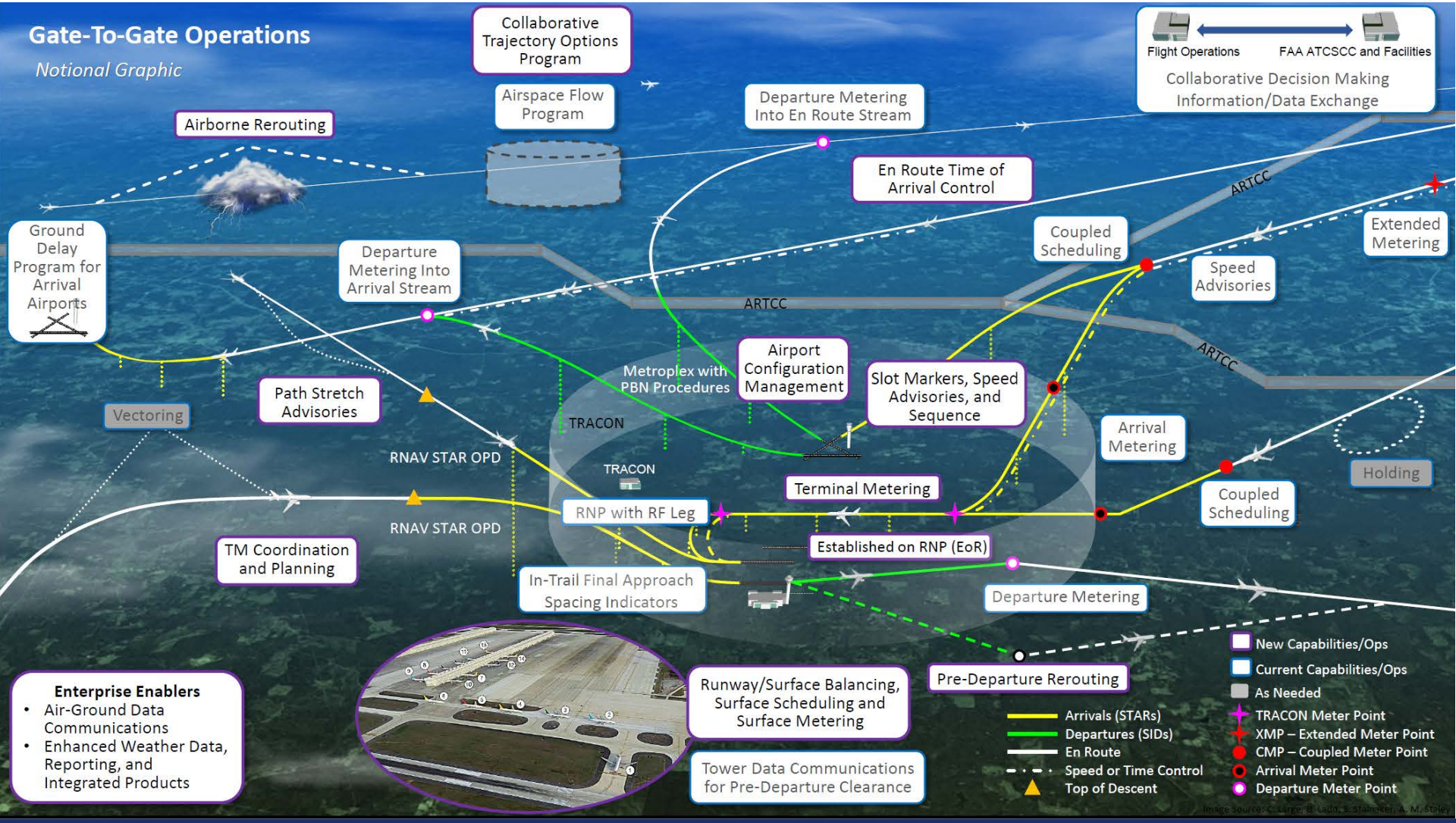
Initial Scope for Implementing TBO

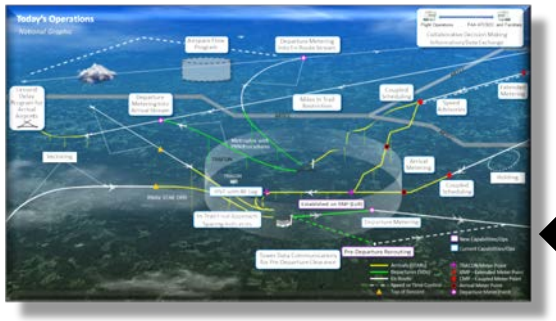


Initial Set of Candidate TBO Capabilities

Function Category	Capabilities	Supporting Technologies
PBN	**RNAV STAR Optimum Profile Descent (OPD)** **RNAV SIDs** **RNP / RNP with RF leg** **Established on RNP (EoR)***	FMS/ RNAV (LNAV/VNAV), RNP, RNP- AR, A-RNP
Strategic Planning / Flow Management	**Airspace Flow Program (AFP), Ground Delay Program (GDP)** **Collaborative Decision-Making*** **Collaborative Trajectory Options Program (CTOP)*** **TM Coordination and Planning**	TFMS/ FSM, IDM SWIM, TFMS, Operator Ground Automation TFMS/ FSM TBFM/ TM Ops Dashboard and Planning Tool
Route Management	**Automated Reroutes** **Pre-Departure Rerouting*** **Airborne Rerouting***	TFMS/ ERAM IDRP, PDRR ABRR
Time-Based Scheduling (Airborne and Surface)	**Arrival Metering** **Coupled Scheduling/Extended Metering** **Departure Metering (scheduling) into Arrival Stream** **Departure Metering (scheduling) into En Route stream** **Terminal Metering** **Runway/Surface Balancing** **Surface Scheduling and Metering**	TBFM/ GIM-S T-to-T, IDAC EDC, IDAC TSAS TFDM
En Route and Terminal Spacing Tools	**Delay Countdown Timer** **Speed Advisories** **In-Trail Final Approach Spacing Indicators** **Path Stretch Advisories** **Slot Markers, Speed Advisories, and Sequence** **En Route Time of Arrival Control (TOAC)**	TBFM/ DCT/MRL GIM-S ATPA Path Stretch TSAS TBFM, FMS/ RTA
Surface Management	**Tower Data Communications for Pre-Departure Clearance** **Electronic Flight Data*** **Airport Configuration Management**	Tower Data Link Services TFDM
Enterprise Enablers	**Information and Data Exchange** **Air-Ground Data Communication** **Enhanced Weather/Aero Data, Reporting, and Integrated Products**	SWIM En Route Initial Services NWP, CSS-Wx ACS

Approach to Applying TBO to the NEC

As-Is State



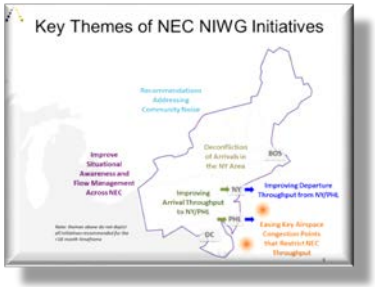
To-Be State

<TRANSITION ROADMAP>

Gap

Current Plans

New Commitments



Evolution Plan Content

Target State	Plan Execution
Objective and Goals	Operating Area Change Increments
Operational Change - Scope - AS-IS vs. TO-BE	Implementation Approach
iTBO Success Criteria and Metrics	Stakeholder Groups and Roles
Assumptions	Integrated Schedule - Leadership Actions - Communications Activities - Organizational/facility Alignments - Training, Evaluation, and Development
Integration, Risks, Opportunities	
Dependencies, Risks, Mitigations, Opportunities	Post-Implementation Operations Sustainment
Impact – Procedures/Agreements	
Impact – Surrounding Operating Areas	

- **Develop NEC TBO Transition Roadmap & Evolution Plan to Close the Gap**

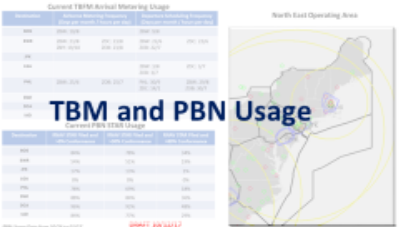
Beyond 18 Month Candidates and TBO

Tools & Technologies Initiatives	Impact	TBO
Early TBFM Pre-Departure scheduling	PHL, EWR, BOS, or LGA	✓
Expand Use of IDAC to Additional NY Area Airports	Airports TBD	✓
Expand IDAC to additional airports (within ZBW and ZDC) delivering arrivals to the NEC airports	Airports TBD	✓
Improve Airborne Metering	EWR	✓
Implement En Route Metering at additional Airports	LGA, TEB, HPN, JFK, DCA, BWI, and IAD	✓
Implement XM, CS, and speed advisories for select NEC airports and expand Freeze Horizons if necessary	Airports TBD	✓
Implement TSAS in the NEC	Airports TBD	✓
Use Required Time of Arrival/Time of Arrival Control Flights Destined to NEC airports	All	✓
PDRR/ABRR Enhancements	All	✓
CRDA for 13L and 22	JFK and LGA	✓
CRDA for 13L/22L to Lower Mins, and to 13R/4R	JFK	✓
CRDA for 22L/29 and 22L/11 both to Lower mins	EWR	✓

TBO Capability Analysis

‘Puzzle Palace’ Layout

- Information grouped by potential TBO Operating Areas
- Each Operating Area Overview contains an overview of TBO-related capabilities, followed by detailed data, organized into 3 areas: Arrival Management, Departure Management, and Enablers



Summary of TBO Activity

	TBFM Arrival Management	Airborne metering to	Departure Scheduling to	EDC	IDAC
ZBW	BOS, Cape airports	BOS, EWR, PHL	EWR, PHL, BOS	Regularly. Many destinations	BOS, BDL, PVD, ALB (EDC Only)
ZNY	Delegated to N90 & PHL TRACONs			ATL & CLT beginning 9/17	Implementation planned 11/17
ZDC		CLT, EWR	ATL, CLT, EWR, PHL	Regularly. Many destinations	DCA, IDA, BWI, RDU, RIC (EDC Only)

- Notes:
  - 8 Core30 airports
  - Extremely complex airspace, large traffic volumes - high risk to disruptions
  - NEC Initiative implementation beginning 10/17
  - Metering compliance is low for BOS (76%) and poor for EWR & PHL. ZNY controllers do not display times.
  - LGA departure scheduling limited to 22 config. N90 desires airborne metering .
  - DSP use is unique to NY airports
  - No sites currently on TSAS or GIM-S waterfall
  - Wash Metroplex complete; No NY Metroplex planned

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4

Current TBFM Arrival Metering Usage

Destination	Airborne Metering Frequency (Days per month / hours per day)	Departure Scheduling Frequency (Days per month / hours per day)	EDC Frequency (Days per month / hours per day)
BOS	ZBW: 10/8	ZBW: 9/8	
EWR	ZBW: 23/8 ZDC: 23/8 ZOB: 23/8	ZBW: 22/6 ZDC:22/6 ZOB: 22/7	ZBW:20/4 ZDC:27/5 ZID:8/3 ZJX:15/3 ZMA: 3/1 ZOB:17/4 ZTL:4/1
JFK			ZBW: 30/6 ZDC: 30/9 ZJX: 16/3 ZMA:2/2 ZOB: 17/8
LGA		ZBW:3/8 ZDC:3/7 ZOB: 3/7	ZBW:28/9 ZDC:30/11 ZID:9/5 ZJX:11/3 ZMA:2/3 ZOB:18/11 ZTL: 6/3
PHL	ZBW: 25/6 ZOB: 25/7	PHL:30/9 ZBW:29/8 ZDC:14/1 ZOB:30/7	
BWI			ZBW: 25/3 ZDC: 11/3 ZOB: 13/1
DCA			ZBW: 28/6 ZDC: 28/5 ZID: 10/5 ZJX:4/2 ZOB: 16/3 ZTL:13/2
IAD			ZBW: 14/1 ZDC:20/1 ZID:5/2 ZJX: 3/2 ZOB:14/2 ZTL: 7/1

Current PBN STAR Usage

Destination	# of RNAV STARs	RNAV STAR Filed and >0% Conformance	RNAV STAR Filed and >30% Conformance	RNAV STAR Filed and >80% Conformance
BOS	3	87%	80%	32%
EWR	2	58%	55%	21%
JFK	1	18%	14%	1%
LGA	0	0%	0%	0%
PHL	4	84%	75%	20%
BWI	3	92%	88%	36%
DCA	7	97%	94%	51%
IAD	9	89%	83%	33%

A Note on Conformance for STARs and SIDs

To be counted as “conforming,” flights must have filed for the procedure in the flight plan.

The % conformance is the proportion of the procedure for which the flight track is within 1 NM of the procedure centerline.

Current TBFM Departure Metering

Origin	Primary Destinations	IDAC	DSP in use	TFDM
BOS	LGA, PHL, JFK, DCA, ATL, EWR, CLT, ORD	EDC Only	No	Config A (2021)
EWR	ATL, CLT	Planned Nov 2017	Yes	Config A (2021)
JFK	CLT	Planned Nov 2017	Yes	Config A (2021)
LGA	ATL, CLT, BOS	Planned Nov 2017	Yes	Config A (2021)
PHL	ATL, CLT	Planned Nov 2017	Yes	Config A (2021)
BWI	ATL, CLT, FLL, JFK	EDC Only	No	Config A (2024)
DCA	LGA, ATL, CLT, JFK, EWR	EDC Only	No	Config A (2024)
IAD	ATL, CLT, JFK, EWR	EDC Only	No	Config A (2024)

Current PBN SID Usage

Origin	# of RNAV SIDs	RNAV SID Filed and >0% Conformance	RNAV SID Filed and >30% Conformance	RNAV SID Filed and >80% Conformance
BOS	9	87%	82%	50%
EWR	1	6%	6%	1%
JFK	2	5%	2%	1%
LGA	5	0%	0%	0%
PHL	0	0%	0%	0%
BWI	3	75%	70%	34%
DCA	9	99%	94%	54%
IAD	9	86%	70%	42%

DRAFT 10/27/17

TBFM Usage from September 2017
PBN Usage Data from 10/16 to 01/17

6

Operational Scenario Overview Excerpts - *Draft*

High-level TFM Scenario Excerpts

Draft

High-level Scenario Steps

Required Steps
Optional Steps

Step 0: (Day Before) TFM personnel (PERTI planner) reviews forecast and develops and coordinates plan/goals for affected flows

Step 1: (Day Of) ATCSCC Severe Weather Specialist reviews latest forecast and updates plan/goals and coordinates it with NAS TMs and AUs

Step 2: AUs actions to respond to the traffic flow management plan

Step 3: ARTCC Facility TMC develops and coordinates plan with NAS TMs and AUs to use TOSs for flows predicted to be impacted by weather

Step 4: ARTCC TMs Apply Strategic and Tactical Actions to Reroute Impacted Arrival Flows

Step 5: ARTCC TMs Apply Strategic and Tactical Actions to Selectively Reroute Impacted Departures

Step 6: TMCs Monitor Departure Queues and Flight Delays

Step 7: Weather Dissipates and TMIs are Reduced and Then Discontinued

Step 0: Day Before TFM (PERTI) Planning

- **Early afternoon before day of operations, the ATCSCC PERTI Planner develops plans based on Ohio Valley forecast**
  - Determine need for / identify playbook reroutes
  - Determine likely need for CTOP
  - Identify preliminary goals for next day operations
  - Use reroute modeling
  - Develop draft plan based on all of the analysis
- **ATCSCC holds webinar that includes discussion of Next Day plan**
  - Participants include TMs from FAA ARTCCs, TRACONs, DDSO (Deputy Directors of Sys Ops), AUs
  - Customer and facility feedback is captured
- **End of afternoon, the PERTI Next Day Plan is finalized**
  - PERTI Next Day Plan released as part of 20:00 Ops Plan advisory (see figure)
- **Field Facilities and customers plan resources using Next Day plan**

ATCSCC ADVZY 001 DCC 08/20/2017 OPERATIONS PLAN
RAW TEXT: EVENT TIME: 20/0100 - AND LATER

******PERTI NEXT DAY PLANNING FOR August 21, 2025******
Summary: Low IFR conditions and light rain forecast in EWR/LGA/PHL through mid-morning. If IFR conditions develop as forecast, GS and or GDPs will be necessary to manage demand.

Thunderstorms forecast for Ohio Valley in mid-afternoon. Expect reroutes/CTOP to eastbound flows. Potential need for GDPs at NY Metros.
. . .
Preliminary Goals:
- Manage EWR/LGA/JFK maximum departure delays to less than 90 minutes due to SWAP. Document actions taken.
- Manage any en route TRANSCON structure to balance demand thru effected facilities. Document actions taken.
- Utilize CTOP for eastbound flows to the maximum extent possible
- Utilize TOS to reroute NY/PHL departures

NEXT PLANNING WEBINAR: 1215Z
EFFECTIVE TIME: 20/0030 - 20/1359
20/08/17 00:30 DCCOPS.lastn35

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Step 3: ARTCC TMU Develop TOS Plan for Flows Predicted to be Impacted

Situation: Storms are forecast to impact NY/PHL westbound departures at 13:00

- **Mid-morning, the ZNY TMC reviews forecast and consults with Center Weather Service Unit (CWSU) specialist concerning impact to NY/PHL westbound departures**
- **Using that information the ZNY TMC**
  - Develops a plan to allow users to submit TOSs for NY/PHL westbound departures predicted to be impacted by weather
  - Verbally coordinates plan with ATCSCC Severe Weather Specialist and adjacent ARTCC and TRACON TMCs (e.g., ZOB/N90/ZDC TMCs)
- **ATCSCC Severe Weather Specialist issues proposed TOS Plan**
- **TOS plan is discussed as part of 11:15 Planning Webinar with users**
- **After webinar, the ATCSCC Severe Weather Specialist issues TOS Plan Advisory**

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Step 4: ARTCC TMs Apply Strategic and Tactical Actions to Reroute Impacted Arrival Flows

Situation: Storm is currently impacting NE arrival flows

- **ZOB TMC**
  - Collaborates with ZID and ZAU to reroute flights and flows impacted by actual storm development
  - CTOP will not eliminate all traffic from impacted airspace
- **ZAU/ZID/ZOB TMCs are using Airborne Rerouting (ABRR) to develop and deliver reroutes to FLM/Sector Controllers in response to actual storm development**
  - Reroute plan consists of: 1) moving TEB/JFK flows north of storm and rejoin normal route at ZNY boundary, 2) moving EWR/LGA flows north through ZBW, and 3) moving BDL/BOS flights north of storm
  - Alternative strategic TMIs such as Airspace Flow Program and Ground Delay Program are applied as needed to balance demand with capacity
- **ARTCC Sector Controllers issue reroutes as directed by TMC by voice or Data Communications for equipped flights**
  - If reroutes do not impact the portion of the flow within the freeze horizon, en route TBM operations will continue
    - ARTCC TMCs adjust metering parameters as necessary
  - If reroutes impact the portion of the flow within the freeze horizon, en route TBM operations may be temporarily suspended for that airspace
    - Traffic may also be directed over a different metering point in another sector where time-based management ops continue
- **TMCs appropriately adjust pre-departure flights destined to this airspace and/or merging into the overhead flow**

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High-level Departure Scenario Excerpts

Draft

High-level Scenario Steps

Scenario A: TBO Departure from TFDM-Equipped ATCT

Required Steps
Optional Steps

Step 0a: Flight Operators submit early intent information (e.g., flight readiness times)

Step 0b: ARTCC TMs initiate APREQ-Call For Release Procedures to fit flights into a NY arrival stream

Step 1: Automation identifies to Tower Controllers flights requiring APREQ-Call for Release times

Step 2: Tower Automation requests APREQ-Call for Release time from Scheduling Automation†

Step 3: Scheduling Automation identifies APREQ-Call for Release time and notifies Tower Automation †

Step 4: Tower controllers manage flight to meet release window

Step 5: ARTCC TM notes the need to reroute and initiates flight plan amendments

Step 6: Tower controllers are notified of the reroute and issue revised clearance and instructions

†There are a variety of operations associated with this step that depend on what systems are available and how they are configured. The scenarios illustrated here show 2 options: facilities with all capabilities present and facilities with TBFM-IDAC alone. There are other potential scenarios which also allow TBO to be achieved at a small ATCT.

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Step 0a: Flight Operators submit early intent information (e.g., flight readiness times)

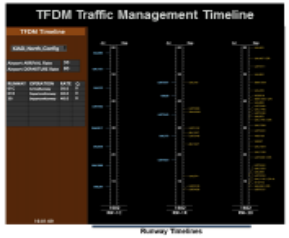
ATCSCC ARTCC TRACON ATCT

- Flight Operators exchange early intent information with TFMS (e.g., flight readiness, route preferences [Trajectory Option Sets], etc.) via SWIM
- TFMS provides early intent information to TFDM via SWIM
- ERAM provides flight plan information to TBFM, TFDM, and TFMS via SWIM
- TFDM assigns an initial departure runway based on planned airport configuration and departure fix
- TFDM generates ETDs for each flight and updates TFMS and TBFM

TFDM Electronic Flight Strip

UAL524	1331	23R	KRDU OXFRD2 FAK	D19	GC
B738	P1255		PHLBO3 ./. KEWR	B1240	
818 01 A	360				

TFDM Traffic Management Timeline



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Step 2: Tower Automation requests APREQ-Call for Release time from Scheduling Automation

ATCSCC ARTCC TRACON ATCT

- Since:
  1. The flight is subject to APREQ-Call for Release and
  2. The flight operator provided an expected ready time (Earliest Off-Block Time, EOBT),

  TFDM automatically, electronically requests a release time from TBFM 10 minutes prior to the flight-operator provided readiness time
  - Request = Earliest Feasible Take Off Time = flight operator readiness time + predicted taxi time
- The request is shown on electronic flight strip as well as the Tower display of TBFM-IDAC (expected to be used only in exception cases)

TFDM Electronic Flight Strip

UAL524	1331	23R	KRDU OXFRD2 FAK	D19	
B738	P1255		PHLBO3 ./. KEWR	CFR-R	
818 01 A	360			B1240	

TBFM (IDAC-IDST)

This scenario depicts the automatic scheduling mode of TFDM with the "Time-Based Parameter" trigger. There are three separate triggers which could be employed based on Tower operational needs. There is also a manual scheduling mode for TFDM.

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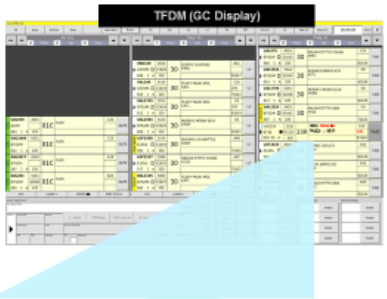
Step 6: Tower controllers are notified of the reroute and issue revised clearance and instructions

ATCSCC ARTCC TRACON ATCT

- TFDM updates the EFS with the route amendment (New portion is highlighted)
- TFDM updates the runway assignment, if necessary
- ATCT FLM/CIC/FD/CD/GC can see the flight's new route via electronic flight strip and that the flight still subject to APREQ/CFR
  - If the PDC is available, the revised route and clearance is issued via voice
  - If the flight is participating with DCL, then the revised route is issued directly to the flight deck
- The flight's release time can be scheduled automatically if the flight is prior to pushback or manually by the ATCT FLM/CIC/FD/CD via TFDM, TBFM-IDAC, or phone call
- The scheduling process repeats similar to step 3 and step 4
- GC provides flight taxi instructions ensuring the flight will meet its release time window

TFDM (GC Display)



UAL524	1331	23R	KRDU RDU8 SBV	D19	TAXI
B738	P1255		PHLBO3 ./. KEWR	CFR	
818 01 A	360			B1240	

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High-level En Route Scenario Excerpts

Draft

High-level Scenario Steps

Required Steps
Optional Steps

- Step 0: En Route TBM Operation is Segmented to Account for Uncertainty
- Step 1: The En route Controller Manages Flights to Meet Specified Crossing Times
- Step 2: Collaboration with the Flight Operator Results in a Modified Schedule
- Step 3: The En Route Controller Issues a New Clearance to Meet the Schedule
- Step 3a: The Controller Uses Speed Control to Meet the Modified Schedule
- Step 3b: A Lateral Path Change is Added to Provide Sufficient Delay
- Step 4: The Controller Executes an Airborne Reroute (ABRR) and Continues Metering

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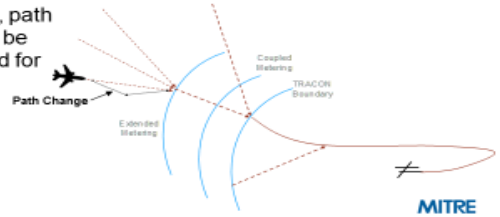
Step 1: The En Route Controller Manages Flights to Meet Specified Crossing Times

- **The En route Controller manages flights to meet the specified crossing times**
  - The controller uses speed control and, as necessary, path change to meet the specified time
    - Speed control can be accomplished with either
      - An assigned speed or
      - For TOAC-capable aircraft, an assigned time of arrival
  - An assigned speed, path and/or altitude may be modified as required for separation while meeting the scheduled time



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Step 3a: The Controller Uses Speed Control to Meet the Modified Schedule

- **MRP indicates if an aircraft is TOAC-capable**

Yellow underlined STAs denote TOAC-capable aircraft, and can be selected for an assigned TOA advisory

Yellow underlined speeds are GIM-S Advisory speeds, and are available whenever speed change alone can meet the schedule

White STA denotes a non-TOAC-capable aircraft

- **Access to assigned speed advisories are also available through the FDB Line 0 "C" Coordination Portal**

Controller selects "C" indicator which brings up the Speed Menu, if speed alone can meet the schedule

Controller selects "∠.78" to accept the advisory

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Step 4: The Controller Executes an Airborne Reroute (ABRR) and Continues Metering (3 of 3)

- **The TFM Reroute Menu allows the controller to display (on the D-side) a Trial Plan of the Pending TFM Reroute**
- **The controller sees that the Trial Plan results are green, and accepts the TFM Reroute**
- **When all aircraft have been rerouted**
  - The MRP is rippled to accommodate the modified ETAs, and metering proceeds

(See Step 3)

Source: Leidos

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High-level Arrival Scenario Excerpts

Draft

High-level Scenario Steps

Required Steps
Optional Steps

- Step 0: Terminal TBM begins when aircraft are handed off at the meter fix
- Step 1: The Terminal Controller Verifies the expected runway and approach
- Step 2: The Terminal Controller Issues Clearances to Meet the Schedule
- Step 3: The Terminal Controller Determines How to Best Resolve Schedule Disruptions
- Step 3a: The Terminal Controller may resolve the situation without adjustment to the schedule
- Step 3b: The Terminal Controller may coordinate schedule modification with the FLM and TM
- Step 3c: The TM will assess the potential impact of schedule modification and coordinate as needed
- Step 4: Flights are Cleared to the Appropriate Approach
- Step 5: Final Controllers Monitor Spacing on the Final Approach

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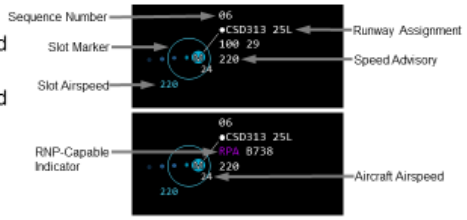
Step 2: The Terminal Controller Issues Clearances to Meet the Schedule (1 of 2)

- The Terminal Controller manages flights to meet specified crossing times over designated points by keeping aircraft targets inside of graphical slot markers
- Terminal controllers are provided with
  - Graphical slot markers which are a instantaneous location of where the aircraft needs to be located to be on schedule
  - Slot marker indicated airspeed
  - Derived aircraft indicated airspeed
  - Speed advisories to regain slot marker conformance



Note: TSAS CNI is based on prototype development, and subject to change

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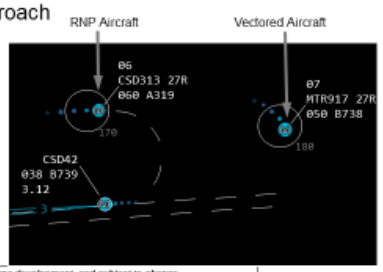
Step 4: Flights are Cleared to the Appropriate Approach

- Capable flights are cleared for RNP approaches. All other flights are given vectors to the final approach
- Scheduling for non-RNP capable flights uses a nominal base turn distance to build the schedule trajectory
  - Creates a consistent, predictable, and repeatable objective path for vectors to the final approach
- Final controllers monitor slot marker conformance for confidence in successful use of RNP approaches
- Tools transition from slot markers to ATPA spacing cones on final approach



Note: TSAS CNI is based on prototype development, and subject to change

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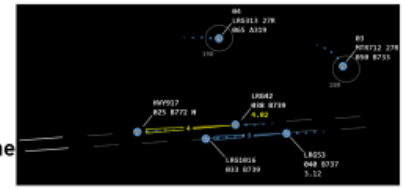
Step 5: Final Controllers Monitor Spacing on the Final Approach

- Final controllers monitor spacing on the final approach using ATPA
- Spacing cones between in-trail aircraft are automatically displayed and present the minimum required separation distance (or time) as determined by automation
- Continuous mileage-readout of the actual measured distance between in-trail arrival aircraft can also be displayed
- If automation predicts that the trailing aircraft will come too close to the leading aircraft, the mileage-readout and spacing cone change color to alert the controller



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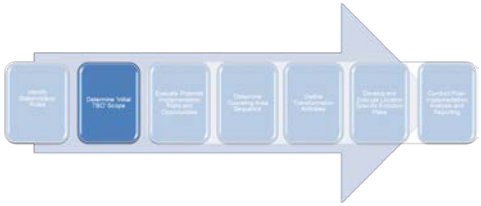
Back-Up Materials

TBO Scope



- **Define General TBO Success Criteria* and Metrics**
  - Outcome Metrics
    - Focus on overall results
    - What are we trying to do? (efficiency, predictability)
    - E.g., On-time arrivals, flying time
    - Align with NAC metrics as appropriate
  - Activity Metrics
    - Focused on specific capabilities/initiatives
    - Are we executing as planned?
    - E.g., Usage frequency, meter time compliance
- **Establish Baseline and Set Targets**

**Success Criteria here is a general project management term that refers to suitably realistic measures by which implementation will be judged to decide whether or not it has been successful in the eyes of stakeholders*

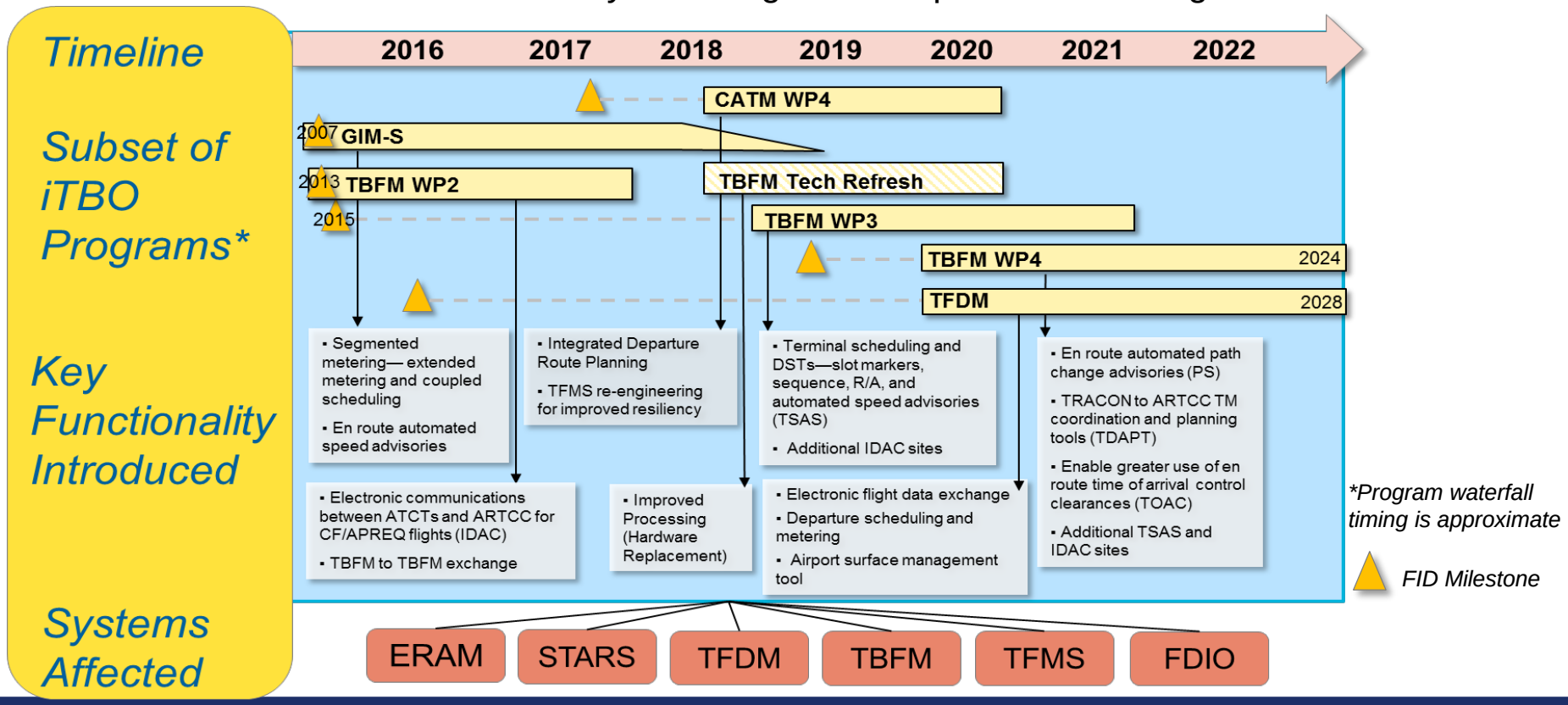
Evaluate Potential Implementation Risks & Opportunities (1/2)

- **Identify/Review Lessons Learned from past Planning and Deployment Activities**
- **Develop Risk Management Strategy**
  - Ensure alignment with any previously identified TBO risks
- **Identify TBO dependencies across programs**
- **Identify and coordinate potential changes to existing programs**

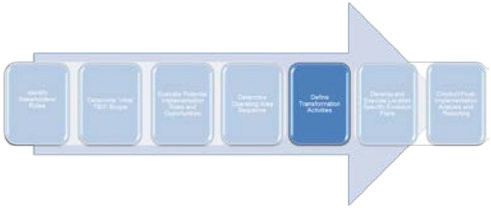
Evaluate Potential Implementation Risks & Opportunities (2/2)

Identify Inter-Dependencies

- Key Functionality Introduced by Many Programs Planned Over Many Years
- Combinations of Functionality Drive Significant Operational Changes

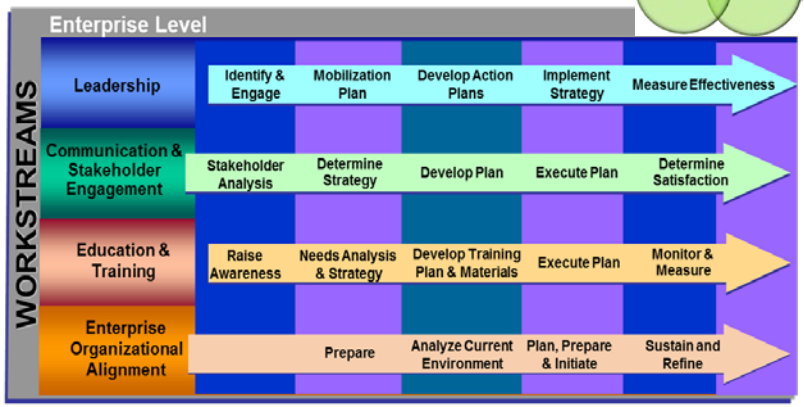


Define Transformation Activities



- **Conduct Detailed Field/Operations Stakeholder Analysis**
  - Impacts, Expectations, and Concerns
- **Define Change Management Strategy Based on Results**
- **Develop Overarching Communications Plan to Address Major Audience Categories**
- **Assess Impact to Current Training Regiment**
- **Develop Transition Roadmap**

Change Management Strategy

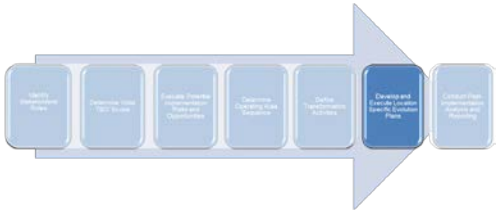


Needs:
- A well thought out Communications Strategy will help to:
  - Provide timely, useful and accurate information,
  - Address stakeholders' key questions and concerns,
  - Prevent misinformation, and
  - Build a foundation for a constructive dialogue

Goals:
- Increase awareness within the organization on key projects and initiatives also increase information exchange within the FAA and other stakeholder communities
- Provide the basis for consistent messaging to key stakeholders
- Increase support and commitment from stakeholders
- Provide the framework for all communications, including key messages, target audience, communication vehicle responsibilities and timing

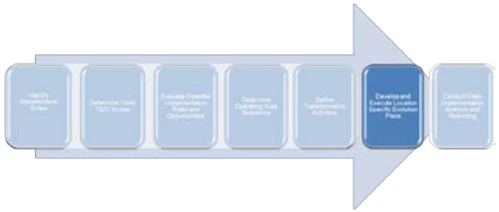
Guiding Principles:
- Keep messages clear, simple, and consistent
- Target messages to the audience and deliver them effectively
- Evaluate content and channels and adjust as needed

Develop and Execute Location Specific Evolution Plans



- **Assign and engage field implementation team**
- **Identify operating area risks and dependencies, and mitigations**
- **Identify impact to surrounding ops/facilities**
- **Define appropriate operating area 'change increments'**
  - Change increments refer to the definition of logical and manageable sets of capabilities and procedures identified for iTBO implementation
  - This is not the same as the NextGen Segment Implementation Plan (NSIP) increments
- **Assess local operating procedures/agreements**
- **Develop tailored plans:**
  - Leadership Actions
  - Communications Activities
  - Organizational and Facility Alignments
  - Training and Development
- **Develop post-implementation, operations sustainment plan**

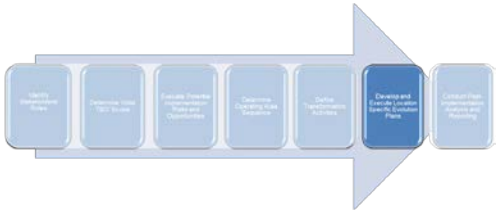
Develop and Execute Location Specific Evolution Plans



Factors for Consideration

- **Location Status and Activities**
  - Available PBN Procedures and Usage
  - Available Systems/Capabilities and Usage
  - Unrelated On-going or Planned Activities
  - Location Specific Issues/Concerns
- **Airspace User Characteristics**
  - Number of Carriers
  - Types of Carriers
  - Aircraft Equipment
  - User Type Variability (GA/Military/Space)
  - Equipage
- **Ops Complexity Characteristics**
  - Primary Runway Configuration (Independent vs. Dependent Ops)
  - Special Use Airspace
  - Seasonal and Weather Considerations (e.g. Wind Profile Variability)
  - Surface Constraints
  - Adjacent Facility Dependencies
- **Resource Availability**
  - Cost/Available Funding
  - Personnel Availability
- **Community Impact/Involvement**

Develop and Execute Location Specific Evolution Plans

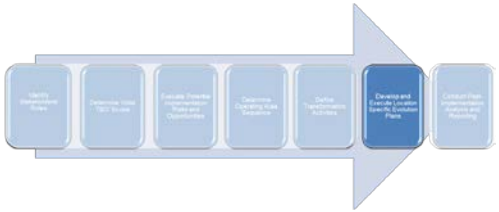


Evolution Plan Content

Target State
Objective and Goals
Operational Change - Scope - AS-IS vs. TO-BE
iTBO Success Criteria and Metrics
Assumptions
Integration, Risks, Opportunities
Dependencies, Risks, Mitigations, Opportunities
Impact – Procedures/Agreements
Impact – Surrounding Operating Areas

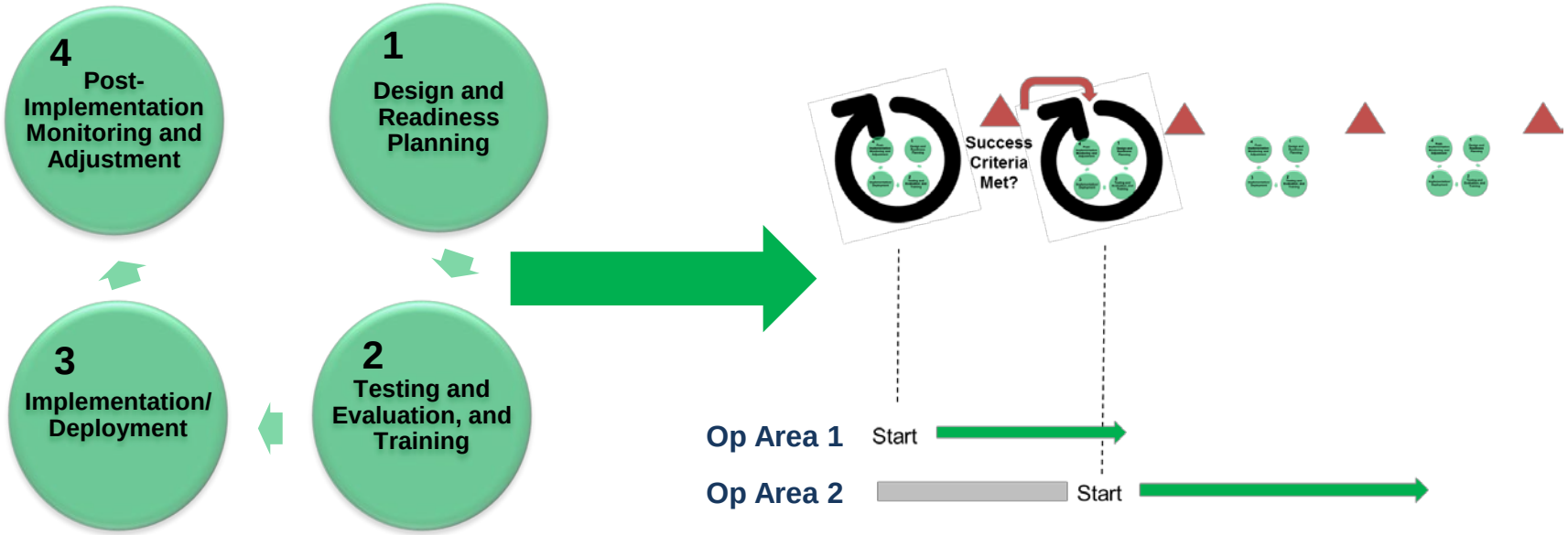
Plan Execution
Operating Area Change Increments
Implementation Approach
Stakeholder Groups and Roles
Integrated Schedule - Leadership Actions - Communications Activities - Organizational/facility Alignments - Training, Evaluation, and Development
Post-Implementation Operations Sustainment

Develop and Execute Location Specific Evolution Plans



Define iTBO Change Increments

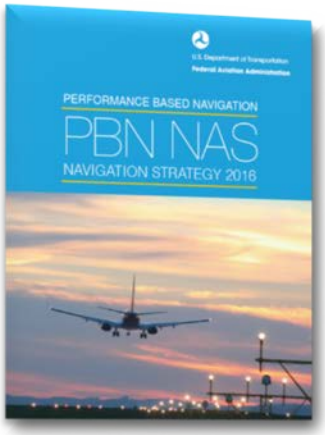
- Change Increments are Logical And Manageable Sets of Capabilities and Procedures
- Steps for Each Change Increment Identified



Conduct Post-Implementation Analysis and Reporting

- **Measure and Report on Success Criteria**
- **Incorporate Evolution Plan Adjustments as needed to Achieve Objectives**
- **Communicate Implementation Status with Stakeholders**

	Near-Term (2016-2020)	Mid-Term (2021-2025)	Far-Term (2026-2030)
PBN NAS	✓ Implement RNAV(GPS) with LPV and LNAV/VNAV approaches at qualifying runways meeting TERPS criteria ✓ Criteria to increase number of runways qualifying for vertically guided approaches • Expand development of PBN special helicopter approaches to hospitals • Continue replacing conventional approaches, SIDs, and STARs with PBN procedures • Initial transition to improved PBN-based point-to-point navigation • Shorten development and implementation time for new ATS routes by removing rulemaking requirement ✓ Transition from Minimum Navigation Performance Specification Airspace (MNPSA) to PBN in the ICAO North Atlantic Region ✓ Expand User Preferred Routes (UPRs) for navigation between North America and Asia	• Implement vertically guided RNAV(GPS) approaches at runways meeting new TERPS criteria • Continue replacing conventional approaches, SIDs and STARs with PBN procedures • Transition to PBN-based point-to-point navigation (en route) • Replace Jet routes and Victor airways with PBN where structure is needed ✓ Leverage reduced separation standards to further expand UPRs	• Vertically guided RNAV(GPS) approaches at qualifying airports with an IAP • Complete the transition to PBN procedures
More Efficient Routes & Procedures	• Expand use of Established on RNP (EoR) at first site ✓ Expand use of Equivalent Lateral Spacing Operations (ELSO) at first two sites ✓ Implement OPDs at airports using RNAV STARs ✓ Implement reduced separation climb/descend requirements for RNP 4 capable aircraft	• Expand EoR at sites supported by cost-benefit analysis ✓ Expand ELSO at sites supported by cost-benefit analysis • Expand use of RNAV (GPS) approaches with LPV and LNAV/VNAV) with RF	
Improved Predictability		• Key airports transitioned to time and speed-based management	• NAS transitioned to time and speed-based management
More Cost Effective & Agile Service Delivery	• Discontinue approximately 70 current VOR facilities • Begin ILS Rationalization at NSG 4 and 5 airports • Reduce unnecessary IFPs (e.g., circling approaches)	• Discontinue about 200 more current VOR facilities • Continue ILS Rationalization at NSG 4 and 5 airports • Reduce unnecessary IFPs (e.g., NDB approaches) • Develop procedure design tools and processes that accelerate the ability to move from criteria to implemented procedures • Complete the transition to digital delivery of chart data • Complete development of an automated tool for periodic review of procedures	• Re-evaluate remaining VOR facilities within the far-term system • ILS rationalization complete at NSG 4 and 5 airports • ILS rationalization analysis for NSG 1, 2, and 3 airports
Increased Access	• Policy for Synthetic Vision Guidance System (SVGS) to qualifying approaches ✓ Policy for Enhanced Flight Vision Systems (EFVS) operation to touchdown • Criteria for low visibility access with LPV		
Improve Navigation Resiliency	• DME/DME RNAV service expanded for NSG 1 and 2 airports initiated • En Route airspace is covered by DME/DME RNAV service (IRU not required) redundancy • Requirements for a Satellite Operations Coordination Concept (SOCC) position at the FAA's ATCSCC	• DME/DME RNAV service expanded for NSG 1 and 2 airports based on site-specific evaluations • SOCC provides real-time, system-level view of NAS navigation resiliency	
Innovation & Continuous Improvement	• Demonstrate A-RNP at first site • Use of PBN approaches with visual separation standards • Further reduce RNP-based separation standards (oceanic) • Enhance community involvement	• Leverage A-RNP at key sites	• A-RNP procedures at sites supported by cost-benefit analysis • Leverage avionics capabilities to reduce separation standards for PBN in IMC • Standardize FMS functionality

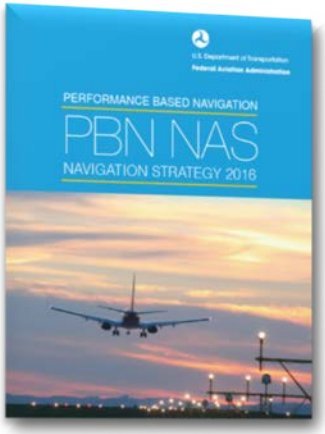


Commitments Listed by Service Improvement

Completed goals are indicated by green text and a checkmark.

Table 6 – Summary of FAA Goals and Commitments

Near Term (2016–2020) Increase Utilization	Mid Term (2021–2025) Streamline Service Delivery	Far Term (2026–2030) A Streamlined NAS
Approach/Terminal ☐ Implement RNAV (GPS) with LPV and LNAV/VNAV approaches at qualifying runways meeting current Terminal Instrument Procedures (TERPS) criteria ☐ Criteria to increase the number of runways qualifying for vertically guided approaches ☐ Expand use of Established on RNP (EoR) at first site ☐ Expand use of Equivalent Lateral Spacing Operations (ELSO) at first two sites ☐ Criteria for low-visibility access with LPV ☐ Use of PBN approaches with visual separation standards ☐ Expand development of PBN special helicopter approaches to hospitals ☐ Policy for Enhanced Flight Vision Systems (EFVS) operation to touchdown ☐ Policy for Synthetic Vision Guidance System (SVGS) to qualifying approaches ☐ Demonstrate A-RNP at first site ☐ Initiate expanded DME/DME coverage for Navigation Service Group 1 and 2 airports ☐ Continue replacing conventional approaches, SIDs and STARs with PBN procedures ☐ Implement Optimized Profile Descents (OPD) at airports using RNAV STARs	**Approach/Terminal** ☐ Implement Vertically guided RNAV (GPS) approaches at runways meeting new TERPS criteria ☐ Expand use of RNAV (GPS) approaches (with LPV and LNAV/VNAV) with RF ☐ Expand use of EoR at sites supported by cost-benefit analysis ☐ Expand use of ELSO at sites supported by cost-benefit analysis ☐ Leverage A-RNP at key sites ☐ DME/DME coverage expanded for Navigation Service Group 1 and 2 airports based on site-specific evaluations ☐ Continue replacing conventional approaches, SIDs and STARs with PBN procedures	**Approach/Terminal** ☐ Vertically guided RNAV (GPS) approaches at qualifying airports with an IAP ☐ A-RNP procedures at sites supported by cost-benefit analysis ☐ Complete the transition to PBN procedures
En Route ☐ Class A airspace is covered by DME/DME (IRU not required) redundancy ☐ Shorten development and implementation time for new ATS routes by removing rulemaking requirement ☐ Initial transition to improved PBN-based point-to-point navigation	**En Route** ☐ Transition to improved PBN-based point-to-point navigation ☐ Replace Jet routes and Victor airways with PBN routes where structure is needed	**Oceanic** ☐ Transition to dynamic UPRs where supported by operator capability
Oceanic ☐ Expand User Preferred Routes (UPRs) for navigation between North America and Asia ☐ Implement reduced separation climb/descend requirements for RNP 4 capable aircraft ☐ Transition from Minimum Navigation Performance Specification (MNPS) to PBN in the ICAO North Atlantic (NAT) Region ☐ Analyze further reduced RNP-based separation standards	**Oceanic** ☐ Leverage reduced separation standards to further expand UPRs	**NAS Operations** ☐ NAS transitioned to time- and speed-based management
	NAS Operations ☐ Expanded time- and speed-based management services for key airports	

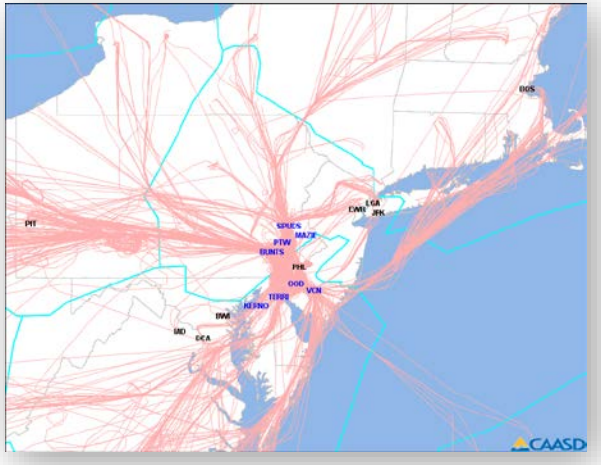


Commitments Listed by Phase of Flight

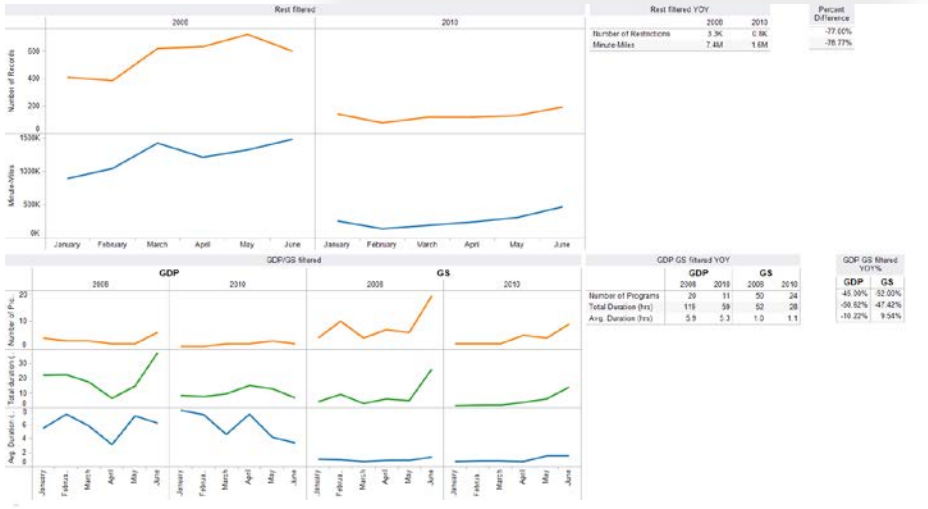
Why Should We Use TBM?

A Measure of Success: Metering to PHL

- **Post-Implementation Analysis to Evaluate Operational impact of Metering to PHL**
  - Jan-June 2008 (pre-TMA) vs Jan-June 2010 (post-TMA)

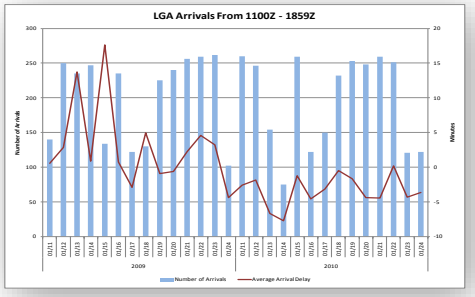


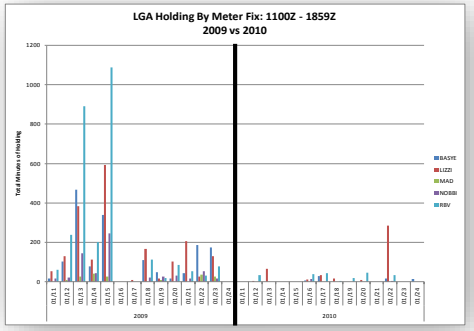
- **Findings showed significant Decrease in Holding** (number of flights held and total duration), **MIT Restrictions** (number and total minute-miles), and the number and duration of both **GDPs and grounds stops**
  - Average peak throughput at PHL increased ~ 3%
  - Holding reduced by ~ 50%



A Measure of Success: Metering to LGA

- **Post-Implementation Analysis to Evaluate Operational impact of Metering to LGA**
  - Comparison of operations (2 week period) in 2009 (before TMA) to 2010 (with TMA)
- **Findings showed Significant Benefits**
  - Arrival Delays
    - Average arrival delay vs flight plan **Decreased** from 2009 to 2010
  - Holding
    - Total minutes of holding **Reduced** in 2010 versus 2009
    - 2009—flights over RBV had greatest amount of holding. 2010—holding more **evenly distributed** across all fixes
  - MIT Usage
    - Number of MIT restrictions issued were ~ 25% *higher* in 2010 than 2009
    - Number of Minute-Miles (measure of MIT severity) were ~40% *Lower* in 2010 than 2009
  - Internal Departures
    - Average internal departure delays were under 5 minutes





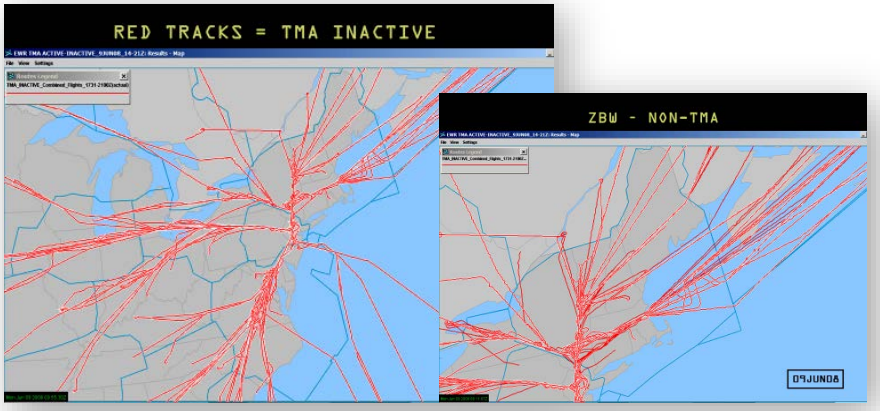
A Measure of Success: Metering to EWR

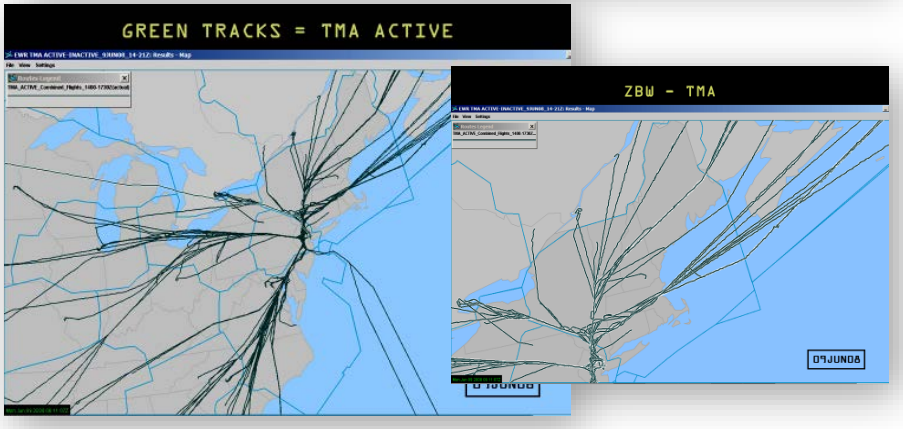
- **Performance Analysis Conducted by Continental Airlines Show Benefits of Metering**

Continental

EWR TMA vs NON-TMA DIFFERENCES
June 9, 12, 25, 2008

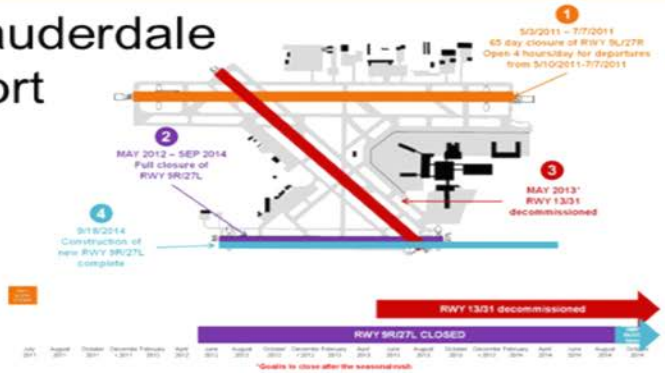
- AVG NON-TMA AIRTIME DIFFERENCE:
  - PLANNED vs ACTUAL AIRTIME = +7.4 MINUTES
  - PLANNED vs ACTUAL AIRTIME PERCENT = +5.3%
- AVERAGE TMA AIRTIME DIFFERENCE:
  - PLANNED vs ACTUAL AIRTIME = +3.4 MINUTES
  - PLANNED vs ACTUAL AIRTIME PERCENT = +3.1%
- SUMMARY:
  - TMA USAGE SAVED AN AVERGE OF 4.0 MINUTES OR 2.2% AIRTIME OVER NON-TMA FLIGHTS

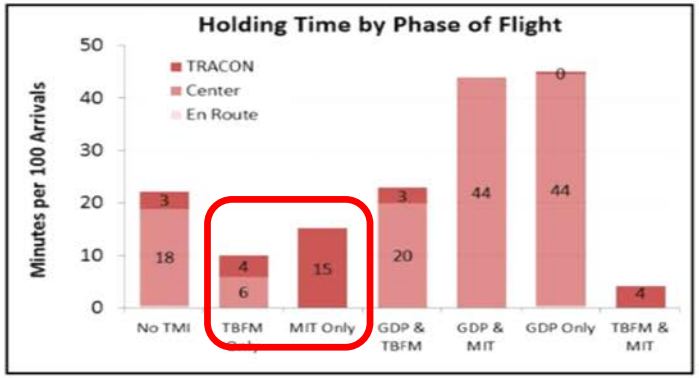




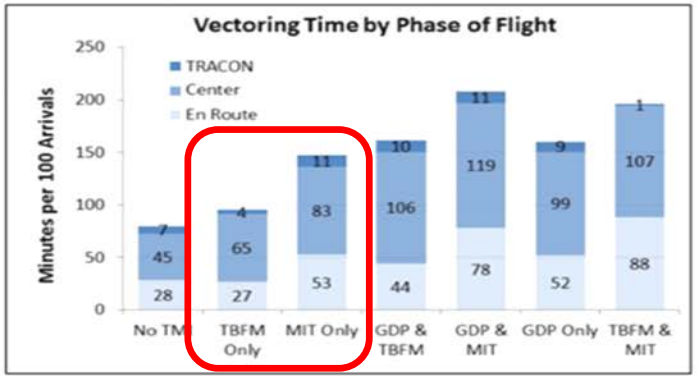
A Measure of Success: Metering to FLL

Ft Lauderdale Airport





- 3 year construction project reduces airport to single runway operation
- 2 years of pre-planning to minimize delays through traffic management initiatives
- Time Based Flow Metering (TBFM) improves efficiency for the capacity constrained airport
- TBFM results in reduced holding and vectoring



A Measure of Success: Metering over MIT

- **2014 TBFM NextGen Operational Performance Assessment**
  - Empirical Analysis of current operations to understand NAS-wide and Local use of TBFM

- **Findings Support Time-Based Metering as More Effective TMI over Miles-In-Trail**
  - **Use of Departure Scheduling**
    - Led to less arrival delay and arrival delay variability
    - Led to less variability of airborne delay
  - **Use of Airborne Metering**
    - Led to decrease in average holding and vectoring delays
    - Led to reduction in variability of holding and vectoring delays
    - Upstream center share of holding/vectoring drops most

Terminal TBM Benefit Areas

Types of Benefit	Benefit	Source
Trajectory Efficiency	Decrease in delays through reduced flight time	TSS2 HITL, 2013
	Savings due to greater use of optimal trajectories and reduced ground tracks	TSS2 HITL, 2013
Throughput*	Increase throughput due to the ability to realize more efficient arrival spacing	TSS2 HITL, 2013; TBFM WP3 Shortfalls, 2013
Safety	Decreased probability of loss of separation due to TSAS spacing assurance	SME input based on reduced route deviations
	Reduced controller workload due to improved capability to maintain the queuing flights on their published routes & STA with less control actions	Various HITLs 2013-2014
	Decreased deviations from published routes	Application of ASIAS study, 2012
Environmental	Reduction in CO_2 emissions and noise level	TSS2 HITL, 2013
TBFM Schedule Improvements	Improved scheduling allows better merging of flows to the runways allowing En Route and TRACON controllers to work toward common plan that includes appropriate spacing at all merge points	SME input based on HITL experience

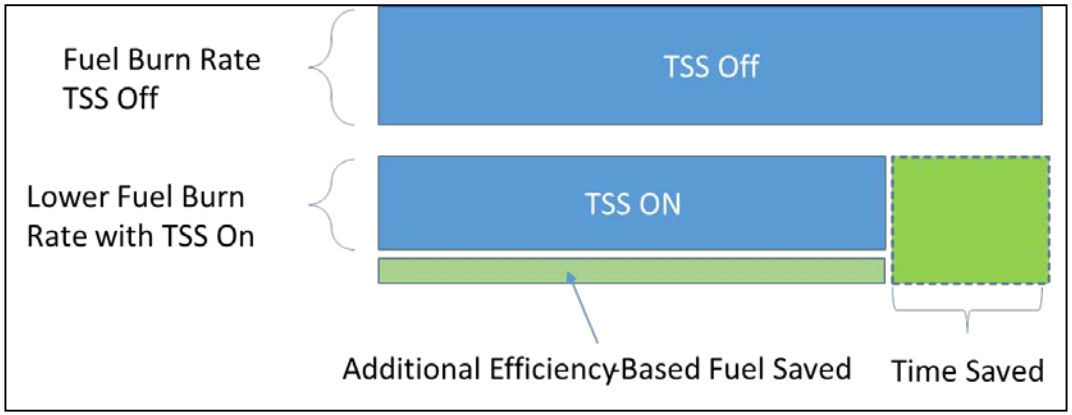
* Not part of economic analysis

ASIAS: Aviation Safety Information Analysis and Sharing
STA: Schedule Time of Arrival

Source: derived from TBFM WP3 BBOE

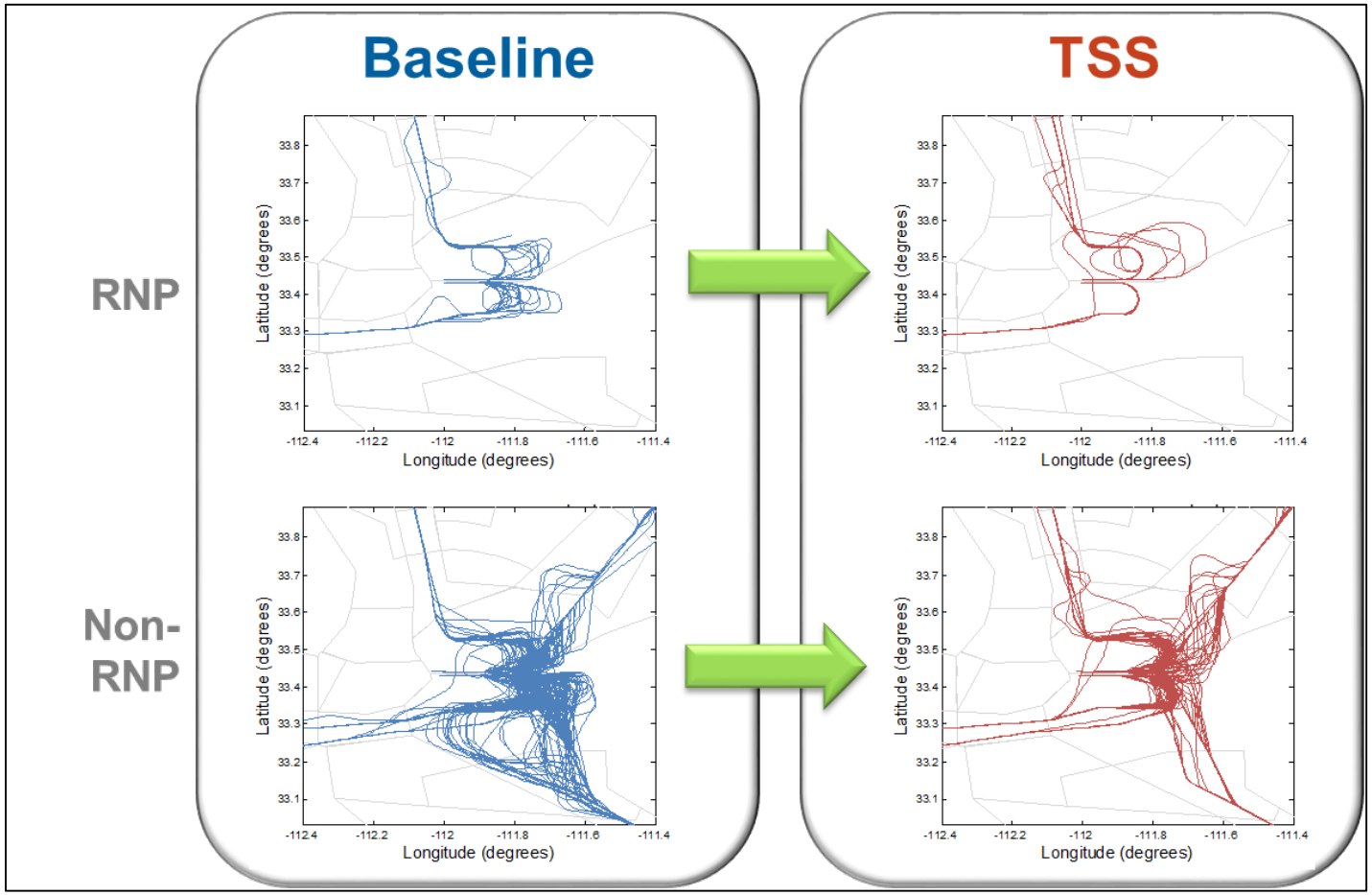
Terminal TBM Enables Reduced Flight Time and Fuel Burn

- **TSAS shortens flying time in TRACON**
  - More RNP approaches with RF-leg (curved)
  - Less vectoring
- **TSAS promotes more efficient trajectories in TRACON**



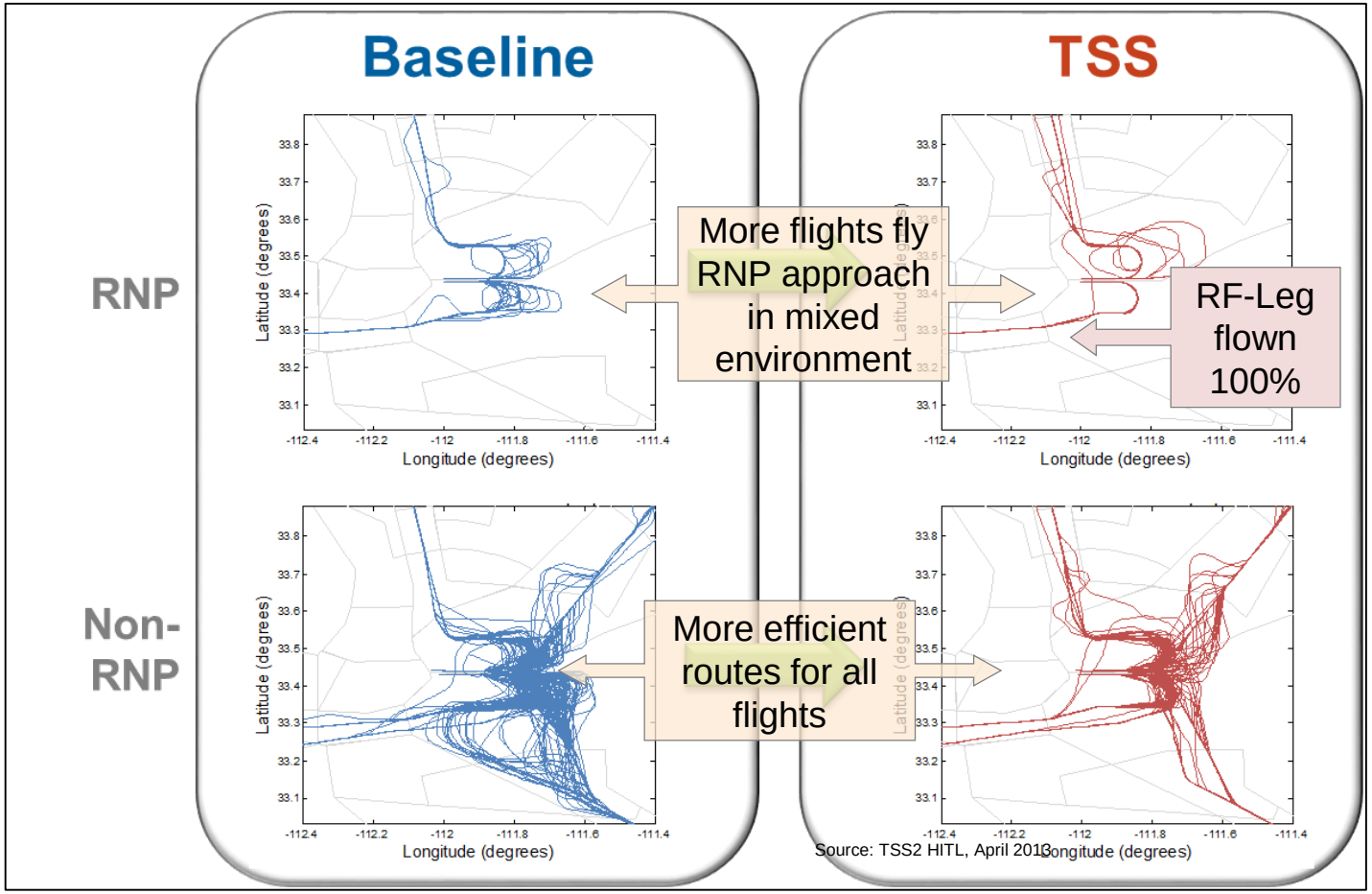
Source: TBFM WP3 BBOE

Terminal TBM: TSAS HITL Simulation Results



Source: TSS2 HITL, April 2013

Terminal TBM: TSAS HITL Simulation Results



Source: TSS2 HITL, April 2013