



CENTER FOR ADVANCED AVIATION SYSTEM DEVELOPMENT (CAASD)

Evaluation of Aircraft Separations Observed in Radar Data of Terminal Operations

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*2008 ICNS Conference
6 May 2008*



Outline

- **Introduction**
- **Terminal Operations**
- **Terminal Radar Separation Standards**
- **Operational Data**
- **Evaluation Approach**
- **Evaluation Metrics and Results**
- **Summary**

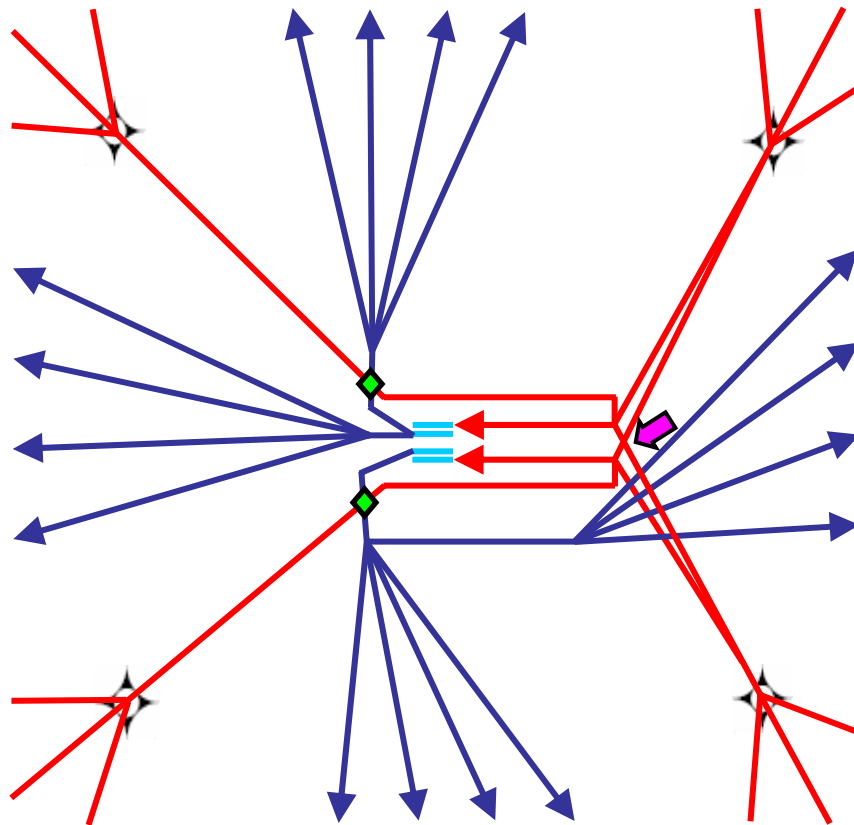


Introduction

- **Separation Standards**
 - Cornerstone for high safety levels
 - Based on accuracy of surveillance equipment
 - **Question: Will the NextGen framework allow for reduced separation standards?**
 - Improved surveillance technologies: ADS-B
 - Performance-based NAS
- **Separation Analysis Capability**
 - **Separation Signature**
 - Airspace designs
 - Operational differences in the applied separation
 - **Baseline current operations**
 - **Support the development, approval, and validation of reduced separation standards**
 - Capacity and efficiency gains



Terminal Operations



- **Arrivals**

- TRACON entry at corner post (⋄)
- Merging and sequencing of long-side and short-side arrivals (➡)

- **Departures**

- Vectors to departure fixes
- Some climbs limited until crossing under long-side arrivals (⋄)



Terminal Radar Separation Standards

- **Separation Standards**

- Radar separation

- **Terminal**
 - 3 NM / 1000 ft
- **Final Approach (< 10 NM)**
 - 2.5 NM in trail / 1000 ft *

- Wake separation

Distance (NM) Final Approach		Leader			
		Heavy	B757	Large	Small
Trailer	Heavy	4	-	-	-
	B757	5	4	-	-
	Large	5	4	-	-
	Small	6	5	4	-

Distance (NM) Terminal		Leader			
		Heavy	B757	Large	Small
Trailer	Heavy	4	-	-	-
	B757	5	4	-	-
	Large	5	4	-	-
	Small	5	5	4	-

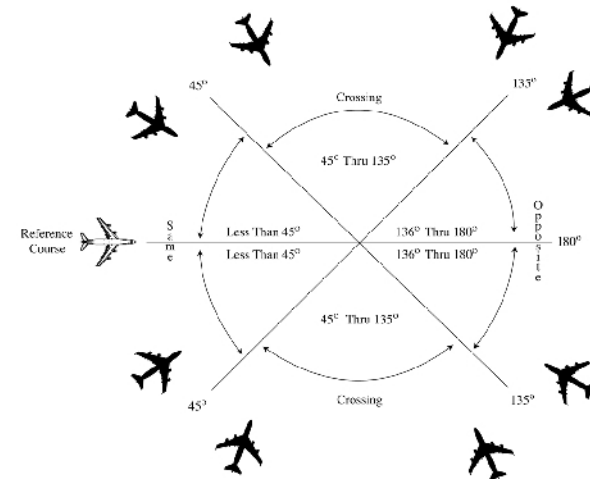
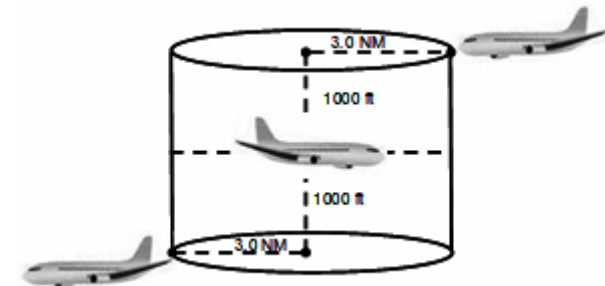
- **Exceptions**

- Passing

- Opposite/reciprocal courses

- Diverging

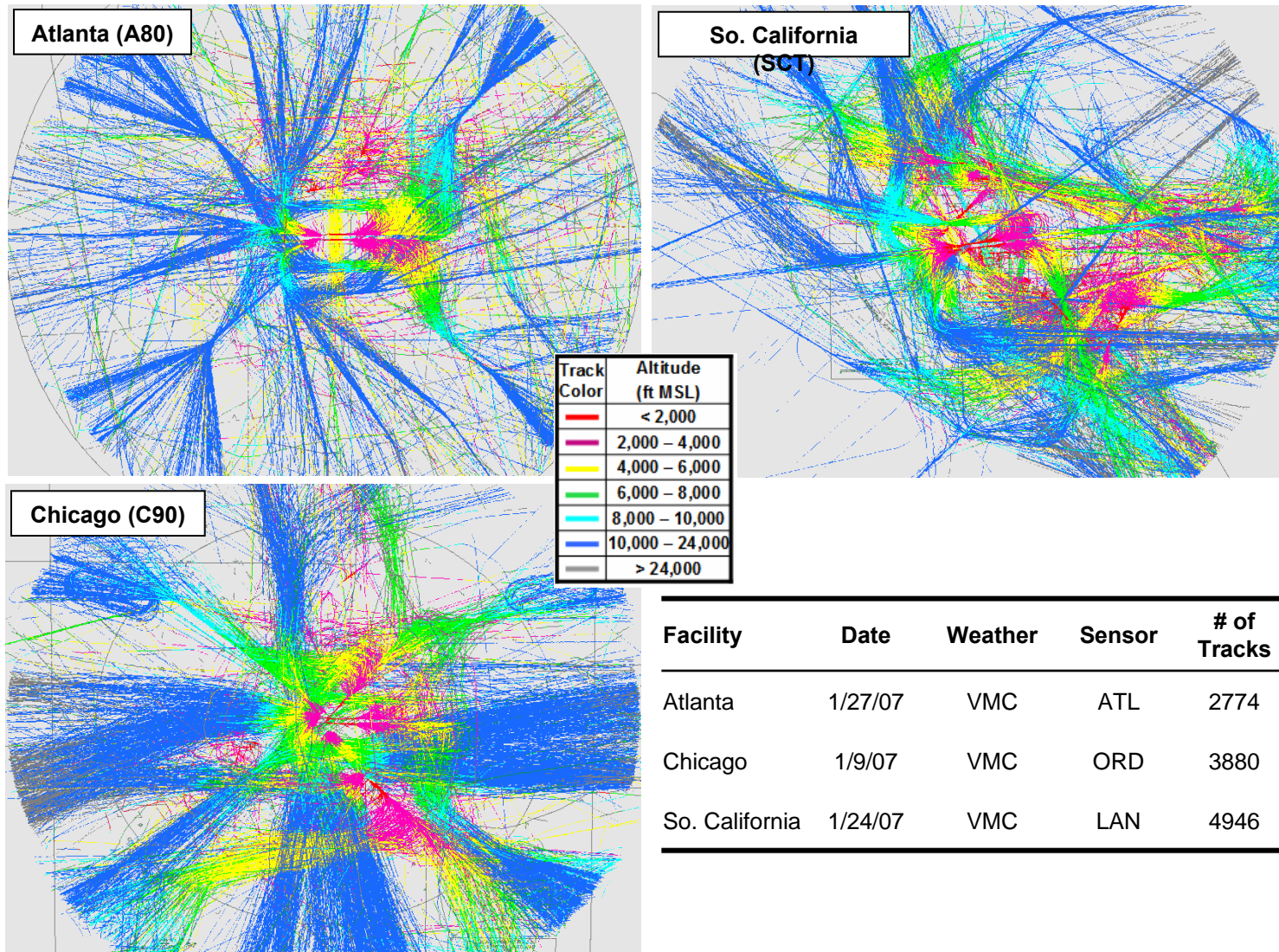
- Same/crossing courses



* Wake turbulence separation standards not applicable and the runway has a documented average occupancy time of 50 seconds or less.



Operational Data





Evaluation Approach

- **Separation Analysis of Track Events (SAFTE)**
 - **Pair-wise evaluation of tracks**
 - Include only radar-identified fixed-wing commercial, corporate, and GA operations
 - Ensure coincidence
 - Evaluate separation standards
 - Terminal
 - Final Approach
- **Note**
 - **Evaluated *Close Proximity Events* ≠ Operational Errors**
 - **The SAFTE analysis does not take into consideration:**
 - Waivers authorizing non-standard operations
 - Applications of efficiency-enhancing visual separation
 - Uncertainties associated with radar/avionics-based measurements of aircraft positions and altitudes



Evaluation Metrics

Minimum Horizontal Spacing

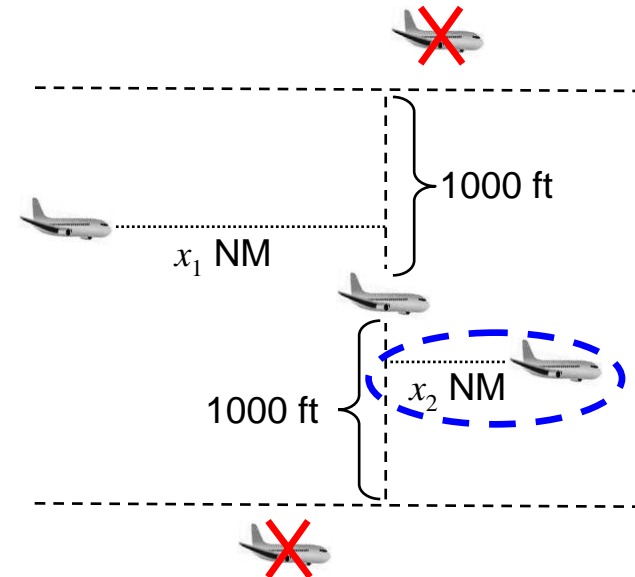
1. Minimum Horizontal Spacing

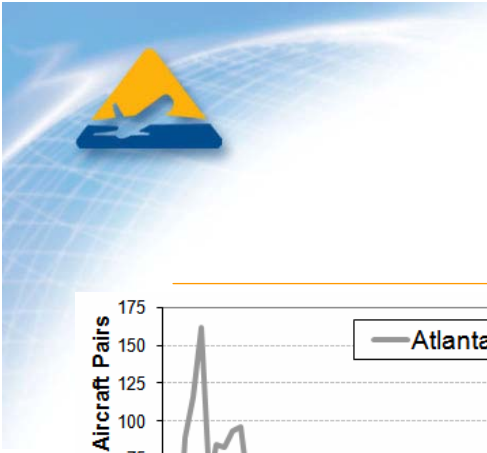
– Evaluates the instantaneous horizontal component of the distance between a target aircraft and:

- All coincident aircraft
- Spaced vertically by less than 1000 ft
- Not classified as passing/diverging

– **Metric will capture operational effects of:**

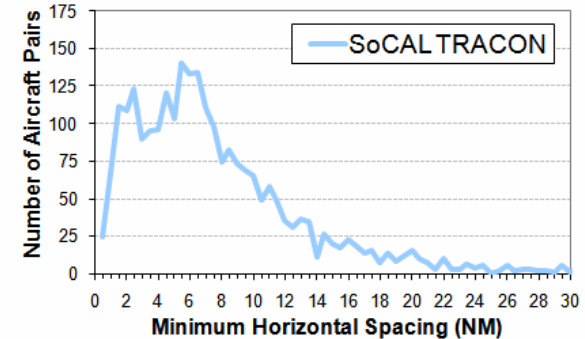
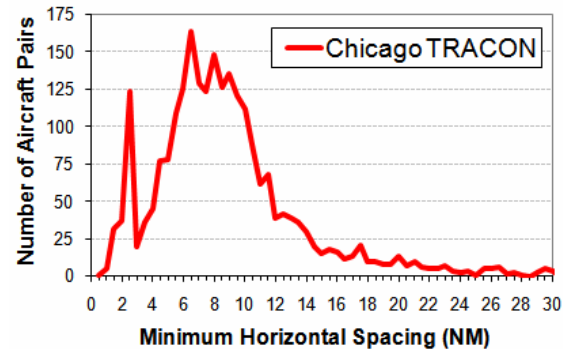
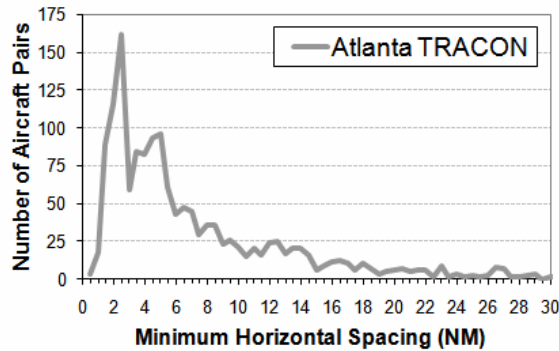
- Waivers authorizing non-standard operations
- Application of visual separation between aircraft
- Uncertainties associated with radar/avionics-based measurements of aircraft positions and altitudes





Evaluation Results

Minimum Horizontal Spacing



Facility	Percentage of minimum horizontal spacings of at least 3 NM	Most often observed minimum horizontal spacing (NM)
Atlanta	81%	2.0 – 2.5
Chicago	94%	6.0 – 6.5
So. California	88%	5.0 – 5.5

- **Differences in separation signatures evident**
 - Number of primary/satellite airports
 - Differences in configuration (parallel operations vs. non-parallel operations, etc.)
 - Number of operations
 - Controller preferences

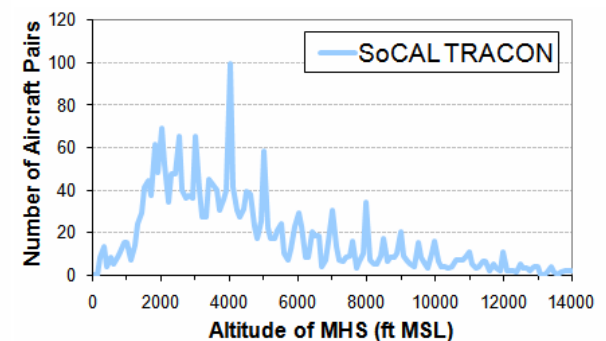
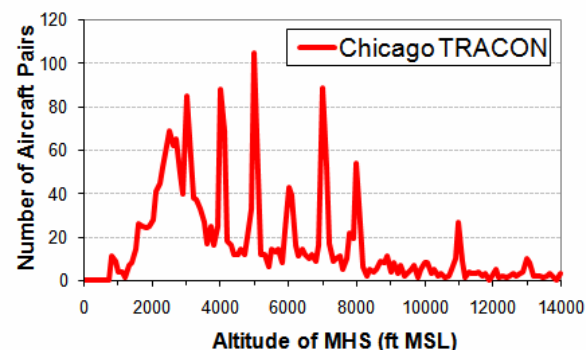
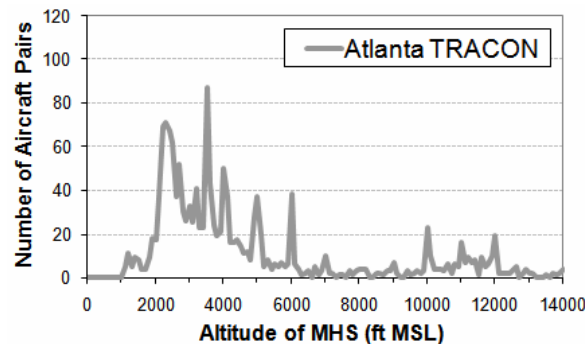


Evaluation Metrics and Results

Altitude of Minimum Horizontal Spacing

2. Altitude of Minimum Horizontal Spacing

- Evaluates the altitude of a target aircraft from the aircraft attaining minimum horizontal spacing from the target aircraft



- **Further differences in separation signatures evident**
- **A80 Notes:**
 - 6000 ft MSL and lower
 - Merge onto final
 - Compression
 - 10000-12000 ft MSL
 - Crossing of arrival and departure flows
- **C90 Notes**
 - Multiple peaks
 - Consistent with step-down descents of arrivals transitioning TRACON airspace
- **SCT Notes**
 - Numerous altitude values
 - Consistent with use of RNAV arrival procedures



Evaluation Metrics

Separation Score

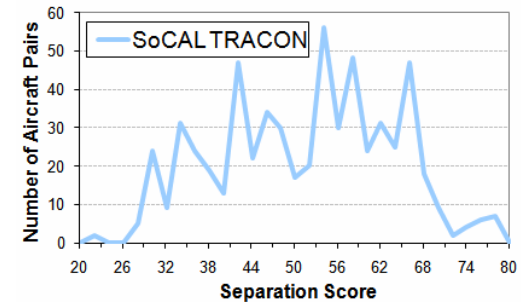
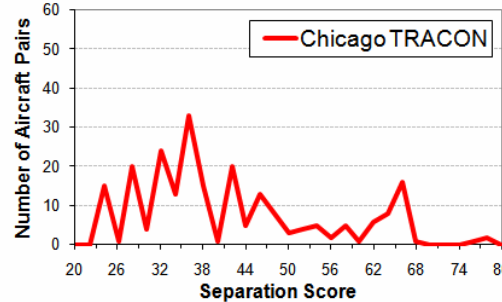
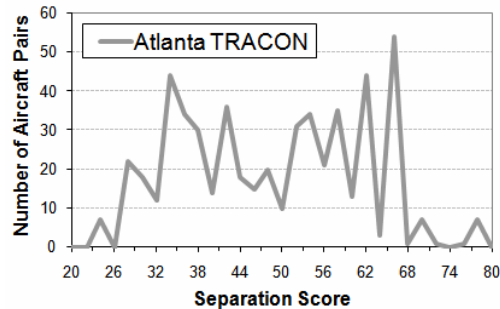
3. Separation Score

- **Characterizes the operational significance of evaluated events**
- **Mirrors the Severity Index (SI), FAA Order 7210.56C**
- **Reflects multiple components in an arbitrary index**
 - Vertical separation
 - Horizontal separation
 - Closure rate
 - Courses (i.e., same, crossing, or converging)
 - Wake turbulence separation standards
- **Higher total score values generally indicate aircraft pairs in closer proximity, involving opposite courses, and having higher closure rates**



Evaluation Results

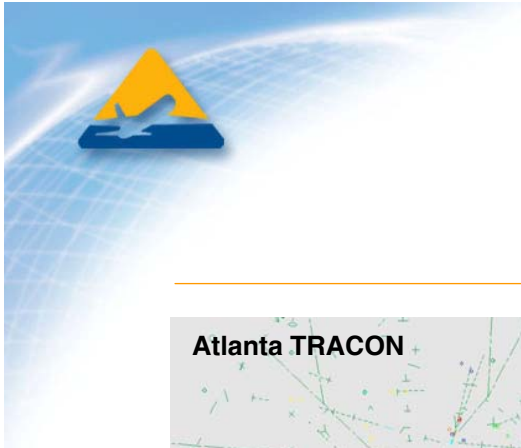
Separation Score (1 of 2)



Facility	Mean Separation Score
Atlanta	48
Chicago	41
So. California	51

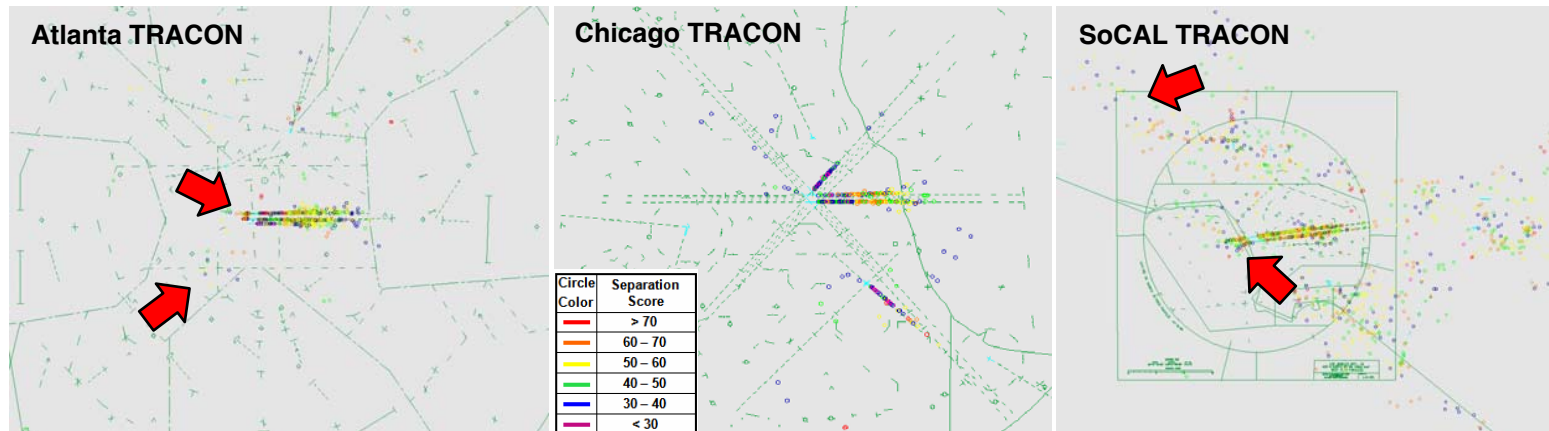
- **Note**

- Higher total score values generally indicate aircraft pairs in closer proximity, involving opposite courses, and having higher closure rates



Evaluation Results

Separation Score (2 of 2)



- **Comparison of separation signatures**
 - Majority of close proximity events occur at the merge onto final approach or on short final
 - Three exception cases:
 - Crossing of long-side arrivals and departures at Atlanta
 - NW Corner-post merge point for LAX arrivals
 - Parallel departures at ATL and LAX



Summary

- **Future reduced separation minima are envisioned to increase airspace capacity and improve operational efficiency**
 - Improved surveillance accuracy, aircraft navigational precision
- **Developed Separation Analysis Capability**
 - Separation signatures
 - Performance baselines
- **Performed Initial Analysis**
 - Quantified differences in separation signatures at three TRACONs
 - Concluded current separation standards represent the greatest operational constraints during the approach phase of flight
- **Next Steps**
 - Characterize operational benchmarks for the development, approval, and validation of reduced separation standards
 - Expand suite of metrics
 - Include additional data sources
 - ASDE-X
 - ADS-B



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