Approved by the NAC September 29, 2011

Recommendations for Implementing Trajectory Operations in the Mid-Term (2011-2018)

A Report of the NextGen Advisory Committee in Response to Tasking from the Federal Aviation Administration (FAA) September 2011
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Executive Summary

The RTCA Trajectory Operations (TOps2) Task Group of the NextGen Advisory Committee Subcommittee (NACSC) was formed in March 2011 and included aircraft operators (flight operations, operational control, and flight planning), flight planning system vendors, OEMs, avionics vendors, MITRE, National Air Traffic Controllers Association (NATCA) and the FAA.

The specific tasking for the Trajectory Operations Task Group is contained in the Terms of Reference for the NextGen Advisory Committee Subcommittee:

To provide continuity and to complete the work of the previous Air Traffic Management Advisory Committee, establish a Trajectory-Based Operations (TOps) Sub-Work Group, (Task Group or “TOps2”) to develop a Trajectory-based operations recommendation and report for consideration at the NextGen Advisory Committee (NAC) September 29, 2011 meeting.

The TOps2 Task Group’s task was to focus on the Mid-Term (2018) Trajectory Operations Concept with consideration for potential evolution beyond 2018.

As presented in the March 2010 version of the FAA NextGen Implementation Plan (NGIP), NextGen is a transformation of the NAS using 21st century technologies to support aviation’s expected growth. The FAA has identified the trajectory-based operations (TBO) concept as a cornerstone to this transformation. The concept represents a fundamental shift of Air Traffic Management (ATM) from clearance-based control to trajectory-based control of aircraft. However, beyond an initial functional description of TBO developed by the Joint Program Development Office (JPDO) NextGen Aircraft Working Group (AWG), there are many aspects of trajectory operations which lack definition and specificity regarding functional and performance allocations, aircraft/ground systems changes and evolution, airspace design considerations, and air traffic management integration.
Note: This document uses the term Trajectory Operations (TOps) to distinguish it from TBO, which has been used in FAA planning as a solution set and was described initially more broadly in the JPDO NextGen Operational Concept.

TOps is defined as the increasing integration of ANSP systems, aircraft systems and Flight Operation Centers (FOC) around a consistent and coherent view of the trajectory, resulting in an operation environment that supports and enables NextGen objectives. In Trajectory Operations, every aircraft that is operating in or managed by the ANSP is managed through representations of a four-dimensional trajectory (4DT). Every managed aircraft known to the system has a 4DT either provided by the user or derived from a flight plan or type of operation. TOps represent a mid-term implementation strategy to gain capacity and efficiency.

This report provides industry feedback on the FAA’s Mid-Term Operational Scenario document (“Mid-Term Operational Scenario OV-6c Scenarios for NAS Enterprise Architecture”) specifically focusing on the mid-term operational concepts and scenarios including a prioritization of the Operational Improvements (OI’s) contained in the NGIP needed to implement the capabilities.

In establishing the priorities for implementing NGIP OI’s, TOps2 followed the Task Force 5 NextGen Mid-Term Implementation Task Force Report recommendation of leveraging present day equipage to provide beneficial use in the near term as more robust capabilities are developed for the future.

Summary of Key Findings

- 22 of the 26 operational scenarios were selected as being related to Trajectory Operations (TOps). These 22 mid-term operational scenarios reflect the key TOps concepts and capabilities required in the 2018 timeframe.
- All 26 mid-term operational scenarios should be baselined and distributed to the industry. The scenarios should be periodically updated by the FAA as concepts are matured and refined with input from all stakeholders.
- The Task Group has provided a prioritized list of Scenarios (Figure 3 on page 14) and Operational Improvements (Figure 5 on page 16) that support implementation of the scenarios. The potential benefits of TOps are tied directly to the acceleration of the

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1 Concept of Operations for Next Generation Air Transportation System, Version 2.0, 13 June 2007
DataComm program and development of new standards for navigation with particular emphasis on vertical and time performance.

- DataComm is crucial to achieving the maximum benefits from TBO, serving as a basic “building block” for this important NextGen capability. Specific DataComm services, Departure Clearances and Route Clearances are critical to realization of TBO (14 of the 22 TOps related operational scenarios assume that the Departure Clearance and/or Route Clearance service is available).

A key finding of the Task Force 5 report was the need for the industry to leverage current equipment as the transition is made to NextGen operations\(^2\).

  - The FAA should leverage existing airline equipage in demonstration projects\(^3\).
  - Need to close on the Long-Term DataComm business case / Forward Plan
  - Need to finish the DataComm Standards and Advanced Services (SC-214) definitions by scheduled 2013 deadline.

  - **Note:** The assumptions and recommendations regarding specific DataComm-related technologies (FANS, ATN, VDL) will be reviewed and subsequently addressed by the follow-on NAC DataComm Roadmap Task Group developing a report for consideration by the NAC in February 2012.

- TOps2 recommends that trajectory operations begin with the exchange of clearances and transition to dynamic routing as more robust capabilities are developed.
- Enhancements to the navigation capabilities of aircraft, RNAV/RNP with Time of Arrival Control (TOAC) in the descent phase, will begin to increase benefits of TBO through the

\(^2\) The TOps2 Task Group concurs with this finding. According to an analysis by The MITRE Corporation, of the 6653 aircraft in the Part 121 fleet; 772 aircraft are FANS enabled, 2417 are FANS capable, and 2548 (of which 1538 are regional aircraft) are not likely to equip with FANS for cost reasons, but are candidates for ATN Baseline One capabilities. The evolution to data communication operations needs to take advantage of the high level of operators currently equipped with FANS 1/A or FANS 1/A+.

Furthermore, allow Required Communications Performance (RCP) to dictate the viable subnetwork (e.g. VDL Mode 0/A/2).

\(^3\) This recommendation envisions using more than just FANS 1/A+ over VDL mode 2 to relay basic Data Link Communications in continental airspace. The FAA should leverage existing airline equipage during field-testing of new capabilities like the proposed DCL trials to validate concepts and to evaluate the actual performance of legacy equipment.
adaptability of the aircraft trajectory to enable operational predictability and arrival accuracy of aircraft.
  o Need navigation standards activity to define requirements in this area by mid 2013 or early 2014.

- Continuing development of ADS-B functionality will provide improvements to trajectory operations through enhanced surveillance functionality (i.e. aircraft-aircraft intrail, spacing requirements, reduced separation requirements, etc.)
- The TOps2 Task Group supports the efforts of the NAC Equipage Ad Hoc and the Business Case Performance Metrics Work Group analysis of the operational capabilities to close on the DataComm business case.
- There is a continued need to work towards harmonization with SESAR and EUROCAE.

**Scope and Methodology**

The Task Group undertook a series of meetings and conference calls focused on level-setting the team via briefings from subject matter experts on the 26 operational scenarios and their associated OIs.

The overall objectives of these meetings were to:

- Review the FAA’s NextGen Mid-term Concept of Operations for the NAS and associated scenarios (“Overview of Mid-Term Operational OV-6c Scenarios for NAS Enterprise Architecture”) and develop suggested modifications.
- Collect documentation on the benefits of mid-term TOps.
- Identify issues associated with both ground and aircraft based systems and technologies that enable mid-term TOps.
- Map NGIP OIs and Capabilities to mid-term operational scenarios.
- Identify industry's prioritization of NextGen capabilities through prioritization of the operational improvements and operational scenarios.
- Identify how TBO can occur in the mid-term and what elements are necessary for the future.
- Consider SESAR and Eurocontrol initiatives enabling TBO.

**Guiding Principles and Assumptions**

The TOps2 Task Group used the following principles and assumptions in its analysis of the scenarios:
• The FAA’s NGIP from March 2011 was used as the baseline document to identify the operational capabilities and implementation timelines. (The assumption was that the FAA will be able to implement the capabilities according to the time frames in the NGIP.)
• Ground-based separation will be the norm in 2018.
• Varying levels of aircraft communication, navigation and flight management equipage is anticipated in the mid-term and beyond.
• Basic DataComm Functions (R-PDC, CPDLC, Weather Reroutes, Tailored Arrivals) will be deployed. **Note:** The assumptions and recommendations regarding specific DataComm-related technologies (FANS, ATN, VDL) will be reviewed and subsequently addressed by the follow-on NAC DataComm Roadmap Task Group developing a report for consideration by the NAC in February 2012.
  o “Exchange of trajectory information” will be used throughout this document to indicate a progression of capabilities from those of FANS 1/A+ (uplink of route clearances with constraints and downlink of basic clearance requests and projected profile information) over ACARS then VDL mode 2, to the capabilities of SC-214 over ATN. (Uplink of route clearances that can include time constraints precise to seconds and downlink of predicted trajectories using extended projected profiles and downlink of requested route clearances.)
• Aircraft DataComm equipment between now and 2018 will increase to a level that is sufficient to achieve benefits from TOps.
• More automation will help controllers, Traffic Flow Management (TFM) specialists and FOC specialists in conduct of ATM (e.g. en route conflict probe, en route weather reroutes, Time Based Flow Management (TBFM), Collaborative Air Traffic Management (CATM)). Appendix A provides a prioritized list of the Mid-Term OIs and Capabilities.
• More automation will begin to help pilots more accurately control aircraft to predicted trajectories with RNAV/RNP TOAC capabilities enhanced to operate in the descent phase.
• Roles and responsibilities of pilots, controllers and TFM specialists will not change.
• ADS-B Out will be on a subset of the fleet by 2018 and by FAA mandate on all of the fleet performing trajectory operations by 2020.
• Definition of a mid-term capability is that the capability is operational and yielding operational benefits to some operators.

To form the basis for a common understanding, TBO provides separation, sequencing, merging and spacing of flights based on a combination of their current and future positions. TBO operates gate-to-gate, extending benefits to all phases of flight operations. TBO uses the 4DT to both strategically manage and tactically control surface and airborne operations. Aircraft are handled by their trajectory.
The following are some of the key concepts associated with Trajectory Operations:

- Every flight being managed by the ATM system has a 4D trajectory, either provided by the user or derived from a flight plan. Trajectories can be generated by aircraft (fully or partially) or by ground systems using the flight plan. Trajectory management will occur in all phases of flight.
- All changes to flights are reflected in its trajectory (unless it’s a safety critical, tactical change).
- Trajectories will exist from pre-departure to post-flight and can be categorized into the following phases:
  - Pre-negotiation: The user determining the details of their planned flight prior to negotiating with the Air Navigation Service Providers (ANSP).
  - Negotiation: Users negotiate with the ANSP to determine their trajectory – this can occur pre-departure through flight planning systems or during active flight -- either directly between the flight and the ANSP or through the Airline Operations Center (AOC).
  - Agreement: A brief phase when a trajectory is agreed to by the user and the ANSP. If an agreement doesn’t occur, the result is the return to the negotiation phase. If an agreement does occur, the phase changes to the execution.
  - Execution: Phase where a flight is maintaining a cleared trajectory as agreed to with the ANSP. Other than safety-critical maneuvers, all changes to trajectories (whether user initiated or ANSP initiated) will be negotiated and agreed upon.
- Clearances in the mid-term can be provided both through voice and data communications. Data communications will be necessary for more complex clearances, which may lead to more highly equipped aircraft getting better service from the ANSP.
- Open trajectories (i.e. vectoring) will be minimized.
- Aircraft will increasingly be equipped for RNAV/RNP and use satellite based navigation.
- While voice communications will exist, basic digital air-ground data exchange capabilities will exist to allow for exchange of weather data, clearances and 4D Trajectory information.
- Net-enabled systems will exist for the FAA and operators to exchange information in a robust manner.
- ANSP Automation will exist to allow increased capacity, efficiency and safety. Routine controller functions are automated and conflict detection and resolution advisories exist for ground systems. Point in space metering will be in use and supported through time-based metering tools.
**Trajectory Operations Scenarios**

During the initial meetings of the Work Group, the FAA and MITRE briefed the Work Group on the “Mid-Term Operational Scenario OV-6c Scenarios for NAS Enterprise Architecture” document developed by the FAA and MITRE to describe the FAA NextGen mid-term operations.

This document was based on the NextGen Implementation Plan, the FAA NextGen Midterm Concept of Operations for the NAS, the NAS EA Mid-Term Operational Improvements and existing mid-term operational concepts. Based on the substantial work already performed by the FAA and MITRE, the TOps2 Task Group redirected its focus to reviewing and commenting on the FAA/MITRE Operational Scenarios document.

In making its recommendations the TOps2 Task Group considered the 26 Mid-Term Operational OV-6c Scenarios and their underlying Operational Improvements of the NAS Enterprise Architecture that were related to TBO. In reviewing the Mid-Term Operational OV-6c Scenarios it was determined that four of the scenarios did not apply directly to Trajectory Operations and as a result they were removed from consideration for this report (1-Airspace Design, 3- Manage Daily Allocation, 18- Improved Low Visibility Runway Access, 22 – Manage Security Operations).

Each of the Mid-Term Operational OV-6c Scenarios describes how the Operational Improvements could be used in a fully functional NextGen future. The TOps2 Task Group reviewed each of the scenarios from the ANSP, FOC and flight deck perspectives and identified equipment that is in use today, as well as the equipment, common services and operational improvements needed to begin the transition to TBO. In taking this approach, the TOps2 Task Group’s objective was to leverage present day equipage to provide beneficial use in the midterm while enabling a fully functional NextGen future.

The key objectives of the TOps2 Task Group’s review of the FAA/MITRE Scenarios were to address the following questions:

- Are the scenarios comprehensive in the coverage of all of the key aspects of the mid-term operational capabilities related to TOps?
- Do the scenarios reflect the concepts identified in the Task Force 5 recommendation?
- Do the scenarios reflect the concepts identified in the 2010 TOps2 Task Group Scenario document?
- What are the dependencies on the ‘FAAs Enablers’?
- Are there any concerns with the scenarios?
  - Systems, people responsibilities, interactions, policies or procedures.
- What are the essential capabilities that need to be implemented and deployed by 2018 to support initial trajectory-based operations?
Figure 1: TOps2 Reference Documentation -- provides a summary of the key reference documentation used by the TOps2 Task Group and their relationships.
Figure 2: Scenario Mapping to Phase of Flight provides a summary of the operational scenarios and their associated phases of flight.

Figure 3: Prioritization of Scenarios -- shows the operational scenario prioritization results of the TOps2 Task Group.

Members of the committee each had an opportunity to vote as to the relative priority of the perceived benefits, time to implement, importance to accomplishment of trajectory operations and existing capabilities of the aircraft. Each scenario was ranked in priority order and the scenarios were then bucketed into relative priority bins of high, medium and low. This recommendation along with the subsequent prioritization of operational improvements is intended to give the FAA guidance on which operational capabilities and benefits are most important to industry relative to trajectory operations. The prioritization level of Scenarios with the associated OIs may not directly correlate. The scenario prioritization is intended to organize one or more Operational Improvements into an operational thread. The Operational Improvements were ranked independently since they may cut across multiple scenarios that may have different priorities.
Figure 3: Prioritization of Scenarios

<table>
<thead>
<tr>
<th>TOps Relative Priority</th>
<th>TOps TG Score</th>
<th>Scenario Number – Scenario Name</th>
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<td>8-Peak Arrivals</td>
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<td>10-Mixed Environment Operations</td>
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<td>1.2</td>
<td>7- Peak Departures</td>
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<td>9-Separating Aircraft using Trajectories</td>
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<td>14-Merging a Flow</td>
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<td>5-Resolve Congestion</td>
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<td>2-Flight Plan (Feedback)</td>
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<td>26-Separation Management and Resolution Advisories</td>
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<td>13-Delegated Separation Responsibility</td>
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**Operational Improvements Priorities for TBO**

By starting with capabilities that reside on the ground and on a number of today’s aircraft, the TOps2 Task Group worked to identify priorities for implementing operational improvements between now and 2018.
**Figure 4: Operational Improvement Mapping to Phase of Flight** -- provides a summary of all the Trajectory Based Operational related Operational Improvements and their associated phases of flight.

**Figure 5: TOps2 Task Group Prioritization of Operational Improvements for Implementing Scenarios** -- shows a summary of the Operational Improvement prioritization results of the TOps2 Task Group. Members of the committee each had an opportunity to vote as to the relative priority of the perceived benefits, time to implement, importance to accomplishment of trajectory operations and existing capabilities of the aircraft. Each Operational Improvement was ranked in priority order and the Operational Improvements were then bucketed into relative priority bins of high, medium and low. Appendix A provides a more detailed list that provides a description for both the Operational Improvement and Operational Capability.
## Figure 5: TOps Task Group Prioritization of Operational Improvements for Implementing Scenarios

<table>
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<td>108209</td>
<td>Increase Capacity and Efficiency Using Area Navigation (RNAV) and Required Navigation Performance (RNP)</td>
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<td>Use Optimized Profile Descent</td>
<td>OPDs Using RNAV and RNP STARs</td>
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**Legend:**
- **H:** High
- **M:** Medium
- **L:** Low
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<td>105302</td>
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Analysis of Trajectory Operations Scenarios

This section provides an overview of the 26 Mid-Term Operational OV-6c Scenarios and their underlying Operational Improvements of the NAS Enterprise Architecture that were related to TBO. It includes the comprehensive evaluations undertaken by the TOps2 Task Group. These 26 scenarios cover all the phases of the flight including Planning, Airport Surface, Departure, En route, Arrivals and Landing.

Each reviewed scenario includes the following elements:

- Description
- TOps Relative Priority
- Benefits
- Key Operational Improvements/Enablers
- Common Services Dependencies
- TOps Assumptions
- TOps Concepts
- TOps Key Findings
**Scenario 1: Airspace Design**

**Description:** The airspace designer reviews historical and proposed future En Route, transition and airport traffic flows, post-operations analyses, climatological weather patterns, demonstrated NAS user preferences and common airport/special airspace requests. The information gleaned from this integrated analysis is used in the creation of predefined airspace configurations in both the enroute and terminal environments. These configurations are tailored to address anticipated NAS capacity and performance needs and impose structure only as required to optimally manage the NAS under expected weather and congestion conditions.

The TOps2 Task Group reviewed this scenario and determined it did not apply directly to Trajectory Operations and as a result it was removed as a consideration for this report.
Scenario 2: Flight Plan Feedback (with Weather)

**Description:** The flight planner develops flight trajectories with consideration given to business objectives with the benefit of feedback on potential constraints from initial intent to the filed flight plan.

**TOps Relative Priority:** High

**Benefits:**

- Increase access for the smaller flight operators through inclusion to collaborative planning for congested airspace
- End-to-end congestion and complexity impacts are managed to reduce unintended consequences and ripple effects from primary TMIs.
- Users can resolve many, if not a majority, of the potential congestion situations by stating their options for dealing with projected constraints. Flight planning data is known and shared.

**Key Operational Improvements/Enablers:**

- Initial Conflict Resolution Advisories (102114) - **High**
- Continuous Flight Day Evaluation (105302) – **High**
  - With the users collaboratively and continuously assess constraints
  - With the users collaboratively develop mitigation strategies that consider the potential constraints
  - Users and Air Navigation Service Provider (ANSP) dynamically adjust both Predeparture and airborne trajectories in response to anticipated and real-time constraints
- Provide Flight Plan Constraint Evaluation with Feedback (101102) - **High**
  - Constraint information that impacts proposed flight routes is available to users for their pre-departure flight planning
  - Update notifications are provided to filers as anticipated constraints change
  - Users can adjust the flight plan based on available information, submit alternative flight plans or wait for a later time to make adjustments
  - Feedback includes the lists of applicable constraints, conditions driving the constraints, the nature of planned responses and implementation timing
- Initial Integration of Weather Information into NAS Automation and Decision Making (103119) - **Medium**
  - Integrating observation and forecast weather information, to drive automated translation into volumetric characterizations of potential weather constraints
  - This translated information serves as direct input into decision support tools (DSTs) that assess resultant NAS impacts to inform decision making by ANSPs
  - Users will have the option of accessing this constraint information so they can better understand the basis for ANSP decision making
- On-Demand NAS Information (102114) – **High**
Common Service Dependencies:

- Data Comm: Predeparture Clearances, Route Clearances
- Surveillance Common Services: ASDE-X surveillance system and/or ADS-B Out
- Weather Common Services (4-D Weather Data Cube)
- Aeronautical Common Services
- SWIM

TOps Assumptions:

- Mixed Equipment Environment
- User systems for flight planning will operate at multiple levels of sophistication
- Feedback on potential constraints is provided to Flight Planning
  - Days in advance
  - At pre-departure
  - During swap route operations
  - To airborne flight plan changes requests
- The availability of weather Information will increase as 4-D weather cube information becomes available.

TOps Comments:

1. Only FANS 1/A equipped aircraft are capable of participating in this operation today
2. Flight trials for Pre-Departure clearances over FANS 1/A over ACARS are expected to begin in October 2012.
3. Continuous flight plan feedback is provided with specific information on constraints (e.g., weather, congestion, mitigation plans) pertinent to the intended flight. Automated dissemination to flight crew, operations centers, and third-party service providers is supported.
4. SWIM-Users and Air Navigation Service Provider (ANSP) dynamically adjust both real-time departure and airborne trajectories in response to anticipated and real-time constraints

TOps Key Findings:

1. This scenario was identified as a high priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. This scenario can be partially implemented prior to the availability of Data Comm Pre-Departure Clearances and Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits
Scenario 3: Manage Daily Allocation (With Weather)

**Description:** Predefined Parameters allow selection and scheduling of airspace (sector) configuration changes to maintain throughput during weather constraints and other capacity/demand disruptions. This includes pre-coordinating configuration changes that would be used to mitigate potential weather events if they arise.

The TOps2 reviewed this scenario and determined it did not apply directly to Trajectory Operations and as a result it was removed as a consideration for this report.
Scenario 4: Weather Advisories

Description: The user develops flight trajectories and objectives utilizing feedback on potential weather constraints and operational impacts. The weather impact information is developed by Weather Advisories and provided to the user by the flight plan feedback capability. Once in-flight, the pilot is automatically advised, by Weather Advisories, of changes in the weather situation that would impact the planned trajectory, or area of flight in the case of General Aviation (GA).

TOps Relative Priority: Med

Benefits:

- Increase safety due to earlier warning of changes in weather situation
- Information provided that does not require user to interpret and integrate multiple weather sources, leading to improved, consistent decision making
- Users and ANSPs can negotiate strategies for dealing with weather from a common understanding of the weather
- Automated feedback to users on weather situation enables more efficient flight planning, while improving safety
- Increase safety in-flight because pilot is warned of changes in previously communicated weather

Key Operational Improvements/Enablers:

- Provide Full Flight Plan Evaluation with Constraint Feedback (101102) - High
  - The flight planner develops flight trajectories and objectives with the benefit of feedback on potential constraints from initial intent to filed flight plan; Initial Integration of Weather Information into NAS
- Initial Integration of Weather Information into NAS Automation and Decision Making (103119) - Medium
  - Integrating current and forecast weather information into decision support tools (DST) that translate these inputs into weather impacts to inform decision making by users and ANSPs
- On-Demand NAS Information (103305) – Medium & Low

Common Service Dependencies:

- Data Comm: Predeparture Clearances, Route Clearances
- Weather Common Services (4D Weather Cube)
- SWIM

TOps Assumptions:

- Mixed Equipment Environment
- User systems for flight planning will operate at multiple levels of sophistication
- Feed back on potential constraints is provided to Flight Planning
  - Days in advance
  - At pre-departure
  - During swap route operations
  - To airborne flight plan changes requests
- The availability of weather information will increase as 4-D weather cube information becomes available.

**TOps Comments:**

1. Initial Conflict Resolution Advisories (102114) also contributes to this scenario for tactical resolution trajectories.
2. FANS 1/A equipped aircraft are capable of participating in this operation
3. Change in trajectory needs to be coordinated between flight deck, FOC and ATC
4. Full implementation relies on common data sharing (same data) between flight deck, FOC and ATC

**TOps Key Findings:**

1. This scenario was identified as a medium priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. This scenario can be partially implemented prior to the availability of Data Comm Pre-Departure Clearances and Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.
4. FAA should ensure GA aircraft have access to the 4-D weather cube information other than over FANS 1/A+ and/or ATN data links. (103119)
Scenario 5: Resolve Congestion

Description: A traffic management specialist determines when the conditions warrant taking action to resolve congestion and issues flight specific adjustments to alleviate the congestion.

TOps Relative Priority: High

Benefits:

- Capacity and efficiency are increased with less frequent disruptions to individual flight profiles.
- Complex clearances are delivered efficiently to aircraft; instances of verbal miscommunication and frequency congestion are reduced.
- Aircraft are provided more efficient conflict resolutions. Capacity is increased by allowing aircraft to fly closer to the separation minima, while improving safety through more accurate conflict prediction.

Key Operational Improvements/Enablers:

- Traffic Management Initiatives with Flight Specific Trajectories (105208) - High
  - Individual flight-specific trajectory changes resulting from Traffic Management Initiatives (TMI) will be disseminated to the appropriate Air Navigation Service Provider (ANSP) automation for tactical approval and execution. This capability will increase the agility of the NAS to adjust and respond to dynamically changing conditions such as bad weather, congestion, and system outages
- Initial Conflict Resolution Advisories (102114) - Medium

Common Service Dependencies:

- Data Comm: Predeparture Clearance, Route Clearance.
- SWIM

TOps Assumptions:

- This scenario will be conducted in a mixed equipage environment
- User systems for modifying flight planning can operate at multiple levels of sophistication
- Individual flight-specific trajectory changes can be sent to equipped aircraft and FOC

TOps Comments:

1. This Scenario is essential to the FAA Data Communications “Go Button” function.
2. Present day equipage can be leveraged to provide beneficial use in the near term as more robust capabilities are developed for the future.
3. Alternate routing can be based on “Play Book” routes
4. FANS 1/A+ equipped aircraft are capable of participating in this operation.
5. Change in trajectory needs to be coordinated between flight deck, FOC and ATC
6. Full implementation relies on SWIM, ERAM, CTOP capabilities, CACR
7. Full implementation is dependent on Automation and Decision Making (103119)

TOps Key Findings:

1. This scenario was identified as a High priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. This scenario can be partially implemented prior to the availability of Data Comm Pre-Departure Clearances and Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.
Scenario 6: Peak Taxi Demand

Description: This thread demonstrates how surface automation capabilities provide for more efficient means of surface operations. Primary focus is on improved taxi routing and conformance monitoring operations.

TOps Relative Priority: Low

Benefits:

- Throughput and capacity at high-density airports are increased. Schedule integrity is maintained and demand is more accurately predicted.
- Efficiency of airport operations is improved along with increased flexibility in staging arrival and departure flows in and out of high-density airports. This results in shorter departure queues and reduced fuel burn and engine emissions. More timely distribution of weather information results in faster turnaround of the airport due to weather impacts and enhanced safety.

Key Operational Improvements/Enablers:

- Initial Surface Traffic Management (104209) - High, Medium & Low
  - Automation of sequencing and staging of surface traffic, primarily Departure traffic, at high density airports to maintain throughput
- Provide Full Surface Situational Information (102406) - Medium
  - Automated broadcast of aircraft and vehicle position to ground and aircraft sensors/receivers will provide a common digital display of the airport environment to Air Navigation Service Provider (ANSP), equipped aircraft, and Flight Operations Center
- Enhanced Surface Traffic Operations (104207) - High
  - Data communication between aircraft and ANSP will be used to exchange clearances, amendments, requests, NAS status, weather information, and surface movement instructions

Common Service Dependencies:

- Surveillance Common Services: ASDE-X surveillance system and/or ADS-B Out
- Flight Common Services
- SWIM

TOps Assumptions:

- The capability of Aircraft to receive taxi route instruction and clearance delivery via data comm. is post Mid-Term.
- This scenario will be conducted in a mixed equipage environment
- Ground Automation performs surface sequencing

TOps Comments:
1. Ground Automation (DST for surface trajectories) is required to perform sequencing.
2. To be fully implemented, automation will be required to determine off-nominal taxi operations.
3. Non-conformance alerting to the flight crew is delayed when alerting automation only resides on the ground.
4. Non-conformance alerting to the controller cannot rely on cockpit automation.
5. Automation to determine off-nominal taxi operations should reside on the flight deck as well as on the ground.
6. SWIM and Data Comm are used to coordinate clearances, amendments, NAS status, and user requests (Data exchange in terms of surface management applications for FOC's.)
7. Inclusion of elements of CDM Surface sub team concept of operations is a critical component of providing insight into collaborative planning and execution.

TOps Key Findings:

1. The capability to send Data Comm Taxi clearances is post Mid-Term.
2. This scenario was identified as a Low priority scenario.
3. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
4. This scenario can be partially implemented prior to the availability of Data Comm Pre-Departure Clearances and Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.
Scenario 7: Peak Departures

Description: This thread highlights the use of automated collaborative scheduling capabilities and the use of time based metering and RNAV and RNP routes to improve departure operations.

TOps Relative Priority: High

Benefits:

- Throughput and capacity at high-density airports are increased. Schedule integrity is maintained and demand is more accurately predicted.
- Efficiency of airport operations is improved along with increased flexibility in staging arrival and departure flows in and out of high-density airports. This results in shorter departure queues and reduced fuel burn and engine emissions. More timely distribution of weather information results in faster turnaround of the airport due to weather impacts and enhanced safety.
- Efficiency and airport throughput are increased by rapidly adjusting and retransmitting revised departure clearances in response to changing conditions.

Key Operational Improvements/Enablers:

- Initial Surface Traffic Management (104209) – High & Medium
  - Automation of sequencing and staging of surface traffic at high density airports to maintain throughput
- Enhanced Surface Traffic Operations (104207) - High
  - Data communication between aircraft and Air Navigation Service Provider (ANSP) will be used to exchange departure clearances and amendments, requests, NAS status, weather information, and surface movement instructions
- Point in Space Metering (104120) - High
  - Provides greater flexibility in assigning metering fixes in support of Trajectory-based operations and RNAV or RNP, e.g., Setting up a Departure Fix as a resource
- Time-Based Metering Using RNAV and RNP Route Assignments (104123) - High
  - RNAV or RNP departure routes will facilitate accurate arrival at metering fixes thus improving efficient merging into overhead flow
- Integrated Arrival/Departure Airspace Management (104122) – High & Low
  - New airspace configurations and expanded separation standards and procedures provide increased flexibility toward increasing capacity at high volume airports

Common Service Dependencies:

- Data Comm: Predeparture Clearances
- Surveillance Common Services
- Flight Common Services
- Weather Common Services
- Aeronautical Common Services
• Present day use of FANS 1/A over ACARS and FANS 1/A+ over ACARS transitioning to FANS 1/A+ over VDL Mode 2 and SC-214 over ATN.

TOps Assumptions:

• This scenario will be conducted in a mixed equipage environment
• RNAV or RNP routes and procedures begin “off the runway” and are closed (no vector legs) through the TRACON
• Individual flight-specific trajectory changes can be sent to aircraft equipped with Data Comm and RNAV/RNP and the FOC. If the trajectory changes are on defined procedures, then they could be sent via voice.

TOps Comments:

1. Present day equipage can be leveraged to provide beneficial use in the near term as more robust capabilities are developed for the future.
2. Portions of this scenario can be implemented without a fully integrating Point in Space Metering
3. Initial implementation could utilize multiple alternate routes selected from a “Play Book”
4. FANS 1/A equipped aircraft are capable of participating in this operation
5. Change in trajectory needs to be coordinated between flight deck, FOC and ATC
6. Full implementation relies on Time-Based Metering Using RNAV and RNP Route Assignments (104123)
7. Full implementation relies on 4-D weather Cube, TBFM, SWIM, ERAM.
8. Full implementation is dependent on Automation and Decision Making (103119)

TOps Key Findings:

1. This scenario was identified as a High priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. This scenario can be partially implemented prior to the availability of Data Comm Pre-Departure Clearances and Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.
4. Implement the capabilities outlined in this scenario in steps leveraging present day equipage (FANS 1/A and ACARS equipped aircraft); Note: this is being done in the DCIT DCL Flight trials
5. Implement using stored departure “Play Book” routes, transition to Automation and Decision Making as it becomes available.
6. Transition to RNAV routes and procedures as they become available and transition to Required Navigational Performance (RNP) routes and procedures when required
Scenario 8: Peak Arrivals

Description: This scenario describes how peak arrival flows would be managed starting from Top of Descent (ToD) in order to meet a meter fix crossing time (MFT) with greater accuracy while allowing for some flight descent efficiency. This thread incorporates ground-based automation, flight deck capabilities, and data communication to utilize closed-loop maneuvers for enabling descent efficiency and for more accurately meeting the meter fix schedule so that in-trail aircraft spacing beyond the MFT is improved.

TOps Relative Priority: High

Benefits:

- Departure capacity increases. A greater number of routes provide more flexibility to respond to severe weather, traffic, and SAA constraints.
- Aircraft are provided more efficient conflict resolutions. Capacity is increased by allowing aircraft to fly closer to the separation minima, while improving safety through more accurate conflict prediction.

Key Operational Improvements/Enablers:

- Time-Based Metering using RNAV and RNP Route Assignments (104123) : High
  - RNAV and RNP routes improve repeatability and predictability of flight tracks which improves meter fix time schedules
  - Provides alternate routes in transition airspace to a meter fix on a separate path if load balancing is needed
  - Potentially makes new runway assignments
- Increase Capacity and Efficiency using RNAV and RNP (108209) : High & Low
  - Provides the structure for route assignments
  - Enables more efficient aircraft trajectories
- Initial Conflict Resolution Advisories (102114) : High
  - Conflict probe with rank-ordered resolution advisories
    - For aircraft-to-aircraft separation

Common Service Dependencies:

- Data Comm: Predeparture Clearances, Route Clearances, Initial Tailored Arrivals
- Flight Common Services
- Surveillance Common Services : ADS-B
- Weather Common Services
- Aeronautical Common Services
Aircraft Enabler:

- ADS-B Out
- ADS-B In to support FIM-s
- FIM-S
- RNAV/RNP with enhanced TOAC

TOps Assumptions:

- This scenario will be conducted in a mixed Data Comm and ADS-B equipage environment
- Aircraft automation for spacing (FIM-S) may be used selectively (Step 6 in Scenario)
- Aircraft will equip with pairwise Interval Management as the business case allows
- Initial deployment of GIM-S automation will have begun
- Flight deck Interval Management Spacing (FIM-S) could be pilot initiated
- FIM-S spacing instructions can be passed over CPDLC as a Free text message
- A DataComm integrated FMS is required for autoloading complex clearances

TOps Comments:

1. Requires DSTs and automation to support revised trajectories, more precise meter times, and dynamic runway assignments
2. The alternative path maneuvers could begin with voice clearances and could evolve to a non-integrated Data Comm capability and then to integrated Data Comm capabilities with route clearance messages (FANS 1/A+)
3. Multiple arrival procedures with a late merge also would greatly help, but such airspace redesign is likely outside the mid-term.
4. The controller could select an appropriate arrival from a list of stored arrival “Play Book” routes.
5. If TBFM automation takes into account the specific RNAV/RNP procedure and speeds that will be flown beyond the Metering Fix, the adjustments to the aircraft needed after the metering fix could be minimized (DFW Metroplex project currently evaluating this)
6. Transition to GIM Automation and Decision Making as it becomes available.
7. FIM-S may be conducted in pairwise intervals and can be done in a mixed environment

TOps Key Findings:

1. This scenario was identified as a High priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. This scenario can be partially implemented prior to the availability of Data Comm Pre-Departure Clearances and Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.
4. This scenario can be partially implemented without a Data Comm Integrated FMS. However, this scenario is dependent on the availability of this capability to realize the full benefits.
5. Flight Interval Management will be operating in a mixed environment in 2018 limited by the availability of aircraft equipped with ADS-B In and ADS-B out.

6. Elements of scenario can be implemented incrementally and should be implemented as soon as possible
   a. Transition to Time Based Flow Metering as soon as the enhancements become operational
   b. Implement Data Linked arrival trajectories based on stored arrival “Play Book” routes
   c. Transition to Dynamically developed Data Linked arrival trajectories (Non-“Play Book” routes) as Initial Conflict Resolution Advisories (102114) become available.
   d. Implementation of FIM-S can run concurrently with Data Linked arrival trajectories
   e. GIM-S instructions can be passed via FANS 1/A+ over ACARS transitioning to FANS 1/A+ over VDL Mode 2 and SC-214 over ATN.
   f. Although a simple path stretch can be given verbally it is recommended that they be given via data link for aircraft equipped to accept a Data Comm route clearance.
   g. Transition to RNAV routes and procedures as they become available and transition to Required Navigational Performance (RNP) routes and procedures when required

7. Implement the capabilities of this scenario in steps leveraging present day equipage (FANS 1/A+ and ACARS equipped aircraft).

8. Implement using stored arrival “Play Book” routes, transition to Automation and Decision Making as it becomes available.

9. The operational concept using both Ground and Aircraft Internal management needs to be completed.
**Scenario 9: Separating Aircraft using Trajectories**

**Description:** This thread illustrates how 4D trajectories are used for separation in en route operations. The use of trajectories supports automated problem detection and resolution with strategic problem notification. Examples are provided for (1) the use of trajectories in resolving an aircraft-to-aircraft problem detected by the automation and notified to the controller and (2) the use of air-ground data communications by the aircraft to request and be cleared on a user-preferred route during changing weather conditions.

**TOps Relative Priority:** High

**Benefits:**

- Increased predictability allows for increased throughput; conflicting trajectories are known further in advance, improving safety; automation increases controller effectiveness in supporting user preferences
- Automating routine information exchange increases efficiency, reduces instances of verbal miscommunication, allows for delivery of more complex clearances, and reduces frequency congestion
- Aircraft are provided more efficient conflict resolutions. Capacity is increased by allowing aircraft to fly closer to the separation minima, while improving safety through more accurate conflict prediction.

**Key Operational Improvements/Enablers:**

- **Initial Integration of Weather Information into NAS Automation and Decision Making (103119): Medium**
  - Volumetric characterizations of weather-constrained airspace provided to automation, ANSPs, and users to support en route operations
  - Automation translates weather information into potentially constrained airspace (e.g., where pilots may not want to fly)
  - As operationally relevant weather changes occur, updates are automatically pushed, to increase available response time
- **Initial Conflict Resolution Advisories (102114): High**
  - ANSP conflict probe is enhanced to provide rank-ordered resolution advisories
  - Conflict detection, trial planning and resolution automation enable ANSP to better accommodate pilot requests for trajectory changes and tailor clearances to the communications medium
  - Automation probes aircraft-to-aircraft problem resolution advisories against weather constrained airspace to avoid unknowingly directing aircraft into hazardous weather
    - The aim is not to separate aircraft from weather, but rather ensure that ranking takes weather (and other constraints) into consideration
- **Increase Capacity and Efficiency Using RNAV and RNP (108209): High & Low**
- RNAV and RNP enable more efficient aircraft trajectories
- RNAV and RNP permit the flexibility of point-to-point operations and allow for the development of routes, procedures, and approaches that are more efficient and free from constraints and inefficiencies of the ground-based NAVAIDs

**Common Service Dependencies:**

- Data Comm: Route Clearances
- Flight Common Services
- Surveillance Common Services: ADS-B
- Weather Common Services
- Aeronautical Common Services
- SWIM

**TOps Assumptions:**

- Mixed Equipment Environment
- Limited Data Comm (SC-214 over ATN) deployment prior to 2018
- A DataComm integrated FMS is required for autoloading complex clearances
- RNAV/RNP with enhanced TOAC will be more widely available prior to 2018

**TOps Comments:**

1. Uploading directly into the Navigation system (FMS) requires integrated Data Comm. especially for types of resolutions shown if a closed path (non-vector, where turn off, turn back, and rejoin points are defined) is desired.
2. Full operations rely on SWIM, Characterization of weather-constrained airspace (Weather Cube)

**TOps Key Findings:**

1. This scenario was identified as a High priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. This scenario can be partially implemented prior to the availability of Data Comm Pre-Departure Clearances and Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.
4. This scenario can be partially implemented without a Data Comm Integrated FMS. However, this scenario is dependent on the availability of this capability to realize the full benefits.
5. Transition to RNAV routes and procedures as they become available and transition to Required Navigational Performance (RNP) routes and procedures when required.
Scenario 10: Mixed Environment Operations

Description: This thread illustrates complex mixed environment situations requiring automation support for controller situation awareness and separation management. Following a position relieve briefing, a set of near simultaneous events occur which the controller must address. 1) A stream of aircraft is overtaking a set of slower aircraft on the same RNAV Route. 2) Handoff of aircraft in delegated separation 3) Automation detects an aircraft drifting away from its RNP-2 route. 4) Automation detects an aircraft with a planned climb. 5) A traffic management initiative is issued to reroute arrival stream to join alternate RNAV STARs as a result of terminal airspace reconfiguration.

TOps Relative Priority: High

Benefits:

- Increased predictability allows for increased throughput; conflicting trajectories are known further in advance, improving safety; automation increases controller effectiveness in supporting user preferences
- Automating routine information exchange increases efficiency, reduces instances of verbal miscommunication, allows for delivery of more complex clearances, and reduces frequency congestion
- Aircraft are provided more efficient conflict resolutions. Capacity is increased by allowing aircraft to fly closer to the separation minima, while improving safety through more accurate conflict prediction.

Key Operational Improvements/Enablers:

- Automation Support for Separation Management (102137) : Medium & Low
  - ANSP automation provides the controller with tools to manage aircraft in a mixed navigation and wake performance environment
  - ANSP automation enhancements provide situational awareness of aircraft with advanced capabilities (e.g., delegated separation maneuvers, equipped vs. non-equipped aircraft, RNAV, RNP and trajectory flight management)
  - Tools assist controller in coordinating with other facilities or positions when aircraft are performing delegated separation maneuvers
- Initial Conflict Resolution Advisories (102114) : High
  - ANSP conflict probe is enhanced to provide rank-ordered resolution advisories
  - Conflict detection, trial planning and resolution automation enable ANSP to better accommodate pilot requests for trajectory changes and tailor to communication medium
- Increase Capacity and Efficiency Using RNAV and RNP (108209) : High & Low
  - RNAV and RNP enables more efficient aircraft trajectories
- RNAV and RNP permit the flexibility of point-to-point operations and allow for the development of routes, procedures, and approaches that are more efficient and free from constraints and inefficiencies of the ground-based NAVAIDs
- Delegated Responsibility for In-Trail Separation (102118) : **Low**
  - Enhanced surveillance and new procedures enable the ANSP to delegate aircraft-to-aircraft separation
- Traffic Management Initiatives with Flight Specific Trajectories (105208) : **High**
  - Individual flight-specific trajectory changes resulting from Traffic Management Initiatives (TMIs) will be disseminated to the appropriate Air Navigation Service Provider (ANSP) automation for tactical approval and execution

**Common Service Dependencies:**

- Data Comm: Route Clearances
- Surveillance Common Services : ADS-B
- Flight Common Services
- Weather Common Services
- Aeronautical Common Services

**Aircraft Enablers:**

- ADS-B Out
- ADS-B In
- FIM-S
- FIM-DS
- RNAV/RNP with enhanced TOAC

**TOps Assumptions:**

- Mixed Equipment Environment
- A DataComm integrated FMS is required for autoloading complex clearances
- Aircraft automation for Interval Management - Spacing (FIM-S) will be used selectively
- Aircraft automation for Interval Management - Delegated Separation (FIM-DS) will be used selectively
- Aircraft will equip with FIM-S and FIM-DS as the business case allows
- Initial deployment of GIM-S automation will have begun
- FIM-S could be pilot initiated
- The use of FIM-DS will be at controller’s discretion
- Initial FIM-S spacing instructions can be passed over CPDLC as a Free text message
- Initial FIM-DS spacing instructions can be passed over CPDLC as a Free text message

**TOps Comments:**
1. Need to consider certification implications of having many different types of equipage combinations and operations that this equipment must be certified for. In addition to aircraft certification issues, there would also be impacts on the ground automation and controllers to have knowledge of what kind of clearance can be sent to which aircraft depending on equipage. How many different “equipage categories” can realistically be differentiated?

**TOps Key Findings:**

1. This scenario was identified as a High priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. This scenario can be partially implemented prior to the availability of Data Comm Pre-Departure Clearances and Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.
4. This scenario can be partially implemented without a Data Comm Integrated FMS. However, this scenario is dependent on the availability of this capability to realize the full benefits.
5. Flight Interval Management will be operating in a mixed environment in 2018 limited by the availability of aircraft equipped with ADS-B In and ADS-B Out.
6. Transition to RNAV routes and procedures as they become available and transition to Required Navigational Performance (RNP) routes and procedures when required.
Scenario 11: Flight Requests a Change in Flight Plan

Description: A pilot requests a flight change based on weather conditions, which exceed their company operating parameters (e.g., moderate turbulence). Several other flights from the same company and others are on a similar route/altitude. As the sector controller evaluates the pilot’s request and provides clearance, the traffic management coordinator (TMC) prepares for the likely cascade of requests by reviewing how to address the intent options of each.

TOps Relative Priority: Medium

Benefits:

- Routing disruptions from Traffic Management Initiatives (TMIs) are reduced. NAS-wide congestion and capacity impacts are diminished.
- Users can resolve many, if not a majority, of the potential congestion situations by stating their options for dealing with projected constraints. Flight planning data is known and shared.
- End-to-end congestion and complexity impacts are managed to reduce unintended consequences and ripple effects from primary TMIs.
- Efficiency of airport operations is improved along with increased flexibility in staging arrival and departure flows in and out of high-density airports. This results in shorter departure queues and reduced fuel burn and engine emissions. More timely distribution of weather information results in faster turnaround of the airport due to weather impacts and enhanced safety.

Key Operational Improvements/Enablers:

- Initial Integration of Weather Information into NAS Automation and Decision Making (103119) : Medium
  - Integrate weather information and its expected impact on individual 4D trajectories into decision-support tools
  - Provide flow managers with a risk-based tool for strategic decision making
- Continuous Flight Day Evaluation (105302) : High & Medium
  - With the users collaboratively and continuously assess constraints
  - With the users collaboratively develop mitigation strategies that consider the potential constraints
  - Users and Air Navigation Service Provider (ANSP) dynamically adjust both pre-departure and airborne trajectories in response to anticipated and real-time constraints
- On-Demand NAS Information (103305) : Medium & Low
  - NAS and aeronautical information is consistent across applications and locations, and available to authorized subscribers and equipped aircraft
  - Information and updates are obtained in a near real-time and distributed in a user-friendly digital or graphic format.

Common Service Dependencies:
• Data Comm: Predeparture Clearances, Route Clearances
• Flight Common Services
• Weather Common Services (4D Weather Cube)
• Aeronautical Common Services
• SWIM

TOps Assumptions:

• Mixed Equipment Environment
• Users can participate at different levels
• RNAV/RNP with enhanced TOAC will be more widely available prior to 2018

TOps Comments:

1. SWIM and 4D Weather Cube are not required for the pilot to request a flight change based on weather conditions, which exceed their company operating parameters (e.g., moderate turbulence) or compromise safe operation. Related OIs include the following: Initial Integration of Weather Information into NAS Automation and Decision Making (103119), Continuous Flight Day Evaluation (105302), On-Demand NAS Information (103305). They all add value to the basic capability of avoiding the weather.
2. Advanced DSTs are required to incorporate NextGen Network weather
3. SWIM, Data Communications (SC-214 via ATN) and 4D Weather Cube are required to fully implement the operational capabilities in this scenario

TOps Key Findings:

1. This scenario was identified as a Med priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. This scenario can be partially implemented prior to the availability of Data Comm Pre-Departure Clearances and Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.
4. Initial Integration of Weather Information into NAS Automation and Decision Making (103119), Continuous Flight Day Evaluation (105302), On-Demand NAS Information (103305) all add to the robustness of conducting closed loop airborne reroutes enabled by Initial Conflict Resolution Advisories (102114) and Automation Support for Separation Management (102137).
Scenario 12: Precision Approach Operations

Description: This scenario presents the use of an RNAV optimized profile descent (OPD) that begins at an aircraft’s top of descent and transits through low to medium density terminal airspace before merging seamlessly with a Ground Based Augmentation System (GBAS) Category II, precision instrument approach.

TOps Relative Priority: Low

Benefits:

- Fuel efficiency improves, and noise, emissions, and holding are reduced.
- Service to airports is expanded, and airport capacity is increased in IFR through increased availability of precision approaches and efficiency of runway operations.
- Departure capacity increases. A greater number of routes provide more flexibility to respond to severe weather, traffic, and SAA constraints.

Key Operational Improvements/Enablers:

- Use Optimized Profile Descent (104124) : High
  - OPDs permit aircraft to remain at higher altitudes on arrival to the airport and use lower power settings during descent
  - OPD arrival procedures will decrease noise and be more fuel-efficient
- Increase Capacity and Efficiency Using RNAV and RNP (108209) : High & Low
  - Both RNAV and RNP will enable more efficient aircraft trajectories
  - RNAV and RNP combined with airspace changes, increase airspace efficiency and capacity
- Ground Based Augmentation System (GBAS) Precision Approaches (107107) : Low
  - GLS supports precision approaches to Category I/II/III minimums
  - GLS can support approach minimums to all runway ends at an airport with fewer restrictions to surface movement, and offers the potential for curved precision approaches

Common Service Dependencies:

- Data Comm: Route Clearances, Initial Tailored Arrivals
- Flight Common Services
- Surveillance Common Services : ADS-B
- Weather Common Services
- Aeronautical Common Services

TOps Assumptions:

- Mixed Equipment Environment
• Users can participate at different levels
• RNAV/RNP with enhanced TOAC will be more widely available prior to 2018

TOps Comments:

1. Vulnerability of GPS signals is a concern for the implementation of Trajectory Operations.
2. Use of Optimized Profile Descent (104124), Increase Capacity and Efficiency Using RNAV and RNP (108209) and Ground Based Augmentation System (GBAS) Precision Approaches (107107) make Trajectory Operations more robust and can all be elements of trajectory requests or as data link clearances sent to the flight deck.

TOps Key Findings:

1. This scenario was identified as a Low priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. This scenario can be mostly implemented prior to the availability of Data Comm Pre-Departure Clearances and Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.
4. This scenario is dependent on ADS-B, ADS-B in Cockpit Display of Traffic Information (CDTI) and spacing automation for the performing aircraft.
5. The development and implementation of Use Optimized Profile Descent (104124), Increase Capacity and Efficiency Using RNAV and RNP (108209) and Ground Based Augmentation System (GBAS) Precision Approaches (107107) can be done in parallel.
6. Leverage the FANS equipage that the airlines have already invested in by developing Tailored Arrivals that can be converted into Optimized Profile Descents (104124).
Scenario 13: Delegated Separation Responsibility

Description: For appropriately equipped aircraft the controller has the option of delegating responsibility for separation between two aircraft. This thread only illustrates delegated spacing in the en route environment.

TOps Relative Priority: Low

Benefits:

- Delegation of separation responsibility to aircraft reduces the controllers’ workload
- Improve Fuel efficiency

Key Operational Improvements/Enablers:

- Delegated Responsibility for In-Trail Separation (102118) : Low
  - Enhanced surveillance and new procedures enable the controller to delegate aircraft-to-aircraft separation
  - Improved display avionics and broadcast positional data provide detailed traffic situational awareness to the flight deck
  - When authorized by the controller, pilots will implement delegated separation between appropriately equipped aircraft using established procedures
- Initial Conflict Resolution Advisories (102114) : High
  - Conflict detection, trial planning and resolution automation enable ANSP to better accommodate pilot requests for trajectory changes and tailor to communication medium available (ie Voice or Data Comm).

Common Service Dependencies:

- Data Comm: Predeparture Clearances, Route Clearances, Initial Tailored Arrivals
- Flight Common Services
- Surveillance Common Services : ADS-B
- Weather Common Services
- Aeronautical Common Services

Aircraft Enabler:

- ADS-B Out
- ADS-B In

TOps Assumptions:

- Mixed Equipment Environment
  - ADS-B out for the target aircraft
• ADS-B in, Cockpit Display of Traffic Information (CDTI), and spacing automation for the performing aircraft
• Delegation will be at controller’s discretion
• Aircraft capabilities and pilot authorizations are stored in the Flight Object
• Information in the Flight Object is available to the controllers for display
• Delegation will be used for certain flight geometries (e.g. in trail)
• Pilot can accept or reject the delegation
  o Flight deck automation must be capable of supporting the pilot in achieving and maintaining spacing
• SC-214 via ATN will support FIM-DS message sets

TOps Comments:

1. Advanced DSTs are required to implement Delegated Responsibility for In-Trail Separation (102118)

TOps Key Findings:

1. This scenario was identified as a Low priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. This scenario can be partially implemented prior to the availability of Data Comm Pre-Departure Clearances and Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits
4. Flight Interval Management will be operating in a mixed environment in 2018 limited by the availability of aircraft equipped with ADS-B In and ADS-B out.
Scenario 14: Merging a Flow

Description: This scenario describes the TMC’s role to look across multiple sectors (or an Area) to evaluate possible points where flights in one stream can merge into another flow of aircraft. The TMC uses automation support to determine which trajectory modification will allow each aircraft to merge into a gap in the flow, and then sends a problem-checked trial plan for that modification to the Sector Controller for implementation.

TOps Relative Priority: High

Benefits:

- Departure capacity increases. A greater number of routes provide more flexibility to respond to severe weather, traffic, and SAA constraints

Key Operational Improvements/Enablers:

- Point-in-Space Metering (104120): High
  - Decision support tools
    - Allow traffic managers to schedule arrival times for constrained resources
    - Allow controllers to manage aircraft trajectories to meet the scheduled meter times
  - Metering can be associated with a point in space (or arc)
- Time Based Metering Using RNAV and RNP Route Assignments (104123): High
  - Metering automation will manage the flow of aircraft to meter fixes, thus permitting efficient use of runways and airspace
- Automation Support for Separation Management (102137): Medium & Low
  - Controllers have tools that assist them in coordinating with other facilities or positions when aircraft are flying parallel RNAV and RNP routes
- Initial Conflict Resolution Advisories (102114): High
  - Automation recommends trajectories that will fulfill the metering schedule.

Common Service Dependencies:

- Data Comm: Route Clearances
- Flight Common Services
- Weather Common Services
- Aeronautical Common Services

TOps Assumptions:

- Mixed Equipment Environment
• Users can participate at different levels
• RNAV/RNP with enhanced TOAC will be more widely available prior to 2018

TOps Comments:

1. TMC Uses “Go Button” to Issue Trajectories that Satisfy Meter Times
2. Building trajectories to meet the sequence requires accurate trajectory predictor in ERAM and/or TBFM to perform what-iffing of potential trajectories - especially if non level maneuvers are involved in meeting the sequence.
3. RNAV/RNP with TOAC on the aircraft and downlink of 4DT from the aircraft can be used to improve the accuracy of predictions at the merge point
4. Point-in-Space Metering (104120) can be achieved by having the Sector Controller advise the flight of either a new path or time to fly

TOps Key Findings:

1. This scenario was identified as a High priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. This scenario can be partially implemented prior to the availability of Data Comm Pre-Departure Clearances and Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.
Scenario 15: Increased Airport Capacity

Description: This scenario combines new automation support for the controller with advanced avionics and flight deck automation support for the pilot to enable an advanced procedure that allows properly equipped and performance-compatible aircraft to be paired and flown together on a precision path to closely spaced parallel runways at significantly reduced separation standards in reduced visibility conditions.

TOps Relative Priority: Med

Benefits:

- More efficient use of closely spaced parallel runways in IMC conditions decreases delays and operational costs due to weather.

Key Operational Improvements/Enablers:

- Improved Parallel Runway Operations (102144): Low
  - Develop new IFR standards that allow closer runway spacing
  - Maintain access to CSPRs in limited visibility by integrating new aircraft technologies
- Wake Turbulence Mitigation for Departures (WTMD): Wind-Based Wake Procedures (102140): Low
  - Increase departure throughput during favorable wind conditions
  - New technology, standards, and procedures will reduce impact of wake vortices
- Automation Support for Separation Management (102137): Medium & Low
  - Automation tools will assist the controller in a mixed navigation and wake performance environment
  - ANSP automation enhancements will provide situational awareness of aircraft with advanced capabilities

Common Service Dependencies:

- Data Comm: New CPDLC messages to be defined by Interval Management Adhoc Industry Group
- Flight Common Services
- Surveillance Common Services: ADS-B
- Weather Common Services
- Aeronautical Common Services

Aircraft Enabler:

- ADS-B Out
- ADS-B In to support FIM-s
- FIM-S
- RNAV/RNP with enhanced TOAC

**TOps Assumptions:**

- Mixed Equipment Environment
- Delegated separation between paired aircraft is required to mitigate risk
  - Pilot, with automation assistance, is responsible for maintaining paired position
  - Pilot takes avoidance action, when required, based on system alerts and displays

**TOps Comments:**

1. NASA completed and experiment on airborne Interval Management with Spacing to Dependent Parallel Runways in June 2011 using a simulated FANS environment to pass very complex route and spacing instructions.
2. NASA has proposed an Airborne Demonstration by NASA in 2014
3. Controller DSTs are required to support the mixed equipage environment

**TOps Key Findings:**

1. This scenario was identified as a Med priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. This scenario can be partially implemented prior to the availability of Data Comm Pre-Departure Clearances and Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.
4. Flight Interval Management will be operating in a mixed environment in 2018 limited by the availability of aircraft equipped with ADS-B In and ADS-B out.
5. The capabilities of Wake Turbulence Mitigation for Departures (WTMD): Wind-Based Wake Procedures (102140) Operational Improvement can be implemented in steps and early steps should not be delayed.
Scenario 16: Terminal Airspace Re-Configuration

Description: This scenario presents a Big Airspace (BA) environment, during a busy arrival and departure time, when a dynamic severe weather event occurs within the boundary of the BA facility. New processes and capabilities are highlighted that will help to improve the transition to a new terminal airspace configuration.

TOps Relative Priority: High

Benefits:

- Terminal area throughput increases using reduced separation earlier in the arrival sequence.
- Delays are reduced by more efficient route sequencing, more effective weather avoidance, decreased vectoring close to the airport, and reduced coordination between terminal and en route controllers.
- Departure capacity increases. A greater number of routes provide more flexibility to respond to severe weather, traffic, and SAA constraints.

Key Operational Improvements/Enablers:

- Integrated Arrival/Departure Airspace Management (104122) : High & Low
- Continuous Flight Day Evaluation (105302) : High & Med
  - Air Navigation Service Providers (ANSP) and users collaboratively and continuously assess constraints (e.g., hazardous weather) and associated Traffic Management Initiative (TMI) mitigation strategies (see ‘Manage Daily Allocation’ scenario)
- Increased Capacity and Efficiency Using RNAV and Required Navigation Performance (RNP) (108209) : High & Low
  - Terminal and en route procedures will be designed for more efficient spacing and will address complex operations
- Flexible Airspace Management (108206) : Low
  - ANSP automation supports reallocation of trajectory information, surveillance, communications and display information to different positions or different facilities
  - Automated tools to support assessment of alternate configurations and remapping of information to appropriate positions
- Traffic Management Initiatives with Flight Specific Trajectories (105208) : High
  - Individual flight-specific trajectory changes resulting from Traffic Management Initiatives (TMIs) will be disseminated to the appropriate Air Navigation Service Provider (ANSP) automation for tactical approval and execution
- Time Based Metering in the Terminal Environment (104128) : High
  - RNAV and RNP routes improve repeatability and predictability of flight tracks which improves meter fix time schedules
  - Provides alternate routes in transition airspace to a meter fix on a separate path if load balancing is needed
- Potentially makes new runway assignments

Initial Integration of Weather Information into NAS Automation and Decision Making (103119): Medium
- Volumetric characterizations of weather-impacted airspace at and around the airport, along with their probabilities, are provided to assist in planning arrival/departure airspace configurations
- As weather changes occur, updates are pushed to ANSPs, users, and DSTs, to increase available response time
  - Volumetric characterizations of weather constraints are utilized to calculate the impact on active and alternative terminal airspace configurations and RNAV/RNP routings

Initial Conflict Resolution Advisories (102114): High
- Automation enables the Air Navigation Service Provider (ANSP) to better accommodate pilot requests of trajectory changes by providing conflict detection trial flight planning, and development and rank-ordering of resolutions taking into account aircraft capabilities and pilot and ANSP preferences

Time-Based Metering Using RNAV and RNP Route Assignments (104123): High
- The Terminal Radar Approach Control (TRACON) RNAV routes for both Standard Instrument Departures (SIDs) and Standard Terminal Arrival Routes (STARs) will be used to calculate the terminal component of aircraft trajectories

Common Service Dependencies:

- Data Comm: Predeparture Clearances, Route Clearances
- Flight Common Services
- Weather Common Services
- Aeronautical Common Services
- SWIM

TOps Assumptions:

- Mixed Equipment Environment
- Users can participate at different levels
- Easier communication and coordination between terminal, transition sectors, and satellite airports because all are managed by a common control service within a single facility
- RNAV/RNP with enhanced TOAC will be more widely available prior to 2018

TOps Comments:

1. The scenario states, “Airborne traffic (that entered the airspace before the switch) are individually rerouted, as appropriate”. Rerouting could leverage current aircraft equipage by using FANS 1/A+ over VDL Mode 2 and then evolve to SC-214 via ATN)
2. FMS Data Comm integration is required to support the reroutes described in this scenario
3. SWIM and 4D Weather Cube are not required to implement the basic operational capabilities described in this scenario. The basic capabilities can be evolved by adding Initial Integration of Weather Information into NAS Automation and Decision Making (103119), Continuous Flight Day Evaluation (105302), Increased Capacity and Efficiency Using RNAV and Required Navigation Performance (RNP) (108209), Flexible Airspace Management (108206) and On-Demand NAS Information (103305) which all adds value to the basic scenario.

4. Time based metering may be used as a tool to support the flow and reduce controller workload.

5. Advanced DSTs are required to incorporate NextGen Network weather

6. SWIM, Data Communications and 4D Weather Cube are required to fully implement the operational capabilities in this scenario

7. The phrase "mixed equipage" applies to the variation in aircraft configurations as the operational capabilities evolve from present day to fully implemented NextGen operations.

**TOps Key Findings:**

1. This scenario was identified as a High priority scenario.

2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.

3. This scenario can be partially implemented prior to the availability of Data Comm Pre-Departure Clearances and Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.
Scenario 17: Improved Management Arrival, Surface, and Departure Flow

**Description:** The IASDFM scenario describes a set of advanced Arrival/Departure flow management capabilities, integrated with advanced surface operations to improve overall airport and terminal airspace throughput and operational efficiency. The scenario addresses the integration of arrival, surface and departure scheduling, integration of Runway and Airspace re-configuration, and electronic sharing of information and collaboration automation to manage the flow of traffic more efficiently.

**TOps Relative Priority:** Med

**Benefits:**

- Airport flow is improved and schedules are more predictable leading to fewer arrival, departure, and surface delays.
- Improved timing and coordination of airport configuration changes leads to more efficient use of the runways and airspace, more informed stakeholder decisions, and more predictable airport transition times.
- Increased operational productivity due to improved collaboration, and reduced execution time

**Key Operational Improvements/Enablers:**

  - Integrate advanced arrival/departure flow management with advanced surface operations
  - Integrate current flight trajectories, as well as real-time airborne and surface event information into ANSP decision support automation to effectively plan and manage A/S/D flow.
  - Aid collaboration between ANSP flow manager with flight operators and with ANSP controllers to effectively manage HD arrival and departure flows
  - Aid departure scheduling and staging and arrival sequencing based on aircraft wake and airborne performance characteristics using advanced automation

**Common Service Dependencies:**

- Data Comm: Predeparture Clearances, Route Clearances, Initial Tailored Arrivals
- Flight Common Services
- Surveillance Common Services : ASDE-X surveillance system and/or ADS-B Out
- Weather Common Services (4-D Weather Data Cube)
- Aeronautical Common Services
- SWIM

**TOps Assumptions:**
• Mixed Equipment Environment
• Users can participate at different levels

TOps Comments:

1. 4-D Weather Cube, SWIM, DSTs combine to create transparency and allow additional time for modeling and planning trajectories and configurations
2. Operators may share some information that will make the larger system more efficient and maintain capacity subject to competitive and antitrust issues
3. Advanced DSTs are required to incorporate NextGen Network weather
4. SWIM, Data Communications (SC-214 via ATN) and 4D Weather Cube are required to fully implement the operational capabilities in this scenario
5. SWIM-Users and Air Navigation Service Provider (ANSP) dynamically adjust both real-time departure and airborne trajectories in response to anticipated and real-time constraints

TOps Key Findings:

1. This scenario was identified as a Med priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. This scenario can be partially implemented prior to the availability of Data Comm Pre-Departure Clearances and Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.
Scenario 18: Improved Low Visibility Runway Access

**Description:** The scenario includes a set of advanced low visibility capabilities to improve runway access. The capabilities are based primarily on the leveraging of advanced avionics to increase access to runways, primarily those with reduced infrastructure, thereby increasing an airport’s capacity during adverse weather conditions. This scenario addresses operations under nominal, low visibility conditions, typically below standard ceiling and visibility minima, where suitably equipped aircraft can continue to operate. The described operations do not discriminate between low, medium or high density airports, except for the ability of the controller to monitor surface traffic via surface surveillance, such as ASDE-X, a capability currently being implemented at the top 35 OEP airports only.

The TOps2 reviewed this scenario and determined it did not apply directly to Trajectory Operations and as a result it was removed as a consideration for this report.
Scenario 19: Improved Runway Safety Situational Awareness

Description: The scenario includes a set of advanced flight deck, tower and airport capabilities to improve the situational awareness and safety of surface operations for controllers and pilots. The capabilities include the proliferation of surface surveillance to high density airports where highly accurate positions of surface traffic are displayed on an airfield map and decision support tools are integrated to provide enhanced capabilities such as predefined taxi routing and surface conformance monitoring and alerting. Flight deck improvements include moving map displays with own ship position and imbedded digital NOTAMS, the position of proximal traffic, and an alerting function to warn the pilot of the potential for runway incursions. Airport infrastructure improvements include improved surface markings, signage, and most notably the installation of runway status lights at selected locations where traffic density and surface complexity result in the potential for incursions and surface collisions.

TOps Relative Priority: Med

Benefits:

- Surface flow and situational awareness are improved and taxi times reduced in low visibility operations
- Runway safety is improved through increased pilot awareness of the flight’s location on the airport surface and of surface traffic for appropriately equipped aircraft

Key Operational Improvements/Enablers:

- Improved Runway Safety Situational Awareness for Controllers (103207) : Low
  - At large airports, current controller tools provide surface displays and can alert controllers when aircraft taxi into areas where a runway incursion could result. Additional ground based capabilities will be developed to improve runway safety that include expansion of runway surveillance technology (i.e., ASDE-X) to additional airports, deployment of low cost surveillance for medium-sized airports, improved runway markings, and initial controller taxi conformance monitoring capabilities. These ground-based tools will provide a range of capabilities to help improve runway safety for medium to large-sized airports.

- Improve Runway Safety Situational Awareness for Pilots (103208) : Medium & Low
  - Runway safety operations are improved by providing pilots with improved awareness of their location on the airport surface as well as runway incursion alerting capabilities. To help minimize pilot disorientation on the airport surface, a surface moving map display with own-ship position will be available. Both ground-based (e.g., RWSL) and cockpit-based runway incursion alerting capabilities will also be available to alert pilots when it’s unsafe to enter the runway. Additional enhancements may include cockpit display of surface traffic (e.g., vehicles and aircraft) and the use of a cockpit display that depicts the runway environment and displays traffic from the surface up to approximately 1,500
feet above ground level on final approach and will be used by the flight crew to help determine runway occupancy.

- **Enhanced Surface Traffic Operations (104207)**: **High**
  - Data communication between aircraft and ANSP is used to exchange clearances, amendments, and requests. At specified airports, data communications is the principle means of communication between ANSP and equipped aircraft. Terminal automation provides the ability to transmit automated terminal information, departure clearances and amendments, and taxi route instructions via data communications, including hold-short instructions. The taxi route instruction data communication function reduces requests for progressive taxi instructions. Benefits arising from this capability, in conjunction with other NAS investments, include enhanced airport throughput, controller efficiency, enhanced safety, as well as reduced fuel-burn and emissions. At the outset, the current system will be expanded to include provision of initial and revised departure clearances directly to the aircraft. Initial and revised taxi route instructions will be added, replacing today's use of voice to accomplish these activities. As a second step, Aeronautical Telecommunication Network (ATN) based capabilities will be added, replacing much of today's system.

- **Full Surface Traffic Management with Conformance Monitoring (104206)**: **Low**
  
  Note: This is a far-term OI (2018-2024) but the capability of automation to monitor conformance (position and path) of surface operations may begin prior to the end of the mid-term.

  - Efficiency and safety of surface traffic management is increased, with corresponding reduction in environmental impacts, through the use of improved surveillance, automation, on-board displays, and data link of taxi instructions. Equipped aircraft and ground vehicles provide surface traffic information in real time to all parties of interest. A comprehensive view of aggregate traffic flows enables ANSP to project demand; predict, plan, and manage surface movements; and balance runway assignments, facilitating more efficient surface movement and arrival and departure flows. Automation monitors conformance (position and path) of surface operations and updates the estimated departure clearance times. Surface optimization automation includes activities such as runway snow removal, aircraft de-icing, and runway configuration.

**Common Service Dependencies:**

- Surveillance Common Services: ASDE-X and/or ADS-B

**Aircraft Enablers:**

- Moving map displays
- Conformance tracking and alerting
TOps Assumptions:

- Mixed Equipment Environment
- Users can participate at different levels

TOps Comments:

1. The time lines for preventing a taxiway incursion are very short. Having a system that determines there is a problem, alerts the controller, redirects the controllers attention, enable the controller to interpret the problem, form a solution, communicate it to the correct pilots to prevent the incursion is probably not the quickest way of getting the problem solved. Conformance tracking and alerting are needed on the ground and on the flight deck
2. This operational capability needs a Level of ramp controller inclusion in pre planning options to ensure safety situational awareness.
3. Pilot contacts ground controller to receive clearance. This may be issued either by voice or data com for equipped aircraft
4. Conflict probe and Alerting needs to be on the ground and on the flight deck

TOps Key Findings:

1. The operational requirements described in this scenario are important and need to be addressed from a safety perspective.
2. This scenario was identified as a Med priority scenario.
3. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
Scenario 20: Wake Turbulence Mitigation for Arrivals (WTMA)

Description: The WTMA capability provides for reduced separation under the principal operational concept attempting to remove constraints imposed by Closely Spaced Parallel Runways (CSPR). The focus of this scenario is one specific concept, Wake Turbulence Mitigation for Arrivals – System (WTMA-S) allows for reduced separations under specific wind and weather conditions. The concept of operations describes a dynamic wind prediction system-based change applying automation to monitor for available wind conditions. Such conditions ensure wake free operations on one of the parallel runways, thus increasing airport arrival rates during these time periods. This concept is an incremental development beyond a static procedural change, Wake Turbulence Mitigation for Arrivals – Procedure (WTMA-P) dependent only on airport configuration, runway geometry, analysis of historical winds, and aircraft weight class.

TOps Relative Priority: Med

Benefits:

- More efficient use of closely spaced parallel runways in IMC conditions decreases delays and operational costs due to weather.

Key Operational Improvements/Enablers:

- Improved Parallel Runway Operations (102141) : Medium & Low
  - Develop new IFR standards that allow closer runway spacing
  - Maintain access to CSPRs in limited visibility by integrating new aircraft technologies
- Wake Turbulence Mitigation for Arrivals (WTMA): CSPRs (102144) : Low
  - Increase arrival throughput during favorable wind conditions
  - New technology, standards, and procedures will reduce impact of wake separations standards
- Initial Integration of Weather Information into NAS Automation and Decision Making (103119) : Medium
  - Advanced warning of weather condition changes are pushed to both ANSPs and users to assist in timely assessment of operational impacts, enabling a smoother transition into/out WTMA
    - Airport ceiling/visibility, arrival corridor wind profiles, and airport surface winds to determine WTMA
    - Volumetric characterization of convection and strong wind shear constraints that might prohibit WTMA
- Initial Improved Weather Information from Non-ground Based Sensors (103116) : Low
  - Increased availability to real-time altitude profile winds enable by NextGen aircraft-based weather observations
Common Service Dependencies:

- Weather Common Services
- SWIM

TOps Comments:

1. Wake Turbulence Mitigation for Arrivals (WTMA): CSPRs (102144) is a system that will benefit all operators at every airport where the capability is installed and its development should not be encumbered.
2. Controller DSTs are required to support the mixed equipage environment

TOps Assumptions:

- Mixed Equipment Environment

TOps Key Findings:

1. This scenario was identified as a Med priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. The capabilities of Wake Turbulence Mitigation for Departures (WTMD): Wind-Based Wake Procedures (102140) Operational Improvement can be implemented in steps.
**Scenario 21: Incremental Congestion Management**

**Description:** This scenario is an expansion of the “Resolve Congestion” scenario, and will address several methods of incrementally resolving congestion. The scenario will focus on tactical response to congestion about 45-90 minutes in advance of a potential congestion event. In contrast to “resolve congestion” which focused on the flight specific adjustment, this scenario will illustrate incremental adjustments to an aggregate flow in response to shifts in probability a constraint will be needed (e.g., weather degrading or clearing).

**TOps Relative Priority: Low**

**Benefits:**

- Impacts to en Route capacity constraints are minimized by resolving congestion with tailored incremental responses using operator preferences
- Capacity and efficiency are increased with less frequent disruptions to individual flight profiles.
- End-to-end congestion and complexity impacts are managed to reduce unintended consequences and ripple effects from primary TMI s.
- Air Traffic Managers and users make more informed decisions concerning air traffic operations with fewer and less severe disruptions to air traffic

**Key Operational Improvements/Enablers:**

- **Provide Full Flight Plan Constraint Evaluation with Feedback (101102) : High**
  - Constraint information that impacts proposed flight routes is available to users for their pre-departure flight planning
  - Update notifications are provided to filers as anticipated constraints change
  - Users can adjust the flight plan based on available information, submit alternative flight plans or wait for a later time to make adjustments
  - Feedback includes the lists of applicable constraints, conditions driving the constraints, the nature of planned responses and implementation timing
- **Continuous Flight Day Evaluation (105302) : High & Medium**
  - With the users collaboratively and continuously assess constraints
  - With the users collaboratively develop mitigation strategies that consider the potential constraints
  - Users and Air Navigation Service Provider (ANSP) dynamically adjust both pre-departure and airborne trajectories in response to anticipated and real-time constraints
- **Traffic Management Initiatives with Flight Specific Trajectories (105208) : High**
  - Individual flight-specific trajectory changes resulting from Traffic Management Initiatives (TMIs) will be disseminated to the appropriate Air Navigation Service Provider (ANSP) automation for tactical approval and execution. This capability will increase the agility of the NAS to adjust and respond to dynamically changing conditions such as bad weather, congestion, and system outages
• Initial Integration of Weather Information into NAS Automation and Decision Making (103119) :
  Medium
  o Integrate weather information and its expected impact on individual 4D trajectories into
decision-support tools
  o Provide flow managers with a risk-based tool for strategic decision making

Common Service Dependencies:

• Data Comm: Route Clearances
• Flight Common Services
• Weather Common Services
• Aeronautical Common Services
• SWIM

TOps Assumptions:

• Mixed Equipment Environment
• Users can participate at different levels

TOps Comments:

1. TMU-based automation and DSTs used for creating TMI-d­elivered to control positions thru
ERAM/SWIM
2. The scenario should also consider the weather condition moving
3. Needs elements of CACR for En Route constraint resolution and trajectory adjustments.
4. Automation (DSTs) generate trajectory amendments to comply with TMIs
5. Full implementation of the described capabilities requires accurate prediction of convective
weather over 2 hour time horizon that can be digitally read by ANSP/FOC automation
6. SWIM and 4D Weather Cube Provide Full Flight Plan Constraint Evaluation with Feedback
(101102), Continuous Flight Day Evaluation (105302) and Initial Integration of Weather
Information into NAS Automation and Decision Making (103119) are not required to initiate the
basic capabilities of this scenario
7. Initial Integration of Weather Information into NAS Automation and Decision Making (103119),
Continuous Flight Day Evaluation (105302), On-Demand NAS Information (103305) all adds value
to the basic capability of avoiding the weather.
8. SWIM, Data Communications (SC-214 via ATN) and 4D Weather Cube are required to fully
implement the operational capabilities in this scenario

TOps Key Findings:

1. This scenario was identified as a Low priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority
recommendations.
3. This scenario can be partially implemented prior to the availability of Data Comm Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.

4. Initial Integration of Weather Information into NAS Automation and Decision Making (103119), Continuous Flight Day Evaluation (105302), On-Demand NAS Information (103305) all add to the robustness of conducting closed loop airborne reroutes enabled by Traffic Management Initiatives with Flight Specific Trajectories (105208)

5. Implement the capabilities in this scenario in steps leveraging present day equipage evolving from FANS 1/A+ over ACARS transitioning to FANS 1/A+ over VDL Mode 2 and SC-214 via ATN.
Scenario 22: Manage Security Operations

**Description:** Airspace Security is managed in relation to two planning timeframes, one being real-time (tactical), as operational security events occur, and the other being at some time prior to the operational security event (strategic), as pre-negotiated security measures or plans. Security measures can take several forms including: a Security Restricted Airspace which is a volumetric expression of airspace further defined by user access instructions, Flight Risk Levels that describe the security characteristic of a type of flight, and pre-negotiated flight plans for certain flights of interest to the U.S., such as Special Interest Flights, Diplomatic Flights, or flights carrying U.S. key government officials. The scenario illustrates how security measures are strategically planned, coordinated, and implemented, how they are tactically monitored, and how non-compliance to planned measures is detected and responded to in a coordinated manner that reduces the impact to NAS operations. Specific emphasis is focused on evaluating the impact of security measures on the NAS, correlation analysis of operational security events, and the expeditious alerting and coordination of both FAA and other government decision-makers. Three security events are described: a response to a predicted Security Restricted Airspace non-compliance event, a response to a flight plan change request for a Special Interest Flight that modifies the pre-negotiated security instructions, and a response to a non-cooperative track that poses a threat to U.S. infrastructure.

The TOps2 reviewed this scenario and determined it did not apply directly to Trajectory Operations and as a result it was removed as a consideration for this report.
Scenario 23: Flight Planning and Traffic Flow Mitigation for Turbulence Avoidance

Description: To support daily planning efforts, Traffic Managers and Users are provided with characterizations of airspace volumes potentially constrained by turbulence, including an expected time period of occurrence. Users utilize the information to plan their flights, based on company rules for dealing with turbulence. Traffic Management (TM) utilizes the information to anticipate which flights might be impacted, and to plan for any TMIs that may be necessary, based on potential congestion due to turbulence. Users and TM re-route flights as necessary, as the turbulence situation clarifies. These proactive actions result in minimizing the number of tactical actions needed by sector controllers to help pilots deal with turbulence.

TOps Relative Priority: Low

Benefits:

- More efficient contingency fuel planning by users, Increased flight safety, ATM decision and flow mitigation plans are more effective and better reflect user preferences
- Engages users earlier, allowing individual preferences to be honored for trajectory changes, increased flight efficiencies, Reduces delays due to controller workload

Key Operational Improvements/Enablers:

- Initial Integration of Weather Information into NAS Automation and Decision Making (103119) : Medium
  - Volumetric characterizations of weather-impacted airspace at and around the airport, along with their probabilities, are provided to assist in planning arrival/departure airspace configurations
  - As weather changes occur, updates are pushed to ANSPs, users, and DSTs, to increase available response time
    - Volumetric characterizations of weather constraints are utilized to calculate the impact on active and alternative terminal airspace configurations and RNAV/RNP routings
- Initial Improved Weather Information from Non-ground Based Sensors (103116) : Low
  - Sensors on aircraft and satellites provide enhanced real-time weather information, including objective, real-time turbulence data from aircraft
    - Real-time, measured turbulence is described using the parameter called Eddy Dissipation Rate (EDR)
    - Depending on type, speed and weight, each aircraft is affected differently by a given EDR value
    - In general, smaller, lighter aircraft are affected more by a given EDR value than are larger, heavier aircraft
High resolution characterizations of potential weather constraints, informed by aircraft- and satellite-based sensors, enable operators and TM to assess the likely impact of weather on specific flights, airspace or airports, and develop mitigation strategies.

- **Continuous Flight Day Evaluation (105302)**: **High & Medium**
  - With the users collaboratively and continuously assess constraints
  - With the users collaboratively develop mitigation strategies that consider the potential constraints
  - Users and Air Navigation Service Provider (ANSP) dynamically adjust both Predeparture and airborne trajectories in response to anticipated and real-time constraints

- **On-Demand NAS Information (103305)**: **Medium & Low**
  - NAS and aeronautical information is consistent across applications and locations, and available to authorize subscribers and equipped aircraft
  - Information and updates are obtained in a near real-time and distributed in a user-friendly digital or graphic format.

**Common Service Dependencies:**

- Data Comm: Route Clearances
- Flight Common Services
- Weather Common Services
- Aeronautical Common Services
- SWIM

**Aircraft Enablers:**

- Data Communications integrated with the FMS

**TOps Assumptions:**

- Mixed Equipment Environment
- Users can participate at different levels

**TOps Comments:**

1. Turbulence forecasting is an objective prediction of the severity of turbulence an aircraft may encounter. On an aircraft flight deck, turbulence reporting and crew reaction is much more subjective. A flight crew will often request altitude changes in light turbulence if there is a cabin service taking place or their subjective evaluation is different than the exact definition of the turbulence terms.

2. The EDR analysis should remove flight crew subjectivity i.e. Depending on type, speed and weight, each aircraft is affected differently by a given EDR value. In general, smaller, lighter aircraft are affected more by a given EDR value than are larger, heavier aircraft.

3. The word "clearance" should be replaced with "trajectory" in this scenario
4. Observation and forecast weather information is translated into constraints and then integrated into decision support tools designed to calculate expected impacts on individual 4D trajectories and provide TMs with risk-based strategic and tactical solution sets.

5. En Route Data Comm (integrated with FMS) would provide significant flexibility in modifying flight route to avoid turbulence when aircraft is already en route.

**TOps Key Findings:**

1. This scenario was identified as a Low priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. This scenario can be partially implemented prior to the availability of Data Comm Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.
4. The operational use of Initial Improved Weather Information from Non-ground Based Sensors (103116) is dependent on SWIM and the 4D Weather Cube. Other Operational Improvements that bring more immediate value should take priority.
Scenario 24: Time-Based Flow Management (TBFM) in the Terminal Environment

Description: The scenario illustrates capabilities built primarily upon the concept to expand time-based metering into the terminal environment. The set of advancements in automation and operations enable traffic managers in the terminal and en route facilities to strategically coordinate, plan and implement Time-Based Flow Management (TBFM) operations inside the terminal airspace. Decision support tools (DSTs) will be available for TRACON traffic managers and controllers to maintain the TBFM schedule and to make tactical adjustments as necessary.

TOps Relative Priority: Med

Benefits:

- Capacity and efficiency in terminal airspace increases with more structured arrival and departure flows. Maximum use of capacity by maintaining the required sequences and runway assignments for the planned procedures
- Increase safety and operational efficiency by modeling and analyzing future actions
- Better satisfy operational objectives for all critical resources through more seamless execution of time based arrival and departure operations

Key Operational Improvements/Enablers:

- Time-Based Metering in the Terminal Environment (104128) : High
  - Implementation of new de-confliction points inside terminal airspace resulting in metering inside the terminal
  - Automation develops trajectories and allocates time-based slots within the terminal environment resulting in sequence and runway assignments which are displayed to terminal controllers
  - Modeling capabilities in the TMU enable traffic managers to perform trial planning such as changing runway assignments
  - Continuous monitoring of actual operations versus expected TBFM schedules to provide feedback to the traffic managers

- Time Based Metering Using RNAV and RNP Route Assignments (104123) : High
  - Metering automation will manage the flow of aircraft to meter fixes, thus permitting efficient use of runways and airspace
  - Provides alternate routes in transition airspace to a meter fix on a separate path if load balancing is needed

- Integrated Arrival/Departure Airspace Management (104122) : High
  - Extended application of terminal procedures and separation standards allows greater flexibility.

- Improved Parallel Runway Operations (102141) : Medium & Low
  - Develop new IFR standards that allow closer runway spacing
o Maintain access to CSPRs in limited visibility by integrating new aircraft technologies

**Common Service Dependencies:**

- Data Comm: Route Clearances
- Flight Common Services
- Surveillance Common Services: ADS-B
- Weather Common Services
- Aeronautical Common Services
- SWIM

**TOps Assumptions:**

- Mixed Equipment Environment
- RNAV/RNP with enhanced TOAC will be more widely available prior to 2018

**TOps Comments:**

1. The transition to Trajectory Operations should enable greater flexibility in the NAS and not simply automate the current structure of the NAS.
2. Not explicitly mentioned, but DSTs should also be able to speed up aircraft to fill slots instead of only delaying them as is done today.
3. Issues section identifies the question of what percentage of aircraft need to be RNAV equipped to efficiently utilize RNAV routes. Although the use of later merge points as suggested should increase ability to handle mixed equipage.

**TOps Key Findings:**

1. This scenario was identified as a Med priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. This scenario can be partially implemented prior to the availability of Data Comm Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.
4. TBFM operations need to accommodate creation of dynamic routing.
Scenario 25: Oceanic Trajectory Based Operations (TBO)

**Description:** To enable airspace users to flight plan and fly closer to their preferred four-dimensional trajectories (4DT) while in U.S. oceanic airspace, additional data will be shared between ATC and the airlines Flight Operations Center (FOC). The FOC shares and updates their flight intent information with new FAA automation which provides feedback on the likelihood of being able to fly their preferred 4D oceanic trajectory. U.S. oceanic controllers are provided with enhanced decision support tools that will enable oceanic clearances to more closely match the users' preferred (and coordinated) trajectory.

**TOps Relative Priority:** Med

**Benefits:**

- Fuel-efficient trajectories are increasingly common with resultant reductions in flight time, fuel consumption and emissions.
- Users can adhere to preferred trajectories with greater frequency, reducing fuel consumption and increasing overall efficiency.
- Users experience fewer disruptions when entering and exiting oceanic tracks. Preferred trajectories are more common, decreasing flight times, fuel burn, and harmful emissions.

**Key Operational Improvements/Enablers:**

- Oceanic In-Trail Climb and Descent (102108) : **High & Medium**
  - When authorized by the controller, reduced longitudinal spacing can be used to allow aircraft to transition to more efficient altitudes
- Flexible Entry Times for Oceanic Tracks (104102) : **Low**
  - Optimized oceanic entry times to fly more efficient trajectories

**Common Service Dependencies:**

- Data Communications (Evolving from FANS 1/A transitioning to FANS 1/A+ and SC-214)

**Aircraft Enabler:**

- ADS-B Out on most aircraft
- RNAV/RNP with enhanced TOAC

**TOps Assumptions:**

- Mixed Equipment Environment
- Users can participate only if properly equipped

**TOps Comments:**

1. Flight trials began August 2011.
T Ops Key Findings:

1. This scenario was identified as a Med priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. We recommend that if the trials for in-trail climbs and descents via ADS-B & ADS-C prove successful then the FAA move to full implementation.
Scenario 26: Separation Management and Resolution Advisories

Description: This thread illustrates how 4D trajectories are used for separation management in en route operations. The use of trajectories supports automated strategic problem detection and resolution. The scenario depicts issues around having two aircraft in different sectors (Sectors A and B) that have a predicted conflict in a common downstream sector (C). The scenario contains three different situations, including instances when there is another sector (D) between one of the aircraft and the sector where the conflict is predicted to occur. The scenario demonstrates why the sector that is in control of the aircraft receives the problem notification and resolution alternatives. Automation support for controller-to-controller coordination and handoff acceptance are used if necessary. The different processes for issuing the resulting clearance for either voice or via data communications are included.

TOps Relative Priority: High

Benefits:

- Increased predictability allows for increased throughput; conflicting trajectories are known further in advance, improving safety; automation increases controller effectiveness in supporting user preferences.
- Automating routine information exchange increases efficiency, reduces instances of verbal miscommunication, allows for delivery of more complex clearances and reduces congestion.
- Aircraft are provided more efficient conflict resolutions. Capacity is increased by allowing aircraft to fly closer to the separation minima, while improving safety through more accurate conflict prediction.

Key Operational Improvements/Enablers:

- Initial Conflict Resolution Advisories (102114): High
  - ANSP conflict probe is enhanced to provide rank-ordered resolution advisories
  - Conflict detection, trial planning and resolution automation enable ANSP to better accommodate pilot requests for trajectory changes and tailor them to the communication medium

Common Service Dependencies:

- Data Comm: Route Clearances
- Flight Common Services
- Aeronautical Common Services

TOps Assumptions:

- Mixed Equipment Environment
- Users can participate only if properly equipped
- RNAV/RNP with enhanced TOAC will be more widely available prior to 2018
TOps Comments:

1. This capability should be part of the DCIT En Route Flight Trials.
2. VDL-2 Latency is:
   - 1.6 sec average
   - 3.21 sec 90th percentile
   - 5.52 sec 95th percentile
3. Definitions in the ConUse seem to be slightly different than what is described in this scenario.

TOps Key Findings:

1. This scenario was identified as a High priority scenario.
2. This scenario can be implemented in stages according to the Operational Improvement Priority recommendations.
3. This scenario can be partially implemented prior to the availability of Data Comm Route Clearance. However, this scenario is dependent on the availability of these capabilities to realize the full benefits.
4. Implement the capabilities in this scenario in steps leveraging present day equipage evolving from FANS 1/A+ over VDL Mode 2 to SC-214 via ATN.
## Appendix A: Operational Improvement Prioritization Details

<table>
<thead>
<tr>
<th>TOps Relative Priority</th>
<th>TOps Score</th>
<th>NGIP OI #</th>
<th>NGIP OI Name</th>
<th>NGIP OI Description</th>
<th>NGIP Capability</th>
<th>NGIP Capability Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>105208</td>
<td></td>
<td>TMIs with Flight-specific Trajectories</td>
<td>This capability will increase the agility of the NAS to adjust and respond to dynamically changing conditions such as impacting weather, congestion and system outages.</td>
<td>Delivery of Pre-Departure Reroutes to Controllers</td>
<td>This increment will give En Route Automation Modernization (ERAM) additional capabilities to receive amended routes pre-departure and provide updated flight data to the tower.</td>
</tr>
<tr>
<td>1.3</td>
<td>105208</td>
<td></td>
<td>TMIs with Flight-specific Trajectories</td>
<td>This capability will increase the agility of the NAS to adjust and respond to dynamically changing conditions such as impacting weather, congestion and system outages.</td>
<td>Basic Rerouting Capability</td>
<td>This capability is the means by which Traffic Flow Management System (TFMS)-generated reroutes are defined and transmitted via System Wide Information Management (SWIM).</td>
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<tr>
<td>H</td>
<td>104123</td>
<td></td>
<td>Time-based Metering Using RNAV and RNP route Assignment</td>
<td>Area Navigation (RNAV), Required Navigation Performance (RNP) and Time-Based Metering (TBM) provide efficient use of runways and airspace in high-density airport environments. Metering automation will manage the flow of aircraft to meter fixes, thus permitting efficient use of runways and airspace.</td>
<td>Use RNAV Route Data to Calculate Trajectories Used to Conduct TBM Ops</td>
<td>The Terminal Radar Approach Control (TRACON) RNAV routes for both Standard Instrument Departures (SIDs) and Standard Terminal Arrival Routes (STARs) will be used to calculate the terminal component of aircraft trajectories.</td>
</tr>
<tr>
<td>1.4</td>
<td>104124</td>
<td></td>
<td>Use Optimized Profile Descent</td>
<td>Optimized Profile Descents permit aircraft to remain at higher altitudes on arrival to the airport and use lower power settings during descent.</td>
<td>OPDs Using RNAV and RNP STARS</td>
<td>OPD procedures are being implemented as RNAV STARS (eventually as RNP STARS, where necessary) with vertical profiles that are designed to allow aircraft to descend using reduced or even idle thrust settings from the top of descent to points along the downwind or final approach.</td>
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<tr>
<td></td>
<td>104128</td>
<td></td>
<td>Time-based Metering in Terminal Environment</td>
<td>Aircraft are time-based metered inside the terminal environment, enhancing efficiency through the optimal use of terminal airspace and surface capacity. This extends current metering capabilities into the terminal environment and furthers the pursuit of end-to-end metering and trajectory-based operations.</td>
<td>-</td>
<td>Aircraft are time-based metered inside the terminal environment, enhancing efficiency through the optimal use of terminal airspace and surface capacity. This extends current metering capabilities into the terminal environment and furthers the pursuit of end-to-end metering and trajectory-based operations.</td>
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<tr>
<td></td>
<td>104207</td>
<td></td>
<td>Enhanced Surface Traffic Operations</td>
<td>Terminal automation provides the ability to transmit automated terminal information, departure hold-short instructions, clearances and amendments, and taxi route instructions via data communications, including</td>
<td>Revised Departure Clearance via Data Comm</td>
<td>A Revised Departure Clearance (DCL) Data Comm capability will allow the FAA to rapidly issue departure clearance revisions, due to weather or other airspace issues, to one or more aircraft equipped with Future Air Navigation System (FANS) waiting to depart.</td>
</tr>
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<tr>
<td>3.0</td>
<td>108209</td>
<td>Increase Capacity and Efficiency Using Area Navigation (RNAV) and Required Navigation Performance (RNP)</td>
<td>Area Navigation (RNAV) and Required Navigation Performance (RNP) can enable more efficient aircraft trajectories. RNAV and RNP, combined with airspace changes, increase airspace efficiency and capacity.</td>
<td>Relative Position Indicator (RPI)</td>
<td>RPI is a tool that can assist both the controller and traffic management in managing the flow of traffic through a terminal area merge point.</td>
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<tr>
<td>1.5</td>
<td>104209</td>
<td>Initial Surface Traffic Management</td>
<td>Departures are sequenced and staged to maintain throughput. Air Navigation Service Provider (ANSP) automation uses departure-scheduling tools to flow surface traffic at high-density airports.</td>
<td>Scheduling and Sequencing</td>
<td>The capability displays the departure surface sequence and runway queues as a recommendation to the controller to improve throughput. The capability provides Traffic Flow Management (TFM) constraints to tower controllers. The capability provides estimated flight-specific event times necessary to meet the departure surface sequence and schedule. These event times are shared with users.</td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td>108209</td>
<td>Increase Capacity and Efficiency Using Area Navigation (RNAV) and Required Navigation Performance (RNP)</td>
<td>Area Navigation (RNAV) and Required Navigation Performance (RNP) can enable more efficient aircraft trajectories. RNAV and RNP, combined with airspace changes, increase airspace efficiency and capacity.</td>
<td>Transition to PBN Routing for Cruise Operations</td>
<td>This approach augments the conventional NAVAID-based Jet and Victor airways with RNAVs, including Q-routes and T-routes.</td>
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<tr>
<td>1.5</td>
<td>101102</td>
<td>Provide Full Flight Plan Constraint Evaluation</td>
<td>Constraint information that impacts the proposed route of flight is incorporated into ANSP automation, and is available to users</td>
<td>Electronic Negotiations</td>
<td>The Electronic Negotiations increment provides flight planners with information about congestion along their intended routes and proposes flight-specific rerouting.</td>
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<tr>
<td>1.6</td>
<td>102108</td>
<td>Oceanic In-Trail Climb Procedure</td>
<td>Air Navigation Service Provider (ANSP) automation enhancements will take advantage of improved communication, navigation and surveillance coverage in the Oceanic domain. When authorized by the controller, pilots of equipped aircraft use established procedures for climbs and descents.</td>
<td>Automatic Dependent Surveillance-Broadcast (ADS-B) Oceanic ITP and Automation</td>
<td>The ADS-B ITP will enable aircraft equipped with ADS-B and appropriate onboard automation to climb and descend through altitudes where current non-ADS-B separation standards would prevent desired altitude changes.</td>
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</tr>
<tr>
<td>1.6</td>
<td>102114</td>
<td>Initial Conflict Resolution Advisories</td>
<td>Automation enables the Air Navigation Service Provider (ANSP) to better accommodate pilot requests of trajectory changes by providing conflict detection trial flight planning, and development and rank-ordering of resolutions taking into account aircraft capabilities and pilot and ANSP preferences</td>
<td>-</td>
<td>Automation enables the Air Navigation Service Provider (ANSP) to better accommodate trajectory changes by detection trial planning non-ground-based sensors (e.g., 28 n pilot requests for providing conflict detection, flight planning, and development and rank-ordering of resolutions taking into account aircraft capabilities and pilot and ANSP preferences.</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>104120</td>
<td>Point-in-Space Metering</td>
<td>Air Navigation Service Provider (ANSP) uses scheduling tools and trajectory-based operations to assure smooth flow of traffic and increase the efficient use of airspace.</td>
<td>Extended Metering</td>
<td>Will provide flow deconfliction for metered aircraft at the meter reference points (upstream from the meter fixes).</td>
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<tr>
<td>TOps Relative Priority</td>
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<tr>
<td></td>
<td></td>
<td>104122</td>
<td>Integrated Arrival/Departure Airspace Management</td>
<td>New airspace design takes advantage of expanded use of terminal procedures and separation standards. This capability expands the use of terminal separation standards and procedures (e.g., 3 nm, degrees divergence) within the newly defined transition airspace. It extends further into current en route airspace (horizontally and vertically).</td>
<td>-</td>
<td>New airspace design takes advantage of expanded use of terminal procedures and separation standards. This capability expands the use of terminal separation standards and procedures (e.g., 3 nm, degrees divergence) within the newly defined transition airspace. It extends further into current en route airspace (horizontally and vertically).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>104124</td>
<td>Use Optimized Profile Descent</td>
<td>Optimized Profile Descents permit aircraft to remain at higher altitudes on arrival to the airport and use lower power settings during descent.</td>
<td>Initial Tailored Arrivals (ITAs)</td>
<td>ITAs are pre-planned, fixed routings assigned by oceanic air traffic control facilities and sent from the Oceanic Automation System (Ocean21) via data communications to suitably equipped (i.e., FANS 1/A) aircraft as an arrival clearance into coastal airports</td>
</tr>
<tr>
<td></td>
<td>1.7</td>
<td>105302</td>
<td>Continuous Flight Data Evaluations</td>
<td>Continuous (real-time) constraints are provided to Air Navigation Service Provider (ANSP) Traffic management decision-support tools and the National Airspace System (NAS) users.</td>
<td>Enhanced Congestion Prediction</td>
<td>The Enhanced Congestion Prediction increment provides improved capabilities to assess the impact of a set of reroutes on the level of demand and other performance metrics for a point of interest</td>
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<td>108209</td>
<td>Increase Capacity and Efficiency Using Area Navigation (RNAV) and Required Navigation Performance (RNP)</td>
<td>Area Navigation (RNAV) and Required Navigation Performance (RNP) can enable more efficient aircraft trajectories. RNAV and RNP, combined with airspace changes, increase airspace efficiency and capacity.</td>
<td>NextGen En Route Distance Measuring Equipment (DME) Infrastructure</td>
<td>Additional DME coverage over the continental United States is needed to optimize and expand RNAV routes by closing coverage gaps at and above Flight Level 240.</td>
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<td>104209</td>
<td>Initial Surface Traffic Management</td>
<td>Departures are sequenced and staged to maintain throughput. Air Navigation Service Provider (ANSP) automation uses departure-scheduling tools to flow surface traffic at high-density airports.</td>
<td>External Data Exchange</td>
<td>The FAA will establish a data exchange infrastructure as well as integrated decision support tools, standards and processes that rely on agreed-to information exchange among stakeholders</td>
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<td>102108</td>
<td>Oceanic In-Trail Climb Procedure</td>
<td>Air Navigation Service Provider (ANSP) automation enhancements will take advantage of improved communication, navigation and surveillance coverage in the Oceanic domain. When authorized by the controller, pilots of equipped aircraft use established procedures for climbs and descents.</td>
<td>Automatic Dependent Surveillance-Contract (ADS-C) Oceanic Climb/Descent</td>
<td>The ADS-C CDP (previously known as ADS-C In-Trail Procedure (ITP)) is a new concept that allows a properly equipped aircraft (e.g., Future Air Navigation System (FANS) 1/A equipage) to climb or descend through the altitude of another properly equipped aircraft with a reduced longitudinal separation distance (compared with the required longitudinal separation minima for same-track, same-altitude aircraft). This procedure allows more aircraft to reach their preferred altitude</td>
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<td>102137</td>
<td>Automation Support for Separation Management</td>
<td>ANSP automation provides the controller with tools to manage aircraft in a mixed navigation and wake performance environment.</td>
<td>Automation Support for Non-Surveillance Airspace</td>
<td>The en route Automation will provide an indication of possible non-surveillance separation violations using a base set of non-surveillance separation rules. This capability will also utilize electronic flight data, eliminating the need for paper flight strips</td>
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<td>102141</td>
<td>Improved Parallel Runway Operations</td>
<td>This improvement will explore concepts to recover lost capacity through reduced separation standards, increased applications of dependent and independent operations, enabled operations in lower visibility conditions and changes in separation responsibility between air traffic control (ATC) and the flight deck</td>
<td>Additional 7110.308 Airport</td>
<td>This increment provides airports with maximum use of closely spaced parallel runways by authorizing participating aircraft to operate at reduced lateral and longitudinal spacing on dependent, instrument approach procedures to runways with centerline spacing less than 2,500 feet. This increment will expand the application of FAA Order 7110.308 beyond the locations and runway ends already approved.</td>
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<td>103119</td>
<td>Initial Integration of Weather Info into NAS Automation and Decision Making</td>
<td>Advances in weather information content and dissemination provide users and/or their decision support with the ability to identify specific weather impacts on operations (e.g., trajectory management and impacts on specific airframes, arrival/departure planning) to ensure continued safe and efficient flight.</td>
<td>-</td>
<td>Advances in weather information content and dissemination provide users and/or their decision support with the ability to identify specific weather impacts on operations...</td>
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<td>103208</td>
<td>Improved Runway Safety Situational Awareness for Pilots</td>
<td>Runway safety operations are improved by providing pilots with improved awareness of their location on the airport surface as well as runway incursion alerting capabilities. Additional enhancements may include the depiction of other traffic within the airport surface environment</td>
<td>Moving Map with Own-Ship Position</td>
<td>Cockpit displays, for instance Electronic Flight Bags (EFBs), may incorporate airport moving map displays that provide constantly changing views of an airport’s runways, taxiways and structures to help pilots identify the airplane’s location on the surface.</td>
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<td>103305</td>
<td>On-Demand NAS Information</td>
<td>NAS and aeronautical information will be available to users on demand. NAS and aeronautical information is consistent across applications and locations, and available to authorized subscribers and equipped aircraft. Proprietary and security-sensitive information is not shared with unauthorized agencies/individuals.</td>
<td>Provide Improved Flight Planning and In-Flight Advisories for Flight Operations Centers (FOCs)/AOCs</td>
<td>This increment ensures that NAS and aeronautical information is consistent, allowing users to subscribe to and receive the most current information from a single source. Information is collected from ground systems and airborne users (via ground support services), aggregated and provided through system-wide information environment, Data Communications, or other means.</td>
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<td>104117</td>
<td>Improved Arrival, Surface, Departure, Flow Operations</td>
<td>This integrates advanced arrival/departure flow management with advanced surface operation functions to improve overall airport capacity and efficiency.</td>
<td>Integrated Departure/Arrival Capability (IDAC)</td>
<td>Increases NAS efficiency and reduces delays by providing decision-making support capabilities for departure flows. IDAC automates the process of monitoring departure demand and identifying departure slots for tower personnel.</td>
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<td>102108</td>
<td>Oceanic In-Trail Climb Procedure</td>
<td>Air Navigation Service Provider (ANSP) automation enhancements will take advantage of improved communication, navigation and surveillance coverage in the Oceanic domain. When authorized by the controller, pilots of equipped aircraft use established procedures for climbs and descents.</td>
<td>ADS-C Automation for Oceanic CDP</td>
<td>The automation enhancements to Ocean21 include capabilities to allow a controller to select two aircraft and ensure they are eligible for ADS-C CDP, send concurrent on-demand position reports to two aircraft, determine if the minimum separation distance between the two aircraft is greater than the ADS-C CDP separation distance (e.g., greater than 15 nautical miles (nm)), display the ADS-C CDP conflict probe results to a controller, and build an uplink clearance message to the ADS-C CDP requesting aircraft and an uplink traffic advisory message to the blocking aircraft</td>
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<td>102137</td>
<td>Automation Support for Separation Management</td>
<td>ANSP automation provides the controller with tools to manage aircraft in a mixed navigation and wake performance environment.</td>
<td>Aircraft-to-Aircraft Alerts for 3-nm Separation Areas</td>
<td>En route conflict alert will be enhanced to support wake vortex separation requirements in 3-nm separation areas and transition airspace. Problem detection and trial planning capabilities will also be enhanced to support aircraft-to-aircraft alerts in 3-nm separation areas and transition airspace, to include alerts based on wake vortex separation requirements</td>
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<td>Assisted Trial Planning Onto the Radar and Data Consoles</td>
<td>Assisted Trial Planning will be integrated on the en route radar and the data consoles. Integrating this capability into the consoles assists radar controllers in determining possible problem-free flight plan changes without having to use the data consoles to create trial plans. A controller will also be able to use this capability to simultaneously examine the problem status of a set of possible clearances.</td>
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<td>Provide Full Surface Situation Information</td>
<td>Surface Situation Information will complement visual observation of the airport surface. Decision support system algorithms will use enhanced target data to support identification and alerting of those aircraft at risk of runway incursion.</td>
<td>-</td>
<td>Surface Situation Information will complement visual observation of the airport surface. Decision support system algorithms will use enhanced target data to support identification and alerting of those aircraft at risk of runway incursion.</td>
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<td>104209</td>
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<td>Initial Surface Traffic Management</td>
<td>Departures are sequenced and staged to maintain throughput. Air Navigation Service Provider (ANSP) automation uses departure-scheduling tools to flow surface traffic at high-density airports.</td>
<td>Airport Config Mgt</td>
<td>To improve responsiveness and effective use of airport resources, and rapidly coordinate airport configuration changes across multiple ANSP activities, this capability provides automation assistance for setting up, assessing and changing the airport configuration.</td>
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<td>105302</td>
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<td>Continuous Flight Data Evaluations</td>
<td>Continuous (real-time) constraints are provided to Air Navigation Service Provider (ANSP) Traffic management decision-support tools and the National Airspace System (NAS) users.</td>
<td>Automated Congestion Resolution</td>
<td>The Automated Congestion Resolution increment recommends reroutes for flight specific Traffic Management Initiatives (TMIs). This allows the traffic manager to adjust the target parameters and evaluate the required trajectory adjustments</td>
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<td>102137</td>
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<td>Automation Support for Separation Management</td>
<td>ANSP automation provides the controller with tools to manage aircraft in a mixed navigation and wake performance environment.</td>
<td>Wake Vortex Separation Indicator</td>
<td>To support the en route controller in applying wake turbulence separation standards, the radar display will indicate static wake vortex separation requirements for any given pair of aircraft.</td>
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<td>102144</td>
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<td>Wake Turbulence Mitigation for Arrivals: Closely Spaced Parallel Runways (CSPRs)</td>
<td>Changes to wake separation minima are implemented based on measured and predicted airport area winds. Supporting procedures, developed at applicable locations based on analysis of wake measurements and safety, allow more closely spaced arrival operations increasing airport/runway capacity in IMC.</td>
<td>-</td>
<td>Changes to wake separation minima are implemented based on measured and predicted airport area winds. Supporting procedures, developed at applicable locations based on analysis of wake measurements and safety, allow more closely spaced arrival operations increasing airport/runway in IMC</td>
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<td>104122</td>
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<td>Integrated Arrival/Departure Airspace Management</td>
<td>ANSP automation uses ADS-B in non-radar airspace to provide reduced separation and flight following. Improved surveillance enables ANSP to use radar-like separation standards and services</td>
<td>-</td>
<td>Provides an integrated approach to arrival and departure management throughout the major metropolitan airspace by incorporating terminal and transition airspace and procedures into one service volume. • Develop and mature initial automation, surveillance and flight data requirements • Conduct technical transfer of automation, surveillance and flight data requirements • Support airspace design/analysis, transition strategy plans and procedures development for initial selected locations</td>
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<td>104209</td>
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<td>104209</td>
<td>Initial Surface Traffic Management</td>
<td>Departures are sequenced and staged to maintain throughput. Air Navigation Service Provider (ANSP) automation uses departure-scheduling tools to flow surface traffic at high-density airports.</td>
<td>Taxi Routing</td>
<td>For improved taxi route efficiency, this capability provides dynamic information on airport taxiways and runways integrated with controller displays.</td>
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<td>108209</td>
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<td>108209</td>
<td>Increase Capacity and Efficiency Using Area Navigation (RNAV) and Required Navigation Performance (RNP)</td>
<td>Area Navigation (RNAV) and Required Navigation Performance (RNP) can enable more efficient aircraft trajectories. RNAV and RNP, combined with airspace changes, increase airspace efficiency and capacity.</td>
<td>FMC Route Offset</td>
<td>Automation provides controllers with support to amend an aircraft’s flight plan to indicate that it has been placed on, or has been taken off, a Flight Management Computer (FMC) lateral offset.</td>
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<td>104102</td>
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<td>104102</td>
<td>Flexible Entry Times for Oceanic Tracks</td>
<td>Optimized oceanic entry times to fly more efficient trajectories</td>
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<td>102140</td>
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<td>102140</td>
<td>Wake Turbulence Mitigation for Departures (WTMD): Wind-Based Wake Procedures</td>
<td>Procedures are developed at applicable locations based on the results of analysis of wake measurements and safety analysis using wake modeling and visualization. During peak demand periods, these procedures allow airports to maintain airport departure throughput during favorable wind conditions.</td>
<td>WTMD</td>
<td>Procedures are developed through analysis of wake measurements and safety analysis using wake modeling and visualization. During peak demand periods, these procedures allow airports to maintain airport departure throughput during favorable wind conditions. A staged implementation of changes in procedures and standards, as well as the implementation of new technology, will safely reduce the impact of wake vortices on operations. This reduction applies to specific types of aircraft and is based on wind blowing an aircraft’s wake away from the parallel runway’s operating area.</td>
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<td>103208</td>
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<td>103208</td>
<td>Improved Runway Safety Situational Awareness for Pilots</td>
<td>Runway safety operations are improved by providing pilots with improved awareness of their location on the airport surface as well as runway incursion alerting capabilities. Additional enhancements may include the depiction of other traffic within the airport surface environment</td>
<td>CDTI with TIS-B and ADS-B for Surface</td>
<td>Surface traffic information for moving map displays is available via TIS-B and from aircraft operating with approved ADS-B capability. Using TIS-B and ADS-B, CDTI will provide a graphical depiction of ground and air traffic, which will improve situational awareness for a variety of operations.</td>
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<td>102118</td>
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<td>102118</td>
<td>Delegated Responsibility for In-Trail Separation</td>
<td>Enhanced surveillance and new procedures enable the ANSP to delegate aircraft-to-aircraft separation. Improved display avionics and broadcast positional data provide detailed traffic situational awareness to the flight deck. When authorized by controller, pilots will implement delegated separation between equipped aircraft using established procedures.</td>
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<td>103207</td>
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<td>Improved Runway Safety Situational Awareness for Controllers</td>
<td>At large airports, current controller tools provide surface displays and can alert controllers when aircraft taxi into areas where a runway incursion could result. Additional ground based capabilities will be developed to improve runway safety that include expansion of runway surveillance technology (i.e., Airport Surface Detection Equipment-Model X (ASDEX)) to additional airports.</td>
<td>ASDE-X to Additional Airports</td>
<td>This increment enables air traffic control (ATC) to detect potential runway conflicts by providing detailed coverage of movement on runways and taxiways.</td>
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<td>107107</td>
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<td>Ground Based Augmentation System (GBAS) Precision Approaches</td>
<td>GBAS support precision approaches to Category I and eventually Category II/III minimums, for properly equipped runways and aircraft GBAS can support approach minimums at airports with fewer restrictions to surface movement, and offers the potential for curved precision approaches. GBAS also can support high-integrity surface movement requirements.</td>
<td>GBAS Cat II/III</td>
<td>ICAO-compliant standards for operational use of GBAS Category II/III systems will be published by 2015.</td>
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<td>104206</td>
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<td>Full Surface Traffic Management with Conformance Monitoring</td>
<td>o Efficiency and safety of surface traffic management is increased, with corresponding reduction in environmental impacts, through the use of improved surveillance, automation, on-board displays, and data link of taxi instructions. Equipped aircraft and ground vehicles provide surface traffic information in real time to all parties of interest. A comprehensive view of aggregate traffic flows enables ANSP to project demand; predict, plan, and manage surface movements; and balance runway assignments, facilitating more efficient surface movement and arrival and departure flows. Automation monitors conformance (position and path) of surface operations and updates the estimated departure clearance times. Surface optimization automation includes activities such as runway snow removal, aircraft de-icing, and runway configuration.</td>
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<td>Improved Parallel Runway Operations</td>
<td>This improvement will explore concepts to recover lost capacity through reduced separation standards, increased applications of dependent and independent operations, enabled operations in lower visibility conditions and changes in separation responsibility between air traffic control (ATC) and the flight deck</td>
<td>Amend Independent and Dependent Runway Standards in Order 7110.65 (Including Blunder Model Analysis)</td>
<td>This increment amends runway spacing standards to achieve increased access to parallel runways with centerline spacing less than 4,300 feet and implements this change at approved locations.</td>
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<td>On-Demand NAS Information</td>
<td>NAS and aeronautical information will be available to users on demand. NAS and aeronautical information is consistent across applications and locations, and available to authorized subscribers and equipped aircraft. Proprietary and security-sensitive information is not shared with unauthorized agencies/individuals.</td>
<td>Provide NAS Status via Digital Notice to Airmen (NOTAMS)</td>
<td>This increment enables the issuance of Digital NOTAMs for those airspace constraints affecting a flight based on its trajectory. The initial implementation includes internal distribution within ANSP of those notices that would be distributed via the Flight Information Services-Broadcast (FIS-B) service.</td>
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<td>Increase Capacity and Efficiency Using Area Navigation (RNAV) and Required Navigation Performance (RNP)</td>
<td>Area Navigation (RNAV) and Required Navigation Performance (RNP) can enable more efficient aircraft trajectories. RNAV and RNP, combined with airspace changes, increase airspace efficiency and capacity.</td>
<td>Automated Terminal Proximity Alert (ATPA)</td>
<td>ATPA is an air traffic control (ATC) automation tool that provides situational awareness and alerts to controllers on color displays of Common Automated Radar Terminal System (CARTS) and on Standard Terminal Automation Replacement System (STARS) displays</td>
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<td>Initial Improved Weather Info from Non-Ground-based Sensors</td>
<td>Additions to the sensor network from non ground-based sensors (e.g., satellite and aircraft) provide operators and the ANSP with enhanced weather information to improve flight and clearance planning, trajectory-based operations and flow management.</td>
<td>-</td>
<td>Additions to the sensor network from non ground-based sensors, e.g., satellite and aircraft) provide operators and the ANSP with enhanced weather information to improve flight and clearance planning, trajectory-based operations and flow management.</td>
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<tr>
<td>Ground Based Augmentation System (GBAS) Precision Approaches</td>
<td>GBAS support precision approaches to Category I and eventually Category II/III minimums, for properly equipped runways and aircraft GBAS can support approach minimums at airports with fewer restrictions to surface movement, and offers the potential for curved precision approaches. GBAS also can support high-integrity surface movement requirements.</td>
<td>GBAS Cat I Non-Federal Approval</td>
<td>GBAS Category I is being implemented as a non-federal system on a per-airport request basis</td>
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<td>Flexible Airspace Management</td>
<td>ANSP automation supports reallocation of trajectory information, surveillance, communications, and display information to different positions or different facilities</td>
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<td>ANSP automation supports reallocation of trajectory information, surveillance, communications, and display information to different positions or different facilities • Develop ARMS evaluation model • Conduct demonstration of ARMS prototype</td>
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<tr>
<td>On-Demand NAS Information</td>
<td>NAS and aeronautical information will be available to users on demand. NAS and aeronautical information is consistent across applications and locations, and available to authorized subscribers and equipped aircraft. Proprietary and security-sensitive information is not shared with unauthorized agencies/individuals.</td>
<td>Airport Data Management, Digital Notices to Airmen (NOTAMS)</td>
<td>This increment provides nationwide service coverage to deliver Traffic Information Services-Broadcast (TIS-B) for both Universal Access Transceiver (UAT) and 1090 MHz Mode S Extended Squitter (1090 ES)</td>
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<td>102141</td>
<td>Improved Parallel Runway Operations</td>
<td>This improvement will explore concepts to recover lost capacity through reduced separation standards, increased applications of dependent and independent operations, enabled operations in lower visibility conditions and changes in separation responsibility between air traffic control (ATC) and the flight deck</td>
<td>Implement SATNAV or ILS for Parallel Runway Ops</td>
<td>This increment will enable policy, standards and procedures to allow use of Satellite Navigation (SATNAV) or Instrument Landing System (ILS) when conducting simultaneous independent and dependent instrument approaches, and implement this new capability at approved locations.</td>
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<td>Wake Turbulence Mitigation for Arrivals-Procedures (WTMA-P) for Heavy/757 Aircraft</td>
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<td>This increment expands the use of procedural dependent staggered approach separation to allow Boeing 757 and heavy aircraft to lead this procedure.</td>
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Appendix B: Task Force 5 Supported Elements

Capability: CATM-TBO Then 4D (OI#8)

Description: Implement and use trajectory-based individual flight planning (e.g., a series of waypoints defining a wind-based, RNAV and RNP or NRS-based trajectory, beyond the current airways system and TBFM) for the best routing available within the context of the day's operations. The trajectory (4D including time/TBFM) is able to be designed to optimize routes and throughput from both an ANSP and operator standpoint, and to reduce miles, emissions, and fuel carriage. A major new enabler is that the operator is able to use more advanced and dynamic flight planning tools to develop the most efficient flight plan. If constraints impact a requested route the customer and ANSP will use electronic negotiation to identify and collaborative on mitigation strategies (route or time). Customer will have a more flexible regulatory framework (e.g., the ability to submit the plan electronically and receive electronic feedback from the ANSP standpoint.) Use TBFM/metering, and merging and spacing tools to allow users and the service provider to negotiate trajectories prior to departure, during en route flight, and during arrival transition to maximize flight efficiency and mitigate system constraints. This builds on TFM Common and assumes Common will be in place. Benefits are therefore incremental (over and above) what are achieved with TFM Common

Capability: DC Reroutes (OI#16)

Description: Convective weather causes many delays in today's system due to the labor-intensive voice exchanges of complex reroutes. New data communications automation will enable significantly faster and more efficient delivery of reroutes around convective weather. This operational improvement will expedite clearance delivery resulting in reduce delays and miles flow during convective weather. Equipage with FANS or ATN with VDL-2 is required to enable this operation.

Capability: Data Comm Routine Communications (OI#17)

Description: Delivery of routine communications via data enables greater sector capacity and throughput. Both FAA and Europe have conducted numerous studies that show significant capacity benefits resulting from data communications basic services. Projected benefits include increased throughput and reduced delays resulting in fewer miles flown and greater on time performance. Equipage with FANS or ATN with VDL-2 is required to enable this operation.

Capability: MMS FDMS (OI#23)

Description: Improve Arrival Metering, Merging and Spacing through Flight Deck Merging and Spacing en route to final approach. From Top of Descent to Landing, maximize traffic flow and enhance dependability of on-time arrival. Optimize queues for flight efficiency and improved predictability.

Capability: Reroutes Weather in Cockpit (OI#31)
**Description:** Enable Aircraft-based Preferential Reroutes, away from the operational structure of the "playbook", to reduce miles flown for suitably equipped aircraft (using new uplinked Graphical Weather & Display)

**Capability:** Separation (MVMC/IMC CAS) (OI#26)

**Description:** Reduce Final Approach (and departure) Spacing in MVMC/IMC by delegating spacing (and separation) to the flight deck on final approach and departure (ADS-B in CDTI assisted visual separation), maintain VMC spacing in IMC conditions. For this assessment, scoring interim step includes a portion of approach segment in IMC terminating in VMC. Not scored is an evolution of this capability which terminates in IMC.

**Capability:** SAA (OI#35)

**Description:** Enable more comprehensive utilization of SAA through real time data exchange to allow for optimized flight planning and utilization both strategically and tactically. Current procedures regarding SAA availability are primarily based on a number of sources that mostly involve manual management and status information sharing processes. NAS stakeholders require technology that facilitates data exchange between DOD, ANSP’s, and AOC/FOC’s that will allow for SAA status schedules to be readily available. Additionally, technologies need to be enabled that offer the ANSP opportunities to monitor, evaluate, collaborate with stakeholders (including SAA users), and mitigate SAA constraints based on real time knowledge of availability along the entire route of flight. Added technologies are required that will allow for schedules to be included in flight plan development.

**Capability:** Revised Departure Clearance (OI#39)

**Description:** Currently departure clearances are delivered digitally today. However, revisions are often needed to the departure clearance and need to given manually by voice. This can cause significant delays due to the length of the clearance and the time it takes the controller to issue it to the pilot. Delivery of revised Departure Clearances via data communications will greatly reduce the time and effort needed to issue the clearance. Expected benefits are reduced ground delays and improved system flexibility, especially during bad weather when many revised departure clearances are needed.

*Equipage with FANS or ATN with VDL-2 is required to enable this operation. It’s possible that FANS may be used with ACARS to perform this operation.*

**Capability:** Tailored Arrivals (OI#42)

**Description:** Using FANS, tailor and send arrival procedures to suitably equipped aircraft. Leverage existing FANS capability in the ATOP system at oceanic ATC facilities to conduct these procedures at coastal airports like San Francisco and Miami: (a) TAs at coastal airports where airspace and traffic permit; (b) TAs at internal NAS airports where airspace and traffic permit.

**Capability:** TFM Common (OI#43)
Description: Improved FAA Stakeholders collaborative decision making (CDM) involvement from pre-planning, to execution, to post execution concerning TFM/ATM. Improvements facilitated by an improved Common Operational Picture (COP). Empowered by common displays and shared operational data.

Capability: TFM Data Comm (OI#44)

Description: The combination of data communications with ground automation is expected to yield significant benefits to airspace users. This capability will leverage CDM/TFM collaboration and automation to ensure airspace user preferences are accommodated quickly and efficiently via data communications delivery of routes. Expected benefits include better accommodation of user preferences, increased throughput and reduced delays resulting in fewer miles flown and greater on time performance.

Capability: Data Comm Reroutes (OI#16)

Description: Convective weather causes many delays in today’s system due to the labor intensive voice exchanges of complex reroutes. New data communications automation will enable significantly faster and more efficient delivery of reroutes around convective weather. This operational improvement will expedite clearance delivery resulting in reduce delays and miles flow during convective weather. Equipage with FANS or ATN with VDL-2 is required to enable this operation.
### Appendix C: Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>4DT</td>
<td>Four Dimensional Trajectory</td>
</tr>
<tr>
<td>ADS-B</td>
<td>Automatic Dependent Surveillance-Broadcast</td>
</tr>
<tr>
<td>AGD</td>
<td>ADS-B Guidance Display</td>
</tr>
<tr>
<td>ANP</td>
<td>Actual Navigation Performance</td>
</tr>
<tr>
<td>ANSP</td>
<td>Air Navigation Service Provider</td>
</tr>
<tr>
<td>AOC</td>
<td>Airline Operations Center</td>
</tr>
<tr>
<td>ASDE-X</td>
<td>Airport Surface Detection Equipment – Model X</td>
</tr>
<tr>
<td>ATM</td>
<td>Air Traffic Management</td>
</tr>
<tr>
<td>ATN</td>
<td>Aeronautical Telecommunications Network</td>
</tr>
<tr>
<td>BA</td>
<td>Big Airspace</td>
</tr>
<tr>
<td>CACR</td>
<td>Collaborative Airspace Constraint Resolution</td>
</tr>
<tr>
<td>CATM</td>
<td>Collaborative Air Traffic Management</td>
</tr>
<tr>
<td>CSPR</td>
<td>Closely-Spaced Parallel Runway</td>
</tr>
<tr>
<td>ERAM</td>
<td>En Route Automation Modernization</td>
</tr>
<tr>
<td>FANS</td>
<td>Future Air Navigation System</td>
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<tr>
<td>FMS</td>
<td>Flight Management System</td>
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<tr>
<td>FOC</td>
<td>Flight Operations Center</td>
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<tr>
<td>GA</td>
<td>General Aviation</td>
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<tr>
<td>GBAS</td>
<td>Ground-Based Augmentation System</td>
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<tr>
<td>GLS</td>
<td>GNSS Landing System</td>
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<tr>
<td>GNSS</td>
<td>Global Navigation Satellite System</td>
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<tr>
<td>ICAO</td>
<td>International Civil Aviation Organization</td>
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<tr>
<td>IMC</td>
<td>Instrument Meteorological Conditions</td>
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<tr>
<td>Acronym</td>
<td>Definition</td>
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<tr>
<td>JPDO</td>
<td>Joint Program and Development Office</td>
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<tr>
<td>LAAS</td>
<td>Local Area Augmentation System</td>
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<tr>
<td>NAS</td>
<td>National Airspace System</td>
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<tr>
<td>NextGen</td>
<td>Next Generation Air Transportation System</td>
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<tr>
<td>OI</td>
<td>Operational Improvement</td>
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<tr>
<td>OPD</td>
<td>Optimized Profile Descent</td>
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<tr>
<td>RNAV</td>
<td>Area Navigation</td>
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<tr>
<td>RNP</td>
<td>Required Navigation Performance</td>
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<tr>
<td>RTA</td>
<td>Required Time of Arrival</td>
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<tr>
<td>RVR</td>
<td>Runway Visual Range</td>
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<tr>
<td>SAA</td>
<td>Special Activity Airspace</td>
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<tr>
<td>SBS</td>
<td>Surveillance and Broadcast Services</td>
</tr>
<tr>
<td>STBO</td>
<td>Surface Trajectory-Based Operations</td>
</tr>
<tr>
<td>SWIM</td>
<td>System-Wide Information Management</td>
</tr>
<tr>
<td>TBO</td>
<td>Trajectory-Based Operations</td>
</tr>
<tr>
<td>TMI</td>
<td>Traffic Management Initiative</td>
</tr>
<tr>
<td>TOps</td>
<td>Trajectory Operations</td>
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<tr>
<td>VNAV</td>
<td>Vertical Navigation</td>
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<tr>
<td>WTMD</td>
<td>Wake Turbulence Mitigation for Departures</td>
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Appendix D: Definitions

Definition of Trajectory Operations

An aircraft trajectory is a representation of the planned or actual flown route in four (4) dimensions (latitude, longitude, altitude and time), with discrete points defined along that route. The granularity of the representation of the flight trajectory depends on the intended use of that information, and may not necessarily include all four dimensions. In its most basic form, a trajectory used by some planning activities may require only a departure airport and time and arrival airport and time (excluding any vertical dimension).

The 4D Trajectory Defined

The flight trajectory is really a 4D trajectory that describes the path of the aircraft through all four dimensions – latitude, longitude, altitude and time. While the actual trajectory is known after it is flown, there is always some uncertainty with respect to the aircraft execution of the intended trajectory. The management of this uncertainty can be improved by maintaining coherent and consistent views of the trajectory in the various systems. This allows all participants to have a coherent representation of the trajectory at any point in time which reflects the latest flight plan, aircraft information, constraints or clearances that are relevant to the use of that trajectory.

The level of detail in a trajectory view will vary depending on the aircraft capability and type of operation. One fairly complete view of the intended trajectory might consist of the desired trajectory parameters which reflect the operator business objectives along with agreed ATM constraints and the actual trajectory (for the portion of the flight that has been completed). Some additional views are described below to clarify the trajectory concept.

Optimized Profile Descent Applications

Optimized profile descents (OPDs) can be accomplished on RNAV or RNP arrivals, with the aircraft optimizing the descent within the pre-published, or negotiated and agreed, vertical constraints. However, an RNAV or RNP procedure alone does not provide the controller sufficient knowledge of the arrival time of the aircraft at merge points, nor the aircraft’s speed profile. Thus, in today’s environment controllers are unable to permit OPDs under moderate or heavy traffic conditions due to the uncertainties associated with the aircraft’s trajectory (in the vertical and time dimensions).

If the ANSP can expect adherence (within the required performance) to the trajectory, then increased use of Optimized Profile Descents (OPDs) may be achieved within the overall operations
### Appendix E: TOps2 Membership

<table>
<thead>
<tr>
<th>First Name</th>
<th>Last Name</th>
<th>Company</th>
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<tbody>
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<td>Alexander</td>
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<td>Barber</td>
<td>Garmin</td>
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<td>Joe</td>
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<td>JetBlue Airways</td>
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<td>Andy</td>
<td>Cebula</td>
<td>RTCA, Inc.</td>
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<tr>
<td>Sarah</td>
<td>Dalton</td>
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<td>Mike</td>
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<td>Pascal</td>
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<td>Joel</td>
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<td>Jon</td>
<td>Pendleton</td>
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</tr>
<tr>
<td>Rick</td>
<td>Shay</td>
<td>United Continental Holdings</td>
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<tr>
<td>David</td>
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<td>Brian</td>
<td>Townsend</td>
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<td>Bryan</td>
<td>Will</td>
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</tbody>
</table>

The following is the list of FAA and MITRE representatives supporting the TOps2 Task Group:

<table>
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<th>Last Name</th>
<th>Company</th>
</tr>
</thead>
<tbody>
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<td>Joe</td>
<td>Celio</td>
<td>The MITRE Corporation</td>
</tr>
<tr>
<td>John</td>
<td>Glassley</td>
<td>Federal Aviation Administration</td>
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<td>Joshua</td>
<td>Gustin</td>
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<td>Jarrett</td>
<td>Larrow</td>
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<td>Michele</td>
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<tr>
<td>Pat</td>
<td>Somersall</td>
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