target. This level of fidelity will deliver to the terminal controller a workable solution that will enhance the use of PBN procedures closer to the airport.

GIM-s is available now for deployment in the NAS and is use at PHX, DEN and SEA. Adaptation work at these key sites to improve performance underway. The NAC endorses implementing GIMS-S at the nine Terminal Sequencing and Spacing sites prior to 2020.

Due to the technical, change management and cultural complexities of deploying this evolutionary tool, the NAC endorses this measured approach. As with all TBFM measures, a robust issue resolution process at the 9 sites should allow for expansion of GIM-S to operationally viable TBFM airports in 2020-time frame.

Terminal Sequencing and Spacing (TSAS)

GIM-S, extended metering and speed advisories, will allow EnRoute controllers to deliver aircraft to the Terminal controller within 30 seconds of their scheduled target time. TSAS extends the timing solution into the terminal airspace and, for the first time, links the timing mission to the terminal controller. The terminal controller is presented timing queues that will allow a high percentage of flights to remain on the PBN approach procedures by applying only speed adjustments. This high fidelity and synchronized, timing will additionally allow for greater throughput by reducing the inter-arrival buffer or gap.

It is important to consider that TSAS is a decision support tool, not a separation tool. Similar to GIM-S, cultural and technical complexities in deployment will exist. Currently, terminal controllers have no experience with time-based sequencing, so this evolutionary change will require excellence in change management.

FAA plans are for initial site IOC at Seattle in FY19, with sites complete by 2022. These sites are: IAH, SEA, LAX, ATL, PHX, DEN, SFO, CLT, and LAS. The NAC endorses this rollout plan, but also recommends completing deployment of TSAS at all NSG1 airports and remaining NSG2 hub airports in the mid-term.

Required Time of Arrival (RTA)

Next generation Flight Management Computers will have a Time-of-arrival-control (TOAC) function to execute a Required Time of Arrival (RTA) instruction and many aircraft have the ability to conduct some of the TOAC functions in specific phases of flight. However, additional research is necessary to evaluate the variability in existing functionality and the operational implication of the differences. Like the

previously recommended tools, an RTA target could be derived from TBFM which controllers would issue to aircraft via voice. This flight deck resource could be used to assist in conditioning traffic flows and potentially reducing controller workloads.

The NAC recommends that the FAA continue its assessment of RTA through additional research and flight demonstrations to evaluate if the existing fleet capabilities can provide a significant operational benefit.

Flight Deck Interval Management (IM): IM EnRoute and Terminal Operations

Flight Deck Interval Management (IM) uses ADS-B IN traffic information to provide speed cues to pilots to manage inter-arrival spacing. The goal of IM is to reduce the variation in inter-arrival spacing, thus enabling more capacity. The more direct control loop enabled by calculation of speed by IM avionics results in a significant reduction in the standard deviation of the inter-arrival rate. This leads to more available capacity, compared to current operations with ATC vectoring and speed assignments. Since IM arrivals end with instrument approach procedures, there is no need to conduct visual approaches to achieve maximum capacity. Maintaining higher arrival rates, similar to VMC arrival rates, will be possible with IM during periods of lower ceiling and visibilities, down to Category 1 approach minimums.

Implementation of IM would require a change in the way traffic is managed. Pilots will have a new task of following speed guidance from avionics to support a spacing task, rather than receiving speed instructions from ATC. Pilots will not be responsible for separation; their only responsibility will be to follow speed guidance from the avionics. Controllers are responsible for separation, however to achieve increased capacity, they may need to apply smaller buffers to the minimum separation standard than those applied today. In the future, it may be possible to reduce current separation standards for IM operations, further increasing capacity.

The FAA and industry need to layout time line for collective process and how that relates to ADS-B In ARC. The potential efficiencies enabled by IM are the same as those recognized by the ADS-B In ARC in 2012 and the recommendations of the ARC to pursue IM and IM with wake mitigation are still valid today. With awareness of atmospheric meteorological conditions, IM systems may be able to monitor for potential increases in the probability of a wake vortex encounter, leading to an IM with wake mitigation capability.

The ADS-B In ARC recognized that the equipage costs and benefits needed further definition. The policies associated with separation standards and ATC and pilot roles and responsibilities as they relate to separation also need to be researched. Many years of research and several HITLs have been conducted on IM capabilities. Previous research has repeatedly demonstrated that the variability (standard deviation) in inter-arrival spacing for IM operations is significantly reduced when compared other concepts. In early 2017, NASA will be conducting a flight demonstration of IM using air transport category aircraft. In 2018 and 2019, several more HITLs will occur to further define procedures, validate avionics and ground automation requirements, and to evaluate the integration of the airborne and ground-based ATC systems. If the flight demonstration and HITLS shows a standard deviation in the inter-arrival rate similar to that predicted through analysis and simulation, the FAA may have a good

business case to continue the development of IM. Likewise, airlines may have a good business case to invest in IM capable ADS-B In avionics.

Therefore, after the demonstration is complete and prior to the FAA's final investment decision, the NAC recommends that an FAA-industry review of the results, including the cost and benefits, should be conducted to determine the final status of future recommendation on IM development and implementation.

Mid-term 2021-2025

Time Based Flow Management (TBFM) and Shared Trajectory Information

The airspace in the next decade must begin its transition to a highly integrated system – Air and Ground components and their associated human participants will need to share information to be most effective. For ground systems such as TBFM to model projected route optimums discounts, the real time data captured and used by airborne systems must be used to optimize the complete system.

The Flight Management System has been designed to perform both path management and to optimize the performance according to a variety of attributes including fuel consumption, minimized cost and time profiles. In today's systems, this information sharing is described in a variety of air-ground messages, primarily used by the aircraft operator.

Coupling these capabilities to the TBFM tools and other evolving ground automation provides an increased situational awareness to allow airspace planners and managers to ensure that individual aircraft trajectories are optimized according to the business interests of the airspace user. These enhanced "degrees of precision" ensure that airspace managers have optimized situational awareness and can better accommodate aircraft with lesser or failed capabilities.

Therefore, the NAC recommends that the FAA begin the process of integrating aircraft trajectory data with ground systems in the midterm.

Evolution of Tools in the Mid-Term

The benefit case for TSAS for some National Service Group 2 airports may not exist. There is however, a need to enable use of PBN at airports, therefore, some type of merging and spacing tool may be necessary. Various tools may be appropriate including CRDA and a yet to be fully defined "light" version of TSAS.

Alternative use of CRDA (Flow Merging and Spacing)

Although CRDA may not be appropriate at all locations (or as a long term solution) because it has significant limits, it should be considered based on a site specific analysis.

Ground-based Interval Management – Spacing (GIM-S)/Path Stretch

GIM-S with Path Stretch allows the aircraft to be metered when a speed solution alone does not exist. When necessary, a path stretch clearance Stretch would be issued and completed in level flight prior to top of descent. Today, controllers complete this task via high workload vectoring.

GIM-S-with Path Stretch extends the time-based solution to 400-500 miles from the arrival airport, gives controllers speed advisories and a de-conflicted off course path to fly (if necessary) to meet TBFM's schedule for sequence allowing OPD's to be flown and more accurately delivering flights to the TRACON.

The FAA plans for Path Stretch include initial operating capability (IOC) at TSAS sites beginning in 2022. The NAC endorses this GIM-S with path stretch timeline. Deployment of GIM-S with path stretch at all TBFM airports, where appropriate, should occur near the end of mid-term time horizon.

EnRoute DataComm will be deployed at all CONUS EnRoute Centers prior to 2022. Included in the Data Comm services are controller initiated reroutes. Due the potential complexity of path stretch clearances, CPDLC delivery to the flight deck would greatly reduce workload. Safety is increased by the transmitting a fully loadable clearance directly to the flight deck.

Therefore, the NAC recommends integrating Data Comm capability into the initial requirements for GIM-S with Path Stretch.

Terminal Sequencing and Spacing (TSAS)

The NAC recommends deployment of TSAS at all NSG1 airports and remaining NSG2 hub airports. TBFM may need to expand to added additional airports that are high value to industry.

Required Time of Arrival (RTA)

The focus during this time frame is the implementation of this capability. The NAC recommends that the use of RTA be available as a supplement to other timing tools during this time frame recognizing that there is a need for a communication mechanism that reconciles between flight crews, dispatchers and controllers.

Flight Deck Interval Management (IM): IM EnRoute and Terminal Operations

A review of the near term activities, including the NASA flight test and HITL events, will provide guidance on whether mid-term efforts are warranted. These flight trials and HITLs must include industry and ATC stakeholders. Assuming a positive benefits case exits, phased development in the 2023 to 2028 should occur. Accordingly, the FAA should consider a funding mechanism to incentivize equipage that has proved successful in the Data Comm integrated services contract.

Far-term 2026-2030

Time Based Flow Management (TBFM) and Aircraft Integration

The airspace in the far term should transition to a highly integrated system – Air and Ground components and their associated human participants need to share information to be most effective. Ground systems that model projected routes do not currently account for the real time data captured and used by airborne systems in their attempts to optimize the system. The result is that projected benefits of system evolution are not realized and aircraft equipment investment returns never mature.

Integration of flight management system trajectory information, data that has been designed to perform both path management and to optimize the performance to achieve fuel consumption, cost and time objectives, will be essential to fully optimize the air traffic control system.

This data rich information exchange will be enabled by new message sets described by the work [2]performed by RTCA SC-214. These messages should be integrated into the EnRoute TBFM tools to provide discrete information exchanges between airspace managers and aircraft systems. These same messages can be exchanged in ground/ground formats between airline planners and airspace capacity and contingency planners.

Coupling these capabilities to the TBFM tools and other evolving ground automation provides an increased situational awareness to allow airspace planners and managers to ensure that individual aircraft trajectories are optimized according to aircraft performance, environmental factors and the business interests of the airspace user. These enhanced "degrees of precision" ensure that airspace managers have optimized situational awareness and can better accommodate aircraft with lesser or failed capabilities.
The use of this information should ensure that multiple systems do not rely on different sources of data. In the Collaborative Decision Making model, the intent is to make the same information available to all decision makers at the same time. This optimizes decision making to ensure that everyone has access to the same data. All part of the information management goal of how the airspace will evolve.

Therefore, the NAC recommends that based on experiences from Near and Mid-Term, the FAA begin implementing advanced Data Comm capabilities defined by SC214.
The FAA should continue with the development of improvements to the timeliness and accuracy of environmental information provided to the aircraft, particularly for the descent phase of flight, such that existing aircraft RTA capabilities can reach their full potential.

Flight Deck Interval Management (IM): IM EnRoute and Terminal Operations

Provided that gateways recommended in the near and midterm meet expectations, arrival and approach applications should be launched. These applications may allow for IM operations to independent and dependent runways (including parallel and converging and crossing runways). Cruise applications to support same route or merging routes should be available. Implementation of IM needs to be integrated with ground time-based systems such that IM capability improves the benefits provided by ground-based tools.

Culture Change to a Time-Based NAS

The broad deployment of Performance Based Navigation (PBN), which has resulted in repeatable paths to/from airports, has enabled the foundation upon which a shift towards a Time-based Scheduling and Management paradigm throughout the National Airspace System (NAS) must be pursued. The repeatability of PBN procedures allows for increased predictability which is a key component for

[2] **SC-214, Standards for Air Traffic Data Communication Services,** established March 22, 2007, is developing Safety and Performance Requirements (SPR) and Interoperability Requirements (INTEROPS) documents for the Air Traffic Services (ATS) supported by data communications to be implemented in the United States by the NextGen Data Communications Program in defined environments through 2025 and in Europe as part of the Single European Sky ATM Research (SESAR) operational improvements. Data communications will introduce services that allow evolution from the current workload-intensive, voice-based air traffic control concepts, to collaborative, management-by-exception operations. Advanced data links between ground and airborne systems are envisioned to increase capacity, allowing greater user access and more efficient flight routing.

sustaining a time-based system which consists of both scheduling and making in-flight adjustments to deliver to that schedule (i.e., management). Time-based scheduling has shown to be more efficient means over use of distance-based spacing goals. More robust solutions for management of arrival flows are needed to more accurately and efficiently meet a time-based schedule. The ultimate goal is to fully utilize the PBN procedures that are developed in a way that does not adversely impact throughput at the most critical sites and Metroplex environments of the NAS.

While there are various practices and techniques (e.g., vectoring, holding) currently used today by national and local air traffic to help manage and space flows, there is a general lack of understanding about what a NAS Time-based Scheduling and Management system means from the perspectives of both Air traffic and System adaptors. This lack of understanding (in regards to a shared vision, set of common goals, and sustainability plan) has contributed to challenges experienced at some field sites when applying more robust tools/automation to meet the schedule, which results in a lack of confidence for managing traffic flows and causing gaps in the effectiveness of the NAS.

Positive steps in the areas of policy and training have been recently taken by the FAA to address transitioning to a NAS Time-Based Scheduling and Management paradigm, which is dependent upon multiple systems (such as Time-Based Flow Management system (TBFM) and Traffic Flow Management System (TFMS), ERAM, and STARS) as well as multiple actors. The following include some updates for clarifying use of the TBFM system today so that it is conducive for transitioning the NAS to a Time-Based Scheduling and Management paradigm.

Policy & Procedures

- The following changes to the Federal Aviation Administration Order JO 7110.65W, Air Traffic Control, and the Briefing Guide:

11–1–1. DUTY RESPONSIBILITY

a. The mission of the traffic management system is to balance air traffic demand with system capacity to ensure the maximum efficient utilization of the NAS.

b. TBFM must be used to the maximum extent feasible in preference to miles-in-trail initiatives.

NOTE–
The benefits of TBFM are best realized through the coordinated effort of all facilities supporting Performance Based Navigation procedures or Traffic Management Initiatives (TMIs).

c. It is recognized that the ATCS is integral in the execution of the traffic management mission.

NOTE–
Complete details of traffic management initiatives and programs can be found in FAAO JO 7210.3, Facility Operation and Administration.

Training

- Traffic Management Coordinator (TMC) and Air Traffic Controller (ATC) training for TBFM has been developed in both the classroom and the eLearning Management System (eLMS). This training has only been developed in the last two years. All operational personnel completed the 90 minute eLMS training by December 2015. It is estimated that it will take three years for all TMCs to go through the seven-day classroom-based course in Oklahoma City.

For well over a decade, the role of proactively managing arrival flows has resided primarily in the EnRoute environment while the terminal airspace has continued to be managed very tactically and reactively. With broader availability of PBN procedures, Terminal (Tower and TRACON) facilities have had to take a more collaborative role in flow management. A flight's schedule in TBFM consists of scheduled times of arrival (STAs) at defined reference points (e.g. meter fixes, merge points, runway thresholds) based on either the flight plan (in EnRoute) or along a fixed nominal route (in terminal). The alignment of the path expected to be taken to these defined reference points relative to the path the flight actually takes is a key component to the TBFM system's ability to accurately calculate an estimated time of arrival value (ETA) upon which to generate a meaningful arrival schedule.

PBN procedures are being developed and implemented so an aircraft can fly a lateral and vertical profile that normally terminates in close proximity to the destination airport and in some cases at the runway

threshold. Lateral and vertical constraints are defined by the PBN procedures to accomplish several things (e.g., comply with airspace restrictions). What was once a normal interaction between controllers and pilots (i.e., vectoring flights to approach) performed on a tactical basis is now being defined by the PBN procedures, thereby minimizing the degree of tactical control required. PBN procedures typically define the following three types of constraints:

- Vertical constraints
    - Intended to keep aircraft on a similar vertical profile throughout the entire procedure and aid in minimizing speed disparities
    - Allow air traffic to de-conflict procedures from other procedures and airspace
- Lateral constraints
    - Procedures today specify most direct routing for lateral efficiency. Conventional procedures typically had bends or "dog legs" defined, which were sometimes a result of the location of ground-based navigation aids as well as the desire to build in an opportunity to make sequencing and spacing adjustments or absorb delay; if no sequencing or spacing was required, flights are often given a short-cut.
- Speed constraints
    - Ensure aircraft are maintaining compatible speeds throughout the entire procedure
    - Allow for the appropriate energy management of the aircraft which is now repeatable and predictable for both pilots and controllers

Three of the most effective techniques ATC have for sequencing and spacing aircraft are the abilities to assign vectors, speeds, and altitudes. With the development of PBN and the desire to remain on the procedure, this limits ATC options in utilizing those techniques. While these options remain available to ATC, the desire to keep aircraft on the procedure can directly conflict with the need for more tactical control if flows are not managed.

Unpublished speed adjustments while on the profile could affect the FMS's ability to keep the aircraft on the procedure. With that being said, traffic management now requires a robust approach at managing flows to any given airport prior to Top of Decent (TOD). TOD normally starts from a minimum of 100 miles from the destination airport. When developing efficient PBN procedures, one must consider criteria standards, de-confliction from other procedures, environmental impacts, airframes (i.e., aerodynamic performance), FMS, and aircraft operator business models. This has proven to be difficult at times and requires stakeholders to work closely together to ensure a safe and efficient end product.

PBN deployment into busy TRACONS has caused individual facilities rely on "outside help" for managing arrival flows, which they didn't have previously. This may mean reaching two to three Area Route Traffic Control Centers (ARTCC) upstream from the arrival facility. Previous methods for managing flows were normally contained within the arrival ARTCC and rarely requested flow management support from upstream facilities. Often, individual ATC facilities tend to focus on resolving arrival flow management issues as "local" problems to be addressed vs. a "big picture" system when applying solutions to those problems.

The habits and culture that are embedded in the NAS today are working. Managing flows in and out of airports on a tactical versus time basis or a combination of the two has been due to “lack of faith” or understanding of the contributions available from the Decision Support Tools (DST). Often facilities depend upon the “tried and true” methods of in-trail spacing using either DST individually or a combination thereof. Some of the tools TMCs use are miles-in-trail, holding, or other components of TBFM rather than a more systematic-oriented time-based approach. ATC and TMC lose confidence in tools already deployed because the tools never delivered what they were told they would, and tool adaptation is not updated to coincide with airspace or procedural changes, thus failing to deliver accurate timing solutions. These barriers have prevented the NAS from moving to a time-based system, but additional emphasis is needed to truly change the entrenched habits and culture embedded in today’s operation. It seems that systems get developed and then put in with the promise they will do “X”. Testing in the lab shows that they can do “X”, but when deployed in operational settings you can't get “X” out of the systems. The opinion from the majority of ATC facilities is that systems are developed, deployed and then success is declared, which creates the appearance of lack of follow through. The measure of success should be the use of a set of metrics that, when evaluated clearly, show systems provided the required output desired to some level of exactness. If systems do not meet these set objectives, then work must be done to meet those objectives before success is declared.

Today this is evidenced in the fact that there are varying degrees of use and acceptance of the available time-based tools. There are a few locations in the NAS where the tool is being fully applied as intended. However, many facilities that use TBFM have morphed its intended use to fit the operation. How the tool should be used and what level of use is acceptable is determined at the local level. These local decisions to either reject or repurpose TBFM are often well intentioned, and often made in an effort to improve the operation in the facility’s area of influence. Without a clear communicated national vision or guidance to that vision, facilities that adapt the use of TBFM never fully understand the implications of a local “work-a-round” and the overall success of the tools. The issue extends beyond the local level because there is a lack of consistent staff to maintain and update these tools. The FAA must hold Program Offices accountable for the systems they deploy and understand that technically these tools need a higher degree of maintenance than is currently being provided. As more complex procedures and systems are deployed, the commitment to monitoring and maintaining them must be a part of the path to success.

The FAA must focus on taking the necessary steps to standardize the use of the tools for overall system benefit and for the NextGen vision of PBN. The culture of each local facility deciding whether a particular tool is beneficial to their particular local operation and having the option to reject using it, or only using portions of it, must change to fully realize the benefits to the overall system. This task is outside the normal delivery of new capabilities and moves into an area of change management. The FAA must incorporate a clear vision and a change management function as part of the implementation strategy. This should be a high priority in order to reduce the risk for both the FAA and industry in not delivering NextGen as promised.

This approach will require starting further out in order to increase utilization during the departure, EnRoute and arrival phase of flight. There is a recognized need from ATC to utilize time-based spacing systems in order to achieve the routine use of PBN. The efficiency gains of a temporal system versus the traditional spatial system are well documented. However, the time, speed, spacing strategies must have the goal of achieving controller and pilot understanding and acceptance to fully realize those benefits.

There are dependencies underpinning a successful cultural change that cannot be ignored and have been pointed out by Subject Matter Experts (SMEs). They include a finely "tuned" and "operationally managed automation system", that will lead controllers to having a high level of confidence in the output provided and will support the ability of aircraft to accurately comply. Training for ATC that includes the vision, philosophy and objectives of the enhancements must be included. At facilities where the tools have already been deployed but are not being used properly, intensive education efforts must be made that stress the benefits to the NAS. There are efforts underway to address system concerns and there must be a continued focus on the automation as a critical component of the NAS, with the support necessary to maintain it as such.

Metrics must be jointly developed and monitored to verify intended results are achieved. With agreement on the need to move to a time-based culture, success will be anchored by leadership of both the FAA and Industry who must to continue to reinforce the change and set the expectation for achievement of the common vision and goals.

Recommendation: The agency adopts change management principles as part of their implementation process to gain the acceptance and culture change to realize the benefits of time-based enhancements.

Findings and Recommendations

The FAA has taken positive steps toward implementing time-based flow management capabilities. The findings and recommendations herein should be considered for enhancements and additions to the FAA's plans associated with PBN implementation.

Findings

- While the FAA has increased efforts associated with Time Based Flow Management implementation and use, overarching / system culture change is needed.
- While the FAA has a leading role to play in implementing ground based decision support tools, time, speed and spacing is highly dependent on aircraft FMS capability and as such requires all stakeholders to fulfill their respective roles and responsibilities in a collaborative and coordinated manner throughout the entire 15-year roadmap.
- Increasingly integrated air to ground capabilities requires alignment between FAA investments and aircraft investments for cost avoidance and adequately timed and optimized benefits.

Recommendations

The NAC recommends that the FAA:

1. Create an agency-wide vision for changing to a time-based system and develop and implement a plan to communicate the vision.
2. Incorporate the roadmap outlined throughout this document for 2016-2020; 2021-2025; and 2026-2030 for decision support tools and aircraft capabilities.
3. Adopt change management principles as part of their implementation process to gain the acceptance and culture change to realize the benefits of time-based enhancements.

Recommendations related to specific capabilities:

1. Continue TBFM system improvements to ensure a strong foundation to build upon for future capabilities that will address the sequencing and spacing necessary for routine use PBN in all domains. Particular attention and emphasis should be placed on site adaptation

and issue resolution. Although improvements in TBFM trajectory modeling have occurred, excellence in site adaptation is crucial to producing desired results.

2. Expand and standardize the use of TBFM in the NAS to meet the goals contained in operational use policy that covers EnRoute, TRACON and Tower airspace. Providing quality change management processes, including early training of the workforce is a key aspect of continued implementation of TBFM. The FAA must have a commitment to have resources necessary for staffing, training and support to sustain this significant change.
3. Evaluate alternate use of CRDA given the extended period of time before the more complete solutions that are currently in development are available. It must be emphasized that the use of existing tools is only seen as a means to provide partial capability during the transition period.
4. The NAC endorses implementing GIMS-S at the nine Terminal Sequencing and Spacing sites prior to 2020.
5. Implement the TSAS rollout plan in the near-term time frame at 9 sites, and complete TSAS at NSG 1 Airports and NSG 2 hub airports in the mid-term timeframe.
6. The FAA continue its assessment of RTA through additional research and flight demonstrations to evaluate if the existing fleet capabilities can provide a significant operational benefit. After the NASA IM demonstration is complete and prior to the FAA's final investment decision, an FAA-industry review of the results, including the cost and benefits, should be conducted to determine the final status of future recommendation on IM development and implementation.
7. The FAA plans for Path Stretch include initial operating capability (IOC) at TSAS sites beginning in 2022. The NAC endorses this GIM-S with path stretch timeline. Deployment of GIM-S with path stretch at all TBFM airports, where appropriate, should occur near the end of mid-term time horizon.
8. Begin the process of integrating aircraft trajectory data with ground systems in the midterm.
9. Consider CRDA as a mid-term solution for flow merging and spacing based on site-specific analyses.
10. Integrate Data Comm capability into the initial requirements for GIM-S with Path Stretch.
11. Make the use of RTA available as a supplement to other timing tools during this time frame recognizing that there is a need for a communication mechanism that reconciles between flight crews, dispatchers and controllers.
12. FAA should consider a funding mechanism for FIM to incentivize equipage that has proved successful in the Data Comm Integrated Services Contract
13. Based on experiences from the Near and Mid-Term, the FAA begin implementing advanced Data Comm capabilities defined by SC214.
14. Continue with the development of improvements to the timeliness and accuracy of environmental information provided to the aircraft, particularly for the descent phase of flight, such that existing aircraft RTA capabilities can reach their full potential.

Appendix A: Organizations Participating in the Performance Based Navigation (PBN) Time, Speed Spacing Task Group

Air Line Pilots Association
Airbus
Alaska Airlines
American Airlines, Inc.
City of Houston, Texas
Delta Air Lines, Inc.
Federal Aviation Administration

Dan Allen	**FedEx Express**	**Group Chair**

GE Aviation
Harris Corporation
HMMH (DP)
Honeywell International, Inc.
JetBlue Airways
Landrum-Brown
Leidos
Metron Aviation, Inc.
National Air Traffic Controllers Association
National Business Aviation Association
Professional Aviation Safety Specialists
Raytheon
Regulus Group
Rockwell Collins, Inc.
RTCA, Inc.

Steve Fulton	**Sandel Avionics, Inc.**	**Group Chair**

SESAR Joint Undertaking
Southwest Airlines
Tetra Tech
The Boeing Company
The MITRE Corporation
U.S. Air Force
United Airlines, Inc.

Appendix B Tasking Letter

U.S. Department
of Transportation

Federal Aviation
Administration

Office of the Deputy Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

December 2, 2015

Ms. Margaret Jenny
President, RTCA, Inc.
1150 18th Street, NW.
Washington, DC 20036

Dear Ms. Jenny:

The NextGen Advisory Committee (NAC) has been instrumental in working with the Federal Aviation Administration (FAA) to address the complexities inherent in moving to greater use of performance-based navigation (PBN) procedures. To further this work, the FAA is seeking the NAC's assistance in the development of a PBN strategy that builds improvements to the National Airspace System (NAS) capacity through time, speed, and aircraft spacing without compromising safety.

The goal of the PBN strategy is to combine the flight efficiency of visual meteorological conditions with the predictability and stability of instrument operations. Operators have implemented a number of capabilities that enable them to fly predictable paths, laterally and vertically, enhancing the ability for air traffic management (ATN1) automation to predict the flow of traffic at airspace constraints, such as runway capacity. Using PBN capabilities when traffic demand is high will depend on effective time, speed, and spacing management to maintain and eventually improve NAS capacity, efficiency, and throughput. The strategy for these ATM capabilities must be aligned to a broader navigation strategy.

The PBN strategy outlines near- (2020), mid- (2025) and far-term (2030) initiatives in the following focus areas:

- Implement PBN throughout the NAS with the right procedures to meet capacity, efficiency, and throughput needs;
- Provide navigation structure where beneficial, and flexibility where possible;
- Shift to time- and speed-based air traffic management;
- Deliver resilient navigation services;
- Modernize the FAA navigation service delivery;
- Enable lower visibility access; and
- Innovate and continuously improve.

These initiatives are possible because the navigation capabilities of aircraft have continued to improve, with a variety of capabilities spanning terminal and en route operations, including RNAV, RNP, advanced RNP, and several types of instrument approach operations (LNAV, LNAV/VNAV, LPV, RNP AR).

The most significant challenge to implementation is the need to integrate the path of a single flight with all of the other flights before and after it. The full use of PBN can only occur when the predictable and efficient path of each aircraft provides safe separation to the preceding and succeeding aircraft. Air traffic controllers are currently able to achieve a safe separation at maximum capacity by adjusting flight paths and speeds close to the final approach. The clear goal is to achieve a similar, or even improved, level of utilization during PBN operations.

Overcoming this challenge requires us to improve air traffic management through speed, spacing, and time control. These improvements require the development, deployment, and use of decision support tools for controllers and pilots. Some decision support tools have already been developed to manage demand and capacity and are being adapted for PBN. The FAA is also deploying ground-based interval management. Merging and spacing tools must be developed to support the PBN operational environment and to manage the differences in aircraft performance. Ultimately a combination of tools will be needed to allow reliable flight path planning prior to top-of-descent and to maintain spacing throughout the arrival.

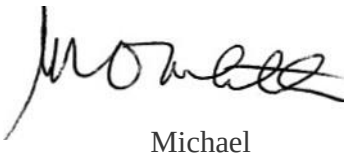
The PBN Strategy depends on the development and application of expanded and more mature scheduling, sequencing, and spacing tools and automation. Example enhancements include:

- Procedure-specified speeds;
- Terminal spacing and sequencing;
- Improved trajectory modeling through PBN and data communications;
- Common winds aloft through uplink of winds;
- Path stretching to absorb larger delays (simple capability using voice communications, or more sophisticated capability using data link communications);
- Flight deck interval management where the controller can assign a time-based spacing objective; and
- Use of a controlled time of arrival at or prior to the top of descent to improve the ordering of traffic

Specifically, the FAA requests that the NAC review the plans for these and related capabilities and develop a 15-year strategy for their deployment that would complement the FAA's NAS navigation strategy. The FAA requests draft findings from this work at the February NAC meeting, followed by a final report no later than the June NAC meeting. The strategy for time, speed and spacing assignment should address what types of tools are appropriate in various operating conditions, what tools should be prioritized, and how the various capabilities can be integrated into efficient traffic flow management.

The FAA will make subject matter expertise available to the NAC upon request. If I can be of further assistance, please contact me or Mr. Bruce DeCleene, Manager, Flight Technologies and Procedures Division, at (202) 267-8790.

Sincerely,



Michael
Whitaker Deputy
Administrator

cc: Edward Bolton, Assistant Administrator, NextGen
John Hickey, Deputy Associate Administrator, Aviation Safety Teri Bristol, Chief Operating Officer, Air Traffic Organization
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THE GOLD STANDARD FOR AVIATION SINCE 1935

Approved by the NextGen Advisory Committee October 2016

Joint Analysis Team: Performance Assessment of North Texas Metroplex and Established on RNP in Denver

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Report of the NextGen Advisory Committee in Response to Tasking from the FAA

October 2016

Joint Analysis Team: Performance Assessment of Metroplex and EoR

Contents

Introduction/Background

The NextGen Advisory Committee (NAC) has been instrumental in helping the Federal Aviation Administration (FAA) move forward with NextGen implementation. In 2014, the Committee approved a recommendation for a set of integrated plans on four focus areas of NextGen capabilities (DataComm, Multiple Runway Operations, PBN, and Surface).

These plans were developed by a joint FAA-Industry team, the NextGen Integration Working Group (NIWG), operating under the NAC. The goal of the NIWG is to identify implementation priorities that deliver measurable benefits by certain dates, and, thereby, increase the community's confidence in NextGen.

In June 2015, the NAC considered and approved six high level performance metrics intended to measure performance impacts attributable to the deployment of the four key NIWG capabilities outlined in the "NextGen Priorities Joint Implementation Plan" of October 2014. The set of metrics are intended for the FAA and industry to collaboratively monitor performance to understand the impact of implementations. The six metrics (detailed in Appendix B) are:

1. Actual Block Time
2. Actual Distance Flown
3. Estimated Fuel Burn

} Measured by city pairs

4. Throughput – Facility Reported Capacity Rates
5. Taxi-Out Time
6. Gate Departure Delay

} Measured at airports

Subsequently, the NAC formed the Joint Analysis Team (JAT) which includes operational and analytical experts from the FAA and industry. The JAT was formed to reach a common statement of fact regarding performance impacts and benefits that can be attributed to implementation of NextGen capabilities. To accomplish this goal, the JAT has analyzed data, metrics, methods and tools typically used by each of the parties in this type of assessment. This has included analyses of other measures deemed appropriate beyond the six metrics noted above. Additionally, the industry, through RTCA, selected PASSUR Aerospace to provide a database and associated analytical capability to track performance of these six metrics.

The JAT's scope involves evaluation of the following capabilities at the following locations:

- Wake ReCat Implementations at Charlotte Douglass International Airport (CLT) and two Chicago area airports – O'Hare International Airport (ORD) and Chicago Midway International Airport (MDW)
- Performance Based Navigation (PBN) Metroplex Implementation in North Texas
- PBN Established on RNP (EoR) in Denver International Airport (DEN)

This report includes findings on North Texas Metroplex and Denver EoR implementations. Findings on Wake ReCat implementations were provided to the NAC in June 2016.

Methodology

The JAT is comprised of data and analysis experts from the FAA as well as the aviation industry, and the team conducted a series of meetings to discuss and review ongoing analysis. This team initially agreed by consensus on methodologies to evaluate the impacts of Metroplex and EoR. A subset of team members then utilized their own company data to assess Metroplex and EoR using these methodologies. Data from the FAA, MITRE, American Airlines and Southwest Airlines were utilized in this process. Team members utilized the agreed-upon methodology and different data sources to analyze the impacts and benefits of Metroplex and EoR. The JAT utilized these analysis results to document agreed upon findings that follow in this report.

The working dynamic between the FAA and industry team members remained a positive and professional one in which capable analysts from different perspectives challenged one another's perspectives. The final product of this body is the result of strong collaboration and sharing of data and ideas between the FAA and industry. The JAT built trust and confidence amongst members throughout the process.

Summary of Findings

Established on RNP (EoR) in Denver

- EoR increased utilization of RNP AR approaches from 5.8% of arrivals to 6.6% of arrivals to Denver, an increase of 12%
  - Time saved from efficient approaches increased from 211 to 282 hours annually
- If an additional waiver is granted, EoR is expected to enable an increase up to 7.1% of arrivals executing RNP AR approaches.
  - Time saved expected to increase to 360 hours annually
- EoR is an important enabler to further future growth of utilization of efficient PBN approaches.

North Texas (NT) Metroplex

- Many external factors challenged pre vs. post Metroplex analysis
  - DFW/AAL re-banking, CRO, over-the-top elimination, Wright amendment at DAL, use of flow metering, change in wind patterns, and WN Cost Index change (speed increase)
- Changes in city pair block times driven by winds, not Metroplex
- The Team recognized the importance of system impacts of the Metroplex and, after analysis, determined to focus on flight trajectory changes within 300 nm as it best approximates effects of the North Texas Metroplex and allows for better isolating external factors pre/post implementation
- Metroplex has…
  - Segregated arrival routes between DFW and DAL

- Added route structure where flights previously vectored off-route
  - Enabler for increased TBFM forecasting accuracy, infrastructure for new tools and improved safety per SMEs
- Slightly increased flight distance within 300nm but slightly reduced time
- Clearly reduced level segments and increased continuous descents, particularly for DFW

Appendix A: Members of the Joint Analysis Team

Mike Cirillo, Airlines for America
John Heimlich, Airlines for America
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Mark McKelligan, NATCA
David Brukman, PASSUR Aerospace
Chris Maccarone, PASSUR Aerospace
Rob Golden, QED Consulting, LLC
Andy Cebula, RTCA, Inc.
Margaret Jenny, RTCA, Inc.
Trin Mitra, RTCA, Inc.
Bill Sperandio, Southwest Airlines
Tass Hudak, The MITRE Corporation
Bobby Kluttz, The MITRE Corporation
Pete Kuzminski, The MITRE Corporation
Debby Pool, The MITRE Corporation
Jeff Shepley, The MITRE Corporation
Marc Brodbeck, United Airlines, Inc.
Alex Burnett, United Airlines, Inc.
Glenn Morse, United Airlines, Inc.
Kevin Swiatek, United Parcel Service

Appendix B: NAC Performance Metrics

		Metric	Reported Values	Comments[1]
Measured on applicable existing *104* city-pairs:	1.	Actual block time	Mean and std dev or 60% percentile	• Actual time from Gate-Out time to Gate-In time for a specified period of time by city pair • GA: I FR flight time from ramp taxi to ramp park
	2.	Actual distance flown	Mean and std dev or 60% percentile	• Actual track distance between key city pairs for a specified period of time • GA: IFR flight distance from take-off to TOC & from TOD to touch down
	3.	Estimated Fuel burn	Mean and std dev	• Actual fuel burn for a specified period of time
Measured at applicable airports	4.	Throughput - facility reported capacity rates *	Mean and peak capacity rates	• Facility Airport Arrival Rates (AAR) & Arrival Departure Rate (ADR) Airlines (recommend: http://www.fly.faa.gov/ois/ however, the working group is open to alternate measurements that meet the requirements) • GA: measured as access events - Radar vector and not SID as OUT event and Ground based nav and not GPS / WAAS-LPV as IN event
	5.	Taxi-out Time *	Mean and std dev or 60% percentile	• Actual time from Gate-Out to Wheels-Off time by airport (minutes/flight) • GA: IFR flight taxi time from ramp taxi to take off
	6.	Gate Departure Delay	Delays/100 act depts. And total delay minutes	• Difference in actual Gate-Out time and scheduled Gate-Out time, Not measured for GA

*** - Identified by FAA**
1 GA data may not currently be collected

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Appendix C: Detailed Methodology and Analysis of Metroplex and EoR

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Joint Analysis Team Report to the NextGen Advisory Committee

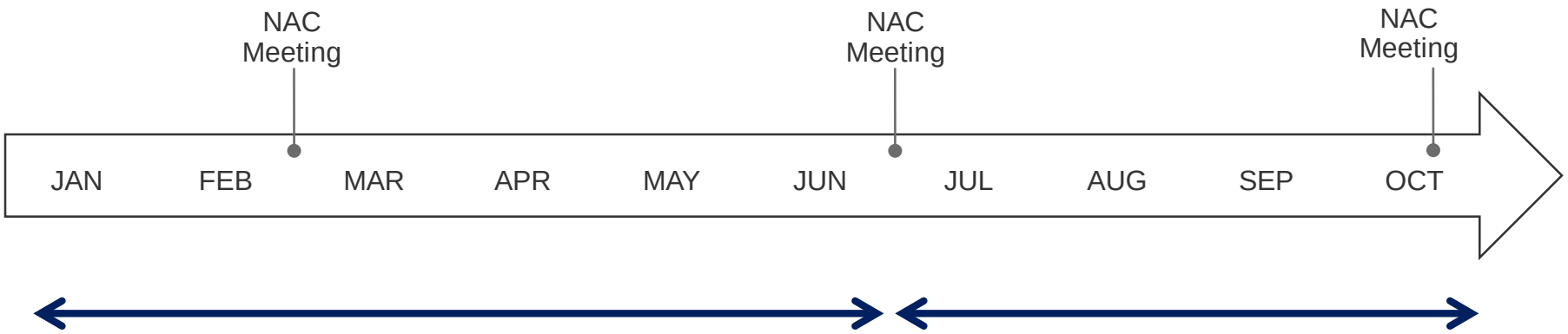
October 5, 2016

Ilhan Ince, American Airlines
Dave Knorr, FAA
Co-Chairs of the Joint Analysis Team

Joint Analysis Team (JAT)

- Goal: develop common statement of facts on NAS performance attributable to NextGen
- Analytical experts from industry and FAA. Participating organizations include:
  - Airlines 4 America
  - ACI North America
  - American Airlines
  - Cessna Aircraft Corp.
  - DFW International Airport
  - Delta Airlines
  - FAA
  - FedEx Express
  - JetBlue Airways
  - Jetcraft Avionics LLC
  - Landrum and Brown
  - MITRE
  - NATCA
  - PASSUR Aerospace
  - Southwest Airlines
  - United Airlines
  - UPS

JAT Schedule and Status



Wake ReCat Assessment

- CLT
- ORD/MDW

PBN Assessment

- Denver Established on RNP (EoR)
- North Texas Metroplex

FOCUS FOR TODAY

JAT Findings – Established on RNP

- EoR increased utilization of RNP AR approaches from 5.8% of arrivals to 6.6% of arrivals to Denver, an increase of 12%
  - Time saved from efficient approaches increased from 211 to 282 hours annually
- If an additional waiver is granted, EoR is expected to enable an increase up to 7.1% of arrivals executing RNP AR approaches
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- EoR is an important enabler to further future growth of utilization of efficient PBN approaches

Annual Benefits from RNP AR with EoR

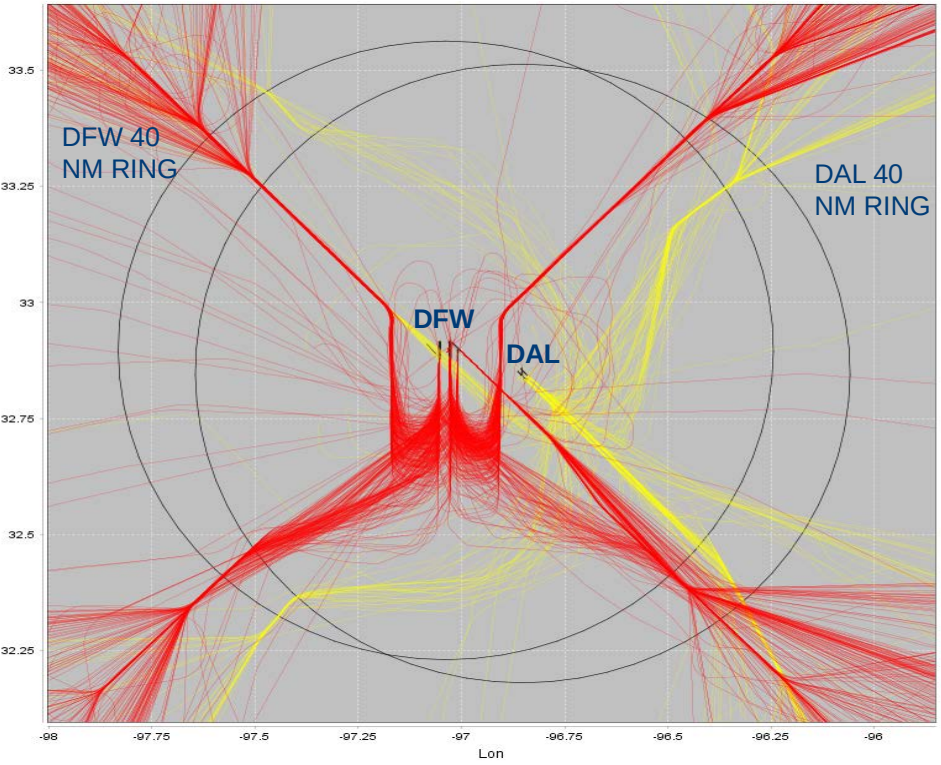
RNP AR benefit	RNP AR Pre-EOR	RNP AR with EOR	RNP AR EOR adjst IMC
Utilization (% of all arrivals)	5.8%	6.6%	7.1%
Avg. Distance Saving (nm/flight)	2.5	2.9	1.5 – 18.3
Overall Arrivals in 2015 (flights)		272,685	
Total Distance Savings (nm)	39,178	52,385	66,757
Avg. Speed at Intercept (kts)	185.3	185.6	185.6
Total Time Savings (hr)	211.5	282.3	359.7

Data Sources:
- ASPM, for annual arrivals and occurrence of IMC
- PDARS, for utilization, distance and time calculations

North Texas Metroplex

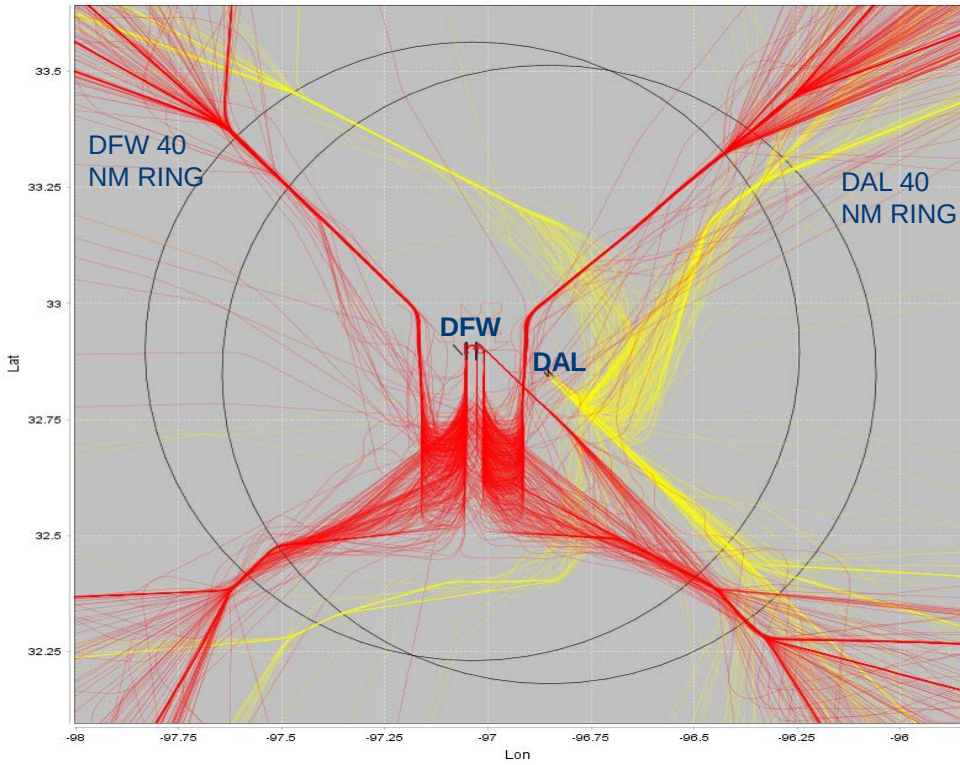
Pre Metroplex Arrival Flows

Oct 2013 – Feb 2014



Post Metroplex Arrival Flows

Oct 2015 – Feb 2016



JAT Findings – NT Metroplex (1 of 2)

- Many external factors challenged pre vs. post metroplex analysis
  - DFW/AAL re-banking, CRO, over-the-top elimination, Wright amendment at DAL, use of flow metering, change in wind patterns, and WN Cost Index change (speed increase)
- Changes in city pair block times driven by winds, not Metroplex
- Team recognized importance of system impacts of the Metroplex and, after analysis, determined to focus on flight trajectory changes within 300 nm as it best approximates effects of NT Metroplex and allows for better isolating external factors pre/post implementation

JAT Findings – NT Metroplex (2 of 2)

- Metroplex has…
  - Segregated arrival routes between DFW and DAL
  - Added route structure where flights previously vectored off-route
    - Enabler for increased TBFM forecasting accuracy, infrastructure for new tools and improved safety per SMEs
  - Slightly increased flight distance within 300nm but slightly reduced time
  - Clearly reduced level segments and increased continuous descents, particularly for DFW

Lessons Learned

EoR

- EoR, in conjunction with terminal sequencing tools and growing aircraft equipage, should further grow the percent of arrivals executing efficient PBN approaches

Metroplex

- Developed a robust Metroplex methodology that effectively accommodates for variety of pre/post implementation changes and may be used in future
- Additional work required: need to document the Metroplex analysis process and determine a joint approach to measure fuel impacts/changes
- Metroplex efforts should continue to ensure they are cognizant of impacts on flight time and distance