Approved by the NextGen Advisory Committee October 2018

NextGen Integration Working Group Rolling Plan 2019-2021 Final Report

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

October 2018

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NextGen Integration Working Group Rolling Plan 2019 - 2021

Background/Introduction

Since inception in 2014, the NextGen Integration Working Group has successfully delivered operational benefits with industry against the joint commitments made in the Joint Implementation Plan and the NextGen Priorities Update. Together the FAA and the aviation community have delivered 174 of 178 commitments to date advancing NextGen at target locations and producing useful and measurable benefits to industry and the U.S. National Airspace System (NAS). Progress of NextGen Priorities is twofold: implementation of the commitments jointly agreed to in the work plan and the resulting operational outcomes and benefits realized. The last NextGen Priorities Joint Implementation Plan, 2017-2019 was published in October 2016 and contained FAA-industry agreed milestones through 2019 in four focus areas: Multiple Runway Operations, Surface Operations and Data Sharing, Data Communications, and Performance Based Navigation. The 2017 Joint Implementation Plan Update included a new NextGen Priority area, the Northeast Corridor (NEC), the busy airspace between Washington, D.C., and Boston that includes Philadelphia and New York City, and associated airspace.

The 3-year focus of this work connects planning closer to the operation and combined with FAA's responsiveness continues to make this an extremely productive effort. The Joint Analysis Team Results provide performance impacts and benefits of some of these capabilities to date and provide a collective FAA and Industry common statement of fact.

Executive Summary

The recommendations herein roll the NextGen Priorities Joint Implementation Plan forward through calendar year 2021 with capabilities that meet the "high benefit, high readiness" criteria that has been the hallmark of NextGen Priorities success. The commitments included outline specific FAA and Industry commitments for the next three years in four key areas to advance NextGen: Data Comm, Multiple Runway Operations, Performance Based Navigation, and Surface and Data Sharing are fundamental to moving the National Airspace System forward offering greater flexibility and operational benefits in a more integrated airspace.

From the last set of NAC recommendations on NextGen Priorities in June of 2016, there has been considerable progress in delivering operational benefits and meeting or exceeding planned commitments. The recommendations in this report build on this foundation and encompass some stretch goals.

The Data Comm NIWG has been a premier example of working together and delivering benefits to industry stakeholders and the NAS as a whole. After completing tower services at 55 sites, the FAA added 7 additional sites, at the request of industry, and completed them nearly a year ahead of schedule and under budget. The JAT analyzed the benefits of tower services and determined that it saves both time and fuel, estimating taxi-out time savings of up to 8.5 minutes per flight in off-nominal operations at studied sites. Using the methods established with the JAT, a comprehensive analysis of Data Comm benefits identified $54M in airline and passenger savings for the year of 2017.

This next 2019 to 2021 plan moves to deploy the en route initial services across all 20 en route control centers expanding the benefits across all phases of flight in the NAS. Data Comm has also taken on the tough issues in order to identify risks and mitigations to ensure all stakeholders can address any shortfalls to successfully implement the program as committed. The plan looks to address issues with both air and ground technology as well as strategies to include more stakeholders in future equipage. In addition, industry and the FAA will work together to promote the use of Data Comm services across as many aircraft types beyond the incentivized equipage program with the joint goal of ensuring the benefits of Data Comm services are realized across the operation for all stakeholders and users of the NAS. The recommendations include establishing fleet equipage targets for Calendar Year 2023 to support follow-on capabilities that target 40% of NAS operations as well as includes developing a strategy for regional jet equipage and for regional jets to participate in and receive benefits from Data Comm services.

Multiple Runway Operations has repeatedly delivered benefits to industry thru procedural innovations and changes without equipage costs to industry stakeholders. In the past, Wake Recategorization 1.5 and 2.0 were successfully deployed across the NAS at 17 Terminal Radar Approach Control (TRACON) facilities and 31 airport locations. The FAA estimates Wake RECAT has saved airlines more than $70 million, extrapolating from the joint analyses team methodology.

The FAA introduced the new consolidated wake turbulence concept that optimizes the best from numerous wake recat procedures into one standard to safely further reduce separation standards that can deployed to any location across the NAS. Moreover, the agency rapidly deployed this capability in 2018 and committed to expanding the procedures to numerous locations across the NAS. Industry commits to examine the benefits of this new concept. The plan identifies other areas for analysis to further evolve procedures that increase throughput by continuing to improve parallel runway operations, closely spaced parallel operations arrivals and departures, and the use of dynamic wake turbulence concepts that factor in wind speed. Finally, the NIWG commits to work together with the joint partners to raise awareness across the NAS on wake turbulence encounters.

The Performance Based Navigation implementation recommendations are built upon the 2016 PBN NAS Navigation Strategy that leverages past successes and builds a compelling future based on aligning 1) aircraft equipage, 2) ground technology/tools and 3) procedures. Aligning these three key elements are the basis for successful activities identified to advance PBN. In past commitments, Metroplex projects have shown to improve operations at some locations.

The plan includes 4 major FAA Metroplex projects (CLE/DTW, DEN, LAS and FL) at numerous major airport locations in the NAS in this report. PBN is a key element of the FAA's trajectory based operations concept to optimize the NAS using time-based management. This report identifies select FAA initial trajectory based operations capabilities to implement across 3 locations in the Northeast Corridor, Denver, and Atlanta. Critical to this plan is a recommendation to develop a multi-year capital implementation plan for PBN that serves as a roadmap for the completion of the 2016 NAS NAV Strategy. It cannot go without noting, consistent and sustainable funding for PBN implementation is needed to achieve the scale of effort needed in this report. Finally, this report identifies recommendations in Ground Based Augmentation System, Advanced Required Navigation Performance, Established on RNP and others that highlight industry capabilities that the FAA can leverage to improve efficiencies in the NAS.

The Surface and Data Sharing initiatives are gaining ground by connecting industry operators to the system wide information management system (SWIM). Fundamental to progress in this area, is the formation of the SWIM Industry-FAA team (SWIFT). This community forum acts as a single environment for collaborative communication and engagement around information and data sharing with the FAA. Data sharing is foundational for traffic flow management (TFM) decision support tools and the TBO concept.

Another key effort for the NIWG Surface and data sharing group is the NAS implementation of the Terminal Flight Data Manager (TFDM) program. TFDM requires critical operator data to integrate arrival, departure and surface operations to meter and deliver time and fuel savings to operators. These areas, along with Collaborative Decision Making (CDM) Steering Group (CSG) activities, support continuity and connectivity with the Surface Collaborative Decision Making (S-CDM) Concept of Operations, and seek to further enhance data exchange between FAA and all aviation stakeholders. FAA and Industry team's partnership with NASA on a surface departure metering capability for integrated arrival/departure/surface work provides valuable lessons learned with the capability already being demonstrated at Charlotte.

The group remains focused on advancing data driven traffic flow management (TFM) across the NAS with an emphasis on the data and connectivity requirements for current and future NAS automation systems.

Specific Recommendations by NextGen Focus Areas

Data Comm - Controller Pilot Data Link Communications (CPDLC)

Background/Introduction

In 2014, the NextGen Advisory Committee (NAC) approved the NextGen Integration Working Group (NIWG) final report and the NextGen Priorities Joint Implementation Plan was presented to Congress. In 2016, the NAC continued the effort and delivered a follow-on Rolling Plan to Congress. Collectively Data Comm have achieved many successes in meeting implementation milestones for fielding NextGen capabilities, advancing work in the four priority areas of Data Comm, Multiple Runway Operations (MRO), Performance Based Navigation (PBN), and Surface Operations.

- Data Comm – In response to NAC recommendations, the FAA deployed Controller Pilot Data Link Communications (CPDLC) Departure Clearance (DCL) Tower Services to all planned airports, well in advance of all planned implementation dates. Furthermore, The NAC Joint Analysis team (JAT) validated the program benefits and metrics confirming that Data Comm is delivering benefits to the NAS. Data Comm is preparing for the implementation of the En Route Initial Services phase of the program, to include completing the necessary transition to National Single Data Authority (NSDA), and conducting risk reduction events in Kansas City (ZKC) airspace, a key site. The program also successfully obtained a Final Investment Decision (FID) for En Route Full Services, to be implemented starting in 2022.

Summary

Evolving the National Airspace System (NAS) to meet the goals of NextGen requires the implementation of advanced data communications between flight crews and air traffic controllers. Continuous communication among controllers and pilots is essential to safely coordinate the thousands of airplanes in the NAS at any given time. As the NAS moves to a time-based flow management system, it will become increasingly critical to have the capability to provide En Route data communications between the flight deck and the controllers. In the future, controllers and pilots communicating verbally using analog radios may detract from technologies that enable the implementation of increasingly complex NextGen capabilities. Voice communication is labor intensive, time consuming, has a propensity for miscommunication and human error, and limits the ability of the NAS to meet future traffic demand. The program also provides an interface to the aircraft operator dispatch function, increasing operational efficiency. The investment in data communications is critical to enhancing the NAS and modernizing air traffic operations.

In an effort to ensure that Data Comm capabilities are delivered and the benefits are realized, the Data Comm NextGen Integration Working Group (NIWG) thoroughly reviewed the FAA Data Comm Program and developed timelines, locations, and services to which both industry and the FAA would commit. To that end, the Data Comm NIWG specifically reviewed nine areas for this rolling plan update. These areas are as follows:

- Reviewed progress of operator equipage progress and recommendations for future equipage
- Reviewed and confirmed the deployment of Data Comm Tower Services to the identified additional seven towers

- Reviewed and confirmed the implementation strategy for Data Comm En Route Initial Services
- Reviewed the development and implementation planning of En Route Full Services
- Reviewed the development of a baseline for the deferred En Route Full Services and identification of enhanced services beyond En Route Full Services utilizing the FANS 1/A message set
- Reviewed the resolution of avionics interoperability concerns, to include the interoperability issues regarding Pegasus 1 avionics
- Reviewed the development of a loadability solution for Runway SID/STARs
- Reviewed the development of a solution for full automation for the confirm assigned route capability
- Reviewed the examination of opportunities to promote efficiencies by integrating Data Comm with other NextGen NIWG capabilities

Operators continue to equip with VHF Digital Link Mode 2 (VDL Mode2) and FANS 1/A avionics and software. Over 1,900 aircraft have already been equipped through the Data Comm Program equipage initiative.

Based on the success of the Tower Services deployed in 2015-2016, the group confirmed its commitment to supporting the implementation of En Route Initial Services in 2018-2019, as well as deployment of Tower Services to the additional towers previously identified by the NIWG. The group recommends the FAA continue to explore deploying Data Comm Tower Services to additional towers and in other En Route airspace in the NAS (e.g., Anchorage, Honolulu, etc.). There is a solid operational and benefits case to deploy Data Comm at Anchorage and Honolulu. However, there are infrastructure and technical limitations at these locations that will need to be addressed in the future to allow these capabilities to be expanded. The group continues its endorsement of the planned En Route Initial Services implementation strategy and waterfall. The group recommends NAS-wide implementation of En Route Initial Services within a one-year timeframe to avoid safety concerns and user acceptability issues associated with a prolonged rollout.

The capabilities in En Route Initial Services will deliver significant benefits to the NAS and are eagerly anticipated by the operator community. The En Route Initial services implementation plan was developed in conjunction with all stakeholders to ensure a smooth transition of these capabilities into NAS operations. The Data Comm NIWG supports the implementation of Data Comm En Route Initial Services to all 20 Air Route Traffic Control Centers (ARTCC) over a one-year period.

The Data Comm NIWG notes that En Route Full Services in their entirety were rated a Tier 1 capability in the initial NAC report. The limitation of funding and the subsequent need to break En Route Full Services will delay the realization of delivery of operational benefits and efficiencies. The Data Comm NIWG recommends that En Route Full Services, a 2014 Tier 1 priority by the NAC, be implemented as soon as possible, and that the FAA investigate acceleration of the deployment ahead of the scheduled IOC in 2022. En Route Full Services includes the previously baselined capabilities: Controller Initiated Re-routes (Full Capability), Direct-to-Fix Messages (Full Capability), Crossing Restrictions (Full Capability, Advisory Messages, and Holding Instructions.

Additionally, The Data Comm NIWG recommends the previously deferred capabilities from Full Services be implemented in the Full Services timeframe. The deferred services to be implemented would include Adapted Arrivals, Speeds (Full Capability), Stuck Microphone, and Beacon Codes. Furthermore, the Data Comm NIWG recommends the FAA investigate including enhanced services in this implementation that can be delivered using the FANS 1/A message set, such as complex re-routes with time, speed and altitude elements, TMC-initiated re-routes, and initial aircraft intent.

The Data Comm NIWG supports the temporary ground system mitigation developed to allow 757 and 767 aircraft using the Pegasus 1 Flight Management System (FMS) to participate in En Route Initial Services. However, this is not a permanent solution and an avionics solution needs to be developed prior to the end of 2021 to allow the 757 and 767 aircraft to continue to receive Data Comm En Route Services.

The Data Comm NIWG recommends as part of FAA tower automation enhancements, that the FAA include the capability to uplink all loadable route clearance elements including runway in the full services timeframe (2022). During the early design phase of Data Comm, it was identified that CPDLC services were limited to the information available in the automation systems delivering the clearance. One such example is the tower data link system does not have the complete information to provide the runway element as part of the uplinked, loadable departure clearance. This data element shortcoming is due to a lack of FAA tower automation capability. One of the primary goals of the Data Comm Implementation Team (DCIT) is to implement CPLDC messages to maximize existing flight deck automation using loadable messages. Reducing the human in the loop dependency by enabling flight deck automation for services such as complex route changes exemplifies the major benefits of Data Comm.

The Data Comm NIWG recommends the full automation of the Confirm Assigned Route function be implemented in the Full Services timeframe. When a re-route is issued, the flight crew follows up by sending the entire active route loaded in the FMC back to the controller. ERAM could be programmed, as it is in Nav Canada and NATS, to evaluate the response and only notify the controller/pilot if the assigned route does not match the Confirm Assigned Route. Today we are expecting the controller to manually go through the Confirm Assigned Route looking for errors. One of the major benefits of Data Comm is the automation's capability to reduce human error.

The Data Comm NIWG recognizes that there are synergies and efficiencies to be gained by integrating NextGen capabilities to deliver holistic benefits that would not be possible with a single capability. The Data Comm NIWG recommends the aviation community continue to identify capabilities to be integrated together that will produce increased operational efficiencies, to include the examination of opportunities to promote efficiencies by integrating Data Comm with other NextGen NIWG capabilities (i.e., Surface, PBN, and NEC).

In summary, the Data Comm NIWG endorses the following:

- The continued commitment for the airlines to equip at least 1,900 aircraft for Data Comm by FY 2019
- The development of target FANS 1/A avionics equipage rates to support follow-on capabilities
- The development of an avionics equipage strategy for regional jets to participate in and receive benefits from Data Comm services
- The continued of deployment of Data Comm Tower Services to seven additional towers: Andrews (ADW), Buffalo (BUF), Charleston (CHS), Columbus (CMH), Fort Myers (RSW), Reno (RNO), and Van Nuys (VNY)
- The investigation of deployment of Data Comm Tower Services to additional towers and in other En Route airspace in the NAS (e.g., Anchorage, Honolulu, etc.)
- The deployment of Data Comm En Route Initial Services to all 20 CONUS ARTCCs in accordance with the agreed to government and industry schedule

    - To avoid safety concerns and user acceptability issues associated with a prolonged deployment the group recommends full implementation of En Route Initial Services within a one-year timeframe
- The continued development and implementation of En Route Full Services
    - The industry members of the Data Comm NIWG recommend the FAA fully fund En Route Full Services
- The development of a baseline and identification of enhanced services utilizing the FANS 1/A message set by Q3 CY2021
- The inclusion of the previously deferred capabilities from Full Services to be implemented in the Full Services timeframe
- The investigation of additional capabilities in the Full Services implementation
- The resolution of avionics interoperability concerns, to include the interoperability issues regarding Pegasus 1 avionics
- The development of a loadability solution for Runway SID/STARs
- The development of a solution for full automation for the confirmed assigned route capability
- The examination of opportunities to promote efficiencies by integrating Data Comm with other NextGen NIWG capabilities

Background

The Data Comm Program will provide data communications services between pilots and air traffic controllers as well as enhanced Air Traffic Control (ATC) information to airline operations centers and other flight following providers. Data Comm will provide a data interface between ground automation and the flight deck for controller and pilot communications, allowing pilots and controllers with a push of a button to send, accept, and insert (if allowed) into flight deck avionics safety-of-flight ATC clearances, instructions, traffic flow management notices, flight crew requests and reports. Data Comm is critical to the success of NextGen, enabling efficiencies not possible with the current voice system.

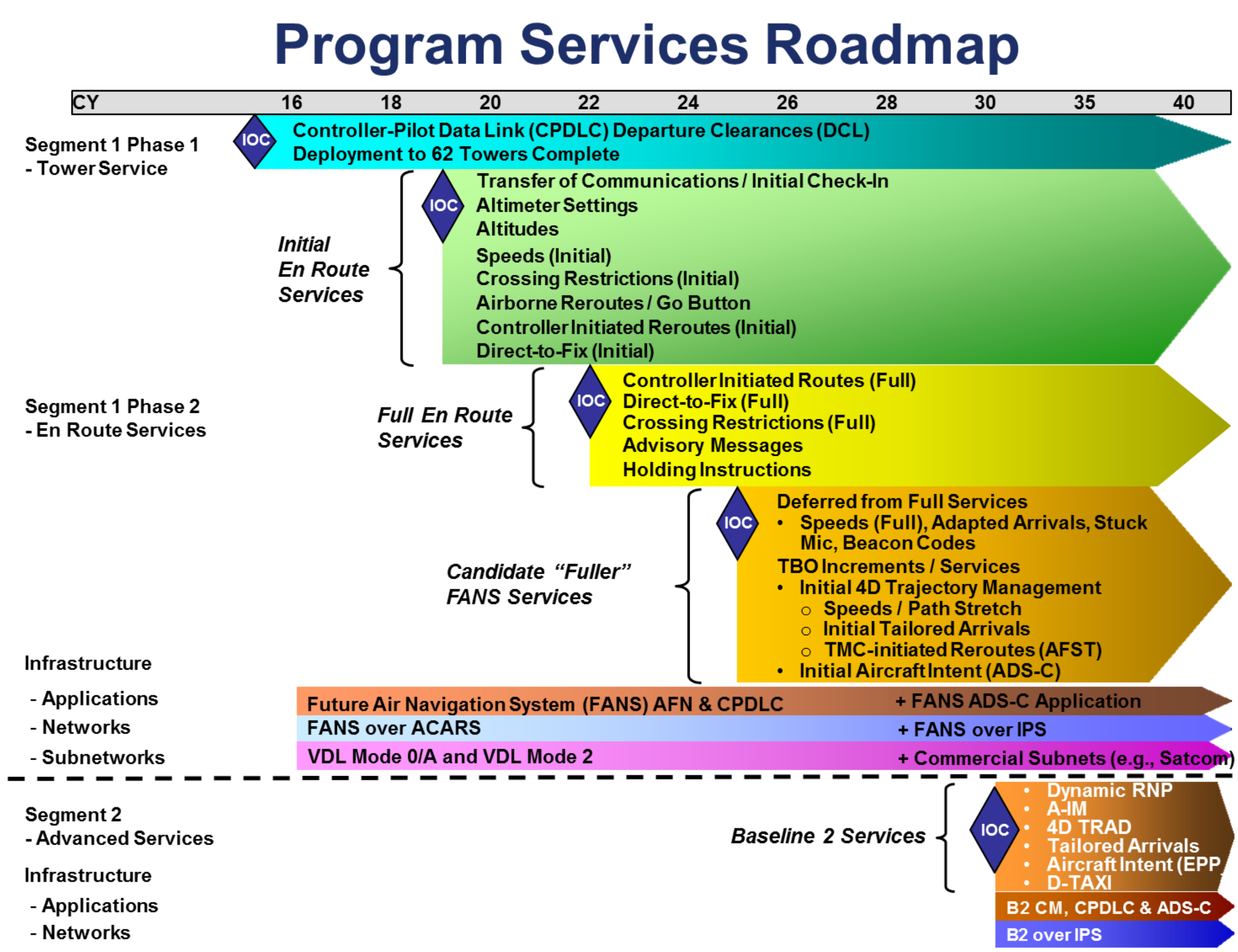
The operational benefits of the Data Comm Program are:

- Enhanced safety by reduced communication errors,
- Reduced communication time between controllers and pilots,
- Increased airspace capacity and efficiency,
- Reduced delays, fuel burn, and carbon emissions,
- Improved re-routing around weather and congestion,
- Increased flexibility and accommodation of user requests,
- Enables NextGen services, such as enhanced re-routes, trajectory operations,
- Enables the communication of complex clearances that can be efficiently executed,
- Ability to do post operational data mining of route changes to improve flight planning,
- Improved situational awareness and reduced time for route clearance acceptance through improved integration of dispatch.

These improvements to the NAS will be realized through the execution of the Data Comm Program in two primary segments. Segment 1 will deliver the initial set of Data Comm services integrated with ground automation support tools in designated ATC Towers (Segment 1 Phase 1), followed by deployment of En Route Services (Segment 1 Phase 2). Segment 2 will further build upon the Tower and En Route services by supporting more advanced NextGen capabilities not possible using voice, such as Dynamic Required Navigation Performance (DRNP), Advanced Interval Management, 4-D Trajectories, and D-TAXI. These advanced services will require the deployment of Baseline 2 avionics. Since Baseline 2 avionics are now not expected to be widely deployed in the NAS until the 2030s, the planned date for the deployment of Baseline 2 infrastructure and applications is now expected to be in the 2030+ timeframe. To bridge the gap until Baseline 2 can be deployed, Data Comm will explore capabilities that can be provided using the current message sets (i.e., FANS 1/A). Although this phase is still in the planning stages, the candidate capabilities to be implemented to bridge the gap are shown in the orange arrow in Figure 1 below and are expected to be available in approximately 2025. The focus of the activities of this working group is on Segment 1 Phases 2 En Route Initial, Full, and Enhanced Services utilizing Future Air Navigation System (FANS) 1/A avionics.

The Data Comm services phasing strategy for the program is shown graphically below in Figure 1. Segment 1 Phase 1 is Tower Services providing Controller Pilot Data Link Communications (CPDLC) Departure Clearances (DCL) and was baselined in May 2012. Segment 1 Phase 2 is CPDLC En Route Service which will be deployed in three increments. En Route Initial Services were baselined in October 2014. A portion of En Route Full Services consisting of Controller Initiated Routes (Full Capability), Direct-to-Fix (Full Capability), Crossing Restrictions (Full Capability), advisory messages and holding instructions were baselined in August 2016. The remaining En Route Full Services consisting of Speeds (Full Capability), Stuck Microphone, Adapted Arrivals and Beacon Codes, along with other enhanced services, have a projected baseline date of Q3 CY2021.

Figure 1. Data Comm Services Strategy



Departure Clearances (DCL) – Segment 1 Phase 1 (S1P1) (Baselined in May 2012)

In S1P1, the Data Comm Program delivered CPDLC DCL to airports including revisions with full route clearances transmitted directly to the aircraft on the airport surface. Route revisions can be loaded directly into aircraft avionics by the pilots. The Data Comm Program implemented CPDLC DCL Services in accordance with the accelerated timeline requested in the 2014 NIWG report, and is currently fully operational in the NAS. CPDLC DCL services expedite the delivery of departure clearances to aircraft, streamline clearance delivery operations and enable quicker recovery from changes in the operational configuration of runways and airspace caused by weather and other events. CPDLC DCL improves efficiency, reduces ground delays, and results in more effective tactical management of NAS resources.

The major elements of Segment 1 Phase 1 are:

- Tower Data Link Services (TDLS) software and hardware enhancements to legacy Pre-Departure Clearances (PDC) functionality to enable Departure Clearance (DCL) services in the Towers.
- En Route Automation Modernization (ERAM) software and hardware enhancements to include logon and session establishment.
- Data Communications Network Service (DCNS) which will provide the air/ground communications network services infrastructure.
- Avionics Equipage Initiative which will provide incentives for operators to equip aircraft with FANS 1/A avionics and VHF Data Link (VDL) Mode 2 radios.

En Route Initial Services – Segment 1 Phase 2 (S1P2) (Baselined in October 2014)
S1P2 En Route Initial Services will leverage the S1P1 infrastructure to deliver services to the En Route domain using CPDLC. En Route Initial Services will include airborne re-routes, altitude and speed assignments, altimeter settings, crossing restrictions, and will automate routine communications such as transfer of communications and initial check-in. Controller initiated re-routes include limited functionality for pilot requested re-routes. The Data Comm En Route Initial Services will contribute to a reduction in flight delays, more efficient routes for aircraft resulting in increased operational efficiency, and enhanced safety all while reducing operational costs for airspace users. As Data Comm becomes fully operational, the majority of pilot-controller exchanges will be handled by Data Comm for Data Comm equipped operators.

The major elements of the En Route Initial Services Segment 1 Phase 2 implementation are:

- ERAM software enhancements for En Route CPDLC applications.
- DCNS expanded coverage and capacity

En Route Full Services – Segment 1 Phase 2 (S1P2) (Baselined in August 2016)
S1P2 En Route Full Services will further leverage the S1P1 infrastructure to deliver additional services to the En Route domain, to include additional CPDLC messages and expanded re-route capabilities. The En Route Full Services will be delivered in two stages. The S1P2 En Route Full Services will include expanded controller and pilot initiated downlinks, direct-to-fix messages, issuing of crossing restrictions, holding restrictions and will automate some routine communications such as advisory messages. The Data Comm En Route Full Services will contribute to a reduction in flight delays, more efficient routes for aircraft resulting in increased operational efficiency, and enhanced safety all while reducing operational costs for airspace users. The addition of Full Services will result in more pilot-controller exchanges being handled by Data Comm for equipped operators.

The FY19 President's Budget Request includes no funding for En Route Full Services. The program has delivered Data Comm to 61 airports over two years ahead of schedule, is widely supported by the airspace users, and is on track to deliver En Route Initial Services starting in late 2018. The decision to eliminate funding for En Route Full Services was due to overall funding constraints. Data Comm has strong industry backing and regularly meets with airspace users ensure the program capabilities and services are aligned with industry plans. This collaboration creates a tremendous amount of forward momentum and cooperation. Restoring the baselined FY19 funding for Data Comm En Route Full Services ensures this momentum between the FAA and airspace users continues and does not jeopardize the airspace user's business case to invest in Data Comm avionics equipage, operations, and pilot training. Entities affected by this deferral in Data Comm En Route capability include airline end users, such as Alaska Airlines, American Airlines, Delta Air Lines, FedEx Express, Hawaiian Airlines, JetBlue Airlines, Southwest Airlines, United Airlines, and UPS, 45 international airlines, hundreds of business aviation users, as well as FAA contractors Harris Corporation and Leidos.

The major element of the En Route Full Services Segment 1 Phase 2 implementation is:

- ERAM software enhancements for En Route CPDLC applications.

Enhanced En Route Services (Not Baselined)
A subsequent stage of En Route Full Services will include Adapted Arrivals, Beacon Codes, Speeds (Full Capability), Stuck Microphone, Initial 4-D Trajectory Management, Path Stretch, Initial Tailored Arrivals, TMC Initiated Re-routes, and Initial Aircraft Intent (ADS-C). Adapted Arrivals, Beacon Codes, Speeds (Full Capability), and Stuck Microphone functionalities were removed from the first stage of the En Route Full Services and placed into this second stage as a result of FAA budget constraints. The airline industry believes the capability for a controller to provide altitude and airspeed constrains on a re-route would be a valuable first step in the development of a truly dynamic tailored arrival and optimized profile descent (OPD) which is a desire of both the FAA and industry. This would also be an important element to enable complex path-stretches off OPDs for time based flow management into the terminal area. The Data Comm NIWG also recommends investigating the feasibility of enhanced services using the current FANS 1/A message set. Such candidate enhanced services include complex re-routes with time, speed, and altitude elements; TMC initiated re-routes, and ADS-C initial aircraft intent. The Data Comm NIWG recommends the FAA baseline these deferred and additional En Route Services by end of Q3 CY2021. Once these services are identified and baselined, the Data Comm NIWG recommends fully funding this effort.

Data Comm Benefits and Metrics

The Data Comm NIWG reviewed and validated the FAA strategy for delivery of Data Comm capabilities to the NAS, for both Segment 1 Phase 1 (S1P1) and Segment 1 Phase 2 (S1P2). The group also agreed with the qualitative benefits expected for both S1P1 and S1P2, as well as identifying categories of metrics to be tracked to measure program success.

Expected Benefits
Data Comm will revolutionize ATC communication between the ground and the cockpit, increasing the capacity, flexibility, and productivity of the NAS. Data Comm provides services which will enhance safety, airspace throughput, flight times, reduce carbon emissions, reduce fuel usage, and other efficiencies in both the Terminal and En Route environments. It will reduce air traffic control communications workload which will reduce air traffic delay and increase efficiency through an increase in controller flexibility. Data Comm will allow complex routing communications that will make better use of available NAS resources such as airspace and airports. This improvement will occur for routine operations and be even more critical during system disruptions such as weather. Data Comm is a key transformational program under NextGen that will enable advanced capabilities, such as Trajectory Based Operations, Advanced Flight Interval Management, Enhanced Surface Movement, and Dynamic RNP. Data Comm will also reduce operational errors, enhancing the safety and efficiency of the NAS.

One significant example of benefits available to the airspace users in En Route Full Services is the ability for flight crews to request a new route during flight. Airlines have preferred routes around weather or to take advantage of favorable wind conditions, sometimes these routes are not available at departure, but open up during flight. Today requesting a new route is a cumbersome and time-consuming process with voice communications, quite often these requests are denied due to the time it takes to communicate, de-conflict, and clear the request from the flight crew. In En Route Full Services, the data link capability allows flight crews to request a more efficient route by electronically sending their preferred route to air traffic control. This capability enables pilots to quickly and seamlessly share their preferred route with an air traffic controller, giving them the same picture. If the route request does not pose a conflict, the controller can then send a revised route clearance back to the flight crew, quickly enabling them to program and execute their preferred route. The airlines anticipate this capability will enable them to fly more efficient routes, saving time and fuel. The airspace users have expressed through the NextGen Advisory Committee (NAC) and other forums that their business case for investing in Data Comm relies on the capabilities delivered by En Route Full Services.

DCL Services at the Tower (S1P1) improves operations in the following manner:

- Improve communication accuracy and safety with digital communication (i.e., reduced read/hear back errors, reduced loss of communications events).
- Improve recovery from service disruptions, mitigate propagated delay, improve schedule reliability, and enable NextGen capabilities.
- Improve controller efficiency.
- Reduce environmental impact due to less fuel burn and emissions.
- Direct cost savings for both the FAA and operators from reduced delay enabled by a reduction in communication time for revised departure clearances and enhanced aircrew coordination with company dispatch.
- Enable post operational data analytics of clearances that are revised from the filed flight plan.

CPDLC Services in En Route (S1P2) will improve operations in the following manner:

- Improve communication accuracy and safety with digital communication (i.e., reduced read/hear back errors, reduced loss of communications events).
- Improve controller and flight crew efficiency by providing automated information exchange.
- Improve rerouting capabilities.
- Allow more efficient routes for aircraft.
- Decrease congestion on voice channels and provide an alternative communications capability.
- Improve NAS capacity and reduced delays associated with congestion and weather.
- Reduce environmental impact due to less fuel burn and emissions.
- Direct cost savings for both the FAA and operators from increased throughput/efficiency realized through reduced delays and improved communications.
- Direct cost savings for both the FAA and operators from reduced distance flown enabled by more precise airborne re-routes.
- Enable post operational data analytics of crossing restrictions, climb/descent requests, holding instructions, and re-routes after take-off to improve flight planning.

The FAA's business case indicates that the S1P1 and S1P2 services to be provided by Data Comm are conservatively estimated to save operators more than $10 billion over the 30-year lifecycle of the program and save the FAA approximately $1 billion in operating costs.

Metrics
The working group recommended the following operational metrics for the program:

Metrics for DCL Services at the Tower (S1P1)

- Data Comm Usage - This category of metric tracks whether the system is being used operationally and therefore whether the system and procedures are operationally suitable and performing as designed.
- Minutes of Comm Time Saved - This category of metric tracks how many controller/pilot communications minutes have been saved by the implemented Data Comm functions. The metric is broadly covered by comparing known voice communication times with the communication times observed during Data Comm exchanges.
- Ground Delays - This category of metric tracks the impact on taxi time changes, on taxi-time variability, and airport recovery which translates into schedule predictability for aircraft operators.
- Airspace Throughput - This category of metric tracks the impact on sector throughput for both routine operations and weather or other disruption events.
- Efficiency - This category of metric tracks the impact on more efficient routes.
- Fuel Burn - This category of metric tracks the impact on the amount of fuel burned.
- Implementation - Industry will jointly track with the FAA the operational milestones published by the program.

Metrics for CPDLC Services in En Route (S1P2)

- Data Comm Usage - This category of metric tracks whether the system is being used operationally and therefore whether the system and procedures are operationally suitable and performing as designed.
- Minutes of Comm Time Saved - This category of metric tracks how many controller/pilot communications minutes have been saved by the implemented Data Comm functions. The metric is measured by comparing known voice communication times with the communication times observed during Data Comm exchanges.
- Improved controller and flight crew efficiency providing reductions in fuel burn, carbon emissions, and flight time through an increase in the most optimum re-routes during a disruption event.
- Airspace Throughput - This category of metric tracks the impact on sector throughput for both routine operations and weather or other disruption events.
- Efficiency - This category of metric tracks the impact on more efficient routes.
- More efficient re-routes (weather and general) – Increased time saved through decreased approval/acceptance time for re-routes, more efficient re-routes through increased use of auxiliary waypoints (HAR, PBD, lat/long), and increased acceptance/approval of weather re-routes before the re-route benefits opportunity window closes.
- Fuel Burn (for the purposes of evaluating Data Comm) - This category of metric tracks the impact on the amount of fuel burned during En Route phase of flight.
- Ability to do post operational data analytics of crossing restrictions, climb/descent requests, holding instructions, and re-routes after take-off to improve flight planning.
- Implementation - Industry will jointly track with the FAA the operational milestones published by the program.

Implementation Plan

The Data Comm Program implemented S1P1 CPDLC DCL Service in 2016, in accordance with the NAC recommended schedule. Following up on a NAC recommendation, the program is in the process of implementing the CPDLC DCL service at an additional seven sites. These additional sites will be operational by the end of 2019.

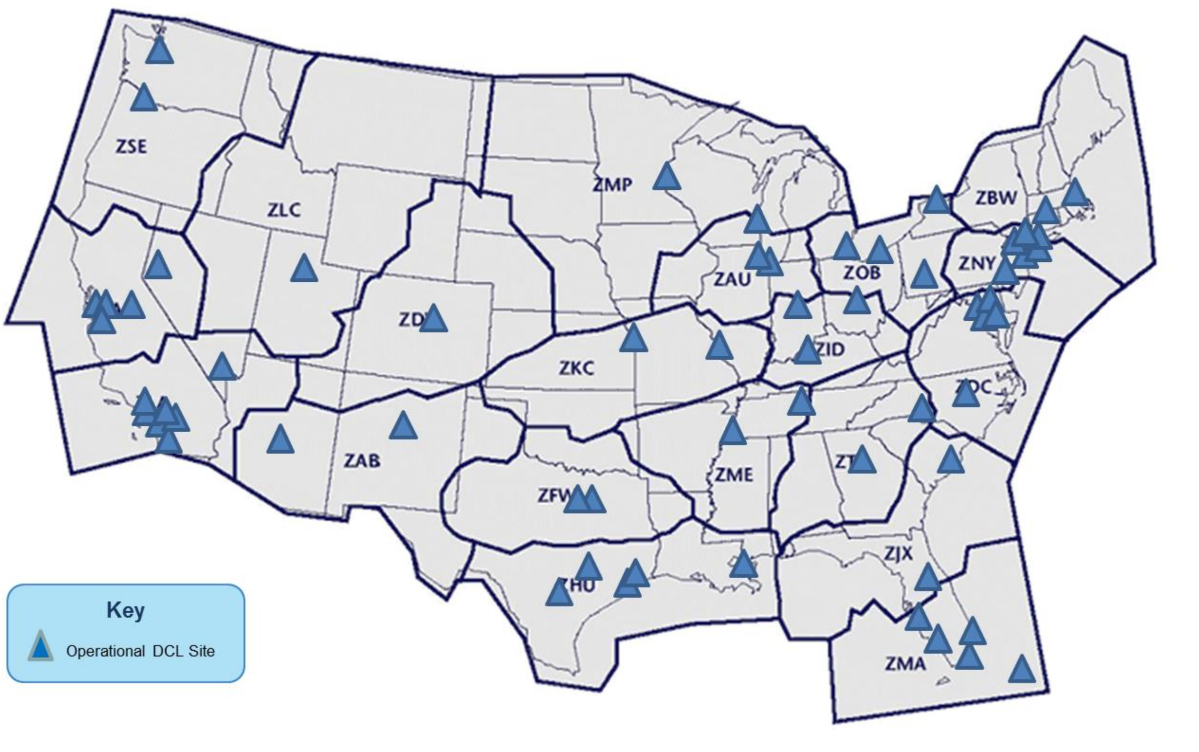
The Data Comm Program is also baselined for cost, schedule, and technical requirements to deliver the S1P2 En Route Initial Services. This plan includes schedule milestones and metrics to ensure the program is delivering its capabilities on time. The program has developed and coordinated the plan for implementation of En Route Initial Services to all 20 ARTCCs.

The program has also developed a plan, schedule, and budget to deliver S1P2 En Route Full Services to include controller and pilot initiated downlinks, direct-to-fix messages, crossing restrictions, holding restrictions and advisory messages. The FAA baselined this stage of the program in August 2016. The program is also developing a plan, schedule, and budget to deliver the remaining S1P2 En Route Full Services to include Adapted Arrivals, Beacon Codes, Speeds (Full Capability), Stuck Microphone, Initial 4-D Trajectory Management, Path Stretch, Initial Tailored Arrivals, TMC Initiated Re-routes, and Initial Aircraft Intent (ADS-C). The baselining date for this stage of the program is yet to be determined. The Data Comm NIWG recommends baselining this stage by the end of Q3 CY2021.

Implementation Locations

The CPDLC DCL service was implemented at the Tower Data Link Services (TDLS) airports, shown in blue in Figure 2. The CPDLC DCL service will be deployed to an additional seven airports by the end of 2019, shown in yellow in Figure 2.

Figure 2. Data Comm Tower Implementation Sites



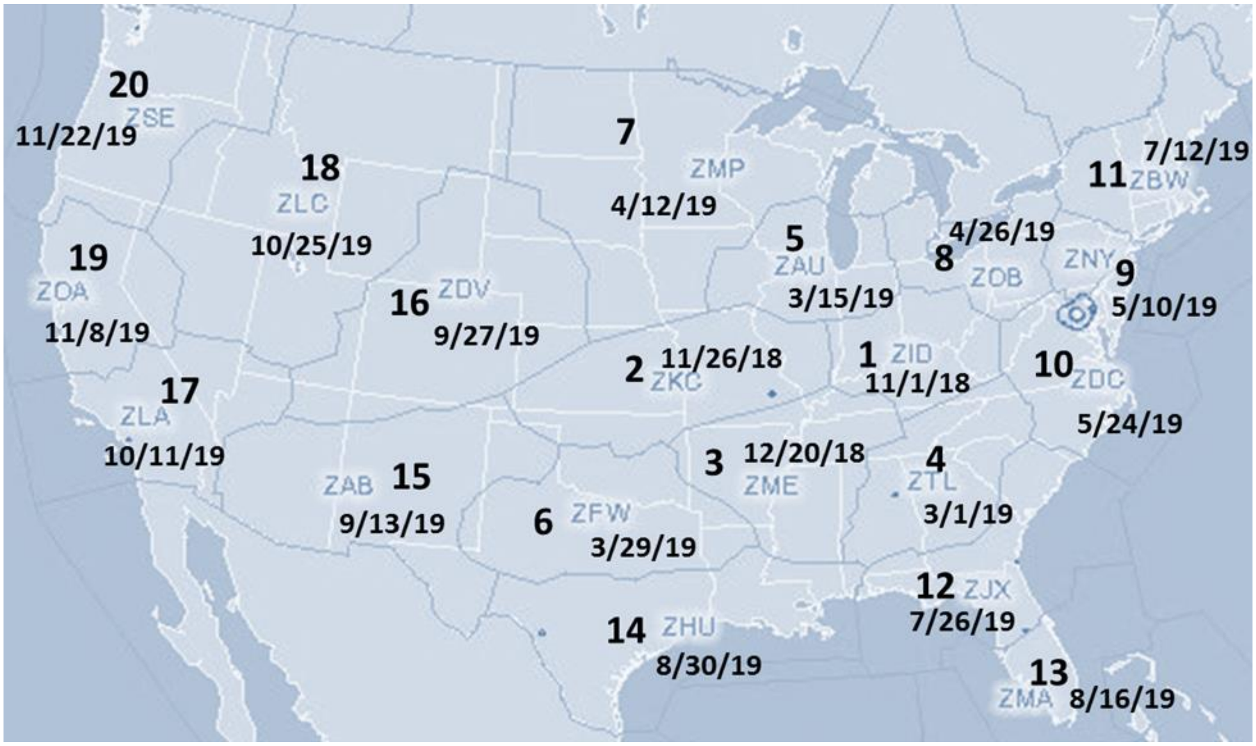
En Route Services – S1P2

En Route Initial Services has been baselined to deliver services beginning in 2019. The FAA is pursuing a schedule to start implementation of En Route Initial Services in 2018, and the Data Comm NIWG supports this schedule. The implementation strategy is shown below in Figure 3. En Route Initial Services will consist of the following CPDLC services:

- Transfer of Communications
- Initial Check-In
- Altimeter Settings
- Altitudes
- Airborne Re-routes/Go Button
- Controller Initiated Routes (Initial)
- Direct-to-Fix (Initial)
- Crossing Restrictions (Initial)
- Speeds (Initial)

The CPDLC services and airborne re-routes will be implemented in the En Route airspace in all 20 CONUS ARTCCs. The En Route initial services will be delivered in the sequence shown below in Figure 3.

Figure 3. Data Comm En Route Initial Services Implementation Waterfall



The En Route Full Services are planned to be delivered beginning in 2022, and will consist of the following CPDLC services:

- Holding Instructions
- Advisory Messages
- Controller Initiated Routes (Full Capability)
- Direct-to-Fix (Full Capability)
- Crossing Restrictions (Full Capability)

Due to budget constraints, the remaining En Route Full Services have been deferred to a future second stage. This stage is planned to be baselined in Q3 CY2021. The following services were deferred:

- Adapted Arrivals
- Speeds (Full Capability)
- Beacon Codes
- Stuck Microphone

The program also plans to implement additional services leveraging the FANS 1/A avionics set when these deferred services are implemented. These additional services are:

- Initial 4D Trajectory Management
- Path Stretch
- Initial Tailored Arrivals
- TMC-initiated Re-routes (AFST)
- Initial Aircraft Intent (ADS-C)

Implementation Activities

In order to implement the Data Comm En Route services into the NAS both the FAA and industry will be required to complete a variety of activities. Some of these activities are national activities to be completed centrally, whereas some activities will be completed at the specific ARTCC sites. These activities will require close coordination between FAA and industry to successfully deliver the Data Comm capabilities to the NAS.

FAA Activities

The FAA will leverage the S1P1 infrastructure to deliver the S1P2 services to the En Route domain. The program will make the necessary enhancements to the TDLS and ERAM software to deliver the expanded capabilities. Additional DCNS and FTI services will be provided to encompass the En Route airspace. S1P2 will continue to leverage FANS 1/A/VDL avionics. The FAA will also conduct the additional required training for controllers and technicians on the additional services.

S1P2 will be comprised primarily of software capability enhancements to TDLS and ERAM. The majority of the infrastructure required for S1P2 services in the En Route domain will have been delivered in the S1P1 phase of the program. However, the FAA will need to conduct additional required training for controllers and technicians on the additional services, in addition to amending appropriate procedures.

The FAA and operators will work closely together during site test and rollout activities. For transition to En Route operations in the NAS to be a success, industry and the operators commit to provide support to FAA sites and operational acceptability test activities. In order for testing to occur, operators need to provide equipped aircraft, trained crews, and dispatch support for key site testing starting in 2018.

S1P2 En Route Initial Services were baselined for cost, schedule and technical requirements at a Final Investment Decision (FID) in Q4 CY 2014. A subset of S1P2 En Route Full Services consisting of Controller Initiated Routes (Full Capability), Direct-to-Fix Messages (Full Capability), Crossing Restrictions (Full Capability), Advisory Messages, and Holding Instructions were baselined for cost, schedule, and technical at an FID in Q3 CY 2016. The deferred S1P2 En Route Full Services, including Speeds (Full Capability), Adapted Arrivals, Stuck Microphone, and Beacon Codes, Initial 4D Trajectory Management, Path Stretch, Initial Tailored Arrivals, TMC-Initiated Re-routes (AFST), and Initial Aircraft Intent (ADS-C) are planned to be baselined at an FID in Q3 CY2021.

Aircraft Operator Activities

In order for controllers to maintain familiarity with CPDLC operations and realize the full Data Comm benefits the FAA estimates at least 1,900 aircraft will need to be equipped with FANS 1/A and VDL Mode 2 avionics. Eight air carriers have signed Memorandums of Agreement (MOAs) to participate in the Data Comm Avionics Incentive Initiative, which when fully executed will provide 1900+ certified and equipped aircraft into the fleet. No additional avionics are required to receive S1P2 En Route services to fully participate in S1P2.

Close coordination will be required between the FAA and operators for delivering the service to the site; therefore, required operator's activities are integrated into the En Route implementation plan. These activities specifically include operator filing of Ops Spec A056, pilot training, support for test and integration, and operations center interoperability testing and software support.

Other Considerations

The NIWG reviewed the FAA's program strategy focusing on functional capabilities, implementation locations and timelines, and operational considerations. The following sections include areas of consideration the NIWG has identified as significant for the successful implementation of the Data Comm capabilities:

Data Comm Equipage

Operator Equipage Commitment (VDL Mode 2/FANS 1/A):

The FAA established a Data Comm equipage incentive program to encourage early adopters and to help achieve a goal for the program of 1900+ aircraft equipped with VHF Digital Link Mode 2 (VDL Mode 2) and FANS 1/A avionics and software by 2019. These funds are part of the Data Comm program baseline. The 1900+ aircraft goal was based upon creating enough daily operations to produce a "tipping point" of Data Comm benefits to the operation and safety of the National Airspace System and to the operators.

The operators are currently executing against MOA commitments for equipping and fully expect to have enough daily operations to produce the expected Data Comm benefits within the NAS.

Additionally, the Data Comm Program has developed a framework to allow FANS 1/A over media other than VDL Mode 2 for Tower and En Route Services. It is projected that over 400 aircraft utilize FANS 1/A over VDL Mode 0 for CPDLC DCL, but will be restricted from En Route services. These aircraft are not incentivized via the Data Comm incentive initiative but add to the number of CPDLC DCL operations per airport per day. The operators are working with their applicable Communications Service Providers (CSP) to identify opportunities for these aircraft to participate in En Route CPDLC.

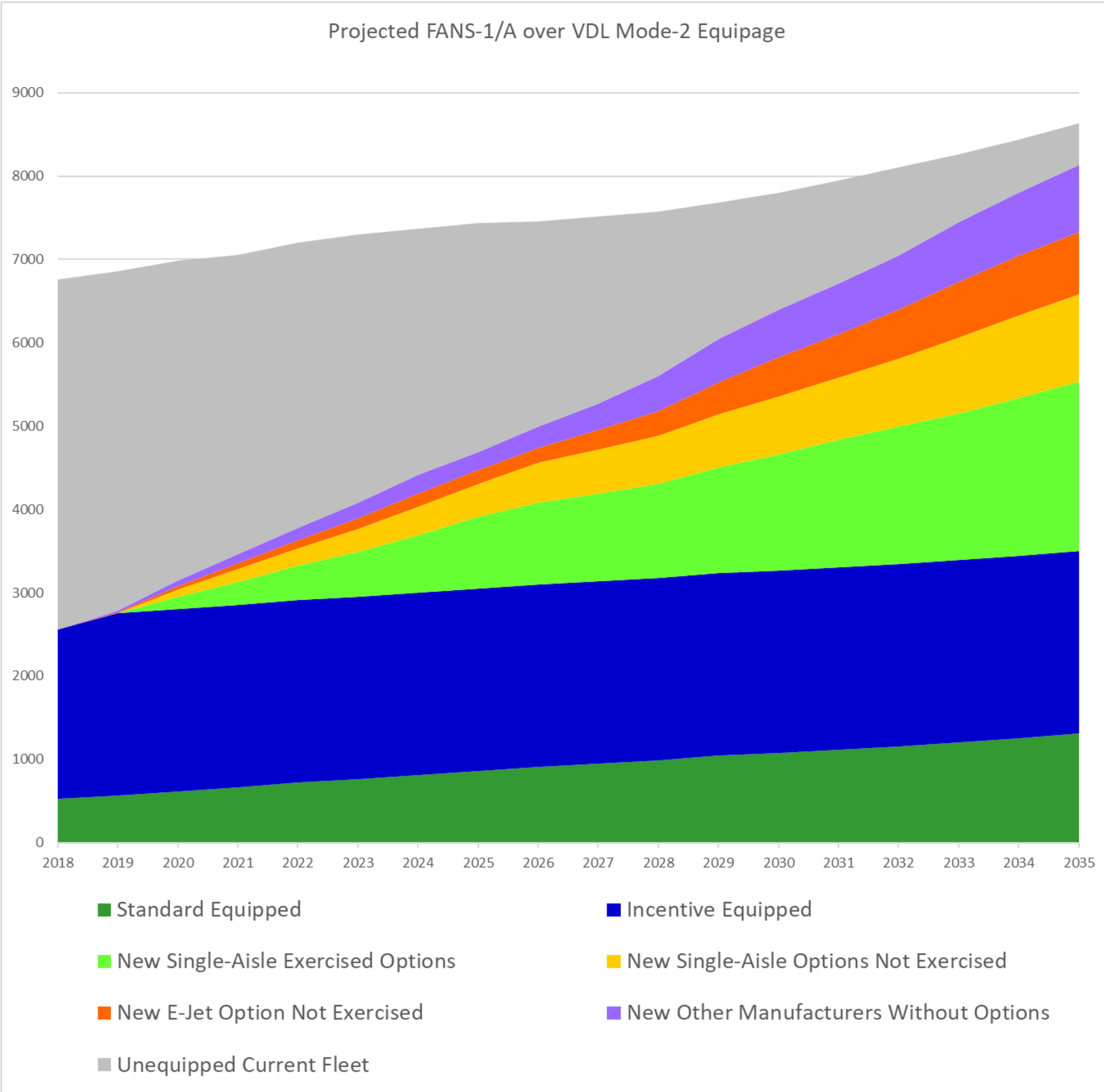
In order for the Data Comm program to be successful, industry stakeholders will work to honor the commitments documented in the MOAs. In addition, industry and the FAA will work together to promote the use of Data Comm services across as many aircraft types beyond the incentivized equipage program with the joint goal of ensuring the benefits of Data Comm services are realized across the operation for all stakeholders and users of the NAS.

Development of a Recommendation for Equipage Target for Follow-On Capabilities:

The Data Comm program has achieved its goal of equipping a minimum 1,900 FANS 1/A and VDL Mode 2 equipped U.S. aircraft by the end of FY 2019. This goal was based on a minimum target of daily IFR flights to achieve operational benefits using CPDLC in domestic U.S. airspace. The range to achieve operational benefits of CPDLC in the NAS is between 20% and 40% of equipped IFR flights.

The Data Comm benefits case demonstrates that increased equipage translates to additional operational benefits to operators and the NAS. Additional equipage will drive benefits in specific regions, such as the Northeast Corridor. The Data Comm program projects substantial growth in the number of U.S. air transport category aircraft expected to be equipped for Data Comm out to 2035, see Figure 4.

Figure 4. Projected Data Comm Equipage



Key equipage assumptions:

- FAA's 2018 *fleet***Forecaster** output used to determine fleet make/model quantities through 2035
- NAC and other provided operator plans have been included in the forecast of equipped capable projections
- VDL Mode 2 is assumed to be standard or exercised option on all new aircraft deliveries
- A220 (CSeries) deliveries are included in the "New Single-Aisle Exercised Options" group
- At retirement, equipped aircraft are replaced by option exercised aircraft

The Data Comm NIWG seeks to establish fleet equipage targets for 2023:

- To support follow-on capabilities and targeting 40% of NAS operations, 3,800 equipped aircraft are sought
- To establish a strategy for regional jet equipage and for regional jets to participate in and receive benefits from Data Comm services

The 2023 target equipage rate of 3,800 air transport category aircraft could be achieved with a mix of initiatives:

- ~3,500 aircraft are expected to be equipped based on current state and exercised options.
- ~300 additional single-aisle aircraft could be equipped were operators to exercise available options.
- ~100 additional E-Jet regional aircraft could be equipped were operators to exercise available options.
- ~200 additional regional jet and turboprop aircraft could be equipped were manufacturers to make options available and were operators to exercise those options.
- Some portion of the unequipped current fleet of ~3,200 aircraft could be equipped where retrofit solutions are available and operator business case challenges could be overcome.
    - ~400 unequipped Airbus single aisle aircraft in the current fleet and scheduled to retire after 2025

Development of a Recommendation for Equipage Strategy for Regional Jets:
There are over 1,600 regional jets operating in U.S. domestic airspace. To date, the Data Comm Program is not aware of any regional jet operator equipping their current or future fleets with FANS 1/A. Data gathered from the regional jet operators indicates that a large portion of the regional jets manufactured in recent years are already equipped with VDL Mode 2. Some of these regional jet models with more advanced avionics have the capability to upgrade to FANS 1/A through a software update.

Initial analysis indications that only one of the two major regional jet fleets on order have an option for FANS 1/A and VDL Mode-2. The regional jet equipage strategy should encourage operators to order fleets with FANS 1/A and VDL Mode-2. In cases where solutions do not exist, the NIWG recommends that regional jet operators should encourage manufacturers of current in production models to develop an orderable FANS 1/A and VDL Mode-2 option.

Many of the congested airspaces where Data Comm can provide the most operational benefits, both En Route CPDLC and CPDLC DCL at airports, have a significant amount of regional jet operations. This regional jet activity is centered around the busiest metroplexes. Therefore, even a small percentage of the regional jet fleet equipping with Data Comm can dramatically increase the operational benefits of Data Comm in that airspace.

Targeting regional jet Data Comm equipage can add approximately 200 equipped aircraft. This can be achieved through a combination of retrofitting newer models and including Data Comm on newly delivered second-generation regional jets such as the E2Jet from Embraer.

The NIWG recommends industry continue to address these equipage challenges to achieve the goal of 3,800 equipped aircraft by 2023. The airline members of the NIWG will work with their regional partners and subsidiaries to develop a regional jet equipage plan. The NIWG also recommends addressing an incentive program for regional jet equipage.

Resolution of Avionics/Pegasus 1 Interoperability Issue

In November 2017, United, American, Delta, UPS and Air Canada met with Boeing and Honeywell to discuss a path forward to fix software issues in the B757 and B767 Pegasus 1 FMS. The meeting included a discussion on latent CPDLC avionics issues. The agreement reached at the October 4, 2017 NAC was that industry would address these issues and retrofit/upgrade the Pegasus 1 avionics by the end of CY 2021. Without a fix implemented in the field, more than 771 domestic B757 and B767 aircraft would not be able to participate in domestic En Route CPDLC after January 2022. In certain regions and airports (e.g., Atlanta, Memphis, Louisville, San Francisco, and Seattle), this may disproportionally affect operations due to the population of B757 and B767 aircraft. In the meeting with Boeing and Honeywell, the operators reviewed Pegasus 1 avionics operational and safety issues. It was noted that there are some CPDLC issues for which the FAA has developed ground mitigations for Initial En Route Services at the expense of the Data Comm program. It was agreed by all parties that these ground mitigations are not acceptable for the long term and need to be addressed prior to the end of CY 2021.

Subsequent to the November 2017 meeting, Honeywell determined that a fix to Pegasus 1 was not feasible and instead is planning to offer a Pegasus 2 upgrade as an alternative. At this time, it is unclear how many operators will install the Pegasus 2 upgrade due to cost and how many aircraft will not be able to participate in En Route Services starting in the CY2022. Removing more than 771 aircraft from En Route CPDLC operations would reduce the operational benefits of the program.

The Data Comm NIWG continues to recommend that fixes to the Pegasus 1 software and/or a Pegasus 2 upgrade be made available. Deliveries of new B767F continue so that operators have time to implement the changes prior to the end of CY 2021. Additionally, the NIWG recommends Boeing and Honeywell work with the operators to assist them in building their business cases. The NIWG will continue to monitor progress of Pegasus 2 upgrades and make recommendations for issue resolutions as necessary.

En Route Implementation Schedule

The implementation rollout schedule for En Route Initial Services presented above was coordinated with the stakeholder community, to include operators, controllers, and FAA facilities, labor and management. The rollout plan, which completes the implementation of En Route Initial Services by CY2019, was developed to ensure there was sufficient time to train the controller stakeholder community while minimizing the amount of time the NAS was in a transition state to having En Route Initial Services available NAS-wide.

It is critical Data Comm adheres to this agreed-to schedule, and not prolong the implementation transition period for these services. A protracted implementation would require the operators to re-plan and delay their training timelines, delaying their participation in the En Route phase of the program. This would result in a delay to the realization of long sought-after Data Comm En Route capabilities and their associated operational and safety benefits. This creation of a 'splintered NAS', where Data Comm Initial Services are available in some airspaces but not others for an extended period of time, would additionally denigrate the pilots' confidence in the Data Comm systems and services, delaying its integration into day-to-day airline operations.

In order for the Data Comm Program to be successful, the FAA should minimize the amount of time the NAS is in a transition state for En Route Initial Services, and adhere to the implementation rollout as closely as possible. Industry and the FAA will continue to work together to identify the FAA and industry resources necessary to ensure a successful implementation of En Route Initial Services.

Full Services Commitment

The FY19 President's Budget Request includes no funding for En Route Full Services. The program has delivered Data Comm to 55 airports over two years ahead of schedule, is widely supported by the airspace users, and is on track to deliver En Route Initial Services starting in late 2018. The decision to eliminate funding for En Route Full Services was due to overall funding constraints. Data Comm has strong industry backing and regularly meets with airspace users ensure the program capabilities and services are aligned with industry plans. This collaboration creates a tremendous amount of forward momentum and cooperation. Restoring the baselined FY19 funding for Data Comm En Route Full Services ensures this momentum between the FAA and airspace users continues and does not jeopardize the airspace user's business case to invest in Data Comm avionics equipage, operations, and pilot training. Entities affected by this deferral in Data Comm En Route capability include airline end users, such as Alaska Airlines, American Airlines, Delta Air Lines, FedEx Express, Hawaiian Airlines, JetBlue Airlines, Southwest Airlines, United Airlines, and UPS 44 international airlines, hundreds of business aviation users, as well as FAA contractors Harris Corporation and Leidos.

Data Comm S1P2 Full Services consist of five Data Comm Services: Crossing Restrictions, Controller Initiated Routes, Direct-to-Fix, Advisory Messages and Holding Instructions. The majority of these services build on functionality developed for S1P2 Initial Services, which is in final development and testing. The additional Data Comm Full Services capabilities allow both Controllers and Pilots to further utilize the Data Comm system to gain operational benefits and efficiencies. First, these services will allow controllers to uplink any speed or altitude restrictions as the plane crosses a fix in the air. Secondly, Full Services will provide controllers and pilots an ability to send additional route messages to change the route of flight. Thirdly, Full Services will allow controllers to uplink repetitive advisory information thus reducing pilot voice requests for the information and allowing the Controller to uplink long holding instructions. The capabilities in Full Services will reduce the need for the controller or pilot to voice complicated instructions consisting of long strings or route fixes that can often cause controllers and pilots to repeat the information until correct and confirmed. The elimination of the Data Comm Full services capabilities would prevent the FAA from further reducing the congestion on radio frequencies, which would reduce the business case benefits and negatively impact the airlines investment in aircraft equipage, which would impact the NextGen benefits accrued in the NAS.

The FAA's investment in Data Comm is critical to improving air safety, reducing delays, increasing fuel savings, and protecting the environment. Today, controllers and pilots communicate verbally using radios. Voice communication is labor intensive, time consuming and limits the ability of the National Airspace System (NAS) to meet future traffic demand. With controllers talking to numerous pilots over the same frequency, there is also the potential for misunderstood instructions. Data Comm is changing this by allowing controllers and pilots to communicate with digitally delivered messages. Data Comm requires ground automation enhancements, an air-to-ground data network, and avionics in the aircraft. Unlike other airspace management enhancements, Data Comm relies on a small incentive fund to support and augment voluntary avionics equipage investment for airspace users. For the most part however, airspace users make the investments in equipment, training, and operations of Data Comm based on the benefits they receive by using the service. Currently at the 62 airports, Data Comm Departure Clearance is already used over 50,000 times weekly and by over 31% of all IFR flight plans filed. To date the Departure Clearance service has saved over 730,000 minutes of voice communications time since the start of operations.

The FAA is on track to start delivering Data Comm to En Route airspace in late 2018. The En Route capabilities are broken into two implementation phases to ensure the capabilities are delivered to the airspace in a safe and controlled manner. En Route Initial services provides basic Data Comm capabilities by migrating routine communications and limited routing capabilities from voice to data. En Route Full Services builds on Initial Services and delivers advanced flight routing capabilities of Data Comm in early 2022.

One significant example of benefits available to the airspace users in En Route Full Services is the ability for flight crews to request a new route during flight. Airlines have preferred routes around weather or to take advantage of favorable wind conditions, sometimes these routes are not available at departure, but open up during flight. Today requesting a new route is a cumbersome and time-consuming process with voice communications, quite often these requests are denied due to the time it takes to communicate, de-conflict, and clear the request from the flight crew. In En Route Full Services, the data link capability allows flight crews to request a more efficient route by electronically sending their preferred route to air traffic control. This capability enables pilots to quickly and seamlessly share their preferred route with the air traffic controller, giving them the same picture. If the route request does not pose a conflict, the controller can then send a revised route clearance back to the flight crew, quickly enabling them to program and execute their preferred route. The airlines anticipate this capability will enable them to fly more efficient routes, saving time and fuel. The airspace users have expressed through the NextGen Advisory Committee (NAC) and other forums that their business case for investing in Data Comm relies on the capabilities delivered by En Route Full Services.

NextGen Integration/Capabilities

The aviation functions of communications, navigation, and surveillance (CNS) have historically been considered as independent capabilities with little need to interface to meet airspace demands. As the aviation industry moves forward to redefine airspace and apply new technology to meet capacity demands, it is apparent that CNS must be considered as complimentary capabilities. The best example of the integration of CNS abilities is advanced interval management. In this case, an aircraft must have the capability to accept a complex clearance (Data Comm), to fly a precise ground track (navigation), and to position the aircraft on a final approach at a determined interval from another aircraft (surveillance). The timeline for implementation of advanced interval management is well beyond the scope of this rolling plan; however, the Data Comm team believes it is time to start initial coordination with other NIWG groups to begin discussions on how interfacing functions may be applied to meet current requirements. An example may be to data link an initial descent routing with altitude and airspeed constraints to meet metering requirements.

The Data Comm NIWG team plans to coordinate with the PBN, Surface, and NEC NIWGs to discuss ideas where coordination of functions may be useful. The PBN and NEC NIWGs have acknowledged the need to interface with Data Comm as a catalyst to meet their needs. A major element of NextGen is the use of infrastructure and advanced ATM to achieve operational goals: safety, capacity, efficiency, predictability, access, and environment. To achieve that goal, multiple parallel industry and FAA programs must coordinate their complex implementation plans. Also, it should be noted that the Data Comm NIWG will need to coordinate with the Surface NIWG to meet their milestone to provide runway/SID/STAR information in an uplinked route revision.

Enhanced Services Utilizing FANS 1/A Message Set

Airspace users recognize the opportunity to leverage their current investments by jointly defining additional services using the existing FANS 1/A message set with the FAA that enable the transition to trajectory-based operations in the NAS. Initial dynamic 4D trajectory management, in conjunction with the aircraft provision of its trajectory intent, provide the means for pilots and controllers to productively collaborate to increase flight efficiency and throughput in constrained airspace; and, to flexibility respond to rapidly changing conditions. By enabling these latent FANS 1/A capabilities, airspace users and the FAA reinforce the Data Comm value proposition; and, thereby, further incentivize additional aircraft users to equip.

Baseline additional Data Comm capabilities for En Route utilizing the existing FANS 1/A message set by the 3rd quarter of CY2021.

Initial Dynamic 4D Trajectory Management

Enhanced FANS 1/A services will provide additional capabilities to maintain flows through or increase capacity in constrained airspace. Controllers will have dynamic and precise trajectory options to use for equipped aircraft during changing operational conditions such as the ability to issue more efficient re-routes around an airspace constraint (e.g., weather, high-density traffic, or special activity airspace). In addition, pilots will be able to downlink more complex route clearance requests that express aircraft operator intent and aircraft-specific constraints. This capability will enable pilots and controllers to request and issue more precise route clearances via FANS 1/A, which contain some combination of lateral, vertical, and speed/time constraints at along-track waypoints on previously adapted ATC routes.

Speeds (Full Capability)

Controllers in the En Route environment generally issue speeds to aircraft to create or maintain spacing with other aircraft along their route of flight. Enhanced FANS 1/A services will provide controllers the option to uplink a speed to the aircraft and automatically update the fourth line of the data block. The ability to uplink these speed assignments enable other NextGen initiatives such as Path Stretch, Separation Advisories and Ground-Based Interval Management – Spacing. *Note: these were originally in Full Services but were deferred due to budget. The NIWG recommends moving the services back into Full Services.*

Complex Re-routes with Altitude, Speed, and Time Elements

Controllers in a TBO environment will be balancing demand among competing metered flows while maintaining separation. They will need to make use of the full capacity of available airspace resources that may require clearances using precise re-routes with altitude, speed, and/or time components. Automation, such as Path Stretch and Conflict Resolution Advisories, can provide solutions with these efficient yet complex clearances. FANS 1/A provides the means to deliver these complex clearances to the flight crew with greater precision and with lower workload for controllers and pilots, than with voice.

Adapted Arrivals

Enhanced FANS 1/A services will provide controllers the ability to uplink pre-adapted, non-published arrival procedures as complex re-routes. ATC facilities create these adapted procedures with input from user-stakeholders, offering significant efficiencies for FANS 1/A equipped aircraft. Once adapted in facility automation, equipped users can request a procedure name via FANS 1/A. Controllers then uplink the pre-adapted full route clearance containing both lateral and vertical guidance to pilots who then push-to-load the clearance into the flight management computer. These procedures may be revised and updated independent of a 56-day charting cycle allowing great flexibility in the NAS, meeting both user needs and air traffic control requirements. *Note: these were originally in Full Services but were deferred due to budget. The NIWG recommends moving the services back into Full Services.*

Tailored Arrivals

Extending the adapted arrivals service, enhanced FANS 1/A services will enable equipped aircraft to downlink dynamically-optimized tailored arrival descent profile requests to controllers. Ground systems will enable controllers to display these tailored arrival requests for evaluation against traffic and other constraints prior to modification and/or approval. By tailoring descent profiles for individual aircraft, equipped airspace users can maximize operating efficiencies that will benefit their bottom line as well as significantly reduce carbon emissions, benefiting the environment.

Enhanced TMC-Initiated Re-routes (AFST-generated flow strategies)

Traffic flow management decision support tools are expected to evolve to generate more precise initiatives that address predicted demand and capacity imbalances due to events such as convective weather. For example, Advanced Flight-Specific Trajectories (AFST) facilitates agile, flexible, and efficient use of En Route capacity that remains available in the context of thunderstorms and other dynamic constraints. AFST provides flight-specific lateral or altitude solutions within 90 minutes of a detected problem. When the AFST solution is delivered to the En Route controller, FANS 1/A provides the efficient clearance delivery method.

Initial Aircraft Intent

Currently, controllers and their decision support tools predict the expected behavior of aircraft through the filed flight plan as incrementally updated by clearances; as such, they cannot reliably predict some aspects of aircraft behavior (e.g., top of descent). Estimated aircraft paths, altitudes, and arrival times for the next route segment(s) of a flight are improved using downlinked aircraft performance and projection data (intermediate intent profile) from the flight management system via an air-to-ground data communications link using safety services (e.g., FANS 1/A automatic dependent surveillance – contract (ADS-C) intermediate intent or FANS 1/A controller-pilot data link communications reported route). The ground-based trajectory modelers used for tactical and strategic operations can use this aircraft data to calibrate the predicted 4D trajectory for the next portion of the flight and/or receive an indication that a trajectory performance parameter (altitude, time) can no longer be met. These improvements will result in better 4D trajectory composition, determining adherence to clearances, and conformance monitoring/ conflict detection accuracy. These initial services provide an important step towards full air-to-ground trajectory synchronization.

Loadability Solution for Runway Dependent SID/STARs

One of the primary goal of the Data Comm Implementation Team (DCIT) has been to implement CPDLC messages to maximize existing flight deck automation through the use of loadable messages. Loading complex route changes provides benefits through reduced communications errors for complex communications, enabling increased information exchange leading to increased airspace efficiency. The increased airspace efficiency creates an environment in which there are reduced flight delays and more optimal flight routes enabling lower fuel burn.

Problem Background: During the early design phase of Data Comm, it was identified that CPDLC services were limited to the information available in the automation systems delivering the clearance. One such example is the tower data link system does not have the complete information to provide the runway element as part of the uplinked, loadable departure clearance. This data element shortcoming is due to a lack of FAA tower automation capability.

Modern RNAV SID, STAR, and RNAV/RNP approach procedures include the runway element as a dependent part of the procedure – meaning without the runway, the clearance would be incomplete.

This led to the Data Comm system designers to not send the Standard Instrument Departure (SID) element of the DCL because many SIDs are designed with a runway as a dependency.

A fully loadable CPDLC clearances results in:

- Increased operational benefit efficiencies,
- Decreased workload and time for pilot to understand and accept clearances,
- Reduced voice ATC calls for clarification
- Enhanced safety

FAA is developing enhanced automation capabilities such as Terminal Flight Data Manager (TFDM) which could provide the ability for all clearance data elements to be available.

Recommendation: As part of FAA tower automation enhancements (i.e., TFDM), FAA should develop and implement the capability to uplink all loadable route clearance elements, including runway. This capability should be developed and implemented in the Data Comm Full services timeframe (2022).

Solution for Full Automation for the Confirm Assigned Route Capability

The NIWG recommends the FAA consider adding automation enhancements to support the validation of uplink message for "Confirm Assigned Route" and it should be implemented in the Full Services timeframe. When a re-route message is issued, the flight crew currently responds by sending the entire active route loaded in the FMC back to the controller. ERAM should be programmed to evaluate the response and only notify the controller/pilot if the assigned route does not match the Confirm Assigned Route, as is done in Nav Canada and NATS. Currently, the controller is expected to manually go through the Confirm Assigned Route message looking for errors. This new capability would further realize the benefits of Data Comm, which is to reduce the possibility of human error.

Data Comm NIWG Milestones

Milestone	FAA or Industry	Implementation (I) or Pre-implementation (P)	Milestone Date Q/CY
Airlines to Equip 1,900 Aircraft	Industry	I	4Q2019
Deploy Tower Services to an additional seven towers	FAA	I	3Q2019
Baseline Enhanced Data Comm Services for En Route utilizing the existing FANS 1/A message set	FAA Industry	P	3Q2021
IOC for Initial En Route Services at all CONUS ARTCCs	FAA	I	4Q2019
Resolution of avionics/Pegasus 1 interoperability issue	Industry	I	4Q2021
Recommendation for target equipage rates for follow-on capabilities	FAA Industry	I	1Q2019
Recommendation for the equipage strategy for Regional Jet equipage	Industry	I	1Q2019
Loadability Solution for Runway SID/STARs	FAA	P	3Q2019
Solution for Full Automation for the Confirm Assigned Route Capability	FAA	P	3Q2019

Multiple Runway Operations (MRO)

Implementation Milestones

- Implement Consolidated Wake Turbulence (CWT) standards at remaining Wake RECAT locations and convert 17 legacy RECAT 1.5 and 2.0 terminals to CWT.

Pre-implementation Milestones

- Perform feasibility and initial safety analysis for improved capacity Closely Spaced Parallel Operations (CSPO) departure concepts.
- Perform feasibility and initial safety analysis for improved capacity CSPO integrated arrival/departure concept.
- Complete safety study of Closely Spaced Parallel Operations with High Update Rate (HUR) Surveillance to determine the minimum runway separation requirements for simultaneous independent operations to dual and triple parallel runways.
- Continue research into and assess benefits of dynamic wake separation concepts, including dynamic pair-wise separation, time based separation, and separation reductions based on real-time conditions in the airspace.
- Perform feasibility study of reduced Minimum Radar Separation (MRS) on final approach including collision risk, impacts on go around rates, and runway occupancy restrictions.
- Analyze ORD Runway 28C Arrival/Runway 22L Departure Wake Encounter Issue and develop mitigation strategies to reduce or eliminate departure delays in this configuration.
- Perform wake behavior analysis to support the use of authorized RNAV (LPV, LNAV/VNAV, RNP-AR) approaches in lieu of ILS for 7110.308 on SFO Runways 19L, and 28L/R and any other locations regularly using 7110.308 procedures.
- Develop and publish additional guidance material for aircraft operators on wake turbulence encounter reporting to promote awareness and support FAA wake encounter data collection. Distribution of this guidance could be accomplished using Safety Alert for Operators (SAFOs), Information for Operators (InFOs, AIM, Advisory Circular update (AC 90-23) Aircraft Wake Turbulence, or direct pilot outreach.

Industry Milestones

- Perform or support assessments of the benefits of CWT implementations at new and legacy RECAT locations to verify no loss of benefits when compared to prior RECAT implementations.
- Collaborate with FAA to promote increased pilot reporting of significant wake turbulence encounters during all phases of flight.

Background

With increasing demand for air travel, the need for improved peak throughput at the busiest airports and in the highly congested arrival and departure airspace is essential to improve performance in our National Airspace System. Increased runway and airport capacity via new procedures, reduced spacing and separation requirements, and more efficient flow management into and out of busy metropolitan airspace is needed to accommodate current and future increases in traffic volume and maximize airport utilization.

Delays ripple throughout the NAS when closely spaced parallel runways are not utilized to the greatest extent possible. This happens frequently when the ceiling and visibility do not support visual approaches. With new technology in the cockpit and a concerted effort to examine wake behavior and the safety standards for closely spaced parallel runway operations, the FAA has made significant progress in providing new procedures and tools to better utilize runway capacity in all weather conditions. With these new procedures and data-driven changes to wake turbulence separation standards (Wake RECAT), we now have the ability to implement a suite of Multiple Runway Operations (MRO) capabilities to maximize arrival and departure rates in more weather conditions.

In 2013, FAA requested the NextGen Advisory Committee (NAC) to develop recommendations related to the FAA's NextGen investments considering the uncertainty of funding for NextGen projects at that time. The MRO portfolio, including Wake RECAT was selected as a high priority initiative because it was capable of rapidly delivering tangible benefits with minimal cost and was expected to be available at specific locations within a three-year rolling time horizon. It was expected that the new procedures and separation standards could deliver immediate benefits to the NAS in this timeframe as long as resources remained available for required safety studies and implementation activity with no unforeseen issues arising during the safety assessment, environmental review, or implementation processes.

The impetus and foundation for the MRO capabilities evolved from specific industry recommendations on "Runway Access" and other longstanding FAA wake turbulence research and development activities. The new separation standards in general, and Wake Turbulence Re-Categorization (Wake RECAT) in particular, have been providing immediate increases in capacity and a reduction of delays at airports implementing the new procedures.

Consolidated Wake Turbulence (CWT) Radar Separation Standards – The Wake RECAT Evolution (FAAO 7110.126)

New wake separation standards are the result of continuing research on wake generation, transport and decay. The FAA Wake Program continues to evolve as the understanding of wake behavior increases and new automation and controller decision support tools become available. Prior to introducing RECAT at selected high value sites in the NAS, wake separations were assigned based on an aircraft's Maximum Certificated Gross Takeoff Weight (MCGTOW). These separations have proven to be very safe for wake vortex hazards; however, it results in greater than necessary separation distances, especially within the heavy weight class. For example, the current FAAO 7110.65 heavy-behind-heavy separation is four miles. This separation is appropriate for a B767 following a B747, but not necessary when the B747 is following the B767.

Wake RECAT separations consider aircraft weight as before, but also consider aircraft wingspan, approach speed and ability to counteract a wake's rolling motion. Using these parameters, FAA recategorized the existing fleet of aircraft and modified the associated wake turbulence minimum separations.

Under the RECAT 1.0 and 1.5 programs, FAA created six categories of aircraft for wake turbulence separation purposes. The categories separated the heavy and large weight classes into four wake categories: two for heavy and two for large. The A388 and A225 became their own wake category, and the small weight class remained as its own wake category.

RECAT 2.0 describes a pairwise separation matrix developed for the most common ICAO type identifier aircraft that comprise 99% of the operations at 32 airports within the U.S. Each aircraft is addressed as both a leader and a follower in each pair. The development of a pairwise separation matrix relies on wake-based data, rather than the legacy weight-based data. Separation reductions are achieved through a better understanding of wake behavior and with pairwise separation of aircraft.

All four of these sets of separation standards have been approved by Safety and Technical Training (AJI) and AOV and have been proven safe operationally. Each set of standards has shown operational benefits aircraft pairings compared to other sets of standards.

The goal of CWT is to use the most operationally advantageous set of separation standards derived from the four current sets of standards. This has resulted in using all time-based wake turbulence separation standards from FAA Order JO 7110.65. Radar-based wake turbulence separation will be based on a categorical system that further refines the grouping of aircraft to provide throughput gains at many of today's constrained airports and yet will be manageable at all airports throughout the NAS.

To date, FAA has made significant progress rolling out Wake RECAT 1.5, 2.0 and CWT at the busiest and most congested terminal areas and airports in the NAS. The FAA has used a phased approach that included continuous learning and refinement while examining operational benefits at specific airports.

Since 2012, Wake RECAT Phase 1 (RECAT 1.5) has been introduced at 23 airports. Phase 2 (RECAT 2.0), static pairwise separation, introduced in September 2016, has been implemented at 8 additional facilities. The introduction of new Consolidated Wake Turbulence (CWT) separation standards began in July 2018 at Phoenix and San Antonio, and at Potomac TRACON in September. The remaining airport/terminal area RECAT commitments will be upgraded to CWT by the end of Q2 2019.

Implementation Plan

Scope

NextGen Multiple Runway Operations capabilities improve access to parallel runways, including closely spaced parallel runways, while Wake RECAT, going forward with CWT and dynamic wake separation concepts (time based separation, etc.) can increase basic runway capacity and airspace throughput. The capabilities in this portfolio have enabled the use of simultaneous approaches (two or more aircraft arriving side-by-side) during periods of reduced flight visibility, decreased the required separations between aircraft on dependent approaches (staggered aircraft arrivals on parallel runways), and optimized wake turbulence separation standards.

These systemic improvements are key to ensuring the necessary minimum separation is applied between aircraft based on extensive data collection and analysis and wake turbulence research conducted over the last 20 years. CWT uses the most operationally advantageous, currently approved radar separation standards (RECAT and FAAO 7110.65) and the existing time based separation standards in FAAO 7110.65 to optimize wake separations and provide maximum benefits. Going forward, the MRO Rolling Plan will capitalize on continuing wake research and associated automation and surveillance improvements to provide meaningful incremental capacity benefits for the NAS by continuing to explore the benefits of dynamic pair-wise and time based separations and pursuing the other pre-implementation milestones listed above and further described below.

Expected Benefits and Metrics

The capabilities recommended in this report will provide benefits via increased arrival and/or departure capacity and throughput. This will lead to reduced delays, more flight opportunities, and better reliability and predictability for the traveling public, particularly during less-than-visual approach weather conditions. The increased capacity available with Wake RECAT, which is usable regardless of prevailing weather conditions, may enable air carriers to achieve additional service capabilities for the traveling and shipping public without a degradation of service quality.

Ultimately, the benefits of new separation standards, including Wake RECAT and CWT, are a function of the fleet mix and demand, as well as runway configuration. The JAT has completed several benefits assessments of RECAT sites and confirmed expected reductions of separation at those sites for relevant aircraft pairings. Going forward, industry will perform or support benefits assessments of the new Consolidated Wake Turbulence standards at select new or legacy locations. It is essential that each iteration of wake standards changes safely provide actual or potential incremental capacity and throughput improvements based on fleet mix and demand. To that end, industry will collaborate with FAA to develop a more robust wake vortex encounter reporting system, including appropriate descriptors similar to existing turbulence intensity reporting criteria and appropriate guidance to pilots including preferred reporting procedures, that is, direct to ATC, or via other means (Aviation Safety Reporting System, etc.).

Recommendations

Recommendation 1: Implement new Consolidated Wake Turbulence standards at legacy RECAT sites on a schedule determined collaboratively with industry based on expected benefits and facility capabilities in accordance with the milestones below.

Recommendation 2: Perform feasibility and initial safety analyses for closely spaced parallel operations departure concepts. This analysis will investigate procedures to recover lost capacity through reduced separation standards and increased applications of dependent and independent operations for Closely Spaced Parallel Runway departure operations. The analysis will be focused on finding ways to develop and update standards and terminal instrument procedures to recover lost capacity due to IMC events by taking advantage of improved course deviation modeling, new aircraft systems with advanced navigation accuracy, and advanced surveillance capabilities.

Recommendation 3: Perform feasibility and initial safety analysis for CSPO integrated arrival/departure concepts**.** This analysis will look for opportunities to reduce the required separation between a departing aircraft on one runway and an arrival on a closely spaced parallel runway, which will increase airport throughput in less than visual conditions. National standards for reduced initial lateral separation between arrivals and departures using closely spaced parallel runways will be based on the results of research that assess the current rule for parallel runways with centerline spacing less than 2500 feet that allows departing aircraft to begin takeoff roll when the arriving aircraft is at least 2 NM out, provided that by 1 minute into the departing aircraft's flight, separation increases to 3 NM. An analysis of lateral and vertical behavior for aircraft when executing a missed approach or divergent departure next to an active parallel will assist with determining whether improvements can be safely implemented.

Recommendation 4*:* Complete safety study of Closely Spaced Parallel Operations with High Update Rate Surveillance. This safety study provides analysis of the minimum runway spacing requirement for simultaneous independent operations to parallel runways while using high update rate (HUR) surveillance. Collision risk is assessed as a function of HUR surveillance capabilities and runway centerline spacing (RCLS) to simultaneous independent dual and triple straight-in and offset final approach courses for Instrument Landing System (ILS) and Global Positioning System (GPS) equipped Area Navigation (RNAV)/Required Navigation Performance (RNP) aircraft. Although this capability may have systemic utility, near term benefits could be realized at JFK, DTW and ORD for simultaneous dual and triple approaches using straight-in ILS procedures versus the current standard that requires an offset approach with runway separations below 3600 feet.

Recommendation 5: Continue research for dynamic pair-wise and time based wake separation concepts. This activity will continue prior efforts to increase throughput at capacity-constrained, high-density airports by researching the aircraft and ground based capabilities required to achieve safe, efficient dynamic pair-wise and time based wake separations for aircraft on approach. The FAA will complete concept and initial safety analysis documentation for dynamic wake spacing to allow for reduction of the RECAT Phase II static pair-wise wake separation standards based on the variable, real-time conditions in the airspace, such as the current winds. This will build on the previous pre-implementation commitment to analyze Heathrow's Time Based Separation concept on final approach, to be completed by 2018.

Recommendation 6: Perform feasibility study of reduced Minimum Radar Separation (MRS) requirements on final approach including collision risk, impacts on go around rate, and runway occupancy restrictions. This activity will investigate MRS requirements for aircraft on approach to allow closer separations when applicable, including extending the current capability to reduce final approach spacing to 2.5 nm within 10 miles out to 20 miles, where currently authorized. Changes to radar separation minima implemented at airports with applicable fleet composition will increase capacity during IMC. Reducing longitudinal separation standards during IMC will provide benefits to airport runway throughput when Runway Occupancy Times allow, while not adversely impacting collision risk, wake risk, or go-around rates. Since go around rates and runway occupancy time are a function of exit locations and fleet mix, the opportunity to universally reduce MRS at more locations will induce airport operators to build more efficient runway exits where they do not exist. This recommendation should consider application of the "2400 meter Reduced Runway Separation Standard" in use in Australia and other locations to facilitate reductions in MRS. This activity should also build a bridge to the reduced separations and increased throughput envisioned with ADS-B In functionality by driving improved exit locations where needed.

Recommendation 7: Perform wake behavior analysis to authorize the use of RNAV (LPV, LNAV/VNAV, RNP AR) approaches in lieu of ILS for 7110.308 operations on SFO Runways 19L and 28L/R and any other locations that routinely use .308 procedures in the future. FAA Order 7110.308C allows a reduction in the required wake separations for dependent operations for runways less than 2,500 feet apart when small or large category aircraft are leading in the dependent pair. The FAA will perform analysis of 7110.308C operations for SFO Runway 19L, 28L and 28R utilizing RNAV approaches to one or both runway ends, which would allow for continued use of 7110.308 operations when an ILS is out of service.

Recommendation 8: Perform wake analysis of ORD Runway 28C Arrival/Runway 22L Departure Wake Encounter Issue and develop mitigation. The FAA will perform this analysis to assess wake separation application at ORD after pilot reported wake encounters led to additional separation being provided by ATC for departures from ORD runway 22L following a Heavy arrival to runway 28C. FAA will analyze wind sensor data acquired at ORD along with aircraft wake data to assess the continuing need for the increased separation (time) or alternatively to explore potential mitigations to reduce the separation.

Recommendation 9: Develop and publish additional guidance material for aircraft operators on wake turbulence encounter reporting to promote awareness and support FAA wake encounter data collection. Distribution of this guidance could be accomplished using Safety Alert for Operators (SAFOs), Information for Operators (InFOs), AIM, Advisory Circular update (AC 90-23) “Aircraft Wake Turbulence,” or direct pilot outreach.

This process will inform industry of the need to report wake encounters through PIREPs, ASRS, and other reporting means to ensure tracking of wake safety issues.

Recommendation 10: Industry will support or perform benefits assessments with data, and/or other resources to ensure there is no loss of capacity or throughput at select initial CWT locations or when CWT is implemented at existing RECAT 1.5 and 2.0 airports. Based on the outcomes of these industry assessments, industry may request the JAT to make a more in-depth analysis of a specific site to validate CWT benefits and separations.

Recommendation 11: Industry to support and distribute FAA guidance material relating to wake turbulence reporting through appropriate means of communication to crews. The methods by which operators communicate the need for increased wake encounter reporting will be dependent upon the approach and guidance issued by the FAA. Industry will inform flight crews of this important reporting element and communicate appropriate steps to be taken based on FAA guidance. This support will include the provision of FAA material highlighting the need for wake encounter reports and documenting the desired reporting methods and procedures.

MRO NIWG Milestones

Milestone	FAA or Industry	Implementation (I) or Pre-implementation (P)	Milestone Date Q/CY
Convert 5 legacy Wake RECAT 1.5 or 2.0 sites to CWT	FAA	I	4Q2019
Convert 7 legacy Wake RECAT 1.5 or 2.0 sites to CWT	FAA	I	4Q2020
Convert 5 legacy Wake RECAT 1.5 or 2.0 sites to CWT	FAA	I	3Q2021

Milestone	FAA or Industry	Implementation (I) or Pre-implementation (P)	Milestone Date Q/CY
Perform feasibility and initial safety analysis for CSPO departure concepts	FAA	P	3Q2019
Perform feasibility and initial safety analysis for CSPO integrated arrival/departure concepts	FAA	P	3Q2020
Complete safety study of Closely Spaced Parallel Operations with High Update Rate Surveillance	FAA	P	2Q2019
Continue research on dynamic and time based wake separation concepts	FAA	P	4Q2019
Perform feasibility study of reduced MRS on final approach including collision risk, impacts on go around rate, and runway occupancy restrictions	FAA	P	1Q2020
Analyze ORD 28C Arrival/22L Departure Wake Encounter Issue and develop mitigation	FAA	P	4Q2019
Analysis of use of RNAV (VNAV) approaches for 7110.308 on SFO 19L/28L/R	FAA	P	4Q2019
Provide guidance material to operators about wake turbulence encounter reporting in the NAS	FAA	P	2Q 2019

Milestone	FAA or Industry	Implementation (I) or Pre-implementation (P)	Milestone Date Q/CY
Operator assessment of benefits from CWT implementations at initial CWT locations and at existing RECAT 1.5 and 2.0 sites	Industry	I	4Q2020
Encourage aircraft operators to report wake encounters via pilot reports to ATC or aviation safety databases based on FAA guidance material	Industry	I	4Q2019

Risks and Other Considerations

The following risks and assumptions were considered as part of the recommended action plan. They must be addressed and/or mitigated to ensure MRO activities continue to provide the benefits the program has delivered to date.

- Successful completion of requisite safety studies and environmental reviews and achieving stakeholder alignment on new standards
- Ensuring continued funding support for safety studies, automation enhancements and implementation
- Ensuring the NAS-wide implementation of the “Consolidated Wake Standard” does not slow down or adversely impact pursuit of the longer term goal of further optimizing separation using Dynamic Wake Separations (Time/Wind Based Separation) to enhance operations and maximize benefits
- Ensuring no loss of benefits due to near-term implementation of Consolidated Wake Turbulence Standards
- Achieving desired reductions in simultaneous parallel runway separation standards using High Update Rate Surveillance with possible application at DTW, ORD, JFK
- Resolving the “LNAV Only” Issue for simultaneous independent parallel operations with a specific focus on “short duration” planned and unplanned ILS outage scenarios. Note: this item was previously removed from our work plan, but has continuing value, particularly as the fleet of LNAV only aircraft diminishes resulting in reduced potential exposure.
- Successful introduction of BOS Runway 4L RNAV Procedure for 7110.308 Operations – This initiative was removed from our work plan due to environmental issues, but the procedure holds great value for maintaining a “closer to VMC” arrival rate when the facility cannot conduct visual approaches.

Operational Use

The MRO NIWG team is committed to implementing reduced separation capabilities through operational use. However, the implementation of new procedures may require additional time to address specific environmental or operational concerns. The team remains committed to monitoring the progress of the following beneficial capabilities:

- BOS Runway 4L RNAV Approach/7110.308 Procedures
- VNAV requirement for closely spaced parallel approaches with ILS out

As we implement new procedures through 2021, there may be additional procedures that will require MRO NIWG review and input based on operational needs and constraints.

Performance Based Navigation (PBN)

Background

Successful pre-implementation and implementation activities identified by the PBN NextGen Integration Working Group (NIWG) have advanced PBN and led to operational approvals that facilitate the use of emerging PBN capabilities. Metroplex projects and single site PBN implementations outlined in previous NIWG plans have continued to proliferate PBN throughout the NAS.

However, the 2016 PBN NAS Navigation Strategy established Near-Term and Mid-Term Goals that the FAA and industry are challenged to meet. With the goal of bringing the NAS Navigation Strategy to an operational level of implementation, the PBN NIWG has identified a number of planning elements that attempt to address the deficiencies for the time frame of CY2019-2021. The planning elements that can be codified are included in this Report as Pre-Implementation and Implementation Milestones. The activities that cannot be codified or do not have any available resources within the FAA are accounted for as Recommendations.

These commitments and recommendations are organized into eleven discussion areas that reflect the primary topics of the NIWG's deliberations, and are summarized into two tables at the end of the PBN section.

- Initial Trajectory Based Operations and PBN Harmonization: PBN is a key element of the FAA's efforts to transform the NAS to Trajectory Based Operations (TBO), optimizing flights using time-based management (TBM), the aircraft's ability to fly precise paths (through PBN), and information exchange between air and ground systems. Members of the NIWG have expressed strong interest in seeing benefits that have long been anticipated through harmonized deployment of aircraft equipment, Initial TBO (iTBO) technical and organizational elements, and PBN procedures. The complexity of iTBO implementation will require regular, robust engagement of industry and government stakeholders to ensure complete success.

- Consistent and Sustainable Funding for PBN Implementation: Sufficient funding of FAA PBN activity is necessary to achieve the scale of effort necessary to meet the goals of the NAS NAV Strategy and the evolution to TBO. A stable, sustained funding source is needed to support the national PBN infrastructure necessary to accomplish the move to TBO, to meet NextGen goals, and transition to the future described in the 2016 NAS NAV Strategy and the TBO Vision.

- Understanding and Addressing the Barriers to Established on RNP (EoR): The NIWG has identified airport candidates to be considered for continuous connected descents and Established on RNP (EoR) operations into dependent runway configurations. The NIWG discussed at length the inconsistent PBN operations at select airports where procedures are available, and the opportunity to extend EoR operations to these airports using existing published PBN procedures. The NIWG has identified a need to understand the extent of barriers to extension and identify mitigations that would allow for the exploitation of aircraft equipage investment, using a site-specific context.

- Holistic Approach to Aircraft Equipage: A critical risk factor is the equipage capability of aircraft. Required certifications are equally important. Industry equipage and certification plans may not support the 2025 capabilities described in the PBN NAS Nav Strategy, and without certain aircraft capabilities, the benefits of the FAA's iTBO implementation plan may be limited. There is an urgent need for a holistic study of both industry and FAA benefits resulting from a harmonized deployment of aircraft capability, iTBO infrastructure, and PBN procedures, inclusive of data communications, navigation, and surveillance capabilities.

- Procedures Gateway Transparency: Previous rolling plan accomplishments have been possible through successful Industry and FAA collaboration. Transparency and accountability for commitments is essential to continuing this success. Communications and coordination challenges have frustrated Industry proponents. The development and implementation progress should be tracked consistently and made available to stakeholders in a timely manner through the IFP Gateway.

- Post Implementation Reporting: Industry stakeholders, including operators and airports, have important perspectives, feedback, and sometimes data that are necessary inputs to the post-implementation process. Full accounting of benefits and consequences of implemented procedures should be part of post-implementation reporting. Industry should have the ability to review and concur with analysis findings and conclusions.

- Track-to-Fix: The PBN NIWG Track-to-Fix EoR milestones from the previous PBN NIWG plans had been held in abeyance and were closed due to concerns raised by aircraft lacking vertical navigation guidance (VNAV) capabilities resulting in potential increased risk of Controlled Flight into Terrain (CFIT) in the final approach segment. They will continue its technical effort, addressing the remaining research items and develop additional mitigation options.

- Advanced RNP: A-RNP offers key benefits provided by RNP, including RF (Radius -To-Fix) curved paths but without some of the certification costs and regulatory requirements. This offers an attractive option for operators with RF capability on various legacy fleets that are not RNP AR. Flights have begun to use these procedures and experience gained from those flights will be collected and shared.

- GBAS/GLS: Industry is asking for a clear plan for GLS Operations, including near-term authorization for Category II minimums and eventual evolution to full Category III. Industry equipage is growing rapidly and concerns about a "mixed equipage" environment can be overcome. GBAS can be used to support precision approaches where none are currently available, achieving a key industry objective of precision approach guidance to all air carrier runways.

- NSG 1 Airports and Metroplex: NSG 1 airports have some of the most complex conditions in the NAS. PBN procedures at these airports should reduce pilot/controller workload and increase schedule reliability/efficiency without reducing airport capacity. As the Metroplex effort completes the final four sites, lessons learned throughout the whole effort should be accumulated and shared.

- NSG 5 Airports and Heliports: In reviewing NSG 5 airport and heliport PBN goals, implementing vertical navigation to more landing surfaces was determined to bring near-term safety and operational benefits and improve the business case for individual operators to equip with PBN capabilities.

The NIWG identified the following risks as critical to implementing PBN and iTBO between CY2019 and the end of CY2021:

- Balancing of aircraft equipage capabilities
- Community acceptance of changes in procedures
- Controller decision support system tools to accommodate and leverage PBN procedures and equipage.

Proposed PBN performance indicators focus on expected outcomes for airlines and airspace users from implemented PBN procedures when combined with necessary aircraft equipage and the appropriate ATC airspace management tools. Successful PBN implementation is site-specific, and the indicators should be defined based on the operational uniqueness of each implementation and tie back to the operational objective of the PBN implementation.

PBN Implementation Findings, Recommendations and Commitments

Initial Trajectory Based Operations and PBN Harmonization

PBN is a key element of the FAA's efforts to transform the NAS to Trajectory Based Operations (TBO), optimizing flights using time-based management (TBM), the aircraft's ability to fly precise paths (through PBN), and information exchange between air and ground systems. The PBN NAS Navigation Strategy outlines the integral nature of PBN and TBM. Essentially, transition to time-based management is necessary to enable higher percentages of PBN operations, using speed, a defined lateral maneuver, or time control to keep flights on their optimal path. Members of the NIWG have expressed strong interest in seeing benefits that have long been anticipated through harmonized deployment of aircraft equipment, Initial TBO (iTBO) technical and organizational elements, and PBN procedures.

TBO seeks to improve operational predictability through more accurate and efficient end-to-end strategic planning and scheduling. Enterprise enablers[1] and data sharing[2] will help address weather and other uncertainties that are potential risks for traffic flow management and routing. Initial TBO capabilities include a number of tools identified in October 2016 report on PBN time, speed, and spacing, including Converging Runway Display Aid (CRDA), Integrated Departure/Arrival Capability (IDAC), Ground Interval Management – Spacing (GIM-S), and Terminal Sequence and Spacing (TSAS). The FAA is focusing on arranging a suite of capabilities with other enablers to enable a more complete set of PBN benefits. A listing of iTBO capabilities and enablers is included in Appendix B. The integration of PBN and TBM presents the opportunity to transition implementation commitments from milestones that focus on individual tools, to integrated commitments that emphasize desired operational outcomes by location and time.

The complexity of iTBO implementation will require regular, robust engagement of industry and government stakeholders to ensure complete success. There are many details to absorb and work through. Industry is particularly interested in understanding the projected level of benefit from iTBO capabilities, and the anticipated increased utilization of PBN. Industry and FAA investments will be interdependent, with decision makers looking for demonstrated benefits. While the continuation of the

[1] Additional detail on Data Communications capabilities and schedule are included in the Data Communications NIWG portion of the Rolling Plan

[2] Additional detail on TFDM capabilities and schedule are included in the Surface and Data Sharing NIWG portion of the Rolling Plan

NIWG process has been proposed, clarity is needed regarding the management of collaborative work efforts during this critical phase of iTBO deployment.

Implementation Commitment: Implement select iTBO capabilities that will enable more precise trajectory management, collaborative scheduling, and repeatable PBN procedures; together designed to increase use of existing capacity, improve operational predictability and flexibility, and enhance flight efficiency:

- In the Northeast Corridor by Q4 CY21[3]
- At an additional operating area (Northwest Mountain - Denver) by Q4 CY20
- At an additional operating area (Southeast – Atlanta) by Q4 CY21

Consistent and Sustainable Funding for PBN Implementation

Sufficient funding of FAA PBN activity is necessary to achieve the scale of effort necessary to meet the goals of the NAS NAV Strategy and the evolution to TBO. Industry and FAA must mutually invest and commit to developing a framework for synchronizing PBN with iTBO implementation.

The 2016 PBN NAS NAV Strategy describes commitments and time periods necessary to transition to the "PBN-centric" US National Airspace System of the future. These goals are difficult to achieve with the current resources and funding mechanisms associated with PBN. The lack of resources reduces the ability to keep up with the production schedule and leads to inefficient procedure maintenance. It can take years to get a new procedure or an amendment implemented. A clearly understood process to prioritize procedure requests is needed. Without resources and understood priorities, the length of time to develop and implement procedures will continue to lengthen, threatening the success of the NAS NAV Strategy.

The NIWG also recognizes that the restrictions of the annual operations funding cycle for the FAA's PBN program lacks the structure and multi-year planning offered by other infrastructure elements of the overall NextGen program. A stable, sustained funding source is needed to support the national PBN infrastructure necessary to accomplish the move to TBO, to meet NextGen goals, and transition to the future described in the 2016 NAS NAV Strategy and the TBO Vision.

Recommendation: The FAA should develop a multi-year capital implementation plan for PBN that serves as a roadmap for the completion of the 2016 NAS NAV Strategy. The plan should be resourced appropriately to support the PBN transition described in the strategy document.

Understanding and Addressing the Barriers to Established on RNP (EoR)

While implementing and using PBN procedures at the nation's busiest airports is an important NextGen objective, enabling PBN operations at airports with lesser dense traffic is also an important goal. The NIWG has identified airport candidates to be considered for continuous connected descents and Established on RNP (EoR) operations into dependent runway configurations. The NIWG discussed at length the inconsistent PBN operations at select airports where PBN procedures are available, and the opportunity to extend EoR operations to these airports using existing published PBN procedures.

The progress accomplished with EoR at DEN has presented additional opportunities to expand that success to other airports (20 candidate airports identified by set of NIWG Technical Pilots). This

[3] Additional detail on NEC capabilities and schedule are included in the NEC NIWG portion of the Rolling Plan

opportunity is challenged by barriers perceived by industry and government that must be resolved for widespread deployment of EoR operations. These barriers to EoR include but are not limited to:

- Finding solutions for both Independent and Dependent Simultaneous RNP approaches
- Finding solutions for use of EoR procedures in both IFR and VFR conditions
- Modernizing separation standards to support EoR operations
- Amending FAA criteria to retain current efficiencies in EoR operations
- Defining a path forward for aircraft equipage
- Pilot/controller training requirements for EoR operations

The NIWG has identified a need to understand the extent of these barriers and identify mitigations that would allow for the exploitation of aircraft equipage investment, using a site-specific context. Six airports, that are representative of NSG 1-4 airports with existing procedures and equipage, were identified as primary candidates for this deep-dive analysis: Denver International (DEN), George Bush Intercontinental (IAH), Nashville International (BNA), Portland International (PDX), Austin-Bergstrom International (AUS), and Sacramento International (SMF). These airports were selected for the unique attributes and opportunities that each one offers.

Pre-implementation Commitment: The FAA will lead an effort partnering with Industry to analyze potential constraints and causes that inhibit the consistent use of EoR procedures at select NSG 1-4 airports in the NAS by Q1 CY20. Industry's broad expertise will contribute important perspectives and experience to this effort. This analysis will also recommend next steps to address the identified constraints and causes. The scope of this analysis includes, but is not limited to: procedure criteria, separation standards, and merging/spacing needs. Three airports selected from the six candidates will be analyzed, representative of NSG 1-4 airports.

Industry Commitment: Industry will identify the three airports for detailed analysis by Q4 CY18. The FAA and its support may provide analysis and data to inform Industry decision.

Recommendation: The FAA and Industry should assemble a collaborative group to evaluate how to overcome the set of barriers studied in the FAA Pre-Implementation Milestone. This multi-disciplined group will consider how to resolve the full set of barriers, to enable widespread deployment of EoR operations, with a particular need for advanced deployment timelines at NSG 2 and NSG 3 airports.

Holistic Approach to Aircraft Equipage

A critical risk factor is the equipage capability of aircraft. The majority of aircraft in the mainline air carrier fleet have Advanced Required Navigation Performance capabilities. However, regional airline and general aviation aircraft fleets have a much lower percentage of equipage. Required certifications (e.g. for RNP AR (Authorization Required)) are equally important. Industry equipage and certification plans may not support the 2025 capabilities described in the PBN NAS Nav Strategy. Recent equipage inventories estimate that there are as many as 1,000 mainline and regional aviation aircraft that are not equipped with the capabilities[4] identified in the NAS NAV Strategy. In addition, without certain aircraft capabilities, the benefits of the FAA's iTBO implementation plan may be limited. These aircraft capabilities extend beyond navigation, and include data provision and collaboration ability, data communications, and time of arrival control.

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[4] From discussion with FAA NextGen Director of Portfolio Management & Technology Development, and MITRE NextGen Equipage inventory, August 2018

Previous benefit studies have been done by industry and the FAA for specific aircraft capabilities or infrastructure upgrades. There is an urgent need for a holistic study of both industry and FAA benefits resulting from a harmonized deployment of aircraft capability, iTBO infrastructure, and PBN procedures, inclusive of data communications, navigation, and surveillance capabilities.

Recommendation: A comprehensive FAA and industry approach should be undertaken that includes benefits resulting from a combined ground and airborne technology implementation schedule.

Procedures Gateway Transparency

Previous rolling plan accomplishments have been possible through successful Industry and FAA collaboration. The NIWG members desire to continue that success, and it is important to note that transparency and accountability for commitments is essential. It is understood that balancing requests for PBN improvements with available resources is a continual challenge. Additionally, as constraints limit the FAA's ability to respond to requests, transparency regarding the status of each project after it is logged into the Instrument Flight Procedure (IFP) Gateway remains a high interest.

Communications and coordination challenges have frustrated Industry proponents. Issues include inability to schedule meetings, delays in publishing amendments, or work conducted without necessary industry involvement[5]. Rationale for delays or schedule changes should be communicated to proponents and other stakeholders to minimize misperception and increase confidence in existing processes.

The development and implementation progress should be tracked consistently and made available to stakeholders in a timely manner through the IFP Gateway. Key characteristics of a more transparent method of communication that would enable proponents (e.g. operators, airports, facilities, communities, others) and service providers/designers to have more productive and meaningful exchanges include:

- Automatic and electronic notification to the proponent on status changes as a procedure progresses along the development life-cycle
- Opportunity to understand decisions and associated circumstances that may delay, reprioritize or conclude that a procedure is not viable

Recommendation: Industry recommends the FAA pursue a system that automatically and electronically, if possible, informs proponents of status changes as a procedure progresses along the development life cycle.

Post Implementation Reporting

The establishment of PBN milestones is a combination of desired industry outcomes balanced with the FAA's business plans and available resources. Industry plays a key role in assessing operational benefits after a milestone has been implemented. This validates the planning and execution of the intended goals which should be established and agreed upon by stakeholders prior to implementation.

Industry stakeholders, including operators and airports, have important perspectives, feedback, and sometimes data that are necessary inputs to the post-implementation process. While an individual stakeholder may have limited access to the tools and resources needed for a comprehensive post-implementation analysis, they should make every effort to collect relevant data and contribute their

[5] Examples include MDW STARs, SNA STAR, CLT STARs, and EGE SID.

findings as part of the validation process. Industry should have access to post-implementation reports developed by the FAA and their support such as MITRE, ATAC or other relevant resources, and should assist in validating the data, results, and conclusions of those reports. Full accounting of benefits and consequences of implemented procedures should be part of post-implementation reporting. Industry should have the ability to review and concur with analysis findings and conclusions. If the findings are negative, the post-implementation process needs to support modification or suspension of the effort, if needed.

Industry Commitment: Industry will provide input, validate data, review findings and confirm conclusions to post-implementation analyses for implemented PBN procedures, within 6 to 12 months of the completed implementation.

Track-to-Fix

The previous PBN Rolling Plan established milestones to enable wider participation of EoR with the following recommendations:

- EoR with Radius-to-Fix (RF), EoR with Track-to-Fix (TF), assessment of TF/RF Concurrent Operations
- RF to xLS (RF/TF) – Assessment/identification of pre-implementation milestones

The PBN NIWG Track-to-Fix EoR milestones from the previous PBN NIWG plans had been held in abeyance and were closed due to concerns raised by aircraft lacking vertical navigation guidance (VNAV) capabilities resulting in potential increased risk of Controlled Flight into Terrain (CFIT) in the final approach segment.

The PARC (Performance-Based Aviation Operations Rulemaking Committee) Navigation Workgroup has taken on the technical task of solving the problem of RNAV to xLS transitions on the final segment. The recommendations from the Nav WG should mitigate CFIT by using the ILS for some EoR applications. Advisory VNAV is another tool under discussion for non-VNAV aircraft. A significant amount of data collected and reviewed from many types of aircraft flying arrivals in Atlanta Hartsfield International (ATL) using a “closed” PBN trajectory from the downwind to the runway indicated a high level of vertical performance from aircraft equipped solely with advisory (no coupled) vertical guidance capability. All parties agreed that a search of the Aviation Safety Information Analysis and Sharing (ASIAS) database should be completed to determine what data might be available for aircraft flying similar “closed” PBN trajectories using advisory vertical guidance capability.

The findings and report are currently pending. Other concerns related to risk analysis and closely-spaced parallel operations are part of the discussion, but no specific outcomes have been agreed to. The Nav WG will continue its technical effort, addressing the remaining research items and develop additional mitigation options. Other data collection efforts (e.g. Fort Myer) may also contribute to the Nav WG deliberations.

Recommendation**:** The FAA should:

- Complete the investigation of available ASIAS data and conduct a review with requisite stakeholders to understand the capability and sufficiency of Advisory VNAV to address the expressed CFIT concerns.

- Continue coordination and work with the PARC on TF to xLS and obtain consensus towards mitigating CFIT concerns.
- Continue dialogue with stakeholders to an agreeable path forward for risk analysis and acceptable parallel operations for non-VNAV aircraft.
- Revisit previous TF milestones and determine next steps.
- Dependent on the outcomes of the PARC Nav WG, consider a single runway application at Las Vegas using RNAV to ILS transition.

Advanced RNP

Advanced RNP (A-RNP) offers key benefits provided by RNP, including RF (Radius -To-Fix) curved paths but without some of the certification costs and regulatory requirements. This offers an attractive option for operators with RF capability on various legacy fleets that are not RNP AR. A-RNP can be leveraged for arrival and departure procedures as well as instrument approaches and approach transitions.

The first A-RNP SID, the APRES (Uh-prā), was recently published for Eagle County Regional Airport (KEGE) in Eagle, Colorado. The procedure lends itself well in meeting the terrain challenged environment at EGE. The RNP .3 containment and RF turns provide a reduced climb gradient and lower takeoff weather minimums than the existing procedures. The development and implementation of the procedure identified a lack of complete understanding of A-RNP criteria and operations approval. Flights have begun to use this procedure and experience gained from those flights will be collected and shared. Figure 1 and Figure 2 show the procedure plate and initial flight path associated with the procedure.

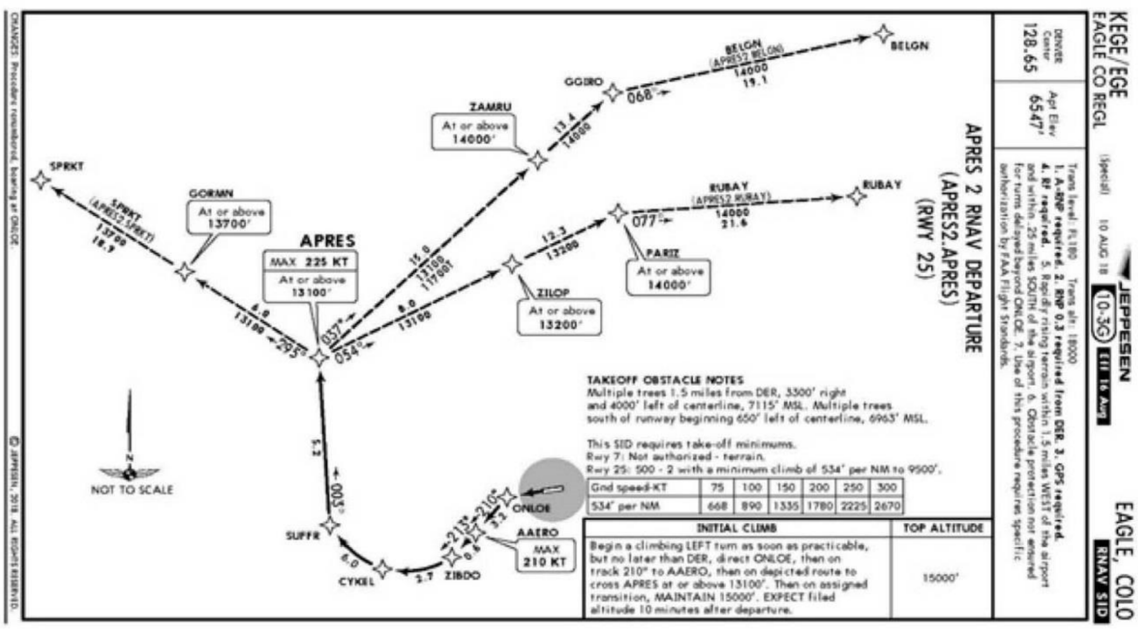

Figure 5: APRES A-RNP SID

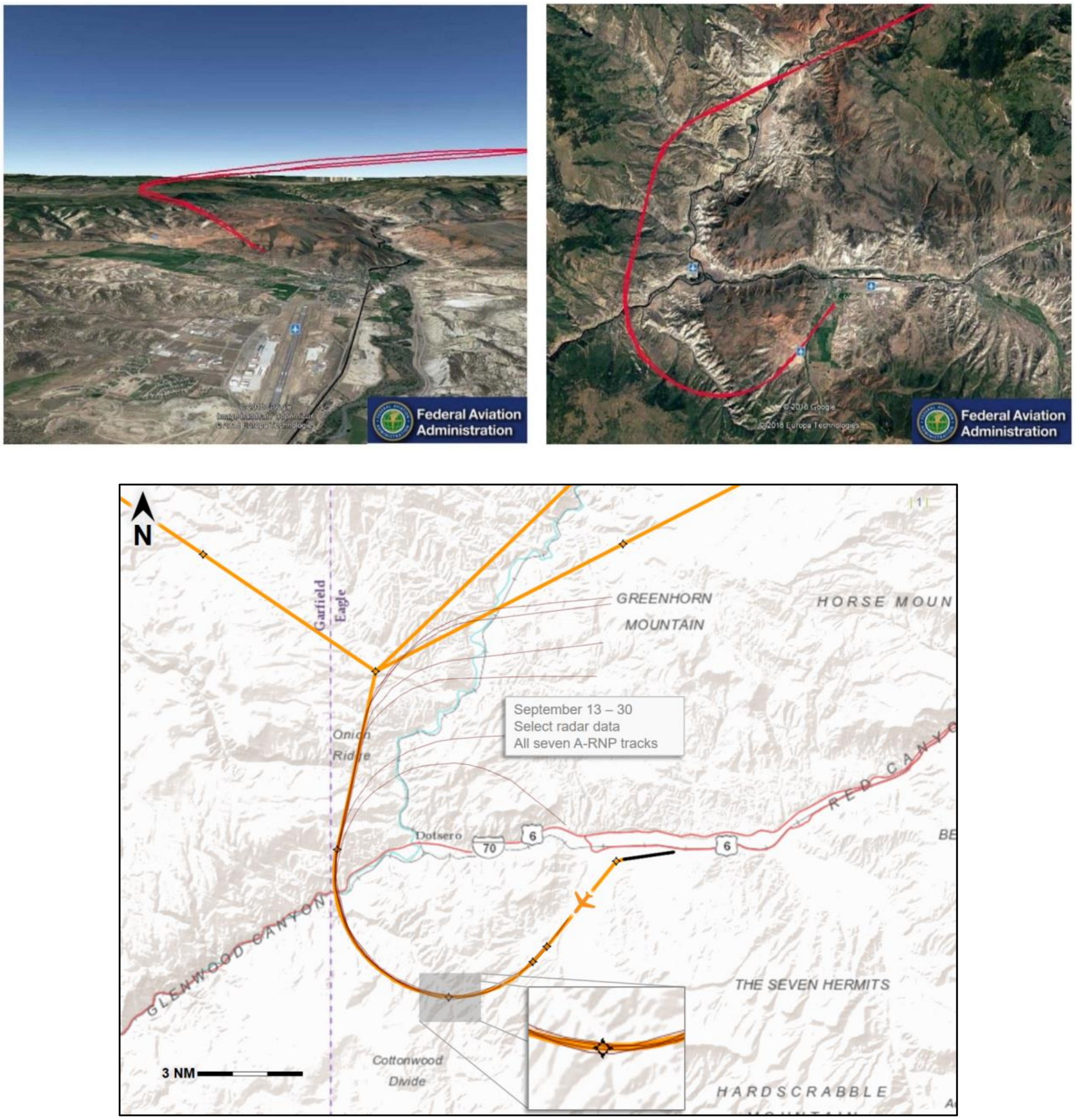

Figure 6: Flight Tracks for APRES A-RNP SID

Recommendation**:** The FAA (AFS and PBN Office) and PARC should:

- Capture lessons learned from Eagle and apply them to subsequent A-RNP initiatives.
- Determine if current criteria, operations approval guidance are easily understood and applied by the stakeholders
- Establish milestones and identify key sites for deployment of A-RNP to include STARs, SIDs and Approaches where it can result in measurable operational efficiency gains.

GBAS/GLS

Industry is asking for a clear plan for GLS Operations, including near-term authorization for Category II minimums and eventual evolution to full Category III. Industry equipage is growing rapidly and concerns about a "mixed equipage" environment can be overcome by designing key instrument approach procedures in a terminal area, including transitions, using the same basic path, whether RF or TF based, or straight-in. Ideally, from a controller's perspective, the only distinguishing factor among the procedures (ILS, GLS, LPV, RNAV, or RNP) would be the minimums. Certification and approval of Category II and ultimately Category III with GLS would allow the approaches to be used simultaneously and transparently on existing Category II/III runways. It may also allow extension of Category II/III capability to runways where it does not currently exist without investment in new ILS equipment. At several NSG-1 and 2 airports, as noted below, GBAS can be used to support precision approaches where none are currently available, achieving a key industry objective of precision approach guidance to all air carrier runways. There is also growing interest at airports in the potential noise benefits of GBAS due to its lateral, longitudinal and vertical flight path capabilities.

The PBN NIWG Team is waiting for the release of an internal FAA paper clarifying the FAA's plan for this program. Industry believes that GBAS offers operational benefits to the user as well as the FAA in terms of system availability and reliability. It also will contribute to the long-term cost reduction of maintaining and replenishing the existing ILS infrastructure. Note that the FAA's commitment to GBAS was memorialized in the PBN NAS Navigation Strategy[6].

Sites of interest for the industry are EWR, LGA, JFK, BOS, ORD, SFO and SEA. Examples of GBAS applications and potential benefits are:

- Newark (EWR):
  - Develop an approach to Runway 29, which could mimic the current GPS X Runway 29, RNAV (RNP) Y Runway 29, and RNAV (RNP) Z Runway 29, but provide a straight-in final approach with vertical guidance. This runway is used to provide critical arrival capacity to accommodate demand under certain wind and weather conditions and minimizes holding or the need for a ground delay program.
  - Develop a curved path approach to tie into the current GLS to Runway 11 using RF and TF leg types.
  - Develop approaches to runways 4L and 22R to permit use as overflow runways in various weather conditions. Existing procedures are being revised to support a .308 operation.
- New York LaGuardia (LGA):
  - Potential for improved minimums to runways 31 and addition of GLS approach with vertical guidance.
  - Development of approaches that de-conflict the JFK and LGA airspace (LGA Runway 31 and JFK Runways 22L/R).
  - Develop approaches using RF and TF legs to Runway 13 that can turn final within the confines of LGA airspace and de-conflict EWR, TEB and LGA. Aircraft from the south

[6] Page 14 and 15 from *PBN NAS Navigation Strategy 2016*:"… FAA will support the delivery of benefits from the operation of the non-Federal GBAS facilities by approving new facilities, developing and publishing GLS approach procedures, training controllers, and providing flight inspection services. FAA is also supporting the development and approval of Cat II/III GLS capability which is expected to be available late in the near term."

would save approximately flying 15 miles compared to the current ILS approach to Runway 13.

- New York John F. Kennedy (JFK):
    - Potential for improved minimums to Runway 13R, which has no ILS, as well as developing offset approaches to runways 4L or 4R, allowing simultaneous independent approaches to these runways.
    - Develop a straight-in approach (ILS is offset) to Runway 22R (improved minimums over the offset approach) and parallel RF and TF leg approaches to runways 13L and 13R.
- Boston (BOS):
    - Conduct an evaluation of potential GBAS procedures and quantify the expected benefits related to redundancy/sustainability, noise abatement and improvements in safety/throughput. Provide precision approach to runway 4L to be used independently or to support 7110.308 procedures.
    - Use the results to inform an airport investment decision for a GBAS ground station.
- Chicago O'Hare (ORD):
    - Provide glide slope and better minimums on runway 4L, offset approach to 28L to conduct simultaneous arrivals, and Cat II backup all runways
    - GBAS is not affected by snow or critical areas which impact taxi routes
- San Francisco (SFO):
    - Provide precision approaches to non-ILS runways 19R, 10L/R. Also provides critical area benefits and back up for ILS
- Seattle-Tacoma (SEA):
    - The Port of Seattle is considering an airport investment decision for a GBAS ground station.
- During severe weather events, hurricanes or extreme flooding, GBAS antennas can be removed, stored, and reinstalled when the weather has improved. GLS approaches have been available and used during snow and ice events at EWR when the ILSs have frozen and were NOTAMed out of service.
- GBAS enables staggered thresholds for noise relief and higher glideslope angles up to autoland limits for potential obstacle clearance. An SFO trial of RNP to GLS showed 46 percent less fuel and 86 percent less noise impact, according to a 2018 Boeing briefing at a University of California-Irvine noise conference.
- As equipage increases, other airports such as Chicago Midway (MDW), DEN, Houston Hobby (HOU), AUS, and BNA will also see similar benefits.

Recommendations: The FAA should:

- Ensure the level of support for GBAS is in accordance with the spirit and guidance in the PBN NAS Navigation Strategy
- Support GLS Category II operational approval, either as a fully certified Category II system, or by authorizing Category II operations on existing Category I systems, thereby leveraging GBAS all-weather capability
- Study the feasibility of using the flexibility of GLS procedures for noise abatement by evaluating higher GP angles not to exceed autoland limitations, and alternative touchdown points.
- Partner with airports and industry to support training and advanced procedure development and ensure procedures are flyable by all aircraft to minimize the impacts of "mixed equipage."
- Support future industry investments in GBAS Category III ground and airborne systems.

NSG 1 Airports and Metroplex

NSG 1 airports have some of the most complex conditions in the NAS. In addition to being among the busiest airports, they are also generally in crowded metropolitan areas and are served by many different operators with varying degrees of technology on their aircraft. Demand at these airports is high and while some NSG 1 airports have ample runways and ample spacing between runways, many do not. PBN procedures at these airports should reduce pilot/controller workload and increase schedule reliability/efficiency without reducing airport capacity. PBN work at these airports should consider equipage mix, alignment with ATC tools, and runway configurations. Deconfliction between primary and secondary airports is also a primary consideration for many of the NSG 1 airports.

The FAA continues to improve overall NAS efficiency by implementing PBN at selected metropolitan areas, or in a metroplex, which has multiple airports and complex air traffic flows. Through the Metroplex program, the FAA collaborates with aviation and community stakeholders to improve regional traffic movement by optimizing airspace and procedures built on precise satellite-based navigation. As the Metroplex effort completes the final four sites, lessons learned throughout the whole Metroplex project should be accumulated and shared. Post-implementation analyses should include measurement of the implemented procedures against the expected project benefits.

Implementation Commitments: Note Environmental Assessment work has been paused since December 2017 for Denver, Las Vegas and Florida; thus, milestones are dependent on completion of environmental work.

Cleveland/Detroit
- Implementation phase complete, Q4 CY18
- Post-implementation phase complete, Q3 CY19

Denver
- Implementation phase start, Q4 CY19
- Implementation phase complete, Q1 CY20
- Post-implementation phase complete, Q4 CY20

Las Vegas
- 100 percent design complete, Q2 CY19
- Implementation phase start, Q2 CY20
- Implementation phase complete, Q3 CY20
- Post-implementation phase complete, Q2 CY21

Florida (SIDs and STARs)[7]
- 100 percent design complete, Q2 CY19
- Implementation phase start, Q3 CY20
- Implementation phase complete, Q2 CY21
- Post-implementation phase complete, Q4 CY21

NSG 5 Airports and Heliports

In reviewing NSG 5 airport and heliport PBN goals, implementing vertical navigation to more landing surfaces was determined to bring near-term safety and operational benefits and improve the business case for individual operators to equip with PBN capabilities. The new U.S. Standard for Terminal Instrument Procedures (TERPS) criteria that facilitates additional LPV approaches to terrain and

[7] High altitude PBN routes associated with the Florida Metroplex will start implementation in Q4 CY18.

obstruction-challenged airports should be implemented at more locations. An example is Medford, OR, where terrain limits approaches from the south. General aviation would benefit from new TERPS criteria at this location if an LPV was implemented.

Recommendation: The FAA should prioritize implementation of additional LPV approaches to terrain and obstruction-challenged airports, with appropriate resources and timelines. The FAA also should work with the helicopter community to further refine the execution of the PBN NAS NAV Strategy for heliports. The NSG for heliports is not listed, which appears to limit the development and prioritization of public PBN procedures to these locations.

Risks/Challenges

The NIWG identified the following risks as critical to implementing PBN and iTBO between CY2019 and the end of CY2021. Key risk factors are:

- Balancing of aircraft equipage capabilities
- Community acceptance of changes in procedures
- Controller decision support system tools to accommodate and leverage PBN procedures and equipage.

Balancing of Aircraft Equipage Capabilities

The PBN NIWG Team recognizes the need for a transition period to provide near-term benefits for highly capable aircraft (as defined by 2025 in the NAS Navigation Strategy) while including less-capable aircraft. The team has a strategy to accommodate aircraft of limited existing capability at selected Navigation Service Group (NSG) 1 airports. A more "forward leaning" strategy is being applied by working to ensure more consistent use of PBN procedures at NSG 2-4 airports operations that will provide benefits to highly capable aircraft.

The more than 2,400 general aviation-centric NSG 5 airports as well as instrument flight rules (IFR) heliports also should be approached with a "forward leaning" attitude. Increasing the number of approaches with vertical guidance to terrain and obstruction-challenged landing surfaces would improve the business case for operators to equip with PBN capabilities. The PBN NIWG Team recognizes the need for increasing the number of localizer performance with vertical guidance (LPV) procedures at these locations, as called for by the PBN NAS Navigation Strategy.

Community Involvement

Important elements for successful implementation of PBN initiatives will be the communication, affirmation of the need for change and the support of all stakeholders. The FAA and operators of aircraft and airports recognize that a key step is engagement with local communities. The NAC PBN Blueprint Community Outreach Task Group report approved by the NAC in 2016 included findings for effective community outreach. It stated that community outreach is the combined responsibility of the FAA, Airports, and Aircraft Operators. The report highlights the essential role of airports in PBN implementation with a unique and critical perspective of community interests. PBN Blueprint Community Outreach report findings are reflected in the *FAA Community Involvement Manual*[8], which

[8] The FAA Community Involvement Manual was published in 2015 and is available at https://www.faa.gov/about/office_org/headquarters_offices/apl/environ_policy_guidance/guidance/media/faa_cim.pdf

describes the high-level framework and processes for involving the community. For PBN procedure development, the FAA emphasizes several key points:

- Airport and airport operators, and the FAA are critical partners in explaining PBN initiatives and benefits, and in communicating with stakeholders throughout the community involvement process.
- The level of community involvement will be tailored to the initiatives under consideration and the potential impact of those specific initiatives.
- Communication with elected officials, local agencies, the public, and other stakeholders on project status will be timely and ongoing. Comments and feedback on specific initiatives from all stakeholders will be considered to inform decision making and project refinements.

Community involvement is an essential element in the PBN implementation process, but it does not reduce, negate or replace the environmental review requirements under the National Environmental Policy Act. As noted in the *FAA Community Involvement Manual*, community involvement activities parallel those in the environmental review process.

Experience has shown that successful PBN implementation efforts typically have established outreach long before beginning the PBN procedure development process. Early engagement at multiple levels can ensure an understanding of the need for PBN and what it may mean to the community. Although the FAA leads in community involvement, PBN success depends upon all stakeholders fulfilling their roles and responsibilities in a collaborative and coordinated manner throughout the entire PBN implementation process. With their understanding of community interests, airport operators play an important role in the collaborative PBN process, especially during the design phase. As specific opportunities are identified, airport and aircraft operators, and the FAA will need to jointly participate in PBN community involvement efforts. FAA leadership has stated that positive advocacy from key operational stakeholders is a critical element for PBN success. While every stakeholder may not agree with every procedure, consistent messaging is essential.

Decision Support Tools/Aircraft Based Tools

The NAC recognized the criticality of controller decision support system tools in the October 2016 report on PBN time, speed, and spacing[9]. The recommendations in that report stressed the need for a 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. This is fundamental to the successful implementation and operation of PBN across the NAS and is essential to ensuring more efficient traffic flows that fully leverage available system capacity. The NIWG endorses the move to iTBO and supports the tools outlined as part of the TBO vision.

Performance Indicators and Success Criteria

Proposed PBN performance indicators focus on expected outcomes for airlines and airspace users from implemented PBN procedures when combined with necessary aircraft equipage and the appropriate ATC airspace management tools. Successful PBN implementation is site-specific, and the indicators should be defined based on the operational uniqueness of each implementation and tie back to the operational objective of the PBN implementation. These goals have broadly included:

[9] "PBN Time, Speed, Spacing Task Group" recommendation approved by the NextGen Advisory Committee, October 2016.

- Maintaining or increasing airport or airspace throughput
- Efficiency of continuous climb and descent procedures to fit the operation
- Most efficient approach procedure that the operation can support
- Support to move toward implementation of initial TBO and use of controller decision support systems

Based on previous PBN implementation and post-implementation assessments conducted by the Joint Analysis Team[10], PBN implementation success has generally been defined as reduced flight time, including taxi-out times for departures. Reduced flight times are driven by either shorter flight paths, increased use of available capacity, or in some cases increased arrival/departure capacity. Measurement of changes in flight distance and capacity requires proper normalization for runway configurations, weather and demand.

Specific success criteria depend on the airport, runway configuration, runway usage and airspace. These scenarios illustrate the efficiency benefits of a PBN implementation but are not comprehensive:

- Scenario 1: Individual airports with PBN arrival procedures
  Indicators: Reduced flight distance, time or both; increased arrival throughput (if applicable)
- Scenario 2: Individual airports with PBN arrival and departure procedures
  Indicators: Reduced flight distance, fuel burn and time; increased throughput or peak capacity (if applicable)
- Scenario 3: Multiple nearby airports with PBN arrival and departure procedures
  Indicators: Increased arrival/departure throughput through deconfliction, decreased taxi out delay, and reduced flight distances/time flown for arrivals and departures

Along with efficiency, PBN implementations may also satisfy other operational needs, such as safety, access and environmental issues. Examples of PBN efforts associated with those objectives:

- Area navigation standard instrument departures (RNAV SID) at Teterboro for access (Northeast Corridor commitment)
- Gary PBN procedures for safety (PBN NIWG joint commitment implemented in 2017)
- STAYY1 RNAV SID for noise reduction at John Wayne Orange County using RF coding (implemented with Southern California Metroplex in 2017)

PBN success also can be represented through output-oriented metrics that complement the outcome-oriented metrics, such as reduction of flying distance and reduction of block time. Measuring the use of a PBN procedure can reflect the successful transition from conventional procedures. This can be accomplished by calculating the percentage of conformance of flight tracks to the published PBN procedure. While this type of output metric may not singularly reflect the purpose of a procedure, nor is not easy to monetize, it can indicate the shift in the operation. Predictability, with elimination of variances and delivery of precise, repeatable paths, is an important benefit of PBN.

[10] The Joint Analysis Team (JAT) is an FAA-Industry collaborative team that evaluates the operational benefits from NextGen implementations.

PBN NIWG Milestones

Milestone	FAA or Industry	Type	Milestone/Commitment	Milestone Date Q/CY
Initial Trajectory Based Operations and PBN Harmonization	FAA	 I I I	Implement select iTBO capabilities that will enable more precise trajectory management, collaborative scheduling, and repeatable PBN procedures; together designed to increase use of existing capacity, improve operational predictability and flexibility, and enhance flight efficiency: • In the Northeast Corridor • At an additional operating area (Northwest Mountain – Denver) • At an additional operating area (Southeast – Atlanta)	 4Q2021 4Q2020 4Q2021
Understanding and Addressing the Barriers to Established on RNP	FAA	P	The **FAA** will lead an effort partnering with Industry to analyze potential constraints and causes that inhibit the consistent use of EoR procedures at select NSG 1-4 airports in the NAS by Q1 CY20. Industry's broad expertise will contribute important perspectives and experience to this effort. This analysis will also recommend next steps to address the identified constraints and causes. The scope of this analysis includes, but is not limited to: procedure criteria, separation standards, and merging/spacing needs. Three airports selected from the six candidates will be analyzed, representative of NSG 1-4 airports.	1Q2020
Understanding and Addressing the Barriers to Established on RNP	Industry	I	**Industry** will identify the three airports for detailed analysis. The FAA and its support may provide analysis and data to inform Industry decision.	4Q2018
Post Implementation Reporting	Industry	I	**Industry** will provide input, validate data, review findings and confirm conclusions to post-implementation analyses for implemented PBN procedures, within 6 to 12 months of the completed implementation.	within 6 to 12 months of the completed implement-ation

Milestone	FAA or Industry	Type	Milestone/Commitment	Milestone Date Q/CY
NSG 1 and Metroplex	FAA	I I	Cleveland/Detroit • Implementation phase complete • Post-implementation phase complete	4Q2018 3Q2019
NSG 1 and Metroplex	FAA	I I I	Denver • Implementation phase start • Implementation phase complete • Post-implementation phase complete	4Q2019 1Q2020 4Q2020
NSG 1 and Metroplex	FAA	P I I I	Las Vegas • 100 percent design complete • Implementation phase start • Implementation phase complete • Post-implementation phase complete	2Q2019 2Q2020 3Q2020 3Q2021
NSG 1 and Metroplex	FAA	P I I I	Florida (SIDs and STARs) • 100 percent design complete • Implementation phase start • Implementation phase complete • Post-implementation phase complete	2Q2019 3Q2020 2Q2021 4Q2021

Key: P – Pre-implementation milestone
I – Implementation milestone

PBN NIWG Recommendations

Initiative	Recommendation
1. Consistent and Sustainable Funding for PBN Implementation	The FAA should develop a multi-year capital implementation plan for PBN that serves as a roadmap for the completion of the 2016 NAS NAV Strategy. The plan should be resourced appropriately to support the PBN transition described in the strategy document.
2. Understanding and Addressing the Barriers to Established on RNP	The FAA and Industry should assemble a collaborative group to evaluate how to overcome the set of barriers studied in the FAA Pre-Implementation Milestone. This multi-disciplined group will consider how to resolve the full set of barriers, to enable widespread deployment of EoR operations, with a particular need for advanced deployment timelines at NSG 2 and NSG 3 airports.
3. Holistic Approach for Aircraft Equipage	A comprehensive FAA and industry approach should be undertaken that includes benefits resulting from a combined ground and airborne technology implementation schedule.
4. Procedures Gateway Transparency	The FAA should pursue a system that automatically and electronically, if possible, informs proponents of status changes as a procedure progresses along the development life cycle.
5. Track-to-Fix	The FAA should: • Complete the investigation of available ASIAS data and conduct a review with requisite stakeholders to understand the capability and sufficiency of advisory VNAV to address the expressed CFIT concerns. • Continue coordination and work with the PARC on TF to xLS and obtain consensus towards mitigating CFIT concerns. • Continue dialogue with stakeholders to an agreeable path forward for risk analysis and acceptable parallel operations for non-VNAV aircraft. • Revisit previous TF milestones and determine next steps • Dependent on the outcomes of the PARC Nav WG, consider a single runway application at Las Vegas using RNAV to ILS transition.
6. Advanced RNP	The FAA (AFS and PBN Office) and PARC should: • Capture lessons learned from Eagle and apply them to

	subsequent A-RNP initiatives. • Determine if current criteria, operations approval guidance are easily understood and applied by the stakeholders • Establish milestones and identify key sites for deployment of A-RNP to include STARs, SIDs and Approaches where it can result in measurable operational efficiency gains.
7. GBAS/GLS	The FAA should: • Ensure the level of support for GBAS is in accordance with the spirit and guidance in the PBN NAS Navigation Strategy • Support GLS Category II operational approval, either as a fully certified Category II system, or by authorizing Category II operations on existing Category I systems, thereby and leveraging GBAS all-weather capability • Study the feasibility of using the flexibility of GLS procedures for noise abatement by evaluating higher GP angles not to exceed autoland limitations, and alternative touchdown points. • Partner with airports and industry to support training and advanced procedure development and ensure procedures are flyable by all aircraft to minimize the impacts of “mixed equipage.” • Support future industry investments in GBAS Category III ground and airborne systems.
8. NSG 5 Airports and Heliports	The FAA should prioritize implementation of additional LPV approaches to terrain and obstruction-challenged airports, with appropriate resources and timelines. The FAA also should work with the helicopter community to further refine the execution of the PBN NAS NAV Strategy for heliports. The NSG for heliports is not listed, which appears to limit the development and prioritization of public PBN procedures to these locations.

Surface and Data Sharing

Executive Summary

The Surface and Data Sharing NextGen Integration Working Group (NIWG) has successfully delivered against the commitments made in the 2014 Joint Implementation Plan, the NextGen Priorities October 2015 Update, as well as the CY2017-CY2019 Surface NIWG Rolling Plan. To continue building upon this success, the NIWG has developed a follow-on set of focal areas and commitments related to maximizing surface-related benefits from the upcoming implementation of the Terminal Flight Data Manager (TFDM) as well as data sharing. These focal areas, along with Collaborative Decision Making (CDM) Steering Group (CSG) tasking, support continuity and connectivity with the Surface Collaborative Decision Making (S-CDM) Concept of Operations, and seek to further enhance data exchange between FAA and all aviation stakeholders. The group is focused on advancing data driven traffic flow management (TFM) across the NAS with an emphasis on the data and connectivity requirements for NAS automation systems.

Background

In 2016, collaboration between Industry and the FAA as part of the Surface NextGen Integration Working Group (NIWG) led to surface traffic management and data sharing recommendations as well as commitments to meet those recommendations by both Industry and FAA. The areas of focus for the recommendations built upon Task Force 5, whose own recommendations were founded upon information sharing and situational awareness of airport flight movement activity.

The 2016 recommendations focused on implementation of the following:

- Terminal Flight Data Manager (TFDM) program
- Data sharing among FAA, flight and airport operators
- Establishment of a forum for ongoing industry engagement with FAA regarding System Wide Information Management (SWIM) data, decision support tools and National Airspace System (NAS) automation, processes, procedures and policies

The collaborative Surface NIWG activity has led to successful progress on all three of these focal areas. The TFDM Program has been launched; operators are sharing key operational data elements with the FAA; and the System Wide Information Management (SWIM) Industry-FAA Team (SWIFT) forum was launched in 2017.

The TFDM Program has no industry dependencies through 2020 aside from preparation for Build 2. For the Build 2 capabilities to be deployed in 2021, TFDM requires flight operator and /or airport authorities (where the airport authority runs the ramp tower) to subscribe to the TFDM Terminal Publication (TTP) Service via SWIM to accomplish the data exchange necessary for successful implementation of the TFDM system.

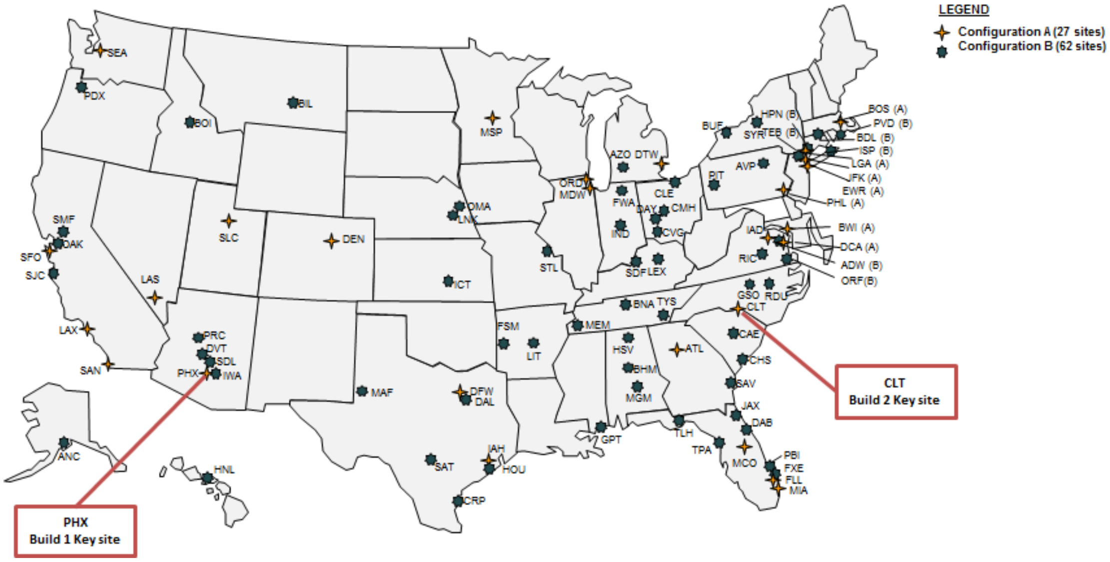

Figure 7 TFDM Implementation Sites by Configuration

It is important to note the expectation that internal and individual industry business case development will be necessary, along with a benefits and risk review, in order for industry to invest in the connection to TTP and other SWIM feeds. Critical to industry business case development is an understanding of what information is available through TTP and other SWIM feeds and the operational context of this information, in order to discern the use of that data in achieving operational benefits.

Some industry discussion around business case development has included concepts such as possible government provision of software as well as hardware to view, manage and operationally integrate TFDM data and procedures into industry operations. FAA and industry agree that NASA ATD-2 activities should be leveraged to the greatest extent possible to support this connectivity and data integration effort.

All FAA and industry commitments and milestones have been completed from the CY2017-CY2019 Surface NIWG Rolling Plan. For complete detail on the status of the current rolling plan, please see the FAA's webpage for "NextGen Priorities – Surface Operations and Data Sharing" at https://www.faa.gov/nextgen/snapshots/priorities/?area=sops.

To continue building upon the successful planning and implementation resulting from the CY2017-CY2019 recommendations referenced above, the NIWG has developed a follow-on set of focal areas for surface and data sharing. These are described in the next section, which provides the foundation for the CY2019-CY2021 plan.

Implementation Plan

Recommendation 1: Support the implementation of TFDM into the NAS to maximize available benefits

- Need to understand SWIM TTP and TFCS connection requirements and the benefits/costs required for implementation

    - Understand data/message types, operational context of the data/information services and technology requirements
- Leverage the benefits to operators included in the TFDM business case information provided in 2018 for industry's business case
- Evaluate the risks of mixed-participation, and associated potential reduction of benefits
- Collaboratively develop policies, procedures, processes, and training
- Promote involvement of all stakeholders (e.g., airlines, airports, business and general aviation, international operators, etc.)
- Expect multiple solutions by operators and airports at different locations - may use vendors to provide connectivity, may involve greater integration in hubs vs spokes
- Industry recognizes that flight operators that are not currently U.S. Collaborative Decision Making (CDM) participants (e.g., foreign flag carriers, regional airlines, recent entrant domestic carriers) and airport operators may have increasingly important roles to play in providing timely operational data (e.g., earliest off block times) to support TFDM and future TBO capabilities.
- Plans to engage these non-CDM participants and establish mechanisms for them to share these operational data need to be established and implemented rapidly and should be aligned with the TFDM implementation "waterfall".
- Airports in this waterfall that serve large numbers of non-CDM operations—whether international carriers, non-CDM domestic carriers, or general aviation—should be identified for early coordination activities to establish (1) what entities will provide non-CDM participant operational data, (2) the mechanisms by which these data will be shared with the FAA and others in industry, and (3) policies, procedures, and technology that need to be implemented to effect this data exchange.
- Ideally, these coordination activities should be integrated with the Collaborative Site Implementation Team (CSIT) outreach activities planned over the course of the TFDM implementation waterfall; note: CSIT visits are planned between 12-18 months prior to each site implementation.

Recommendation 2: Support successful NASA ATD-2 Technology Transfer to facilitate TFDM implementation

- Leverage NASA-issued Notice of Opportunity to identify requirements for successful tech transfer to industry
- Leverage NASA ATD-2 Investments to maximize NAS Benefits for TFDM and iTBO/TBO
- Reinforce commitment to NASA ATD-2 technology / knowledge transfer through active NIWG support
    - Format and parameters of transfer
    - Technology transfer to FAA
    - Technology transfer to industry
        - Open source opportunities

Recommendation 3: Enhance data exchange between the FAA and all aviation stakeholders

- Data exchange supports:
    - The TBO/iTBO concept
    - TFMS, TBFM, TFDM and other NAS automation programs
    - Use of trajectory option sets (TOS) to enable timely provision and updates to industry route preferences when FAA systems are properly configured to receive and manage alternatives
    - Data driven Traffic Flow Management
- SWIM Industry-FAA team (SWIFT), CDM, and similar organizations should be leveraged to the greatest extend possible. Non-CDM operators, airports, and other stakeholder participation should be inclusive.
    - SWIFT establishes a community forum that acts as a single environment for collaborative communication and engagement around information and data sharing for the FAA. It offers a unique and evolving community outreach platform to discuss the FAA data and information services to the external community.

Recommendation 4: Common industry/FAA metrics and maximizing use of 'big data' to inform data-driven decision making

- Use of the term 'big data' in this document refers to the analytical process of taking multiple data sources and tabulating trends and predicting benefits as well as impacts
- The use of common industry/FAA metrics supports collaboration between FAA, industry, airport authorities (and other stakeholders) toward successful surface departure management
    - Surface departure metering is a highly collaborative process, and is an integral part of the iTBO "gate to gate" concept
    - Use of a common set of metrics encourages all stakeholders to participate in meetings to collaboratively assess/review/critique surface management
- The set of metrics that were put forward by the Joint Analysis Team (JAT) and approved by the NextGen Advisory Committee (NAC) in June of 2015 should be leveraged. These metrics are "intended for the FAA and industry to collaboratively monitor performance to understand the impact of implementations" (*citation from:* https://www.faa.gov/nextgen/snapshots/priorities/jat/media/JAT_BOS_GYY_OPDs_Datacomm_Report.pdf) of the four key NIWG capabilities described in the *NextGen Priorities Joint Implementation Plan* of October 2014, and include:
    - Three metrics to be measured by city pairs:
        1. Actual Block Time
        2. Actual Distance Flown
        3. Estimated Fuel Burn
    - Three metrics to be measured at airports:

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

- Collaboration between Surface and Data Sharing NIWG with JAT as needed to understand how FAA / industry agreed to calculate these metrics, and suggest additional metrics if appropriate
- *Note:* The SWIFT forum may be used to address "operational context" considerations of the information available over SWIM, and associated implications to operational metrics.
    - The SWIFT should continue to evolve and engage with industry to address needs and concerns about information and relevant operational metrics, and associated FAA data sharing and information services to the aviation industry.

Risks

- Operator/airport timing of connectivity/access to SWIM TFDM Terminal Publication (TTP) Service
- Operator timing of connectivity/access to SWIM TFDM FOS Collaboration Services (TFCS), to allow for departure substitutions during surface departure metering
- Process for integration of data and operational decision making to meet TMAT times by all operators (U.S. airlines, foreign carriers, general and business aviation) and impact of gate usage

Surface NIWG Milestones

Milestone	FAA or Industry	Implementation (I) or Pre-implementation (P)	Milestone Date Q/CY
FAA Milestones: CY2019			
- Q4: The TFDM Program will complete the Operational Testing for Build 1	FAA	P	4Q2019
- Q4: NASA ATD-2 Interim technology transfer from *Phase 2: Fused IADS* at CLT	FAA	P	4Q2019
CY2020: - Q1: The TFDM Program will achieve the key site Initial Operating Capability (IOC) for Build 1 at PHX	FAA	I	1Q2020
- Q3: The TFDM Program will achieve the In-Service Decision (ISD) for Build 1 to allow additional TFDM system deployments into the NAS	FAA	P	3Q2020
- Q3: NASA ATD-2 Final technology transfer from *Phase 3: Terminal Departure IADS* at Dallas	FAA	P	3Q2020
- Q4: The TFDM Program will achieve IOC at 3 additional sites	FAA	I	4Q2020
CY2021:			
- Q1: The TFDM Program will achieve the key site Initial Operating Capability (IOC) for Build 2 at CLT	FAA	I	1Q2021
- Q3: The TFDM Program will achieve the In-Service Decision (ISD) for Build 2 to allow additional deployments of the full TFDM system capabilities into the NAS	FAA	I	3Q2021
- Q4: The TFDM Program will achieve IOC at 9 additional sites	FAA	I	4Q2021
Industry Milestones:			
CY2019			
- Q3: Review TFDM waterfall list and denote airports that have a	Industry	I	3Q2019

significant non-CDM flight operator presence (e.g., foreign flag carrier, non-CDM domestic carriers, general aviation) -			
CY2019-CY2021			
- Industry will collaborate with FAA during all remaining CSIT visits, that is, all industry-managed ramps will have the relevant industry member(s) participate and provide input as needed. This includes flight operators, airport operators, and third party ramp control providers, as appropriate. - Industry will participate and provide input during recurring SWIFT meetings, which are scheduled once a quarter, to ensure widespread community awareness of the available data and dependencies. All meeting presentations as well as meeting minutes will be made available to all industry participants following every SWIFT meeting, allowing awareness for all industry members present or not present. o SWIM TTP feed-connectivity to achieve TFDM surface metering benefits o SWIM TFCS feed-connectivity to accomplish departure substitutions during surface departure metering o Other decision support tools and NAS automation systems and the associated FAA data o SWIM and non-SWIM data exchange platforms	Industry	I	4Q2021

Appendix A – Membership

Data Comm NIWG Membership

Industry Co-chair: Chuck Stewart, United Airlines
Industry Co-chair: John O'Sullivan, Harris
FAA PMO SME: Jesse Wijntjes
FAA NextGen SME: Juan Narvid

Name	Organization
Daniel Allen	FedEx
Stacey Bechdolt	RAA
Scott Bender	FAA
Joseph Bertapelle	JetBlue Airways
Mike Boynton	American Airlines
Frank Buck	MITRE
Lou Casale	UPS
Andy Cebula	RTCA
Peter Challan	Harris
Perry Clausen	Southwest
Chris Collings	Harris
Jerome Condis	Airbus
Edward Evans	Southwest
Tams Frederic	FAA
Chad Geyer	NATCA
Steve Giles	MITRE
Jens Hennig	GAMA
David Heron	DoD
Fran Hill	Leidos
Tyler Juergens	Gulfstream
Gregg Kastman	UPS
Erik Levins	Hawaiian Airlines
John McCormick	FedEx
Rob Mead	Boeing

Name	Organization
Juan Narvid	FAA
Kieran O'Carroll	IATA
Andrew Onken	Rockwell Collins
Raymond Orie	FAA Contractor
John O'Sullivan	Harris
Mark Patterson	FAA
Jon Pendleton	Delta Air Lines
Darrell Pennington	ALPA
Bret Peyton	Alaska Airlines
Jasenka Rakas	UC Berkeley
Colin Rice	City of Houston
Anthony Rios	Avionica
Andrew Roy	ASRI
Brad Sims	SWAPA
Gus Skalkos	Sennheiser
Steve Smothers	Textron Aviation
Tom Staigle	Delta Air Lines
Wade Stanfield	Thales
Chuck Stewart	United Airlines
Kevin Swiatek	UPS
Brandi Teel	RTCA
Stephen Vantrees	FAA
Terry Walters	Alaska Airlines
Lee Weinstein	Leidos
Jesse Wijntjes	FAA

Appendix A – Membership *(continued)*

MRO NIWG Membership

Industry Co-chair: Glenn Morse, United Airlines
Industry Co-chair: Jon Tree, Boeing
FAA ATO SME: Harold Cooper, FAA
FAA NextGen SME: Paul Strande, FAA

Name	Organization
Glenn Morse	United Airlines, Co-Chair
Jon Tree	Boeing, Co-Chair
Bob Everson	Southwest Airlines
Dan Hanlon	Raytheon
Frank Alexander	Atlas Air
Jens Hennig	GAMA
John Bergener	SFO International
Mark Hopkins	Delta Air Lines
Marshall Koch	Mitre
Mike Cirillo	Airlines for America
Andy Marosvari	NATCA
Barbara Cogliandro	Metron Aviation
Todd OakWood	Embraer
Flavio Leo	MASSPORT
Chris Oswald	ACI
Darrell Pennington	ALPA
Paul Strande	FAA SME

Name	Organization
Harold Cooper	FAA SME
Phil Santos	FedEx
Jeff Tittsworth	FAA SME
Colin Rice	Houston Airport
Tim Stull	American Airlines
Lynae Craig	Alaska Airlines

Appendix A – Membership *(continued)*

PBN NIWG Membership

Industry Co-chair: Brian Townsend, American Airlines
Industry Co-chair: Steve Fulton, Independent Consultant
FAA PMO SME: Rob Hunt, FAA
FAA ATO SME: Donna Creasap, FAA
FAA AVS SME: Merrill "Jazz" Armstrong, FAA

Name	Organization
Merrill "Jazz" Armstrong	FAA SME
Frank Alexander	Atlas Air
Ric Babock	Allied Pilots Association
Michael Bailey	Northrup Grumman
Sean Barbee	PASS
Stacey Bechdolt	RAA
Bret Payton	Alaska Airlines
John Blair	FAA AVS
Trent Bigler	FAA AVS
Michael Cirillo	Airlines for America
Rick Boll	NBAA
Jonathon Bonds	UPS
John Brandt	MITRE
Brian Swain	Delta Air Lines
Rich Terry	Delta Air Lines
Todd Oakwood	Embraer
Rob Hunt	FAA SME
Donna Creasap	FAA SME
Brian Townsend	American Airlines, Co-Chair
Heidi Williams	NBAA
Jeff Woods	NATCA
Steve Fulton	Fulton Aviation, Co-Chair
Gregg Tennille	MITRE
Bennie Hutto	NATCA

Name	Organization
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Joshua Kuntzman	DoD
Joseph Bertapelle	JetBlue
Scott Dehart	Southwest Airlines
Andrew Benich	American Airlines
Alexis Fecteau	Boeing
Larry Hills	FedEx
Lev Prichard	Allied Pilots Association
Mike McKee	FlyDenver
William Murphy	IATA
Glenn Morse	United
Ron Renk	United
Lynae Craig	Alaska Airlines
David Havrud	Boeing
Perry Clausen	Southwest Airlines
Marc Henegar	ALPA
Greg Young	Delta
George Hodgson	Southwest Airlines
Lee Brown	Landrum & Brown
Christian Cast	UPS
Rune Duke	AOPA
Gary McMullin	Southwest Airlines
Marshall Koch	MITRE
Phil Hargarten	NATCA

Appendix A – Membership *(continued)*

Surface and Data Sharing NIWG Membership

Industry Co-chair: Robert Goldman, Delta Air Lines
Industry Co-chair: Steve Vail, Mosaic
FAA PMO SME: Mike Huffman, FAA
FAA NextGen SME: Ben Marple, FAA
FAA System Operations SME: Dave Foyle, FAA

Name	Organization
Rob Goldman	Delta, Co-Chair
Steve Vail	Mosaic, Co-Chair
Joe Bertapelle	JetBlue
Jack Celie	DOD AF
Greg Berkebile	Saab Sensis
Rick Dalton	Southwest
Al Capps	NASA
Mike Cirillo	Airlines for America
Rick Boll	NBAA
Ben Marple	FAA, ANG
Josh Gustin	FAA, ATO
Chris Oswald	ACI
Dave Foyle	FAA SME
Dan Allen	FedEx
Bernie Davis	American Airlines
Charlie Mead	American Airlines
Tim Stull	American Airlines
Steve Link	HARRIS
Eric Van Drunt	Leidos
Flavio Leo	Massport
Curt Hedgepeth	McCarran Airport
Anthony Charles	McCarran Airport
William Leber	PASSUR
Dan London	SAAB Sensis
Stephen Burnham	SAIC
Dean Snell	NBAA

Name	Organization
Pete Slattery	NATCA
Shawn Engelland	NASA
Glenn Morse	United
Susan Pfingstler	United
Ralph Tamburro	PANYNJ
Lee Brown	Landrum & Brown

Appendix B: PBN: Initial Trajectory Based Operations Capabilities

Function Category	Capabilities
PBN	RNAV STAR Optimum Profile Descent (OPD) RNAV SIDs RNP / RNP with RF leg *Established on RNP (EoR)*
Strategic Planning / Flow Management	Airspace Flow Program (AFP), Ground Delay Program (GDP) *Collaborative Trajectory Options Program (CTOP)* *TM Coordination and Planning*
Route Management	Automated Reroutes Pre-Departure Rerouting Airborne Rerouting
Time-Based Scheduling (Airborne and Surface)	Arrival Metering Coupled Scheduling/Extended Metering Collaborative Air Traffic Management Departure Metering (scheduling) into Arrival Stream Departure Metering (scheduling) into En Route Stream *Terminal Metering* *Runway/Surface Balancing* *Surface Scheduling and Metering*
En Route and Terminal Spacing Tools	Converging/Crossing Runway Operation Spacing Indicators In-Trail Final Approach Spacing Indicators Delay Countdown Timer Speed Advisories *Path Stretch Advisories* *Slot Markers, Speed Advisories, and Sequence* *En Route Time of Arrival Control (TOAC)*
Surface Management	Tower Data Communications for Pre-Departure Clearance *Electronic Flight Data* *Airport Configuration Management*
Enterprise Enablers	Information and Data Exchange *Air-Ground Data Communication* *Enhanced Weather Data, Reporting, and Integrated Products*

Source: “Initial Trajectory Based Operations Overview” briefing from FAA on August 16, 2018

Key:
Currently available capabilities are in normal font
Planned capabilities are in italic font