Integrated Arrival/ Departure Service
"Big Airspace"

Project Results Summary

Presented to: Transportation Research Board

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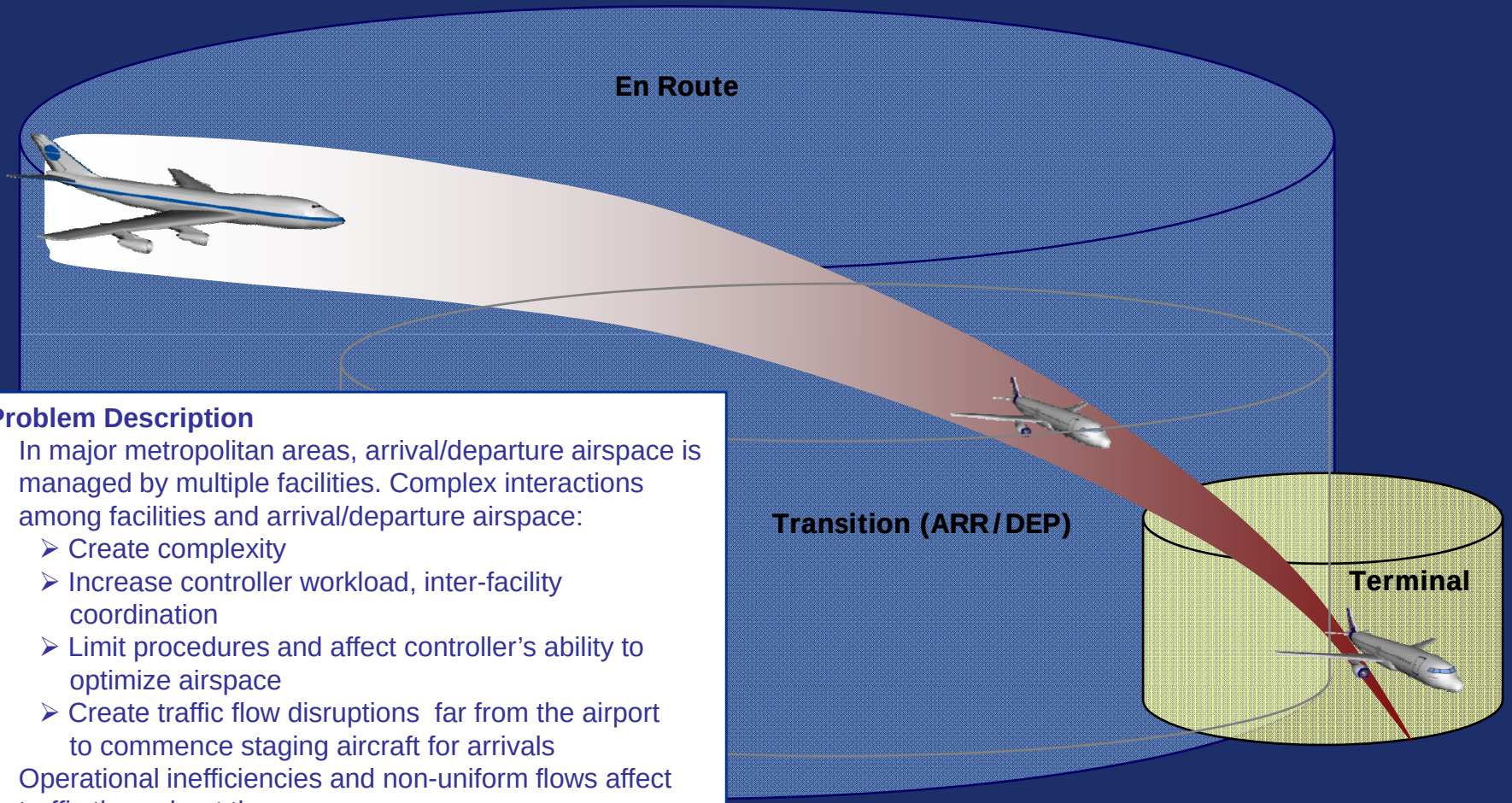
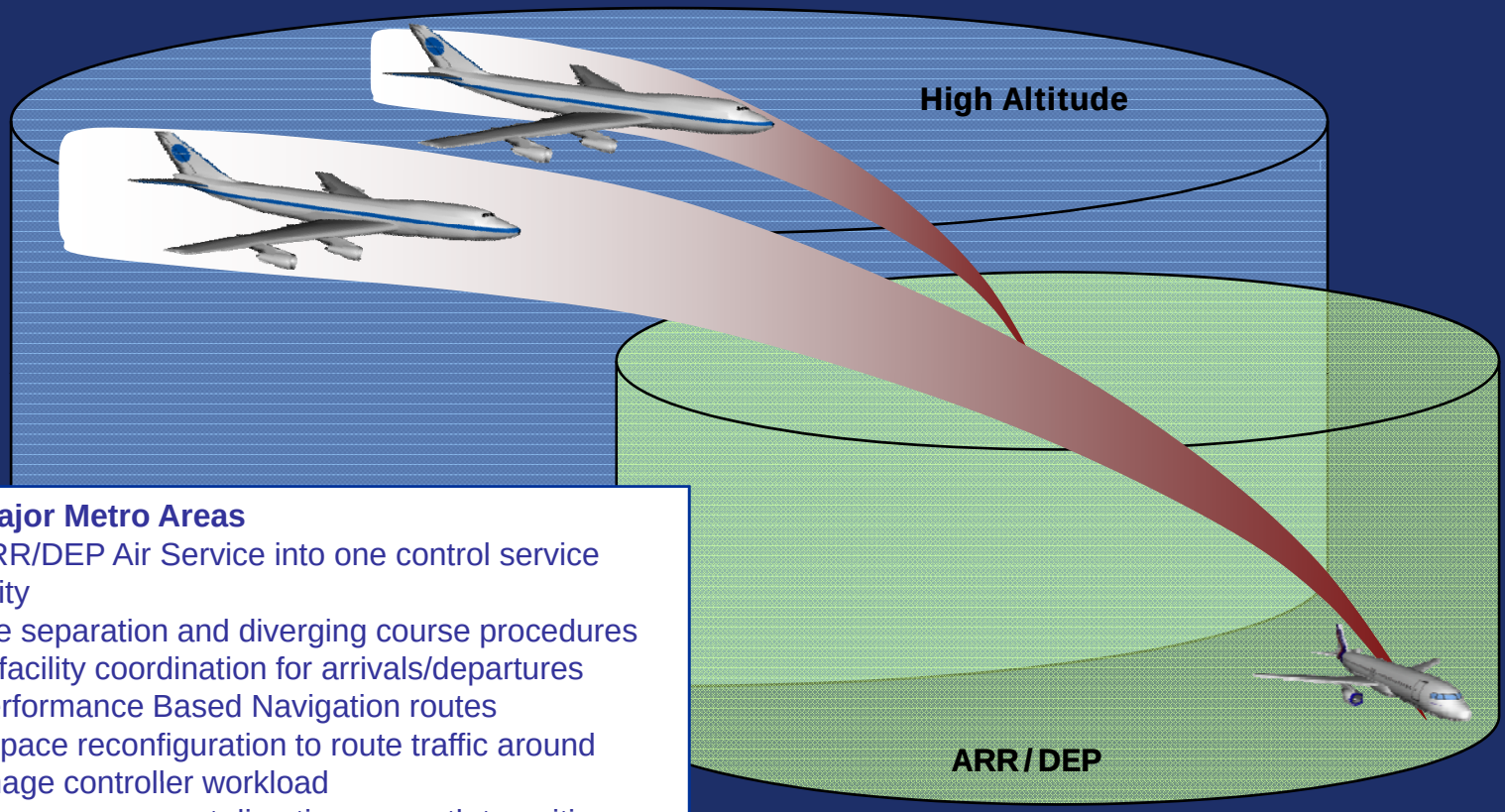
Current Arrival/Departure Operations



Problem Description

- In major metropolitan areas, arrival/departure airspace is managed by multiple facilities. Complex interactions among facilities and arrival/departure airspace:
  - Create complexity
  - Increase controller workload, inter-facility coordination
  - Limit procedures and affect controller's ability to optimize airspace
  - Create traffic flow disruptions far from the airport to commence staging aircraft for arrivals
- Operational inefficiencies and non-uniform flows affect traffic throughout the area
- Increased airline, FAA, and consumer costs

Big Airspace Concept



Concept for Major Metro Areas

- ✓ Integrates ARR/DEP Air Service into one control service and one facility
- ✓ Applies 3 mile separation and diverging course procedures
- ✓Reduce inter-facility coordination for arrivals/departures
- ✓ Additional Performance Based Navigation 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

Concept Validation Approach

- **Developed Concept of Operations**
- **Developed Generic Airspace Simulations to model concept**
  - Fast-Time Simulation Modeling based on 2012 (baseline), +50%, and +100% traffic levels
    - Fast Time Traffic Simulations (FT) using AWSIM modeled entire arrival/departure airspace for a 24 hour period to estimate operational efficiency improvements
    - Human Performance Modeling (HPM) using Air Midas modeled two arrival and departure sectors to estimate workload effect of increased traffic and data communications
  - Real-Time, Human-in-the-Loop (HITL) Simulation using current automation platforms and tools with baseline traffic levels and two arrival and departure sectors measured effect of concept on controllers and validated flight efficiency improvements
- **Conducted Preliminary Safety and Requirements Analysis**
- **Conducted ROM Cost-Benefit Analysis**

Service Provider Impacts

- **Workload**
  - Overall ratings lower in Big Airspace (BA) than in Baseline (BL)
    - Feeder/Airport Departure sector workload was significantly lower in BA
    - Workload increased with traffic and weather in transition sectors (both BL and BA); decreased after Dynamic Resectorization in BA
    - Adjacent high altitude (Ghost) sector showed significant workload reductions in BA (e.g., less holding, fewer clearances)
  - BA procedures enabled controllers to successfully complete tasks without interruption (as indicated by "task interruption index")
  - With BA procedural and airspace changes, controllers could handle up to 50 percent more traffic with about the same workload levels as BL
  - With BA *and* data communications (for clearances and transfer of control), controllers could handle about 100 percent more traffic, and up to 150 percent more traffic before performance degraded

Service Provider Impacts (cont.)

- **Task Performance**
  - No significant change in the number of aircraft handled in the HITL simulations (possibly due to duration of the simulations)
  - Ground-to-ground communications decreased in BA for arrivals, no difference for departures
  - Air-to-ground communications increased in arrival transition sector in BA, less air-to-ground communications in other sectors in BA
- **Safety**
  - No significant change in number of operational errors in HITL
  - Number of conflicts in FT decreased significantly in BA -- 32% at 2012 traffic levels and 13% at higher traffic levels
- **Controller Acceptance**
  - BA had a positive effect on control strategies over BL
  - Situation awareness higher in BA, or in some cases, no difference from BL
  - Dynamic sector boundary had a positive effect for the sector that received airspace, but did not negatively effect sector that gave airspace
  - Combined control room fostered more cooperative work environment; favored by controllers but did not have impact on performance metrics

Operational Efficiency

- All analyses showed improved operational efficiency from additional routes and dynamic airspace resectorization in BA

Measurement/Traffic	2012	+50%	+100%
Avg Flight Time Savings per Flight (no Wx)	0.34 min	0.78 min	1.37 min
Avg Flight Time Savings per Flight (Wx)	0.96 min	1.18 min	1.57 min
Distance Flown Savings per Flight (no Wx)	0.75 nmi	0.89 nmi	1.07 nmi
Distance Flown Savings per Flight (Wx)	4.99 nmi	6.51 nmi	8.21 nmi

- HITLs validated efficiency improvement estimates
- More efficient flow strategies in BA evidenced by increased use of speed clearances issued (+13%) and reduction in number of altitude (-10%) and heading clearances (-18%)
- Benefits of dynamic resectorization likely dependent on integrated TMU
- Given large traffic volume in major metropolitan areas, relatively small savings per flight leads to large system benefit

Benefits Analysis

- FT Simulation Results (Flight Time Savings) used to estimate benefits based on a weather adjusted linear extrapolation
- Convective Weather Impact Data from 2006 (Air Traffic Analysis, Inc.) used to determine weather and no weather weighting
- Economic Information for Investment Analysis (ATO-F November 2006 and May 2007) used to estimate monetary benefits associated with Aircraft Direct Operating Cost (ADOC) and Passenger Value of Time (PVT) savings
- Terminal Area Forecast (TAF) 2006 used to estimate number of flights and extrapolate time savings

Cost-Benefit Analysis Results

- **Implementation of the BA concept at 7 sites found to be highly cost beneficial, with an estimated benefit/cost (B/C) ratio of 6.8**
  - Total estimated present value ADOC and PVT benefits of $2,680 million and costs of $396 million
- **Excluding PVT, the concept is still found to be highly beneficial, with an estimated B/C ratio of 3.8**
  - Total estimated present value benefits of $1,485 million and costs of $396 million
- **Significant benefits at major metropolitan areas lead to short payback period**

Big Airspace Key Enablers

- **Operational**
  - 3 mile separation
  - Use of current minima for diverging courses
  - Integrated airspace and TMU
  - Dynamic resectorization of bi-directional routes
  - 5 mile lateral spacing of Performance Based Navigation routes
- **Technical**
  - Required Navigation Performance to enable 5 mile lateral route spacing
  - Automation
    - Potential SDP upgrades to meet RSP, flight data amendment capabilities and arrival sequencing tools
    - Time-based departure sequencing tool could be needed for airports where same runway used for arrivals and departures
  - Potential surveillance changes needed to meet Required Surveillance Performance (RSP) for BA procedural requirements (e.g., 3 mile separation)
  - New large communications switch, leased circuits, and air-to-ground communications channels to handle transition

Additional Analyses Required

- **Detailed analyses to support decisions**
  - Airspace for selected sites
    - Site specific airspace design alternatives
    - Environmental and Noise Analysis
- **Facility Analysis**
  - Specific building and space requirements
  - Integration with Future Facility Plan
  - Life Cycle Cost Analysis (include controller staff estimates and facility cost estimates)
- **Preliminary Program Requirements and Technical Alternatives**
  - Assessment of RSP capabilities for 3 and 5 mile separation
  - RSP criteria for diverging courses

Impact on the Industry

- Big Airspace is a concept.
  - **Requires additional research and technology development**
  - **Some attributes may be incorporated in future redesigns**
- Based on listed dependencies first true Big Airspace facility not before 2016
- Currently targeted at major metro areas with complex multi-airport configurations
  - **Could change if metro relievers become significantly more active**
- What to watch for:
  - **Increased efficiency at runways leads to greater demand at the terminals**