



Federal Aviation
Administration

Trajectory Based Operations (TBO) Solution Set

*Presentation to the 2009 I-CNS
Conference*

Rowena Mendez

TBO Solution Set Coordinator

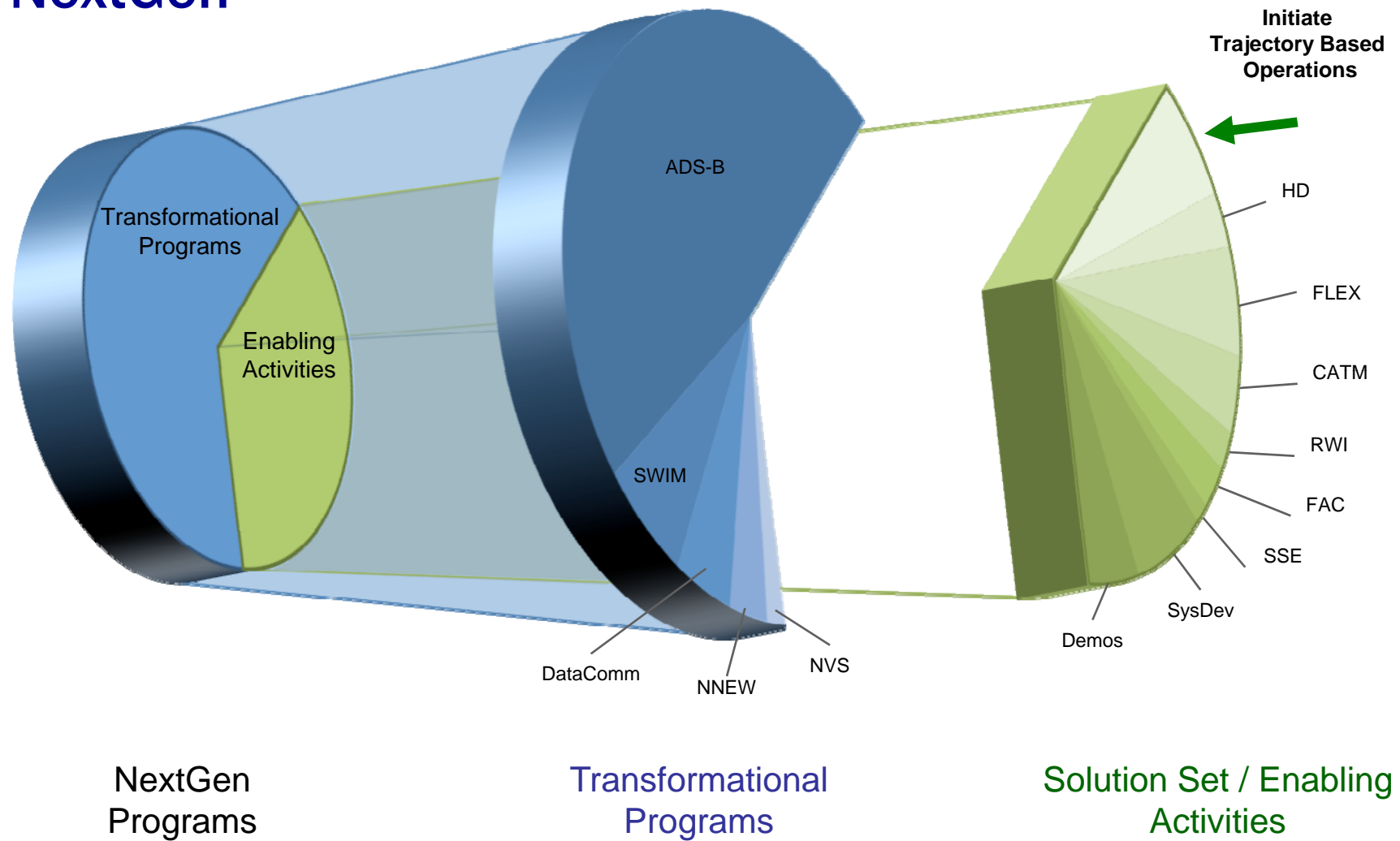
May 15, 2009

Agenda

- TBO Solution Set within NextGen
 - Defined
 - Operational Improvements
- Scenarios
- Implementing TBO

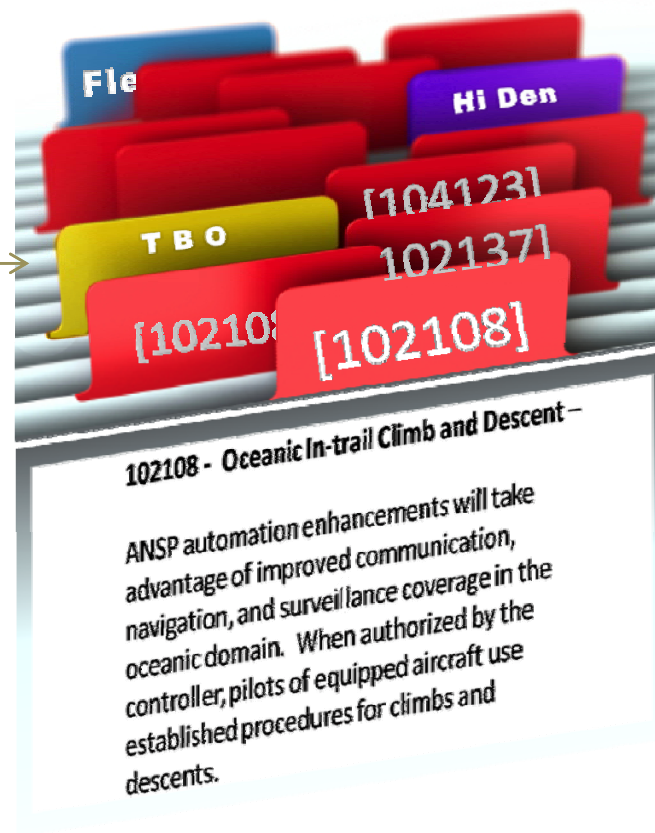


NextGen

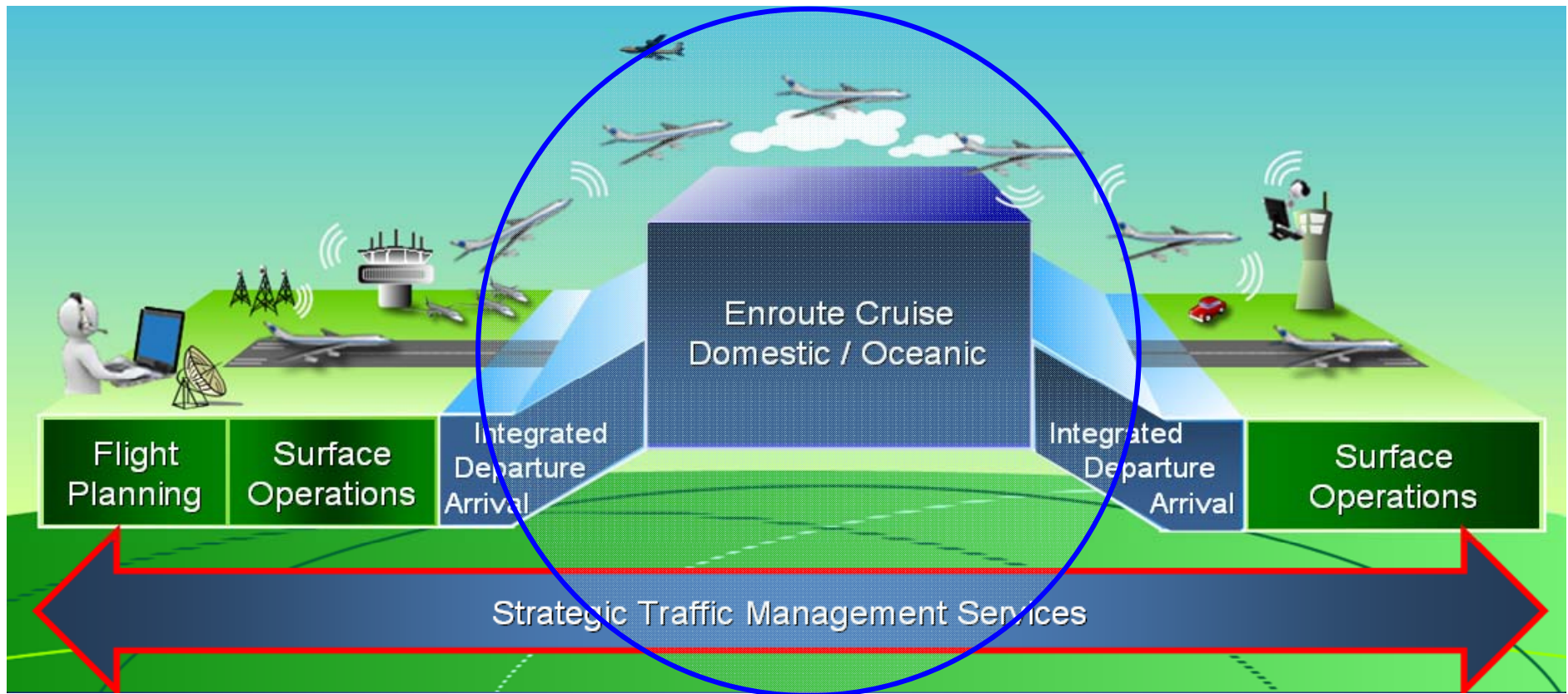


NextGen Capabilities will be Implemented Solution Set Portfolios

NEXTGEN Portfolio		Transformational Programs					
		ADS-B	SWIM	DATA-COM	NNEW	NVS	
Enabling Activities	TBO	X	X	X	X	X	
	HIGH DEN	X	X	X	X	X	
	FLEX	X	X	X	X	X	
	CATM	X	X	X	X		
	RWI	X	X	X	X		
	SSE	X	X	X	X		
	NET FAC		X	X	X	X	



TBO Solution Set Focus



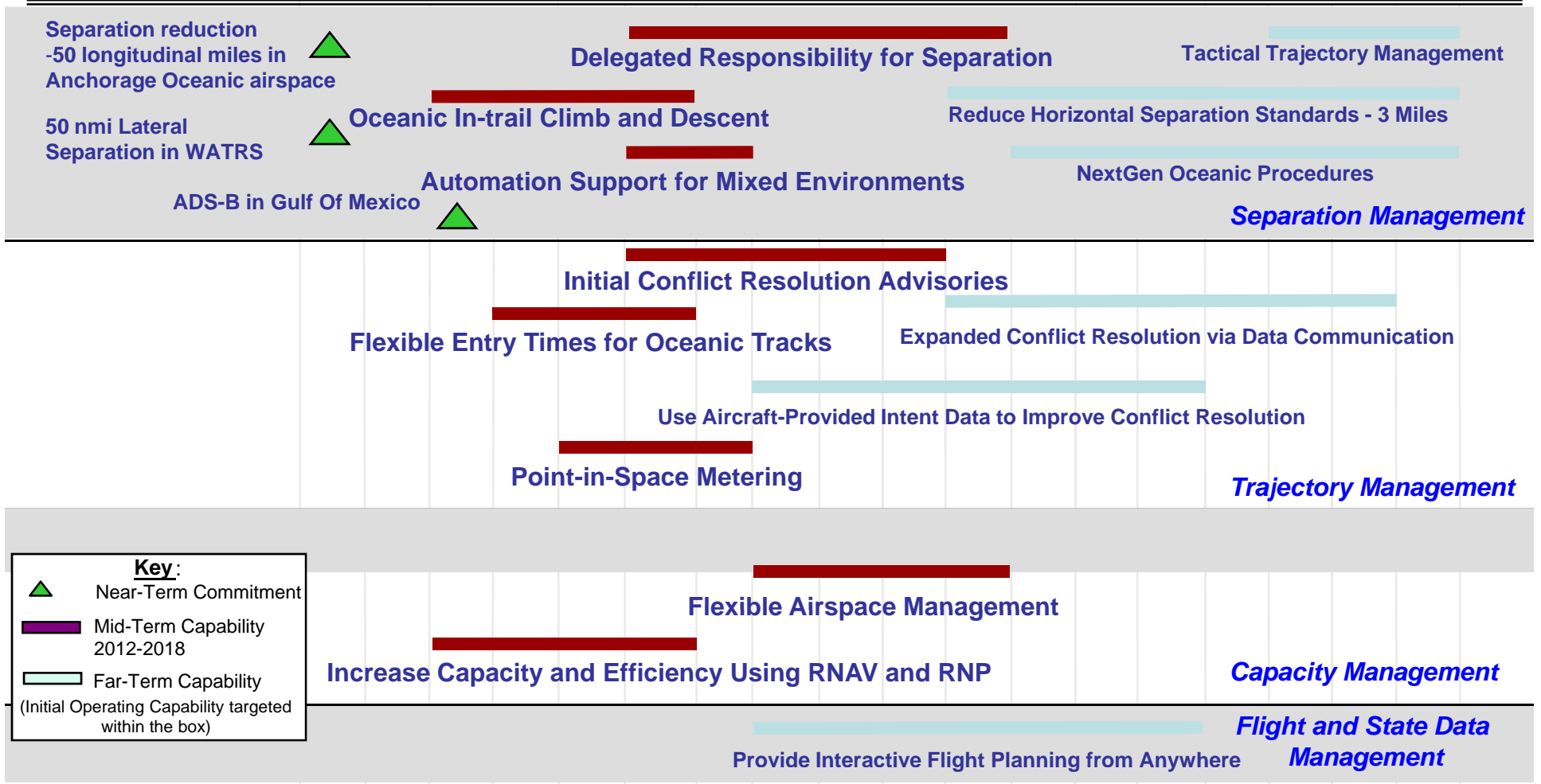
Summary Description

- Trajectory-based Operations (TBO) represent a shift from clearance-based to trajectory-based control.
- Goals:
 - Gate to Gate
 - Safe and Efficient Separation Management
 - Management of Trajectories
 - Accommodate User Preferences to the extend possible

This solution set (Initiate Trajectory Based Operations) focuses primarily on en route cruise operations, although the effects of the trajectory-based operations will be felt in all phases of flight.

Initiate Trajectory Based Operations Solution Set

FY 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2025



TBO Solution Set – Operational Improvements



Separation Management

- **Oceanic In-trail Climb and Descent**
102108
- **Delegated Responsibility for Separation**
102118
- **Automation Support for Mixed Environments**
102137

Trajectory Management

- **Flexible Entry Time for Oceanic Tracks**
104102
- **Point in Space Metering**
104120
- **Initial Conflict Resolution Advisories**
102114

Capacity Management

- **Flexible Airspace Management**
108206
- **Increase Capacity and Efficiency Using RNAV and RNP**
108209

TBO Solution Set – Operational Improvements



Separation Management

- **Oceanic In-trail Climb and Descent - 102108**
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.
- **Delegated Responsibility for Separation - 102118**
Enhanced surveillance and new procedures enable the ANSP to delegate aircraft-to-aircraft separation. Improved display avionics and broadcast positional data provide detailed traffic situation awareness to the flight deck. When authorized by the controller, pilots will implement delegated separation between equipment aircraft using established procedures.
- **Automation Support for Mixed Environments – 102137**
The ANSP automation provides the controller with tools to manage aircraft in a mixed navigation and wake performance environment.

TBO Solution Set – Operational Improvements



Trajectory Management

- **Flexible Entry Times for Oceanic Tracks – 104102**
Flexible Entry Times for Oceanic Tracks – Flexible entry times into oceanic tracks or flows will allow greater use of user-preferred trajectories.
- **Point in Space Metering - 104120**
ANSP uses scheduling tools and trajectory-based operations to assure a smooth flow of traffic and increase the efficient use of airspace.
- **Initial Conflict Resolution Advisories - 102114**
The ANSP conflict probe is enhanced to not only recognize conflicts but to provide rank-ordered resolution advisories to the provider, who may select one of the resolutions to issue to the aircraft. Automation enables ANSP to better accommodate pilot requests for trajectory changes by providing conflict detection, trial flight planning, and development of resolutions and an optimal ranking of resolutions.



TBO Solution Set – Operational Improvements



Capacity Management

- **Flexible Airspace Management - 108206**
ANSP automation supports reallocation of trajectory information, surveillance, communications, and display information to different positions or different facilities.
- **Increase Capacity and Efficiency Using RNAV and RNP - 108209**
Both Area Navigation (RNAV) and Required Navigational Performance (RNP) enable more efficient aircraft trajectories. RNAV and RNP combined with airspace changes, increase airspace efficiency and capacity.

Scenario Objective

- Develop Enterprise–level NAS EA Artifacts
- Improve understanding of operational improvements
- Identify issues and gaps associated with operational improvements
- Promote cross-domain integration



Scenario Summary (1 of 2)

Scenario Name	Associated NAS EA Mid-Term Operational Improvements
Airspace Design	<ul style="list-style-type: none"> ·Flexible Airspace Management (TBO) ·Continuous Flight Day Evaluation (CATM) ·Improved Management of Airspace for Special Use (CATM)
Flight Plan Feedback	<ul style="list-style-type: none"> ·Flight Plan Constraint Evaluation with Feedback (CATM) ·Continuous Flight Day Evaluation (CATM) ·On-Demand NAS Information (CATM)
Manage Daily Allocation	<ul style="list-style-type: none"> ·Continuous Flight Day Evaluation (CATM) ·Flexible Airspace Management (TBO)
Weather Advisories	<ul style="list-style-type: none"> ·Flight Plan Constraint Evaluation with Feedback (CATM) ·Initial Integration of Weather Information into NAS Automation and Decision Making (RWI) ·Initial Improved weather Information from Non-ground Based Sensors (RWI)
Resolve Congestion	<ul style="list-style-type: none"> ·Traffic Management Initiatives with Flight Specific Trajectories (CATM)
Peak Taxi Demand	<ul style="list-style-type: none"> ·Initial Surface Traffic Management (HD) ·Provide Full Surface Situation (Flex) ·Enhanced Surface Traffic Operations (Flex)
Peak Departures	<ul style="list-style-type: none"> ·Initial Surface Traffic Management (HD) ·Enhanced Surface Traffic Operations (Flex) ·Point in Space Metering (TBO) ·Time Based Metering using RNAV and RNP Route Assignments (HD) ·Integrated Arrival/Departure Airspace Management (HD)



Scenario Summary (2 of 2)

Scenario Name	Associated NAS EA Mid-Term Operational Improvements
Peak Arrivals	<ul style="list-style-type: none"> ·Time Based Metering using RNAV and RNP Route Assignments (HD) ·Increase Capacity and Efficiency using RNAV and RNP (TBO) ·Initial Conflict Resolution Advisories (TBO) ·Integrated Arrival/Departure Airspace Management (HD)
Separating Aircraft using Trajectories	<ul style="list-style-type: none"> ·Increase Capacity and Efficiency using RNAV and RNP (TBO) ·Initial Conflict Resolution Advisories (TBO) ·Trajectory Flight Data Management (CATM)
Mixed Environment Operations	<ul style="list-style-type: none"> ·Automation Support for Mixed Environment (TBO) ·Initial Conflict Resolution Advisories (TBO) ·Increase Capacity and Efficiency using RNAV and RNP (TBO) ·Trajectory Flight Data Management (CATM) ·Delegated Responsibility for Separation (TBO) ·Traffic Management Initiatives with Flight Specific Trajectories (CATM)
Flight Requests a Change in Flight Plan	<ul style="list-style-type: none"> ·Trajectory Flight Data Management (CATM) ·On-Demand NAS Information (CATM) ·Trajectory Based Weather Impact Evaluation (RWI)
Precision Approach Operations	<ul style="list-style-type: none"> ·Use Optimized Profile Descent (Flex) ·Increase Capacity and Efficiency using RNAV and RNP (TBO) ·Ground Based Augmentation System (GBAS) Precision Approaches (Flex)

Scenario Content

- NextGen Context
- Assumptions
- Highlighted Operational Improvements (OIs)
- Operational Change
- OV-1s
- High-Level Activity Overview
- Detailed Scenario Activity Walk-Through
- OV-6c
- Issues



Implementation of Trajectory Based Operations

FY 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

2025

Separation Management



Variable Separation - Probed and displayed

- Develop algorithms and display requirements, Develop implementation requirements , Conduct safety case

TSAFE – Conflict Alert Improvements

- Tech Transfer from NASA, Evaluate algorithms and analysis, Develop implementation requirements , Conduct safety case

Trajectory model upgrades to support RNP

- Develop algorithms and display requirements, Develop implementation requirements , Conduct safety case



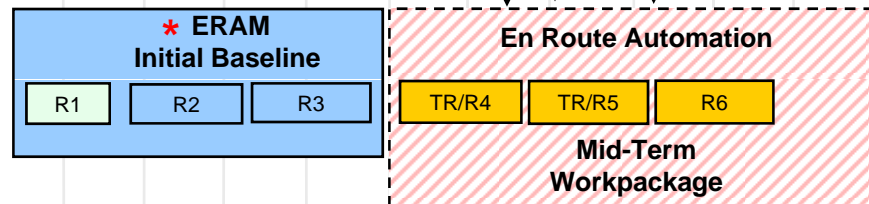
Multi-Sensor Processing – RADAR

- Evaluate alternatives methods, Develop SDP implementation requirements, Conduct safety case



High Altitude Specialty

- Concept of Use for High Altitude, Develop Information Requirements. Prototype display and conduct simulation, Develop implementation requirements, conduct safety case



Implementation of Trajectory Based Operations

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Trajectory Management

Point in-space metering

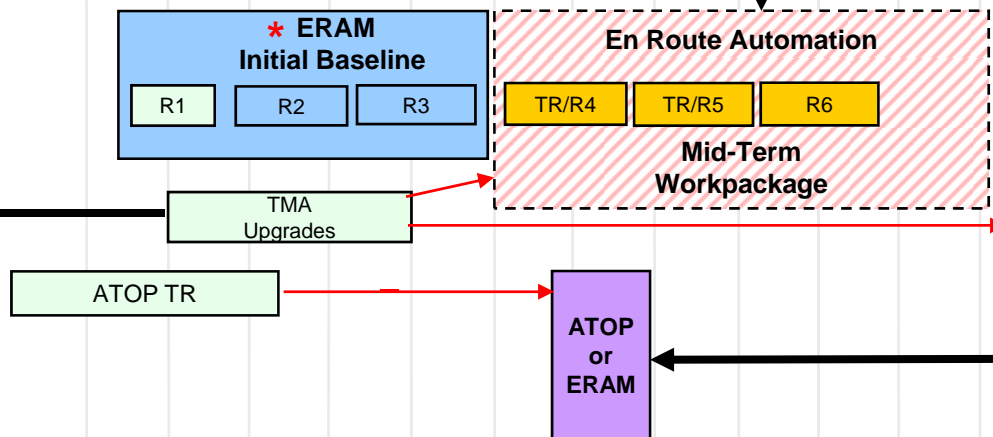
- Tech Transfer from NASA, Field Demonstration, Evaluate algorithms and analysis, Develop implementation requirements , Conduct safety case

Oceanic Trajectory Management

- Conduct field demonstration of Collaborative Trajectory Planner – Oceanic , Develop Web-based CTP
- Develop algorithms and display requirements, Develop implementation requirements

Resolution Advisories

- Tech Transfer MITRE – Evaluate algorithms, Develop display and implementation requirements, Conduct Safety Case



Implementation of Trajectory Based Operations

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Capacity Management - RNAV Network



NextGen DME

- Identify coverage gaps for RNP Above FL180 and major terminal areas, develop DME requirement to fill gap, Site DMEs, procure and install



For additional information on NextGen

please visit the website:

<http://www.faa.gov/nextgen>

