NAS EA 2018 OV-6c: Operational Scenarios

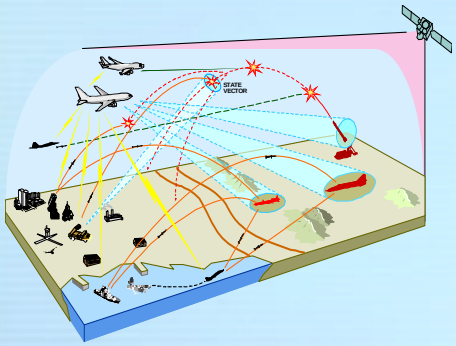
June 24, 2009

Presented by: MITRE/CAASD

Presented for: FAA NAS EA Conference

Product Overviews

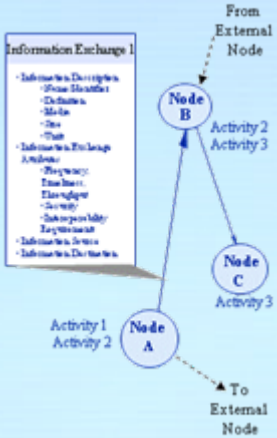
High-Level Operational Concept Description (OV-1)



High-level graphical description of the operational concept of interest

Provides a quick orientation for architecture audience and decision makers

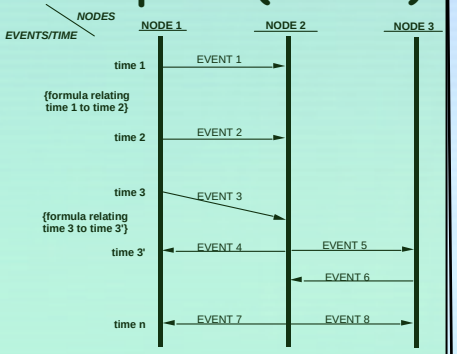
Operational Node Connectivity Description (OV-2)



Operational nodes, activities performed at each node, node-to-node relationships, and information needlines

Shows who produces information and who uses it

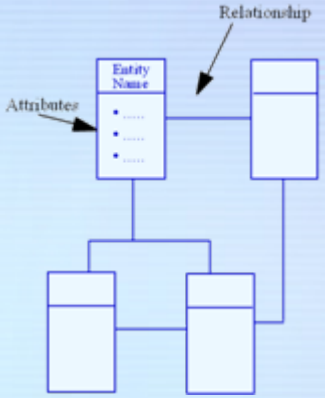
Operational Node Connectivity Description (OV-6c)



Provides a time-ordered examination of the information exchanges between participating operational nodes as a result of a particular scenario

Valuable for moving to the next level of detail from initial operating concepts

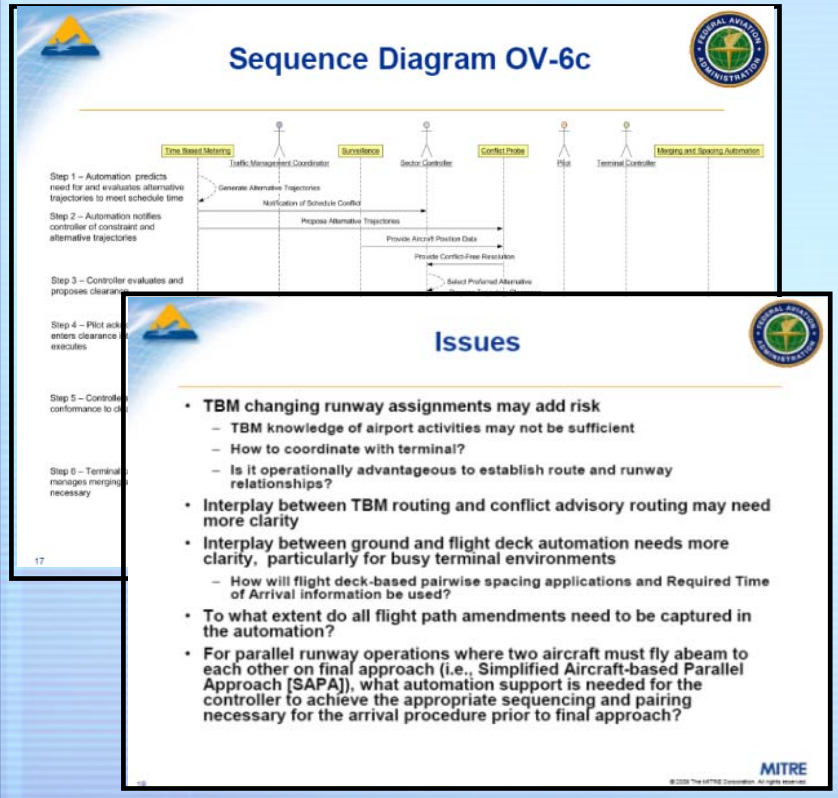
Logical Data Model (OV-7)



Describes the structure of an architecture domain's system data types, their attributes as well as interrelationships

Supports interoperability between architectures, since these definitions may be used by other organizations to determine system data compatibility

OV-6c Scenario Framework: Objective & Approach (1 of 2)



- Objective
  - Develop Enterprise–level NAS EA Artifacts
  - Improve understanding of NextGen operational improvements (OIs)
  - Identify issues associated with operational improvements
    - Will help to define requirements and follow-on research activities
- Initial scenarios (16 total) developed between FAA Concept Development Group, NextGen I&I, and NAS EA
  - Focus on FY08 Mid-Term NextGen Implementation Plan OIs
- Scenario described in briefings with narrative text and operational diagrams/models using selected DoDAF Operational Views (OVs)
  - OV-1: Concept Graphic
  - OV-6c: Sequence diagram

OV-6c Scenario Framework: Objective & Approach (2 of 2)

- Focus is to develop consensus understanding of OIs
  - Scenarios are coordination/discussion mechanisms
- Developed to describe end of the Mid-Term (2018)
- Emphasis on describing enterprise-level operations and not systems
  - Leverages ongoing detailed ConOps / ConUse efforts (e.g., Big Airspace)
- Intentionally cross-domain to emphasize integrated ATM operations
- Not intended to be exhaustive scenario list
  - Initial focus on 'plain vanilla' nominal scenarios
  - Develop additional scenarios as needed
    - Equipment failure, with or without Data Comm, etc.

Scenario Summary (1 of 4)

Scenario Number	Scenario Name	Description	Associated NAS EA Mid-Term Operational Improvements
1	Airspace Design	The airspace designer reviews historical performance as well as airport and special airspace requests to tailor airspace configurations to address routine performance needs.	• Flexible Airspace Management (TBO) • Continuous Flight Day Evaluation (CATM) • Improved Management of Airspace for Special Use (CATM)
2	Flight Plan Feedback	The flight planner develops flight trajectories and objectives with the benefit of feedback on potential constraints from initial intent to filed flight plan.	• Flight Plan Constraint Evaluation with Feedback (CATM) • Continuous Flight Day Evaluation (CATM) • On-Demand NAS Information (CATM)
3	Manage Daily Allocation	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.	• Continuous Flight Day Evaluation (CATM) • Flexible Airspace Management (TBO)
4	Weather Advisories	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.	• 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)

Scenario Summary (2 of 4)

Scenario Number	Scenario Name	Description	Associated NAS EA Mid-Term Operational Improvements
5	Resolve Congestion	A traffic management specialist determines when the conditions warrant taking action to resolve congestion and issues flight specific adjustments to alleviate the congestion.	• Traffic Management Initiatives with Flight Specific Trajectories (CATM)
6	Peak Taxi Demand	This Scenario demonstrates how surface automation capabilities provide for more efficient means of surface operations. Primary focus is on improved taxi routing and conformance monitoring operations.	• Initial Surface Traffic Management (HD) • Provide Full Surface Situation (Flex) • Enhanced Surface Traffic Operations (Flex)
7	Peak Departures	This Scenario highlights the use of automated collaborative scheduling capabilities and the use of time based metering and RNAV and RNP routes to improve departure operations.	• 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)
8	Peak Arrivals	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.	• 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)

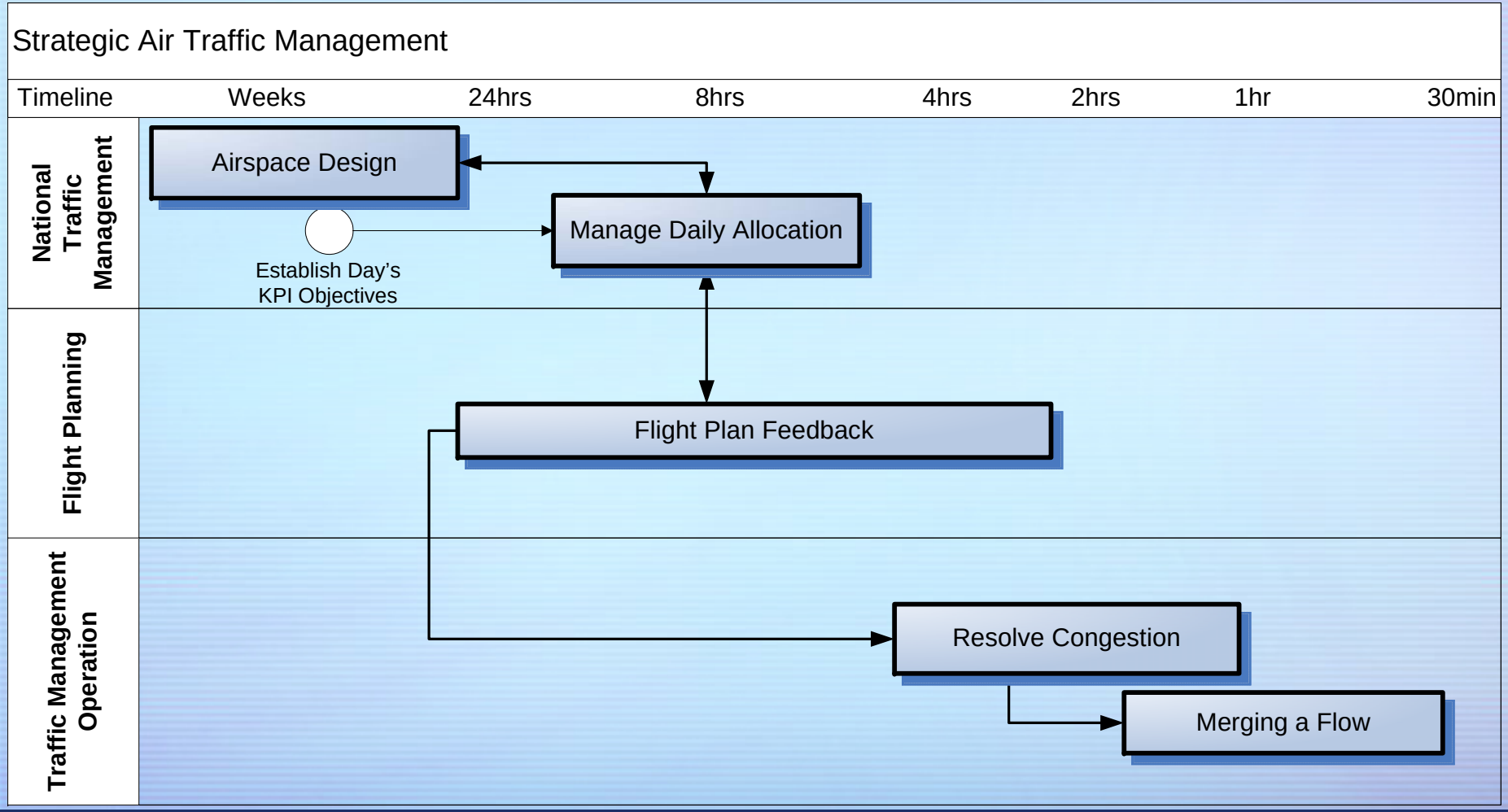
Scenario Summary (3 of 4)

Scenario Number	Scenario Name	Description	Associated NAS EA Mid-Term Operational Improvements
9	Separating Aircraft using Trajectories	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.	• Increase Capacity and Efficiency using RNAV and RNP (TBO) • Initial Conflict Resolution Advisories (TBO) • Trajectory Flight Data Management (CATM)
10	Mixed Environment Operations	This thread illustrates complex mixed environment situations requiring automation support for controller situation awareness and separation management. Following a position relief briefing a set of near-simultaneous events occurs 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 a separation problem for an aircraft with a planned climb 5.A TMI is issued to reroute arrival stream to join alternate RNAV STARs as a result of terminal airspace reconfiguration.	• 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)
11	Flight Requests a Change in Flight Plan	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 provide clearance, the Strategic Controller prepare for the likely cascade of requests by reviewing how to address the intent options of each.	• Trajectory Flight Data Management (CATM) • On-Demand NAS Information (CATM) • Trajectory Based Weather Impact Evaluation (RWI)
12	Precision Approach Operations	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.	• Use Optimized Profile Descent (Flex) • Increase Capacity and Efficiency using RNAV and RNP (TBO) • Ground Based Augmentation System (GBAS) Precision Approaches (Flex)

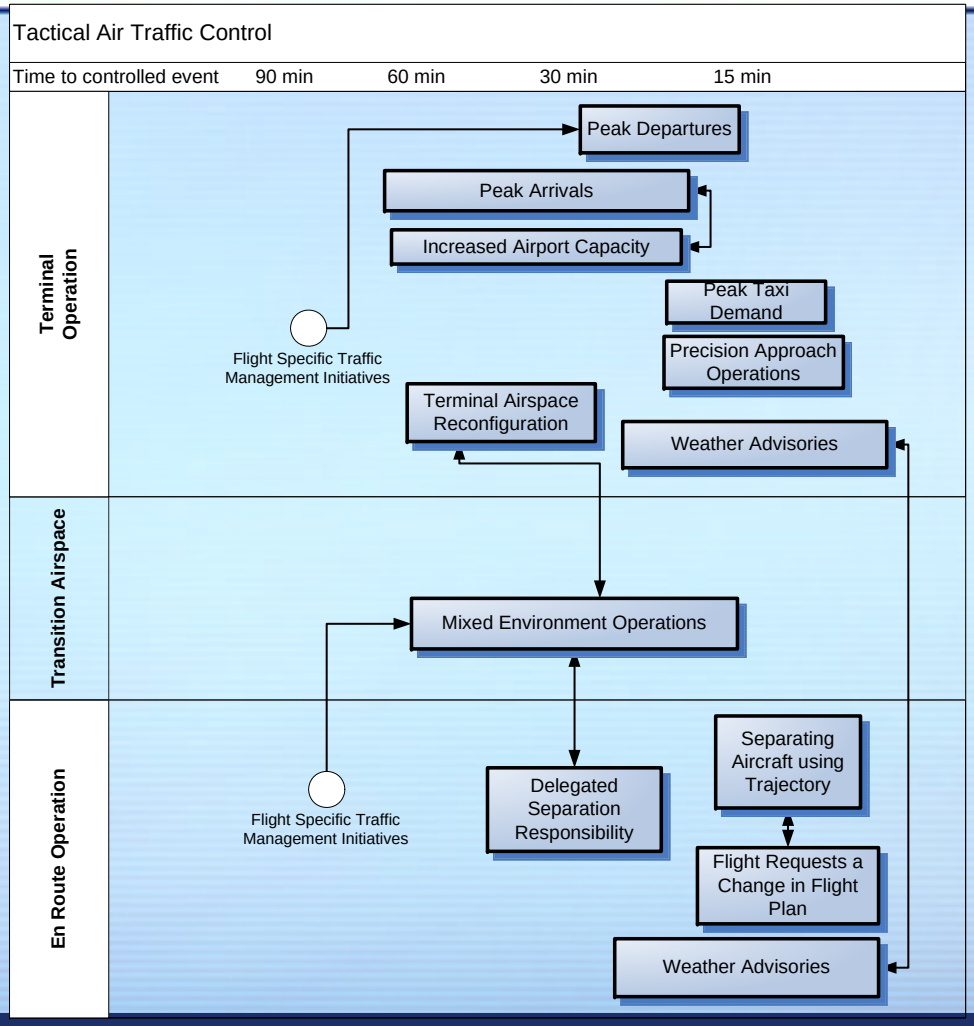
Scenario Summary (4 of 4)

Scenario Number	Scenario Name	Description	Associated NAS EA Mid-Term Operational Improvements
13	Delegated Separation Responsibility	For appropriately equipped aircraft the controller has the option of delegating responsibility for separation between two aircraft. This scenario only illustrates delegated spacing in the en route environment (terminal is covered by another Operational Improvement).	• Delegated Responsibility for Separation (TBO)
14	Merging a Flow	This scenario describes the Air Traffic Control (ATC) Strategic Controller'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 Strategic Controller 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.	• Point-in-Space Metering (TBO) • Time-Based Metering using RNAV and RNP Route Assignments (HD) • Automation Support for Mixed Environment (TBO)
15	Increased Airport Capacity	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.	• Improved Operations to Closely Spaced Parallel Runways (HD) • Wake Turbulence Mitigation for Departures (Flex) • Automation Support for Mixed Environments (TBO)
16	Terminal Airspace Re-Configuration	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.	• Integrated Arrival/Departure Airspace Management (HD) • Continuous Flight Day Evaluation (CATM) • Trajectory Flight Data Management (CATM) • Increased Capacity and Efficiency using RNAV and RNP (TBO) • Flexible Airspace Management (TBO)

Mid-term Scenario Linkage: Strategic Planning



Mid-term Scenario Linkage: Tactical Execution



OV-6c Scenarios: Content Overview

- Word Document
  - Provides context and summary descriptions for each scenario
- Briefing Package
  - NextGen Context- Provide general context for how the scenario fits within the NextGen concept.
  - Assumptions- Includes any assumptions associated with the scenario. This may include assumptions such as new information requirements, key technology enablers, equipage levels, performance based aircraft requirements etc.
  - Highlighted Operational Improvements (OIs)- List of OIs that apply to the scenario with descriptions of applicable portions of the OI that contribute to the scenario.
  - Operational Change: Table that contains for each operational change a descriptions of the current process, the changes to the future process (e.g., improved data, more frequent updates, level of automation assistance, etc) and the benefits of the change (e.g., increased IMC arrival rates).
  - OV-1s: A high-level OV-1 that describes both present (as-is) and future (to-be) operations.
  - High-Level Activity Overview: Provide a slide depicting a step-by-step sequence of activities that will be used to describe the scenario
  - Detailed Scenario Activity Walk-Through: For each activity, a slide with text that describes the activities in greater detail.
  - Sequence Diagram: OV-6c Sequence diagrams that captures the previously described activities, associated operational actors/functional capabilities, and information flows.
  - Issues: Open issues in operational improvements (e.g., needed functionality for operational scenario is not described in any current OI) that have been identified

Next Steps

- Incorporate feedback from FAA reviews for final submission in September
  - Ops SME workshops and other review sessions
- Leverage OV-6c sequence diagrams to develop mid-term OV-5 activity models and automation requirements
- Explore implementation in data architect tool

Back-up:
Sample Scenario for Terminal Airspace Reconfiguration

NAS EA OV-6c Scenario 16: Terminal Airspace Re-Configuration

April 2009

NextGen Scenario Context

- Scenario concerned with tactical options rather than long term (e.g., 2-3 hrs) planning
- Scenario highlights a Big Airspace[1] (BA) facility during heavy traffic
  - This scenario is closely related to the 'Manage Daily Allocation' scenario. Non-BA facilities would have similar operations but without the BA benefits
  - 'Managing Arrivals During Peak Banks' scenario addresses more details of the arrival operation
- Weather in scenario occurs within BA facility boundaries

1.The concept of Big Airspace is explained on future slides.

Scenario Assumptions

- Aircraft are Area Navigation (RNAV) equipped; satellite airports will support mixed equipage operations (e.g., non-equipped aircraft)
- Conflict probe remains available in transition sector airspace
- Flexible Airspace Operational Improvement (OI) does not apply to traditional terminal airspace

Highlighted Operational Improvements 1 of 2

- Integrated Arrival/Departure Airspace Management
  - Concept and Benefits covered in later slides
- Continuous Flight Day Evaluation
  - 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)
- Trajectory Flight Data Management
  - Provides improved flight data coordination between facilities
  - Manages data based on volumes of interest that can be redefined to meet changes to airspace/routings
- Increased Capacity and Efficiency Using RNAV and Required Navigation Performance (RNP)
  - Terminal and en route procedures will be designed for more efficient spacing and will address complex operations

Highlighted Operational Improvements 2 of 2

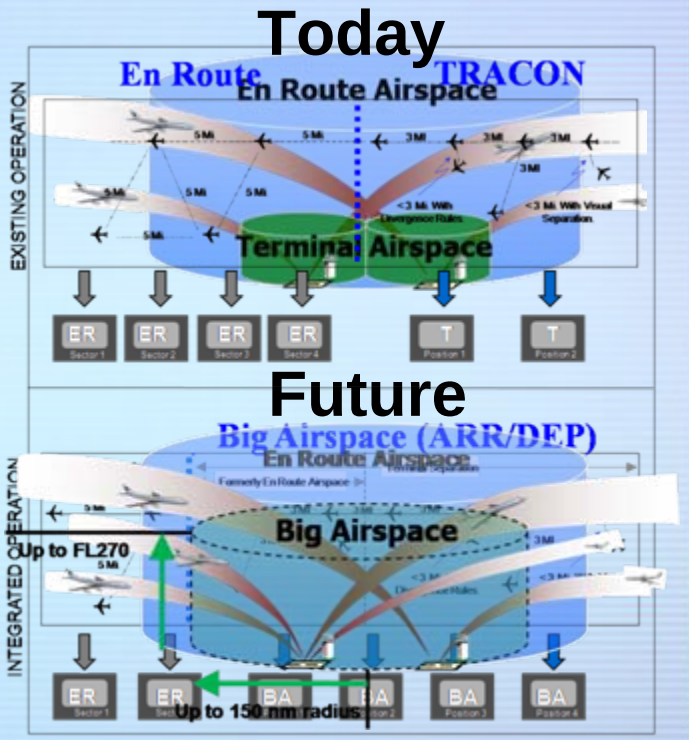
- Flexible Airspace Management
  - ANSP automation supports reallocation of trajectory information, surveillance, communications and display information to different positions or different facilities
  - Automated tools to support assessment of alternate configurations and remapping of information to appropriate positions

Evolution Context for Operations

Solution Set	Operational Improvement	FY 08	FY 09	FY 10	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17	FY 18	FY 19	FY 20
Increase Arrivals/ Departures At High Density Airports	Integrated arrival/departure airspace management													
Improve Collaborative ATM	Trajectory Flight Data Management													
	Continuous Flight Day Evaluation													
Initiate Trajectory Based Operations	Increased Capacity and Efficiency Using RNAV and RNP													
	Flexible Airspace Management													

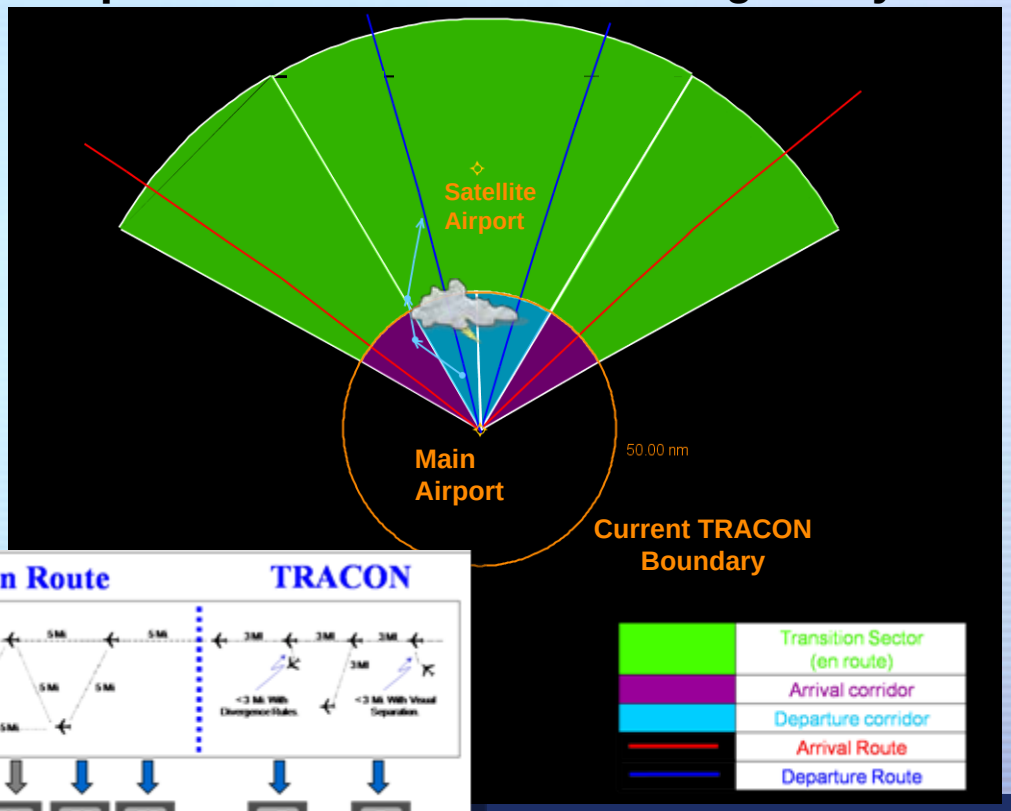
Integrated Arrival/Departure Service Concept Operational Change

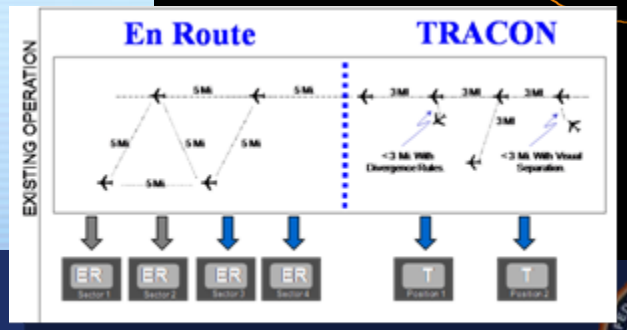
Current Ops. Description	Operational Change	Benefits
TRACON boundary is close to runway so limited space to set up departures for differing separation standards causing delays	Expanded lateral & vertical airspace boundaries under control by single facility	-Supports seamless transition of arrivals and departure -Allows for greater airspace capacity and efficiency
3 Nautical Mile (NM) separation standards and terminal procedures apply to terminal airspace. En route (5nm) separation standards apply to transition airspace.	Expanded use of 3 Nautical Mile (NM) separation standards and terminal procedures to include all BA airspace	Enabling increase in number of route options & reduction in flight time
Requires manual coordination and collaboration between multiple facilities when tactical maneuvers occur	Increased Airspace & control services in a single facility	Increasing efficiency of coordination
Some airports have implemented RNAV procedures, but there exists limited route flexibility due to airspace constraints	Additional RNAV & RNP arrivals and departures	Resulting in increased throughput
Bidirectional Routes, i.e. pre-defined dynamic airspace re-configurable to support either arrival or departure flows, difficult to manage due to inter-facility coordination.	Bidirectional Routes, i.e. pre-defined dynamic airspace re-configurable to support either arrival or departure flows, enabled by coordination within a single facility	Allowing for tactical airspace changes to efficiently address airspace capacity changes, and reduce delay
Manual assessment of operational constraints	Traffic Flow Management (TFM) decision support capabilities	Enabling and enhancing the use of additional routes/ airspace configurations and improving throughput while reducing delays



Current Operations OV-1

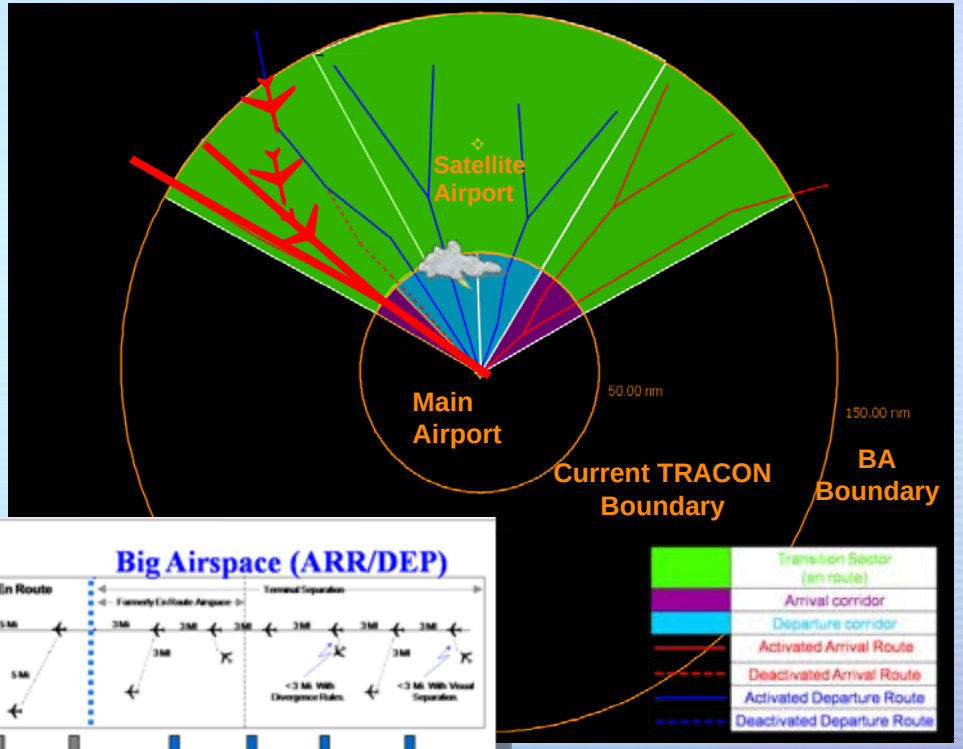
- Limited maneuverability and route flexibility due to airspace constraints
- TRACON boundaries (laterally and vertically) limit space to set up departures for increased en route separation standards causing delays
- Sizable coordination required when tactical maneuvers occur (e.g., vectoring into adjacent terminal areas of control)
- Coordination may require participation by Command Center and/or ARTCC and/or other TRACON facilities

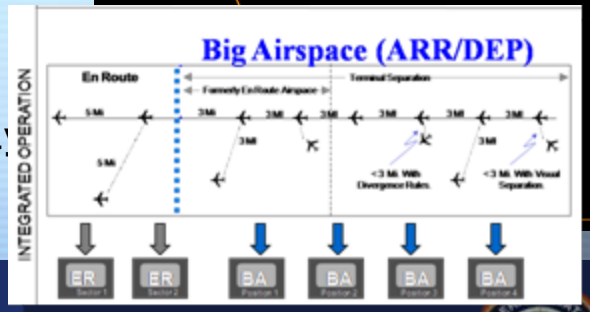




Future Operations OV-1

- Airspace assigned terminal separation standards and procedures are expanded (laterally and vertically). Enabled by enhanced surveillance data processing.
  - Increased options and predictability due to more predefined RNAV routes
  - Allows for greater maneuverability of traffic
- Predefined bi-directional routes and configurations allow for greater flexibility of airspace
- Easier communication and coordination between terminal, transition sectors, and satellite airports because all are managed by a common control service within a single facility
- Automation tool to determine operational constraints
  - Enabled by 'Continuous Flight Day Evaluation' OI





High level Activity Overview
Terminal Airspace Reconfiguration

Step 0: Airspace is configured according to the baseline plan for flight day.

Step 1: TFM automation determines there is a status change for a portion of airspace and notifies BA traffic management coordinator (TMC).

Step 2: BA TMC evaluates predefined alternate RNAV SIDs and STARs and reconfiguration. BA TMC collaborates with BA front line manager (FLM) to make a decision.

Step 3: ANSP identifies which upstream arrival aircraft will be last to use arrival route before it is deactivated.

Step 4: Selected RNAV SID(s) and STAR(s), and reconfiguration are coordinated within BA facility and with adjacent facilities.

Step 5a: ANSP manually deactivates arrival route, activates departure route, and performs predefined reconfiguration.

Step 5b: Upstream facility issues reroute clearances to affected flights in en route airspace. Tower issues reroute clearances to affected surface traffic.

Step 6: Controller maintains responsibility of aircraft separation and monitors flight conformance to RNAV procedures.

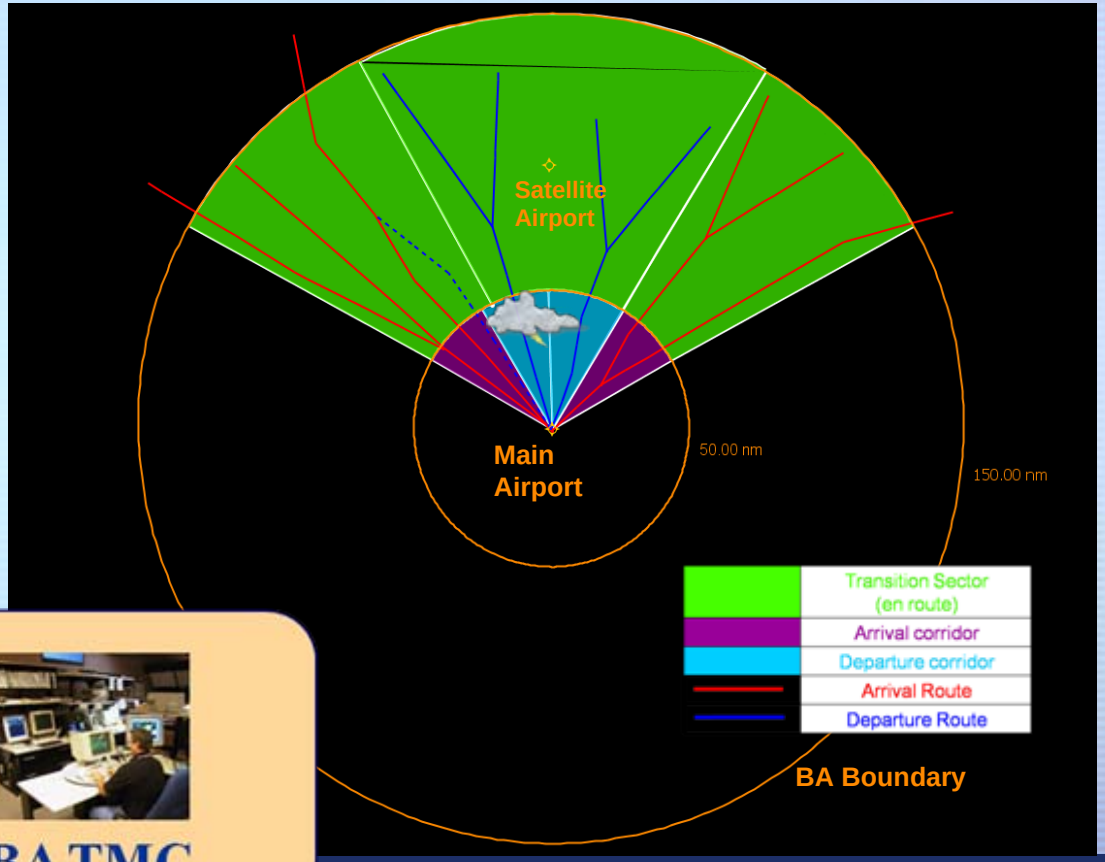
Step 0: Airspace is configured according to the baseline plan for flight day.

- ‘Manage Daily Allocation’ scenario describes how the baseline plan is determined
  - Baseline plan includes predefined airspace configurations (sector boundaries and airspace volume definitions) and selected routes for the flight day (or part of the flight day depending on predicted weather)
  - Baseline plan also includes a schedule for changing between configurations (to account for nominal changes in arrival and departure rushes not impacted by unexpected weather)
  - Takes into account airspace capacity, forecasted weather, and scheduling throughout the day

Step 1: TFM automation determines there is a status change for a portion of airspace and notifies BA traffic management coordinator (TMC).

- TFM automation determines that operational constraints, such as weather, will cause demand within a portion of airspace to exceed its capacity

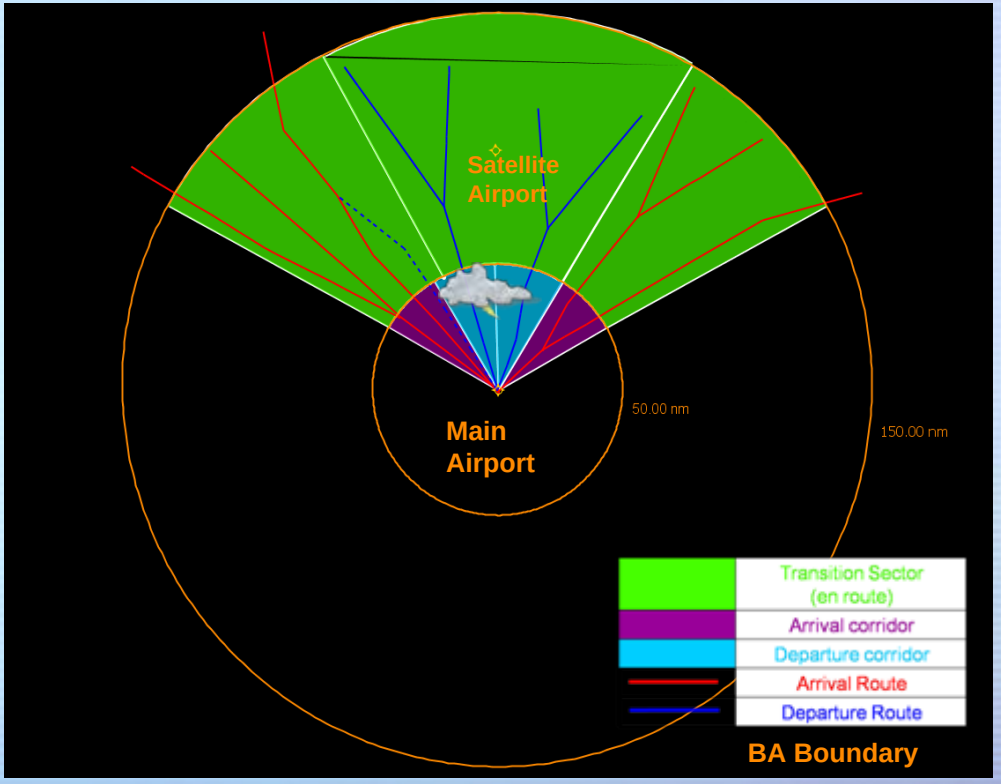
- TFM automation notifies BA TMC of the operational constraint, and indicates which flights are affected



Step 2: BA TMC evaluates predefined alternate RNAV SIDs and STARs and reconfiguration. BA TMC collaborates with BA front line manager (FLM) to make a decision.

- BA TMC manually evaluates predefined routing and reconfiguration options considering all available information
  - See 'Manage Daily Allocation' scenario for more details

- BA provides increased options
  - More predefined RNAV routes due to expanded use of 3 NM separation
  - More airspace is controlled by the same facility
  - Availability of bi-directional routes
- BA TMC collaborates with BA FLM(s) to evaluate and select one of the predefined options for implementation

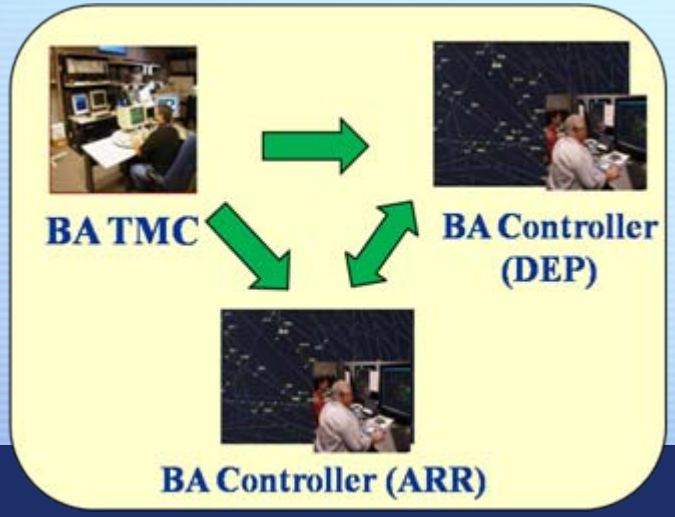


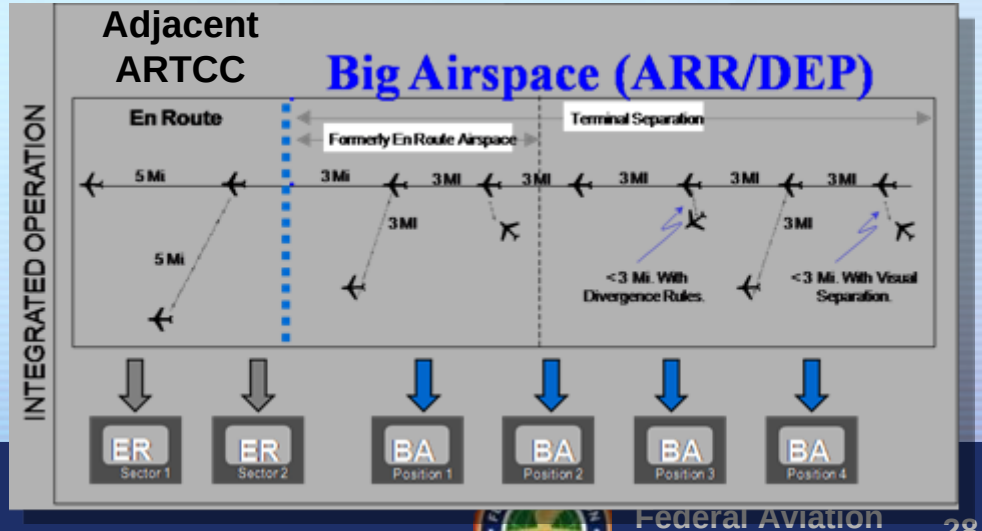
Step 3: ANSP identifies which upstream arrival aircraft will be last to use arrival route before it is deactivated.

- ANSP decides which arrival aircraft will be last to use arrival route before it is deactivated and which arrival aircraft will be the first to be rerouted to alternate STAR
  - May be TMC role, FLM role, or a collaboration between both

Step 4: Selected RNAV SID(s) and STAR(s), and reconfiguration are coordinated within BA facility and with adjacent facilities.

- Selected RNAV SID(s) and STAR(s) and reconfiguration are coordinated within BA facility
  - Controllers, managers, and supervisors responsible for the expanded airspace are all within a single facility, reducing the need for inter-facility coordination
- Selected RNAV SID(s) and STAR(s) and reconfiguration are also coordinated with tower, adjacent en route facilities, and others as appropriate
  - Includes coordination with the Command Center (if necessary)





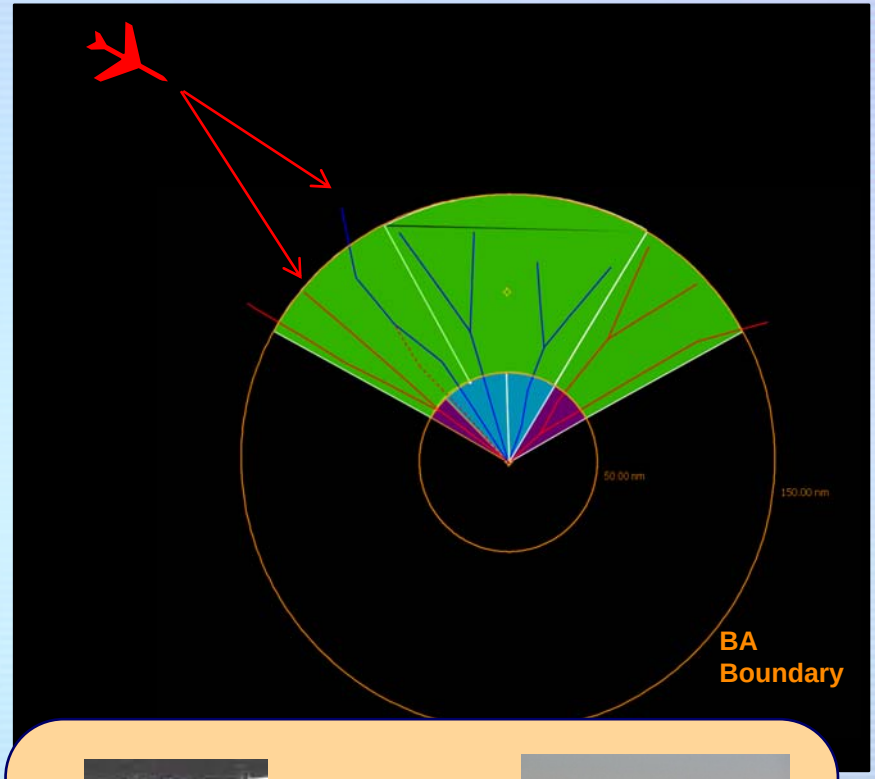
Step 5a: ANSP manually deactivates arrival route, activates departure route, and performs predefined reconfiguration.

- Flights allocated to use arrival route before it is deactivated are allowed to clear the airspace
- ANSP manually deactivates arrival route, activates departure route, and performs predefined reconfiguration
  - May be accomplished through a clearance and/or a system-wide message
- Coordination with other facilities to deactivate arrival route, activate departure route, and perform reconfiguration manually
- Airborne traffic (that entered the airspace before the switch) are individually rerouted, as appropriate
  - Changes to trajectory are updated in the system

BA TMC

Step 5b: Upstream facility issues reroute clearances to affected flights in en route airspace. Tower issues reroute clearances to affected surface traffic.

- Flights in en route airspace are rerouted to join alternate RNAV STAR(s) by upstream facility
  - Automation will have evaluated the reroute and provide conflict resolutions as needed (see the 'Initial Resolution Advisories' OI)
    - See 'Resolve Congestion' scenario for more details
- Tower controller issues alternate RNAV SID(s) clearance via uplink (or voice when necessary) to surface traffic
  - Use of manual and automated methods for issuing reroutes
    - See 'Resolve Congestion' scenario for more details

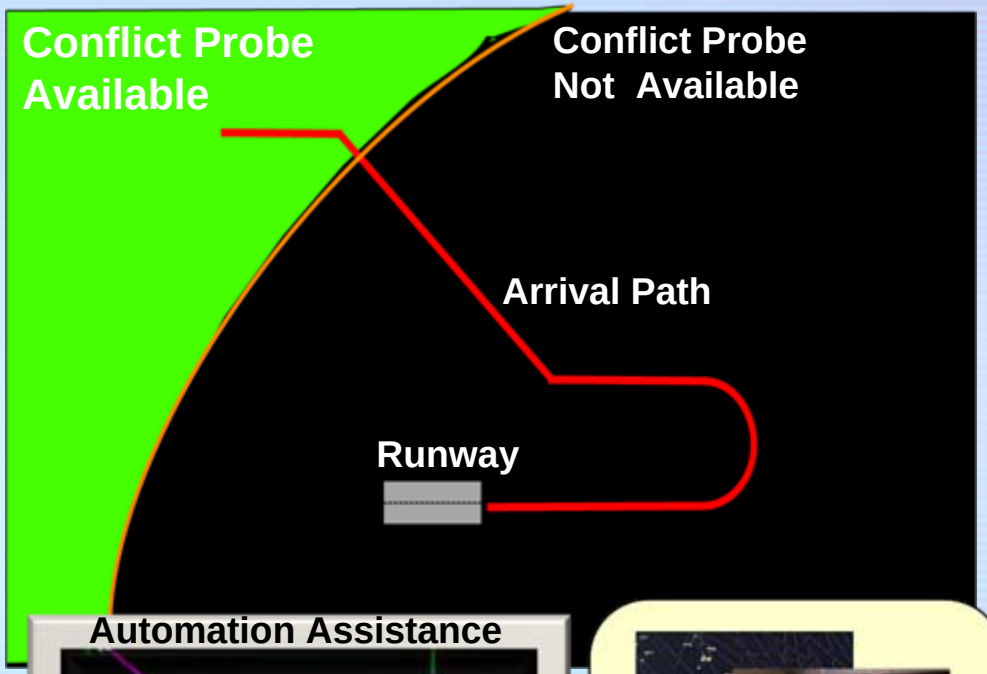


Tower Controller

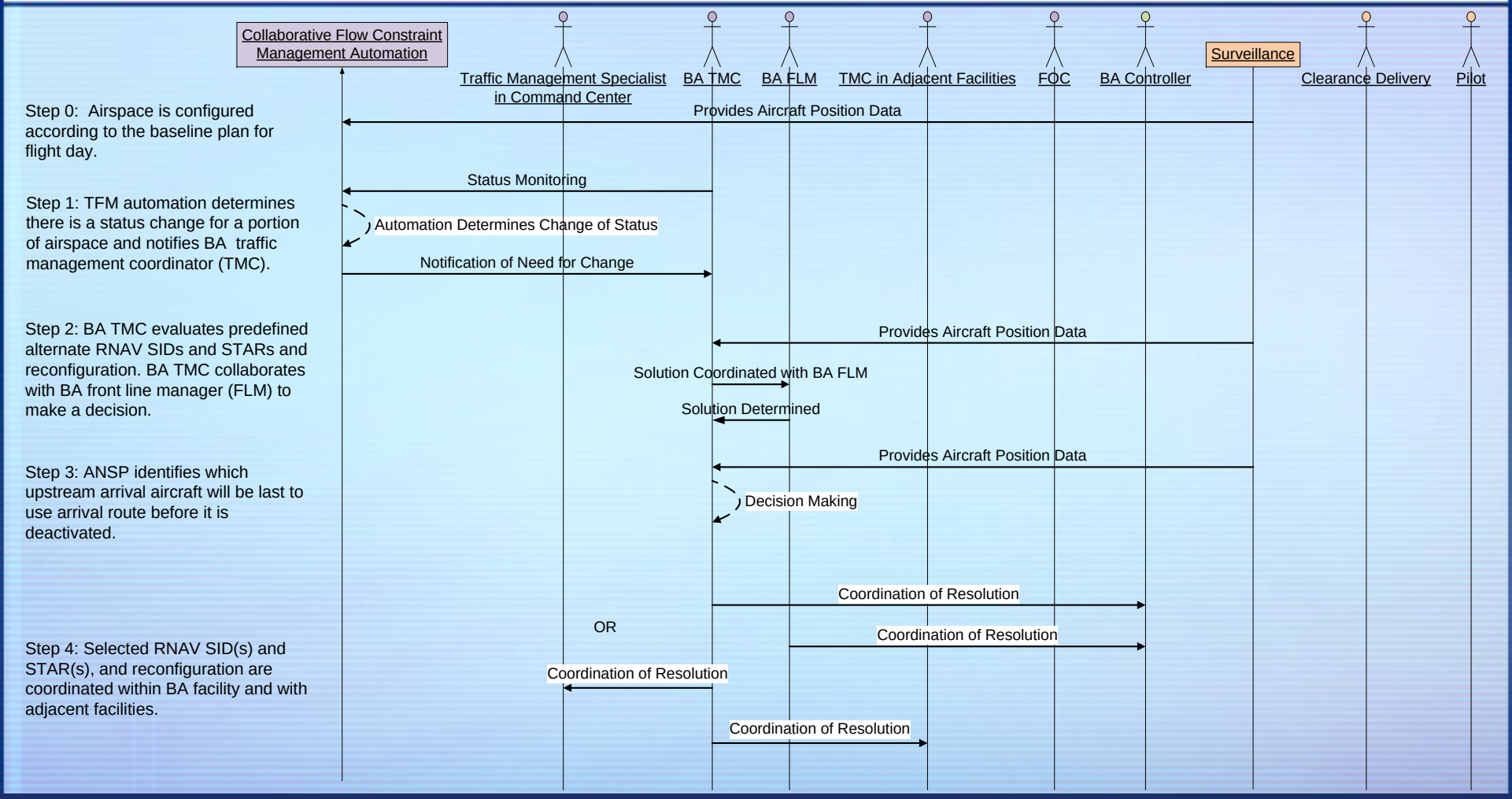
Departures

Step 6: Controller maintains responsibility of aircraft separation and monitors flight conformance to RNAV procedures.

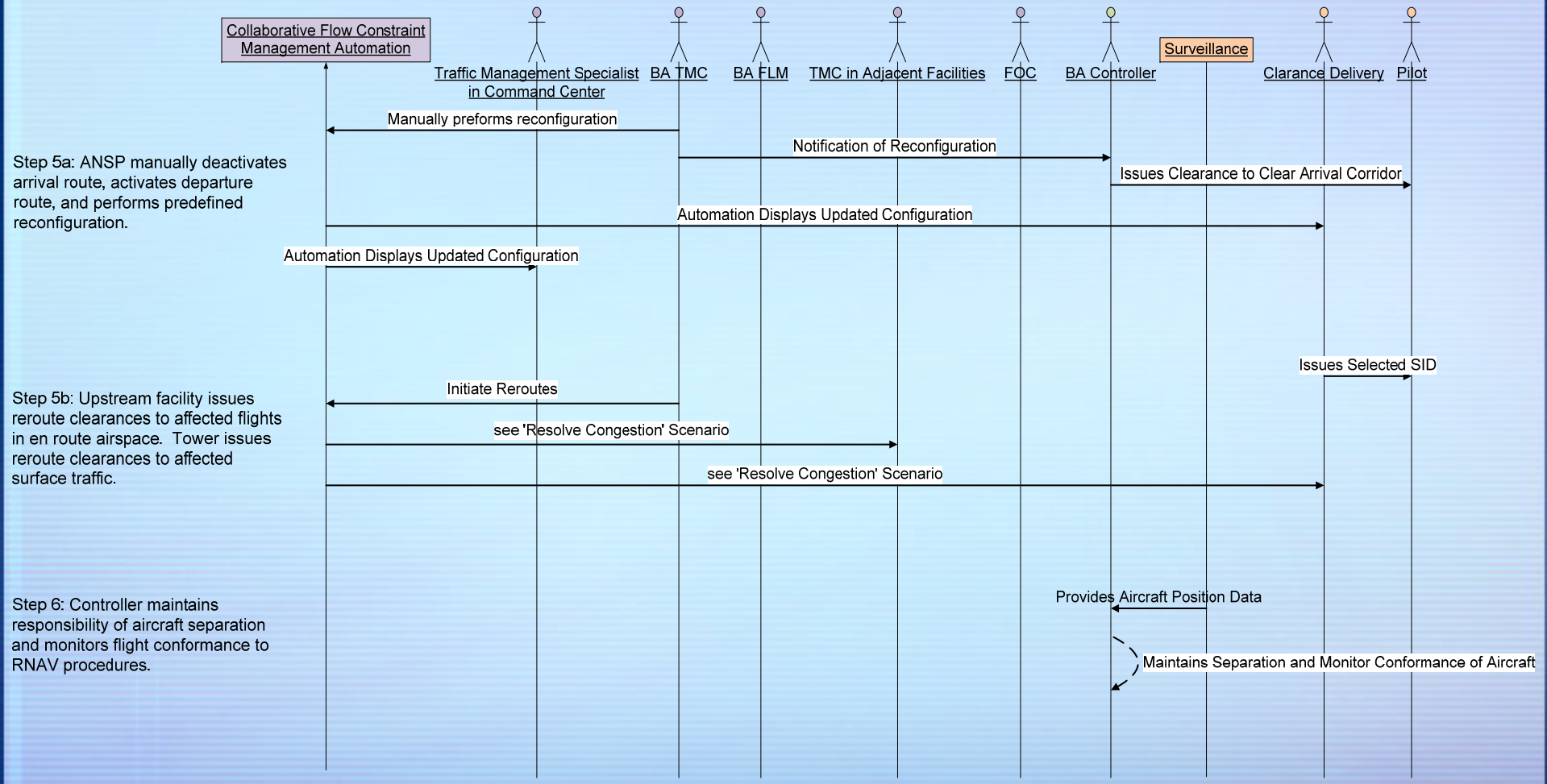
- Controller maintains responsibility for aircraft separation and monitoring flight conformance to the constraints defined by RNAV procedures
- Manual methods may be used
- Controllers may be assisted by automation for monitoring aircraft conformance to the constraints of the procedure including compliance with navigation performance required
- Other automation for merging and spacing described in 'Managing Arrivals During Peak Banks' scenario



Sequence Diagram OV-6c



Sequence Diagram OV-6c (continued)



Gaps in the NGIP

- Automation to support the ability to reconfigure airspace (i.e., evaluate, coordinate, and execute)
- May need improved flight data management automation support at position in a BA facility. Current plans for BA describe this capability available for radar associate consoles only.

Issues

- How dependent will effective rerouting be upon high levels of aircraft data communication equipage?
- Is data communication with FMS integration required to more efficiently reroute aircraft?
- Problem Detection and Resolution adjustment to support terminal separation rules and procedures in transition airspace
- What TMC initiates rerouting outside BA facility? Is this coordinated via automation between the BA TMC and other TMCs?