Weather Integrated into 4D Trajectory Tools

FAA NextGen Plans

Federal Aviation Administration

Presented to: Friends/Partners in Aviation Weather

By: Steve Bradford, Chief Scientist Architecture and NextGen Development

Date: 15 July 2008

Agenda

- **Provide a look at NextGen with respect to trajectory based operations and weather**
  - Near-term
 - Mid-term
  - Long-term

NextGen: Improving Service Delivery

Today's NAS

Ground-based Navigation and Surveillance

Air Traffic Control Communications By Voice

Disconnected Information Systems

Air Traffic "Control"

Fragmented Weather Forecasting

Airport Operations Limited By Visibility Conditions

Forensic Safety Systems

NextGen

Satellite-based Navigation and Surveillance

Clearance Trajectories and Routine Information Sent Digitally

Information More Readily Accessible

Air Traffic "Management"

Forecasts Embedded into Decisions

Operations Continue Into Lower Visibility Conditions

Prognostic Safety Systems
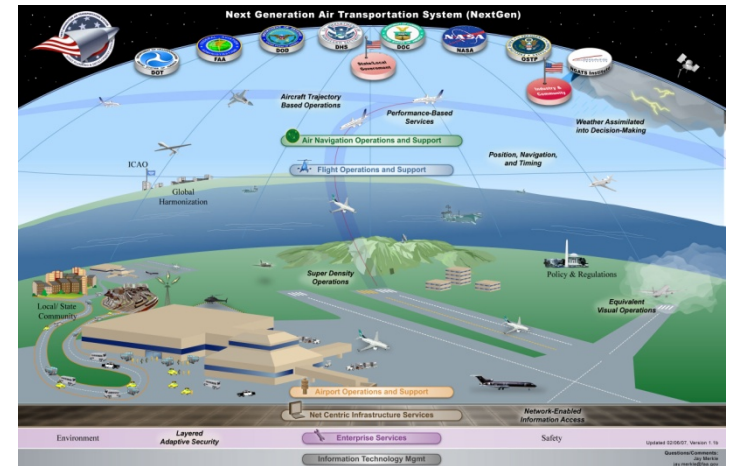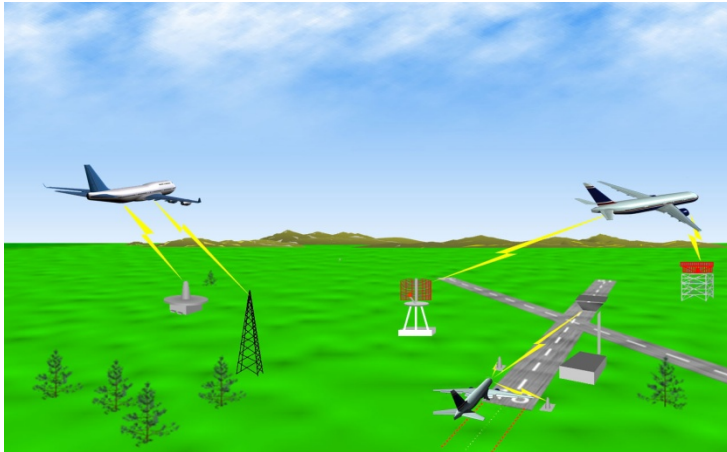
En Route Congestion
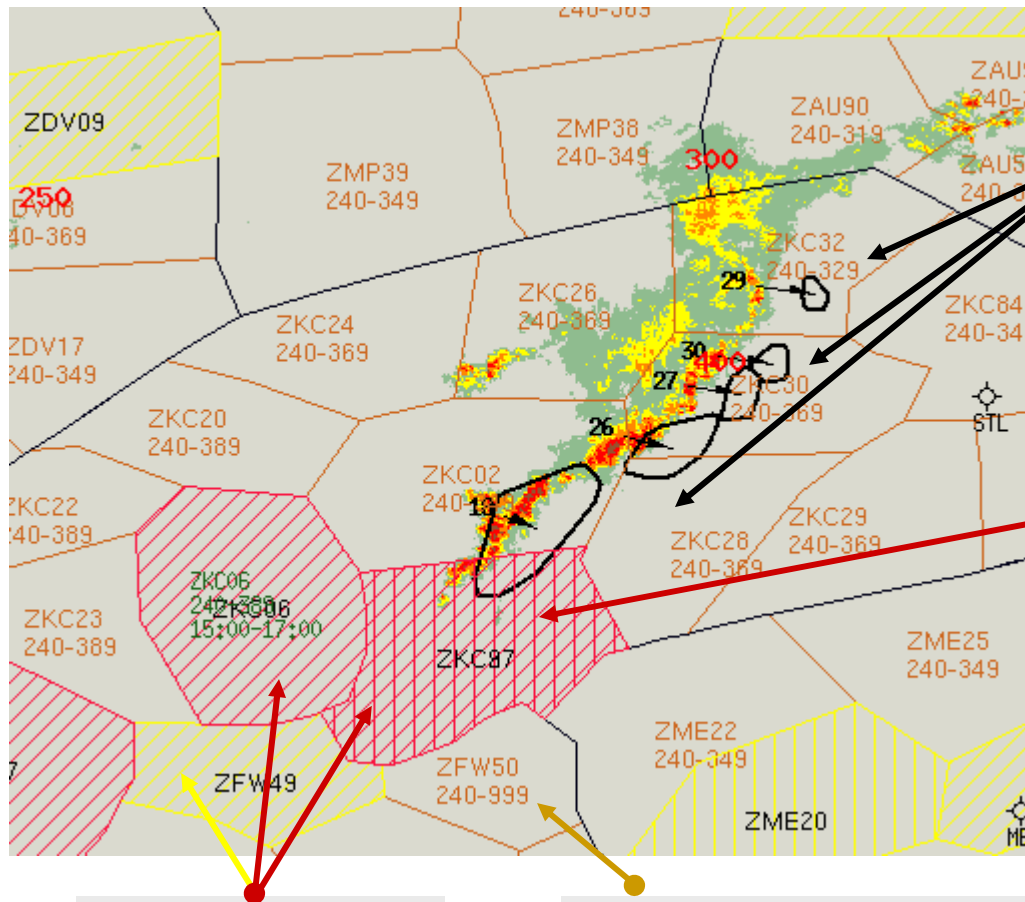
Uncertain weather forecasts indicate current and future loss of airspace capacity...

Uncertain traffic forecasts provide airspace demand...

If demand exceeds capacity, delays will occur and safety may be compromised.

Given the uncertainty:
When should air traffic be restricted?
Which flights should be affected?
How do NAS operators participate?

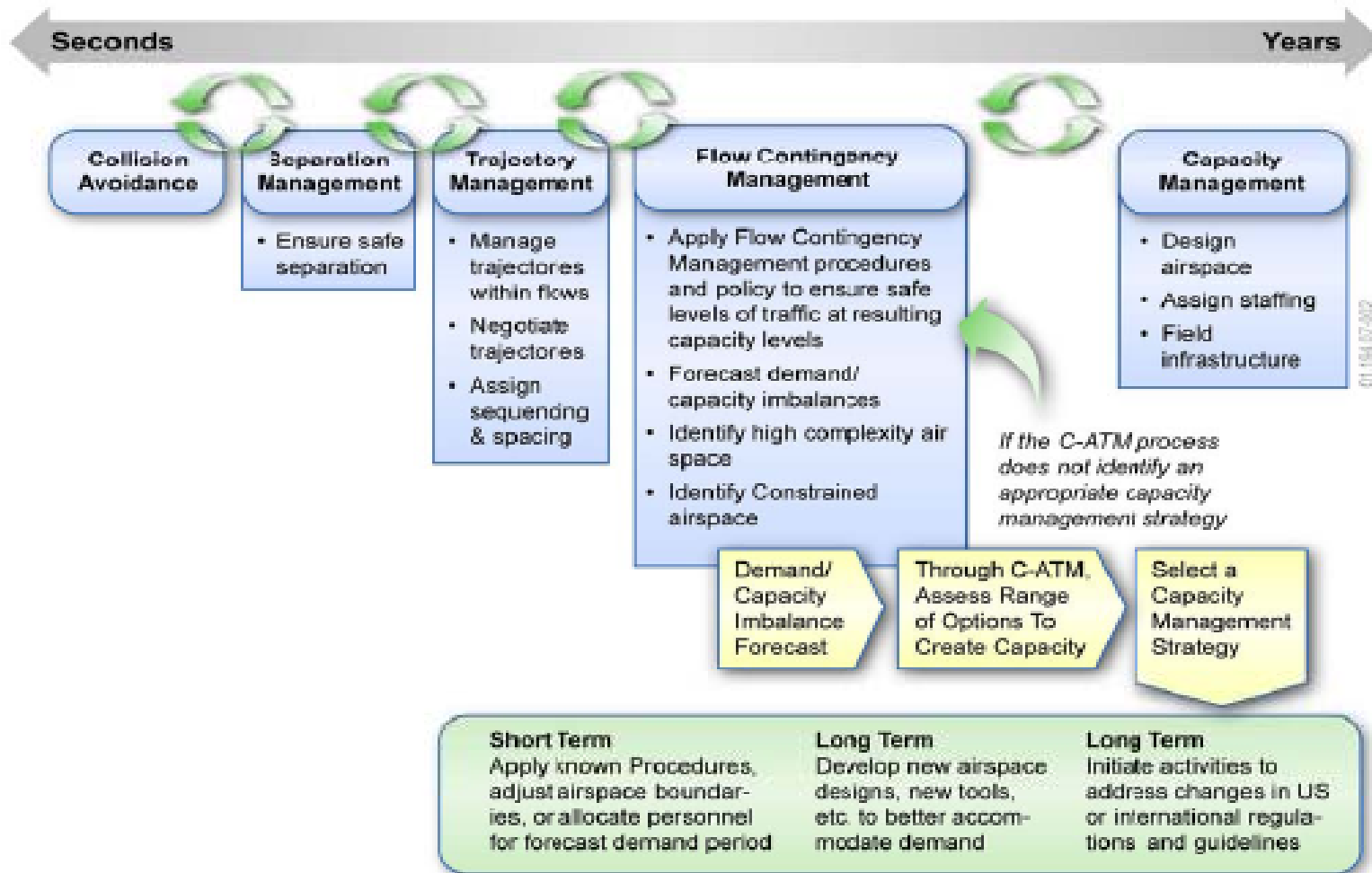Congestion Alerts

Air traffic control sector

Scope

- **Integration into decision support to tactical and strategic flow initiatives**
  - Traffic flow initiatives are exercised specifically in response to forecast and present WX conditions to segregate aircraft operations from specific areas.
  - The net effect is the "separation" of streams of aircraft from individual or large-scale meteorological phenomena.
  - Not "separation"

  Extracted from an ATO paper on separation from weather

ATM NextGen Framework

Figure 2-2. ATM Decisions—Interactive and Integrated Across Time Horizons

Near-term

Near-Term: Today - 2012

Applying NextGen Capabilities Today To Relieve Congestion

Federal Aviation Administration

RNAV/RNP Deconflict

RNAV/RNP Deconflict

Acronyms

ASDE-X
Airport Surface Detection Equipment-Model X

RNP
Required Navigation Performance

RNAV
Area Navigation

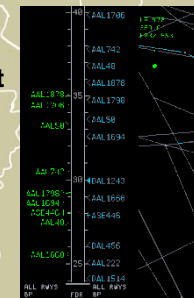**TMA**
Traffic Management Advisor

ORD ORD

MDW

ORD MDW

LGA
EWR JFK
IAD DCA BWI

DFW
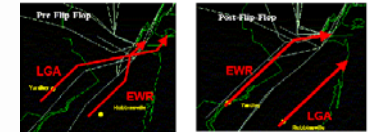
Traffic Management Advisor

RNAV/RNP Deconflict

Surface Management with ASDE-X

DFW DAL

IAH HOU
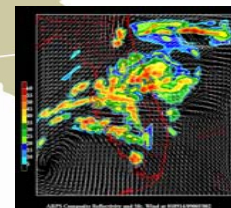
Predictive Weather

FY08 – FY09 CAASD Program

- **<u>Weather Integration:</u>**
  - CAASD will define operational requirements for integration of weather into decision support tools.
  - Support the FAA in gathering weather, automation and operational subject matter experts to identify the information requirements including quality of service performance.
    - In particular, CAASD will include in this definition information regarding type, accuracy, persistence, and correlation between geographic descriptions of weather.
    - These operational requirements will be captured and categorized with respect to tactical, near tactical and strategic requirements.

Decision-Making Time Horizons
Strategic vs Tactical
weather – operational needs

GA
Go/no go

Airport Surface movement

Departure, path

ARTCC

TRACON

TRACON

Tower

Ceiling and Visibilities (Fog) CAT II/III operations

Tower

Airport
Icing ..
Snow and
runway
contamination

Tactical TFM
airborne

Tactical
Adjustments

Sequential
decision-making
Forecast/observations

Turbulence
while
En-route

Off

On

Facility driven
Forecast
"proactive"
forecast

Facility driven
Tactical
Observations
ground

Out

In

Long range
Forecast/observations
National view

ATCSCC

ARTCC TMU

ATC

Long range
Forecast
Strategic
Day of

Tactical
ATCSCC

Strategic
ATCSCC

Departure stop
APREQs
ESP/DSP
EDCT
MIT/MINIT

Impact
delays

Airborne holding, flight diversions
Flight deviations
MIT management
Shutting the door on adjacent sector
Route status

Integrated scenario

Long range
Forecast
Strategic
Pre day

Strategic
ARTCC

Tactical
ARTCC

Tactical

-360	-240	-120	-60	-45	P	+Time En-Route	Time

CCFP

ITWS

NEXRAD

CIWS

METAR

PIREP s

METAR

NCWF-2   NCWF

SIGMET

Airborne RADAR

Outlook.. Convective SIGMET

TAF

15 July 2008

Federal Aviation Administration

10

Actor | Decisions | WX Components | Access

Actor

- Commercial Pilot
- Controller
- TMC CWSU
- AOC Dispatcher
- AOC ATC coordinator
- ATCSCC planner
- ATCSCC National Operations Manager

Decisions

After CWSU, assimilates data from Wx Components and briefs TMC on weather information and impact for respective domain and surrounding facilities. Issues Meteorological Impact Statement (MIS) which is distributed over the FAA ... Printout (F...

TMC deciding on ... the ARTCC, b... Constraints, including appropriate Staffing

Immediate Flight Planning for long distance flights, Equipment selection/swaps due potential route constraints, Fuel and Load Planning. Anticipation of operational impact later.

Strategic Company operations plan, Fleet deployment strategy, Impact mitigation, Coordination for reroute requests

Long-term strategic planning for potential route/airport issues discussed but not necessarily implemented. Solicit feedback from airlines regarding strategy to handle impact today.

Determine Significant Potential National Airspace Impacts if any, with other governmental departments and provide strategic guidance. May consider staffing issues based on potential impact to the NAS

Capability Needs Model of Multiple Actors

WX Components

- Terminal Area Forecasts
- ...Forecasts
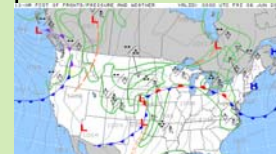- Forecast Winds, Surface and Aloft, velocity and direction
- Forecast convective activity position and intensity
- Forecast Icing
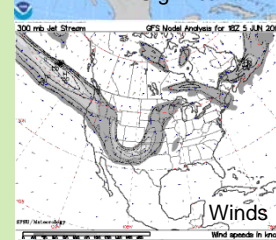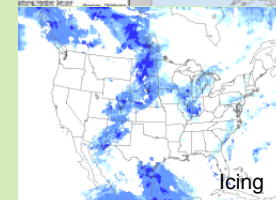- Forecast turbulence

Access

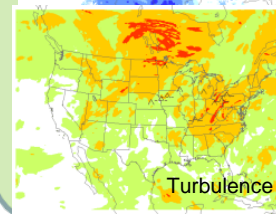SIGMETS/AIRMETs
TAFs
METARs
CWAs
MIS

Significant WX

Winds

Convective Impact

Icing

Turbulence

Time

CURRENT 8-10 hour out

Real time "Now"

Collaborative Air Traffic Management
Advanced Methods for Traffic Flow Management

Description of Project
• The project objective is to provide well defined and well understood methodologies to support the advancement of Traffic Flow Management capabilities. This activity is structured into three parts – probabilistic TFM, integration of weather and the TFM flight object.

Supports the Following Capabilities
• Trajectory Flight Data Management
• Full flight Plan Constraints Evaluation with Feedback
• Full Collaborative Decision Making
• Manage Airspace as Trajectories

FY 2010 Milestones
• …
• Review of current weather tools and analysis on weather versus decision support tools functionalities.
• Develop integration plan for inclusion of weather data and DST algorithms into appropriate TFM tools.
• Develop initial implementation plan and decision package

Benefits
Key benefits for Advanced Methods for TFM include:

• Improved situational awareness for traffic managers
• Improved prediction performance for TFM decision support systems
• Improved decision heuristics for airspace demand management
• Coupled weather and traffic prediction
• Flexible TFM around weather constraints

RPD Number: ZON.18-00
Appropriation Type: F&E
BLI Number: 1A12B0

Funding:

Near-term targets

- **RNAV/RNP**
- **Optimal Profile Descent**
  - Tailored Arrivals
  - CDA's
  - RNP 3D
- **Time-based metering and profiles**
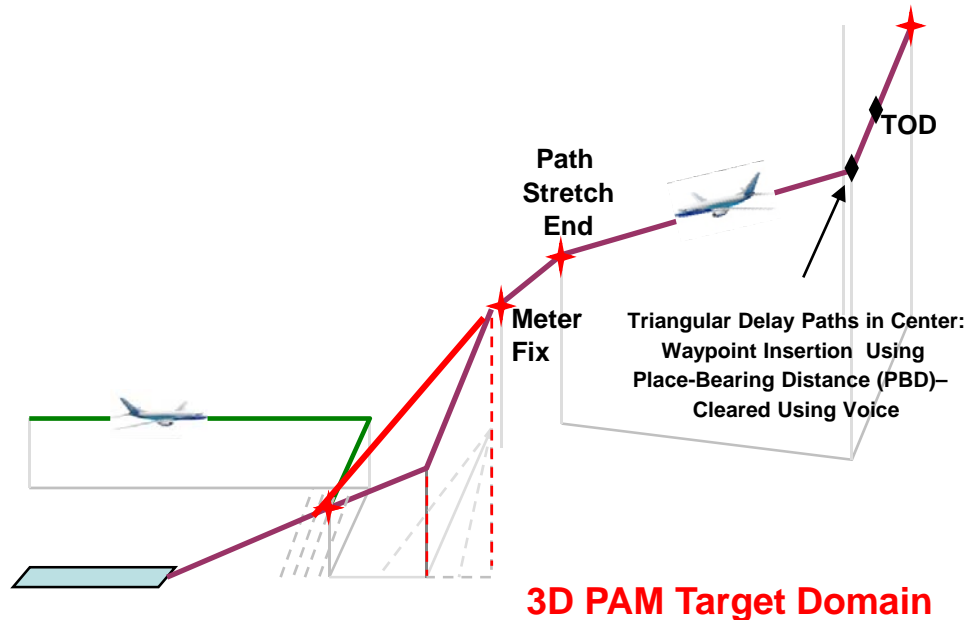 - Multi-center – major-metro TMA
  - 3D PAM

Tailored Arrivals (TAs)

- Initiative: Integrate automation tools to provide cleared trajectory path, which is uplinked to the aircraft and flown by FMS

- Partners: NASA Ames, Boeing, Sensis, AAL, Foreign Carriers, potential AMC

- Schedule: FY08 Live Flight Trials at MIA (Sept)

- Estimated benefits per arrival:
  - $300 - $500
  - 1200 – 2000 lbs of CO_2 savings

Growing International Interest: Netherlands, Australia, Japan

3D Path Arrival Management (3D PAM)

Path Stretch End

Meter Fix

TOD

Triangular Delay Paths in Center: Waypoint Insertion Using Place-Bearing Distance (PBD)– Cleared Using Voice

3D PAM Target Domain

- Initiative: Move toward 4-D Trajectory Management; aircraft executes TMA plan

- Partners: NASA Ames, Boeing, Sensis, Continental, AAL

- Schedule:
  – FY08 Human-in-the-Loop Simulation
  – FY09 Live Flight Trials at DEN

- Estimated benefits per arrival:
  – $250. - $500
  – 900 – 2000 lbs of CO_2 savings

Early Mid-term

- **Initial Conflict Advisories**
  - Conflict detection
  - Resolution advisories
  - Voice Based
- **Big Airspace**

Big Airspace Concept

High Altitude
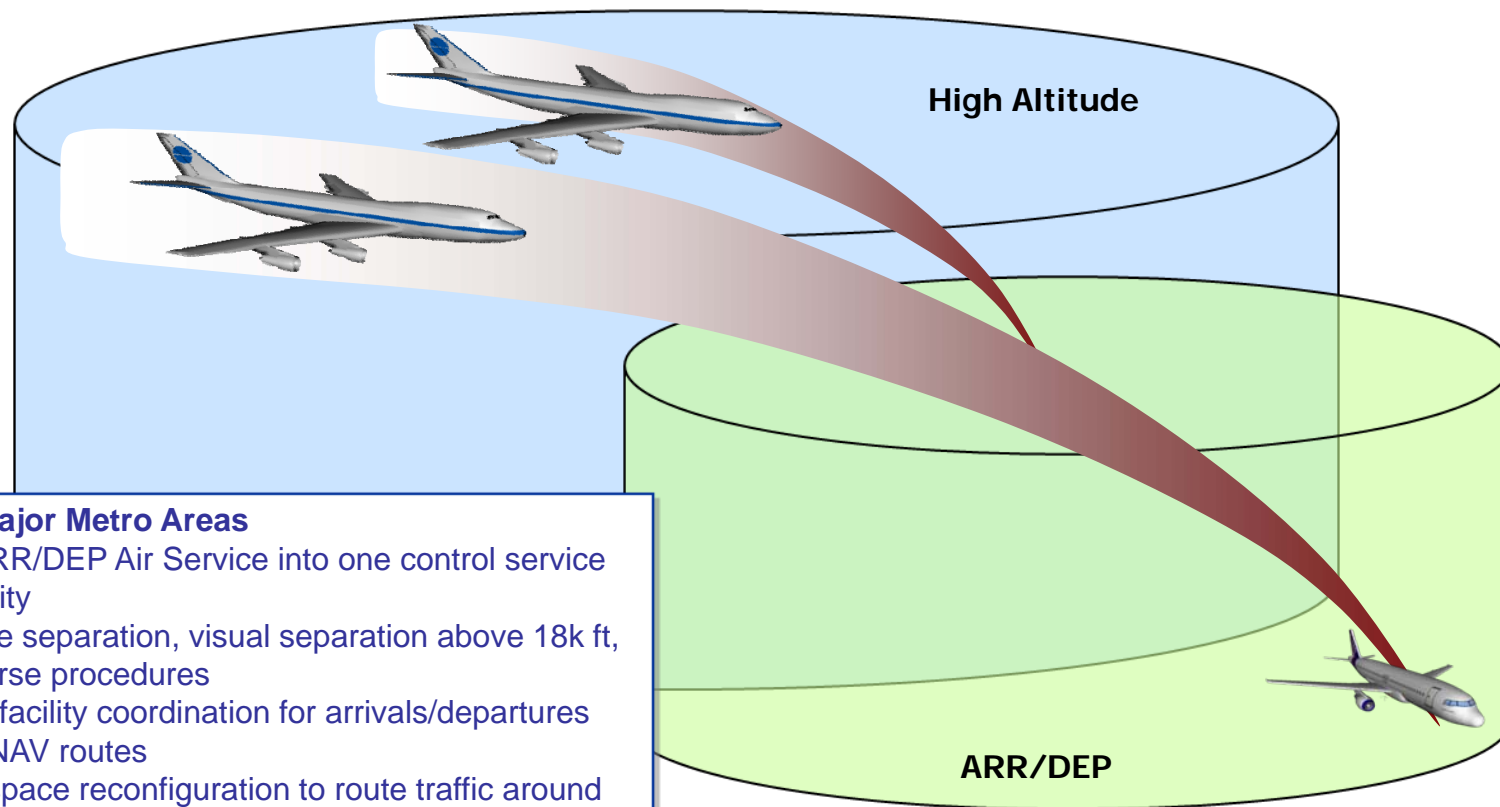
ARR/DEP

Concept for Major Metro Areas
- ✓ Integrates ARR/DEP Air Service into one control service and one facility
- ✓ Applies 3 mile separation, visual separation above 18k ft, diverging course procedures
- ✓ Reduce inter-facility coordination for arrivals/departures
- ✓ Additional RNAV routes
- ✓ Dynamic airspace reconfiguration to route traffic around WX and manage controller workload
- ✓ Integrated flow management directives smooth transition
- ✓ Initial step to achieve NextGen Super-Density Ops

Late Mid-term

Trajectory Based Airspace

- **Concept –**
  - Controllers require less local knowledge
  - Automation and decision support can provide information
  - Controllers capable of providing full service in greater portions of the airspace

- **Benefits**
  - Limited dynamic resectorization
  - Increased flexibility in staffing
    - Especially seasonal variations

Flexible Airspace

- **Dynamic Airspace of old concept**
  - Recognizes Limitations
- **Assumes**
  - System supports increased flexibility for controller
  - Airspace design tool with auto-evaluations
  - New voice switch provides flexibility for remapping positions
  - ERAM
    - Flight Data Management
    - Surveillance Data Processing
  - Airspace Resource Management System

Multi-sector Planner

- **New role for intermediate trajectory management**
- **Re-assessment of En Route organizational and functional configurations**
- **Required Capabilities**
  - Digital data communication among all operators
  - Improved positioning accuracy for flight operations,
  - System-wide information management
  - Medium-term conflict prediction
  - Predictive sector complexity assessment