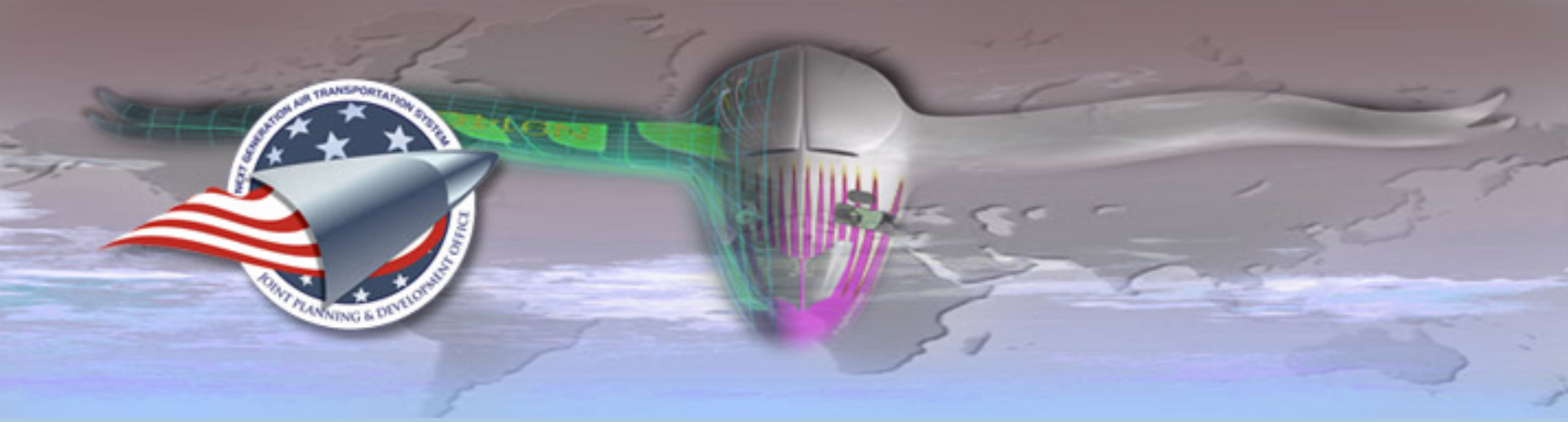


Impacts of National Airspace System Transformation

VAMS Technical Interchange #5
March 9, 2005

Sherry Borener, Director
JPDO - Evaluations & Analysis Division

Evaluation

Mission and Team

The Evaluation Working Group (EWG) will assess strategies for transforming the NAS and meeting the high level national goals and provide the JPDO principals with trade-offs - <u>providing the knowledge necessary to prioritize investments</u> in each JPDO organization.

The EWG Team:

CAASD

Seagull Technology

VENTANA systems, inc.

OLD DOMINION UNIVERSITY

LMI GOVERNMENT CONSULTING

GRA, Incorporated

JPDO Organization

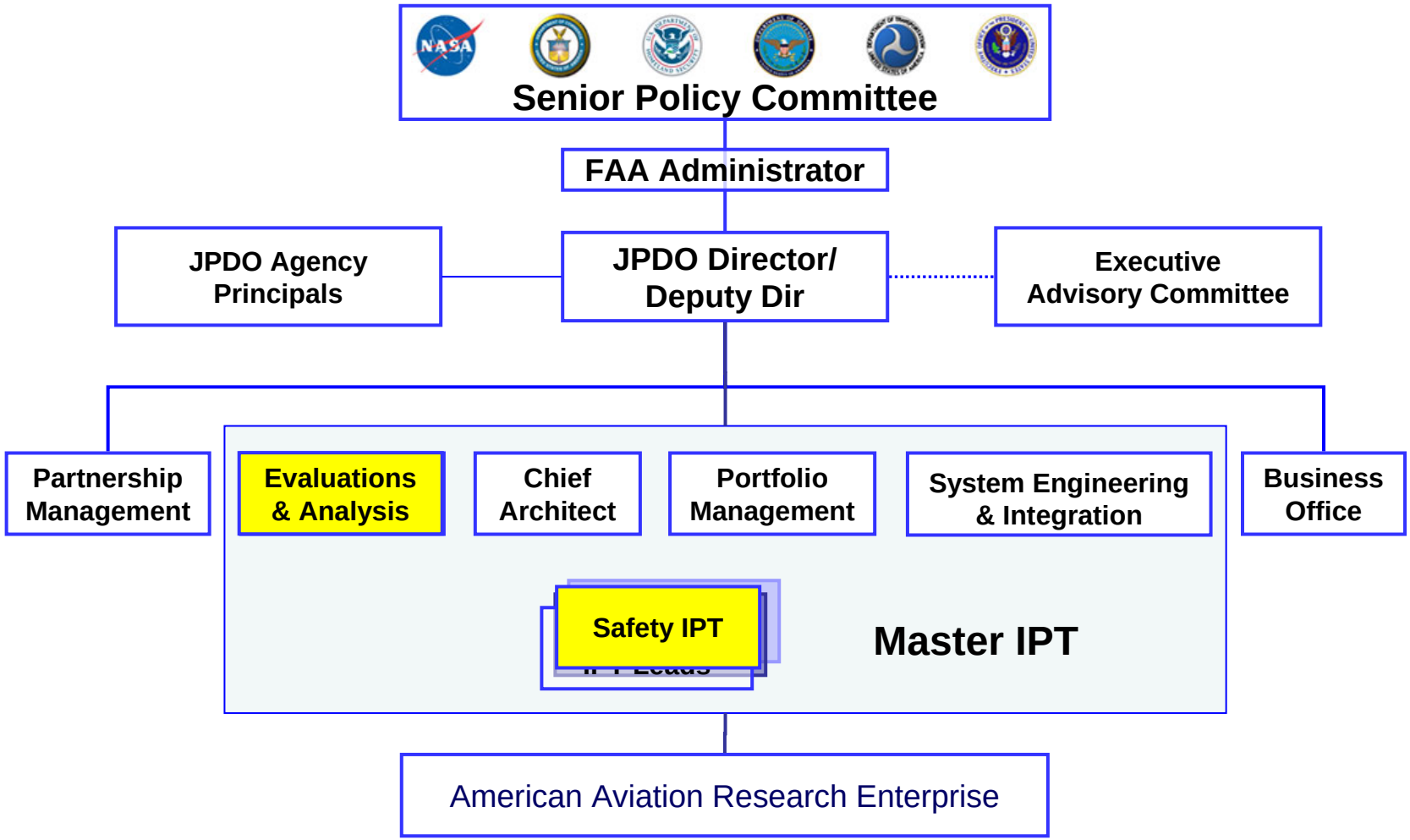
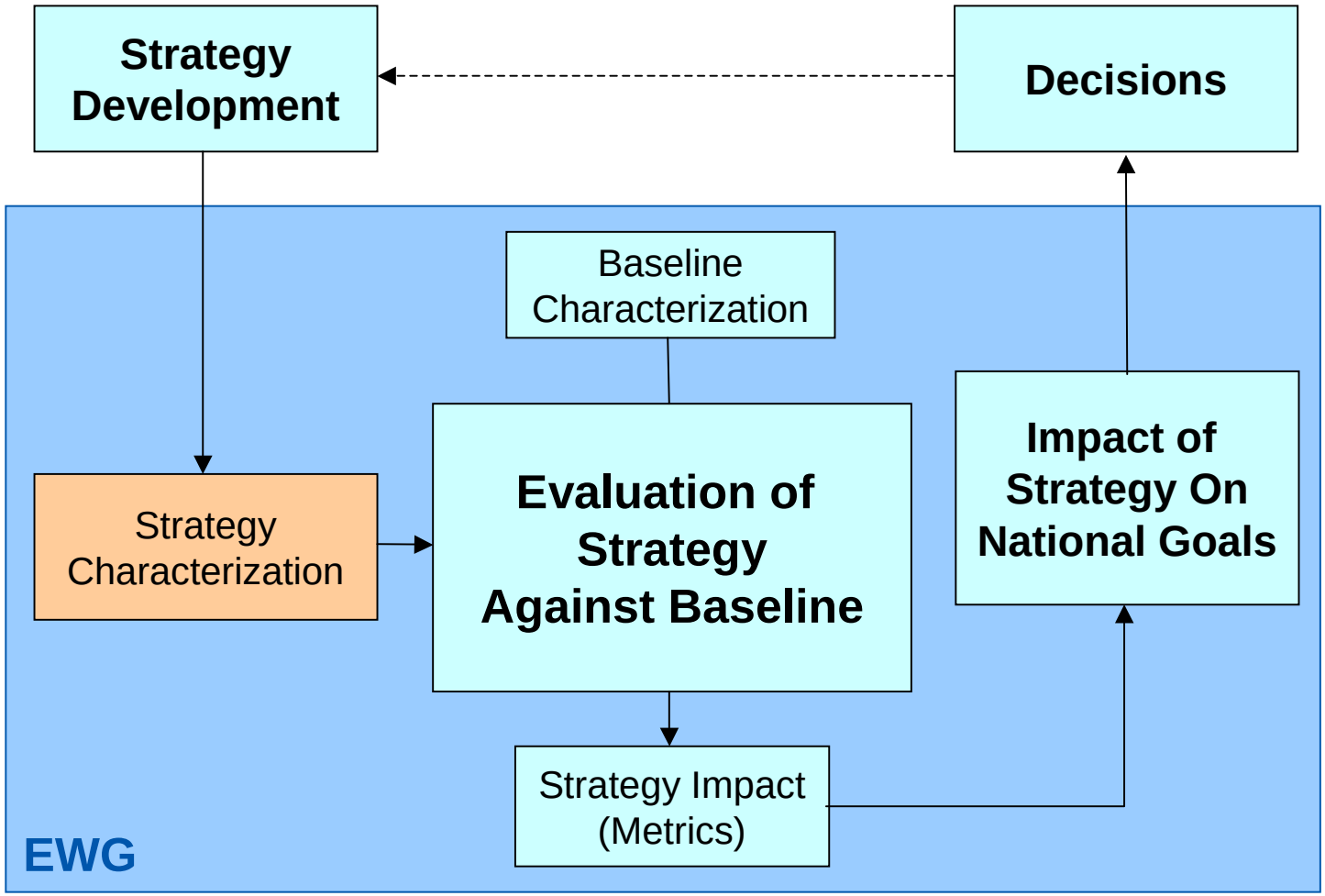
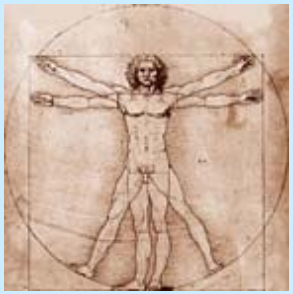


Figure 1-1: Evaluation Approach



Major Dimensions of the Air Transportation System

A. *Pax/Cargo Demand*

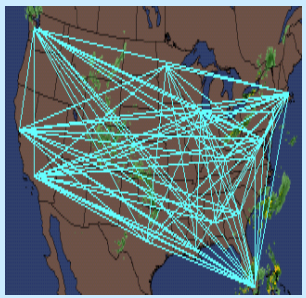


1) Current
2) Terminal Area Forecast Growth to 2014 & 2025
3) 2X TAF Based Constrained Growth
4) 3X TAF

B. *Fleet Mix/ Aircraft Types*

1) Current Scaled
2) More Regional Jets
3) New Vehicles
   - Microjets
   - UAVs
   - E-STOL/RIA
   - SST

C. *Business Model/ Schedule*

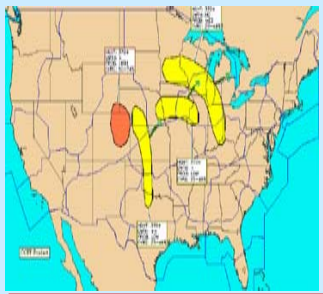


1) Current (mostly Hub & Spoke)
2) More Point to Point + Regional Airports
3) Massive Small Airport Utilization

D. *NAS Capability*

1) Current
2) 2014 OEP
3) Increased Capacity of:
   - Landside
   - Surface
   - Runways
   - Terminal
   - En route
4) Systemic:
   - CNS
   - SWIM
   - Wx Prediction

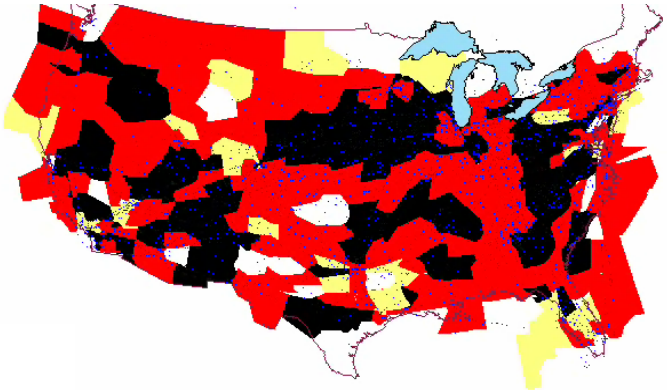
E. *Disruptions /Weather*



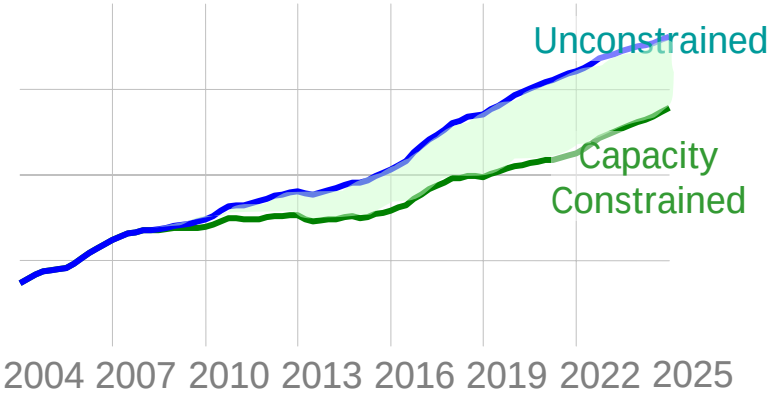
1) Good Weather (Wx)
2) Bad Weather
   - Airport IFR
   - En route
   - 7 Wx days
3) Disruption
   - Sudden Shutdown of an airport or region

Example Performance Analyses

CAPACITY: Future Airspace Overload

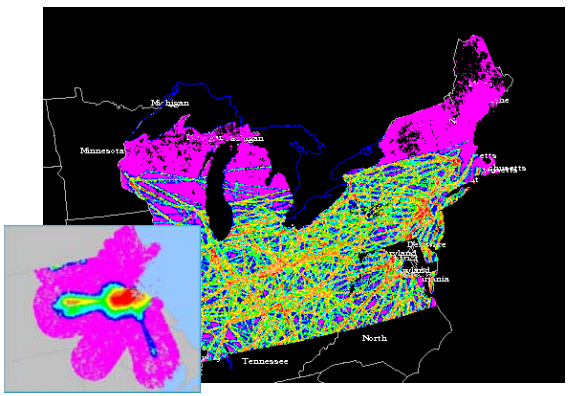


COST: Lost Airline Profit

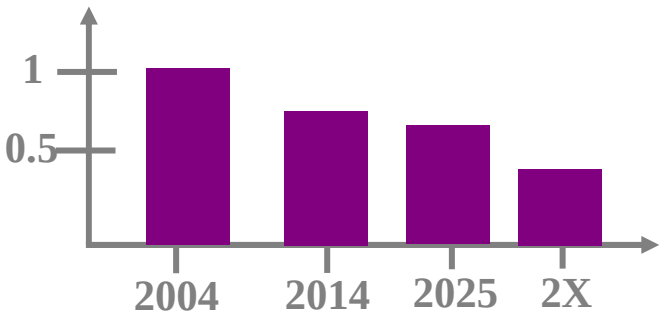


Shortfalls in capacity lead to significant economic consequences.

ENVIRONMENT: Increased Noise Impact

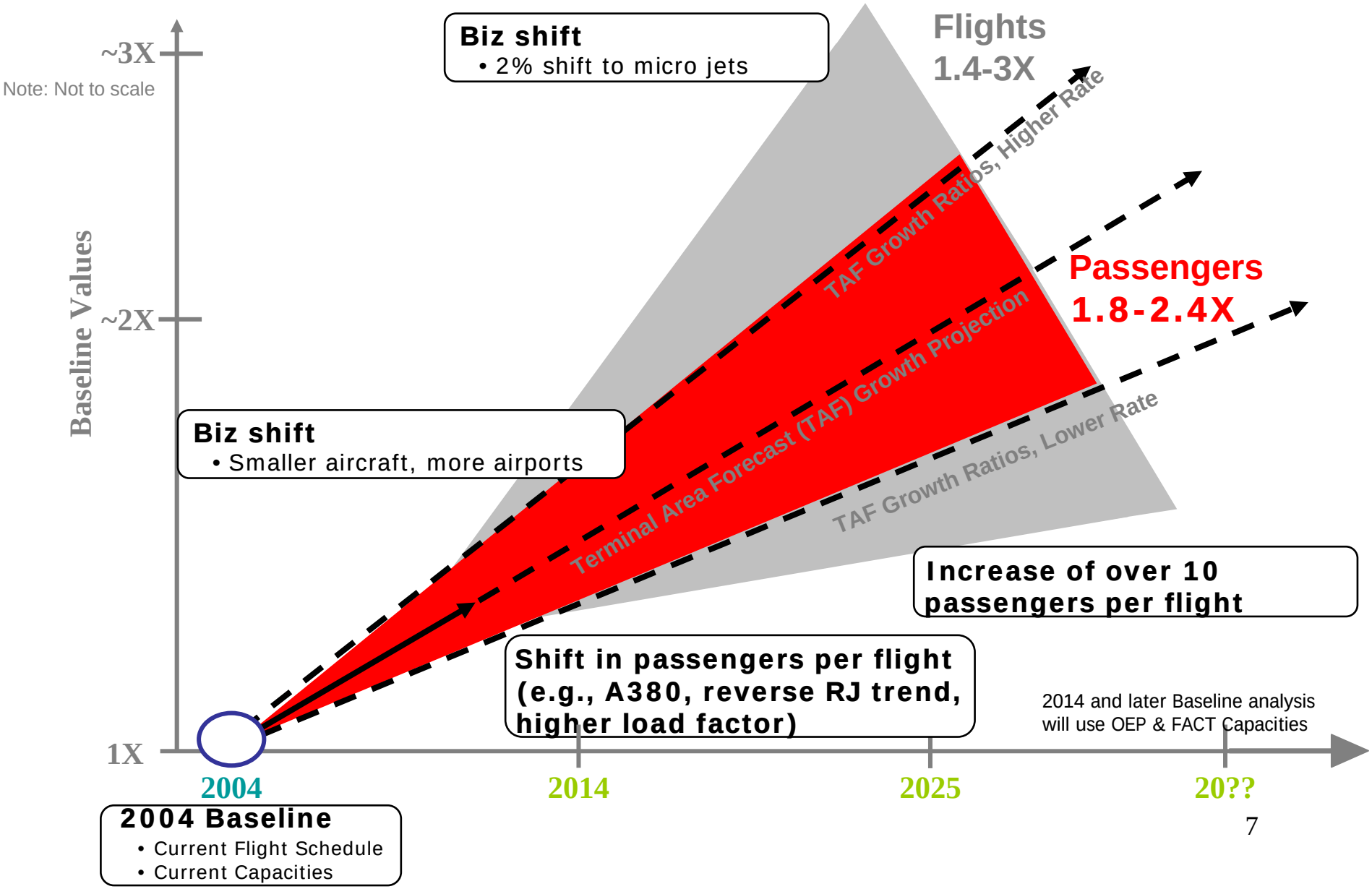


SAFETY: Fatal Accident Rate Must Decrease to Maintain Current Safety Record



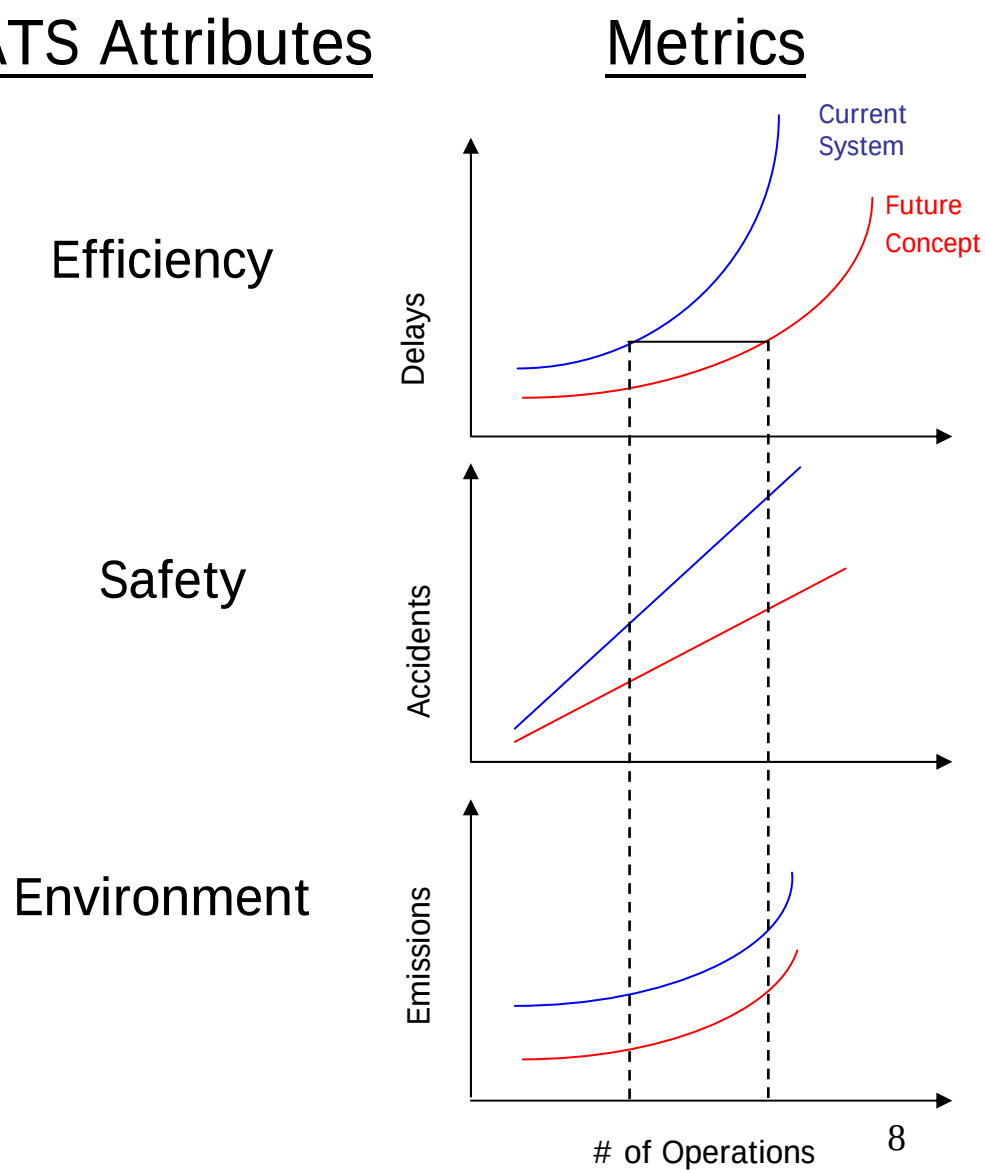
Major capacity increases using existing paradigm lead to significant environmental and safety issues

Future Environment and Demand

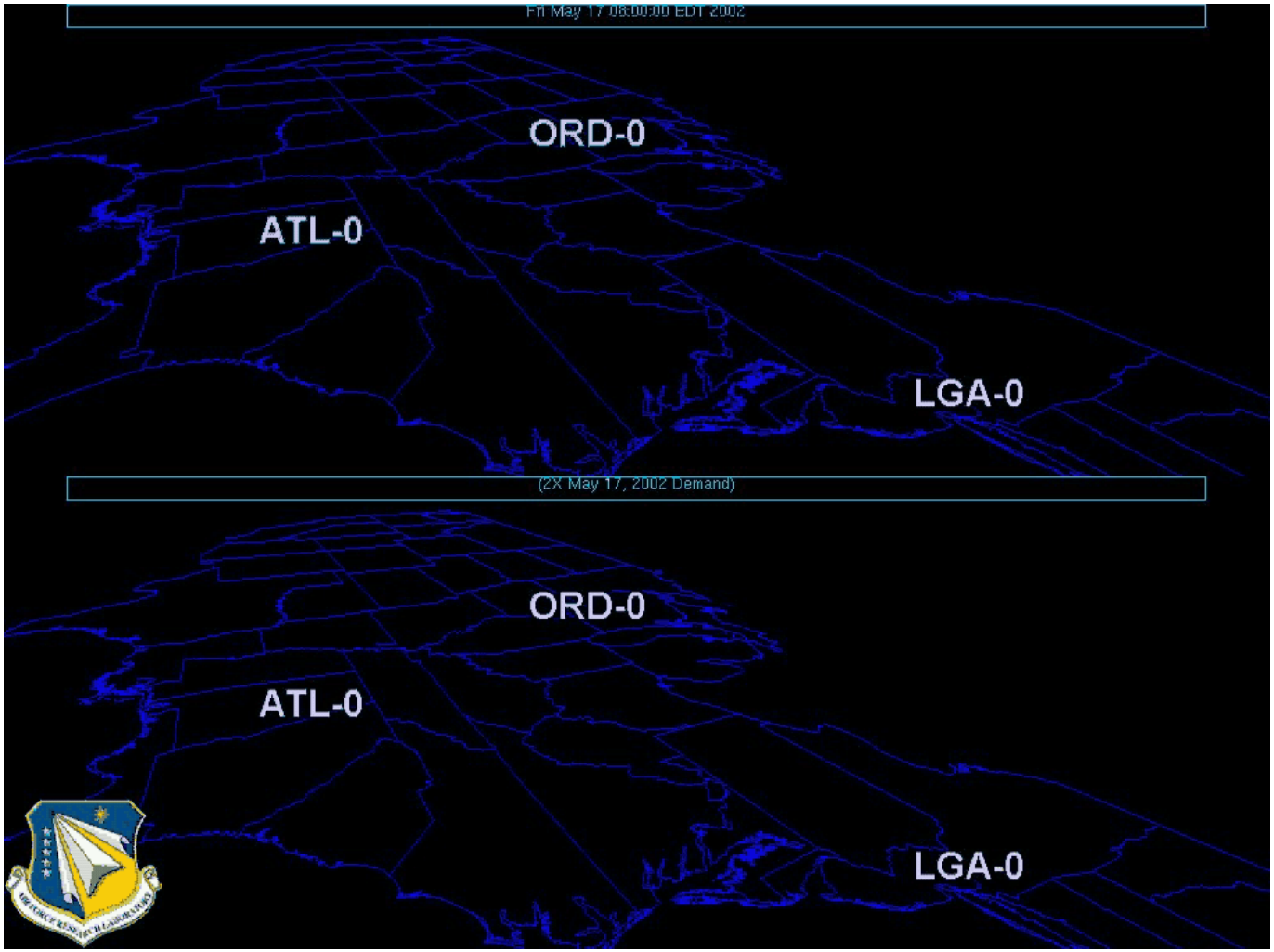


EAD Metrics

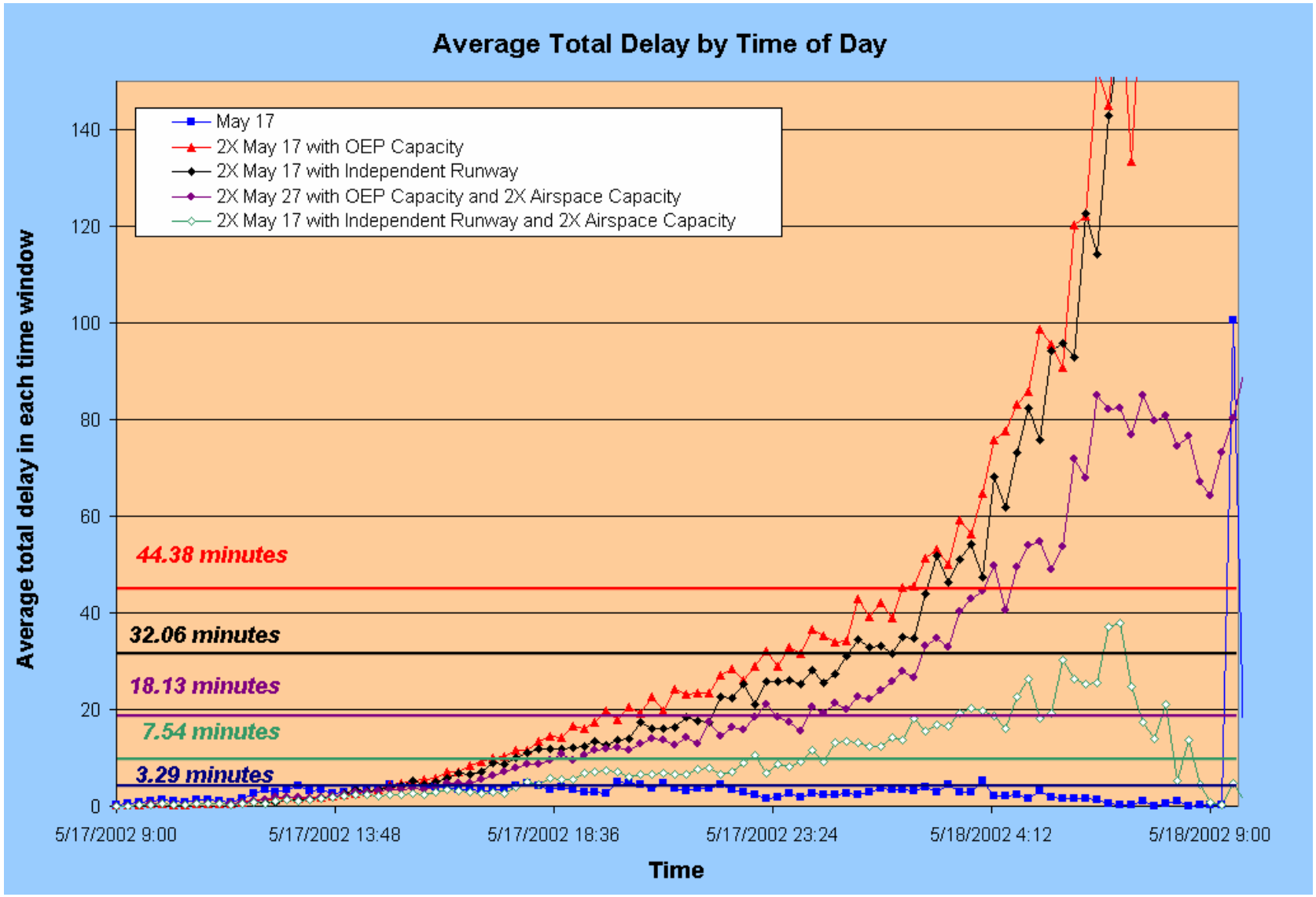
- Metrics capture the potential benefits of future strategies for key ATS attributes such as Efficiency, Safety, Environment, Security, etc.
- The common denominator for all EAD metrics is the forecast total number of aircraft operations.
- The use of a common metric allows evaluation of the benefit tradeoffs across multiple ATS attributes.



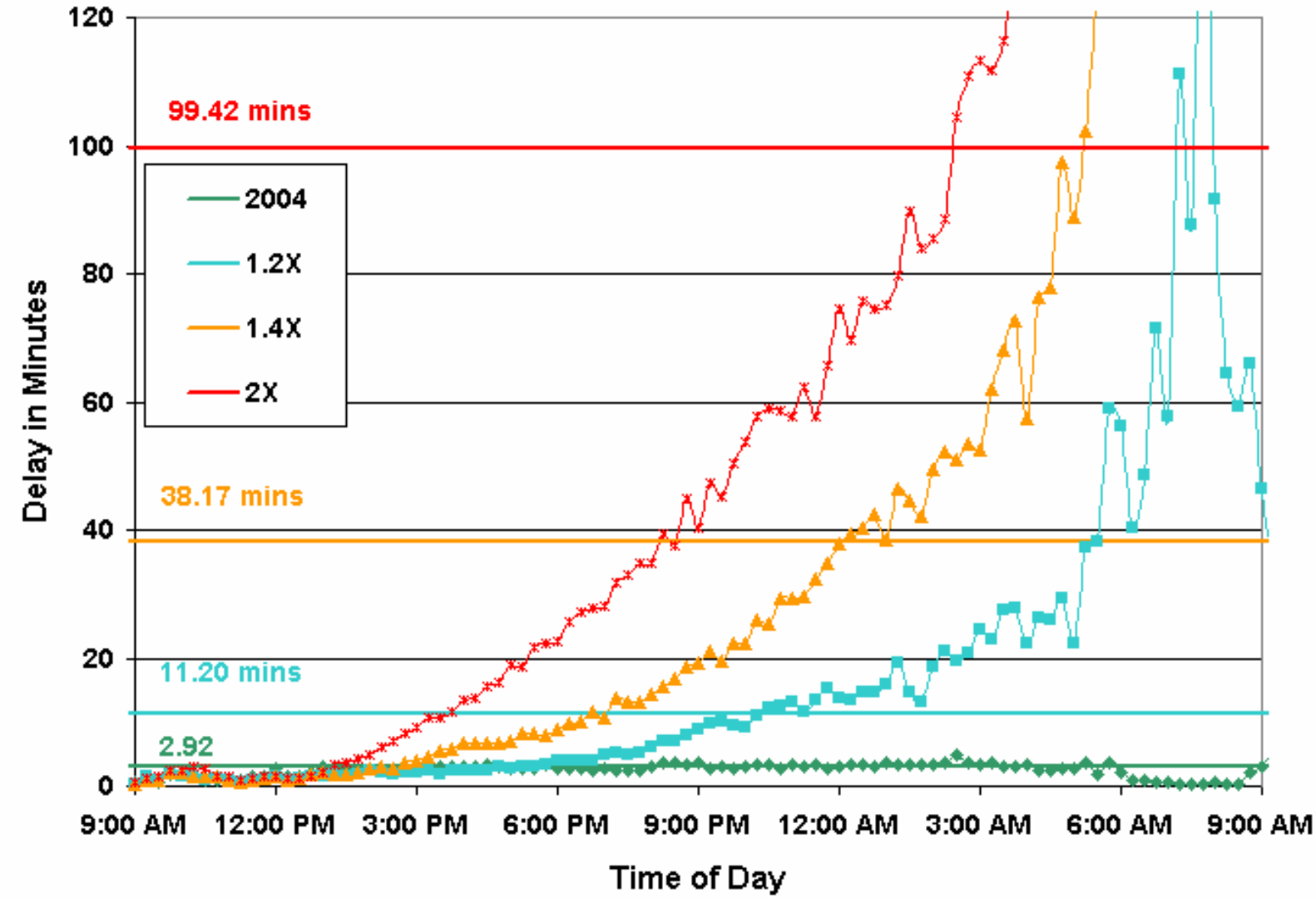
JVIEW Day View 2X



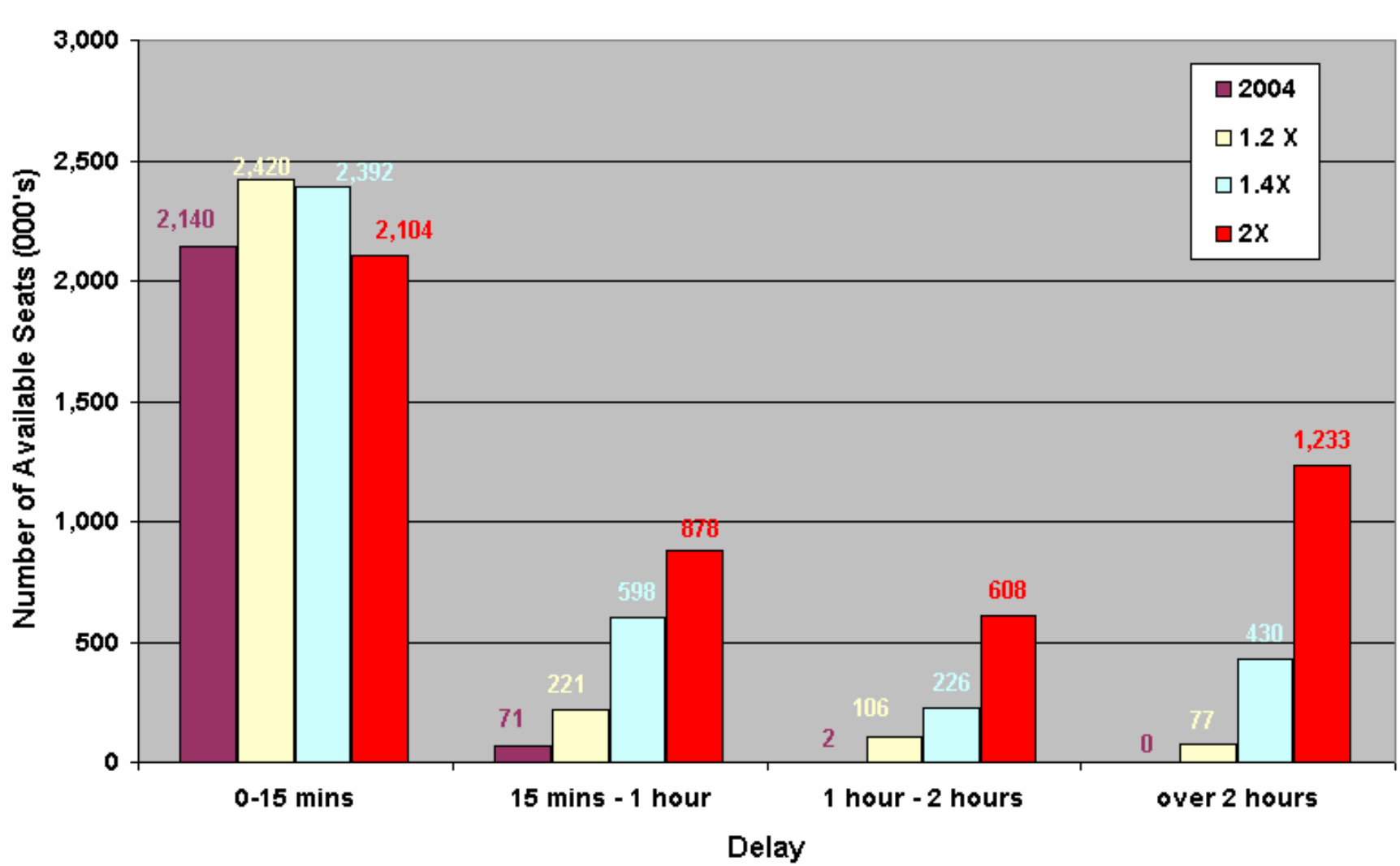
Time-of-day Delay Distribution Comparison



Average Arrival Delay by Time of Day



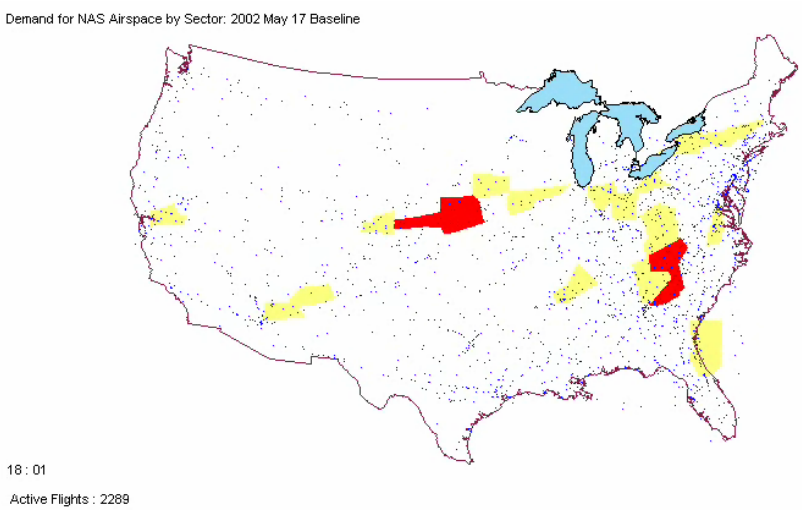
Arrival Delay Effect on Passengers



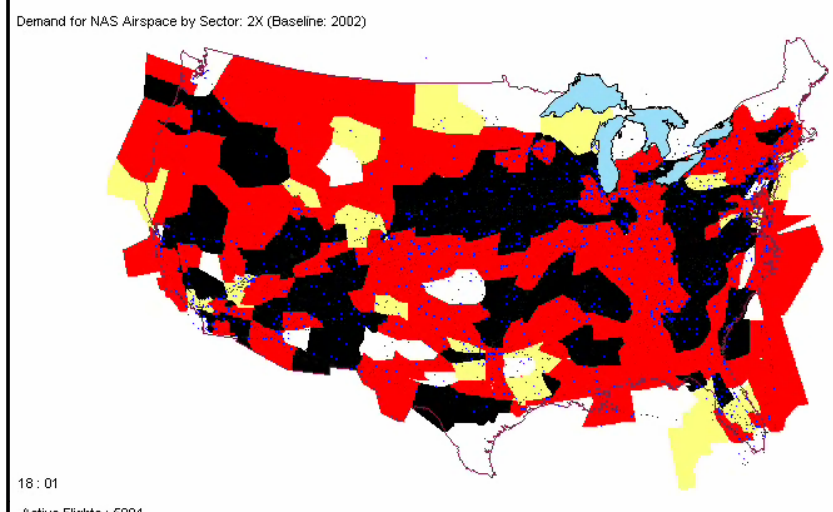
Airspace Loading:
Mid-Day EST Demand for Airspace

Snapshot at ~1pm EDT

Baseline Demand (2002)



Future 2X Demand



AvAnalyst™
Seagull Technology

VAMS ACES Simulation B 2.0.3
Unconstrained Airports & Airspace
250 Airports, 24 hour simulation
Future growth based on Terminal Area Forecast (TAF)

2002: ~27K flights total
Future 2X: ~54K flights total

Sector Color Loading index:

Yellow: 80 – 125% of sector capacity

Red: 125 - 200% of sector capacity

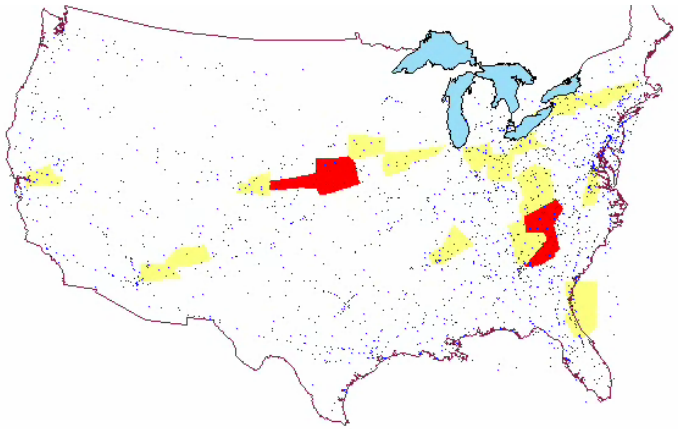
Black: > 200% of sector capacity

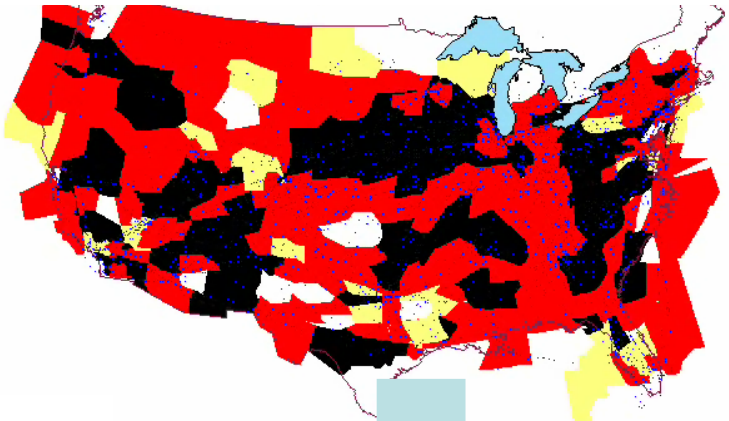
Airspace Loading:
Subdivide Sectors / More Controllers

Baseline Demand (2002)
Current Sector Capacities

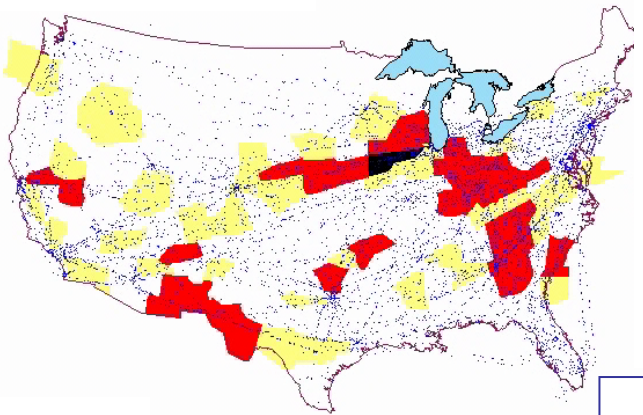
Snapshot at ~1pm EDT
2X Future Demand

2X Future Demand
Current Sector Capacities

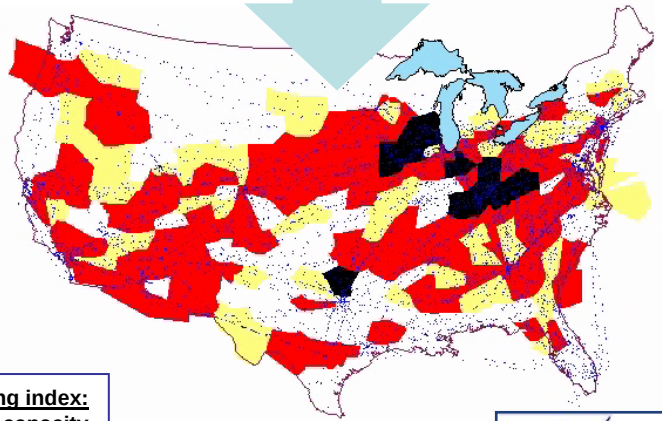




3X the number of Sectors and Controllers



2X the number of Sectors and Controllers



Sector Color Loading index:

- Yellow: 80 – 125% of sector capacity
- Red: 125 - 200% of sector capacity
- Black: > 200% of sector capacity

AvAnalyst™
Seagull Technology

Demand and Airport Capacity Ratio Analysis

- Hourly Airport Capacity

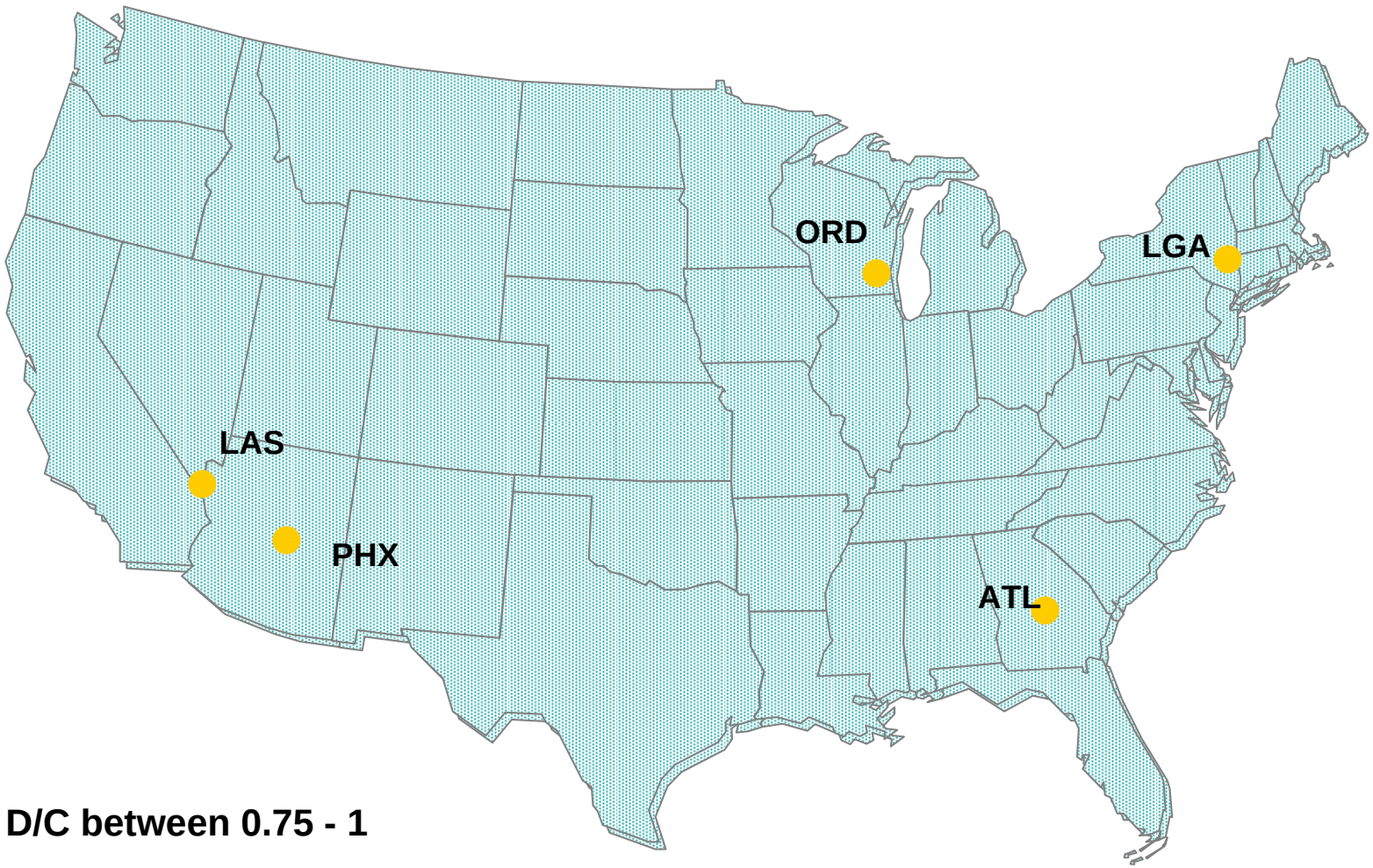
$$Airport\ Capacity = VFR\ Capacity$$

- The daily airport capacity is assumed to be 16 hours of the hourly VFR airport capacity

- Based on previous Welch and Lloyd study*, as the demand to adjusted capacity ratio (D/C) passes approximately 0.75, airports start experiencing disproportional delays.

*Welch, J. D., and Lloyd, R. T., " Estimating Airport System Delay Performance", 4th USA/Europe Air Traffic management R&D Seminar, Santa Fe, 3-7 December 2001

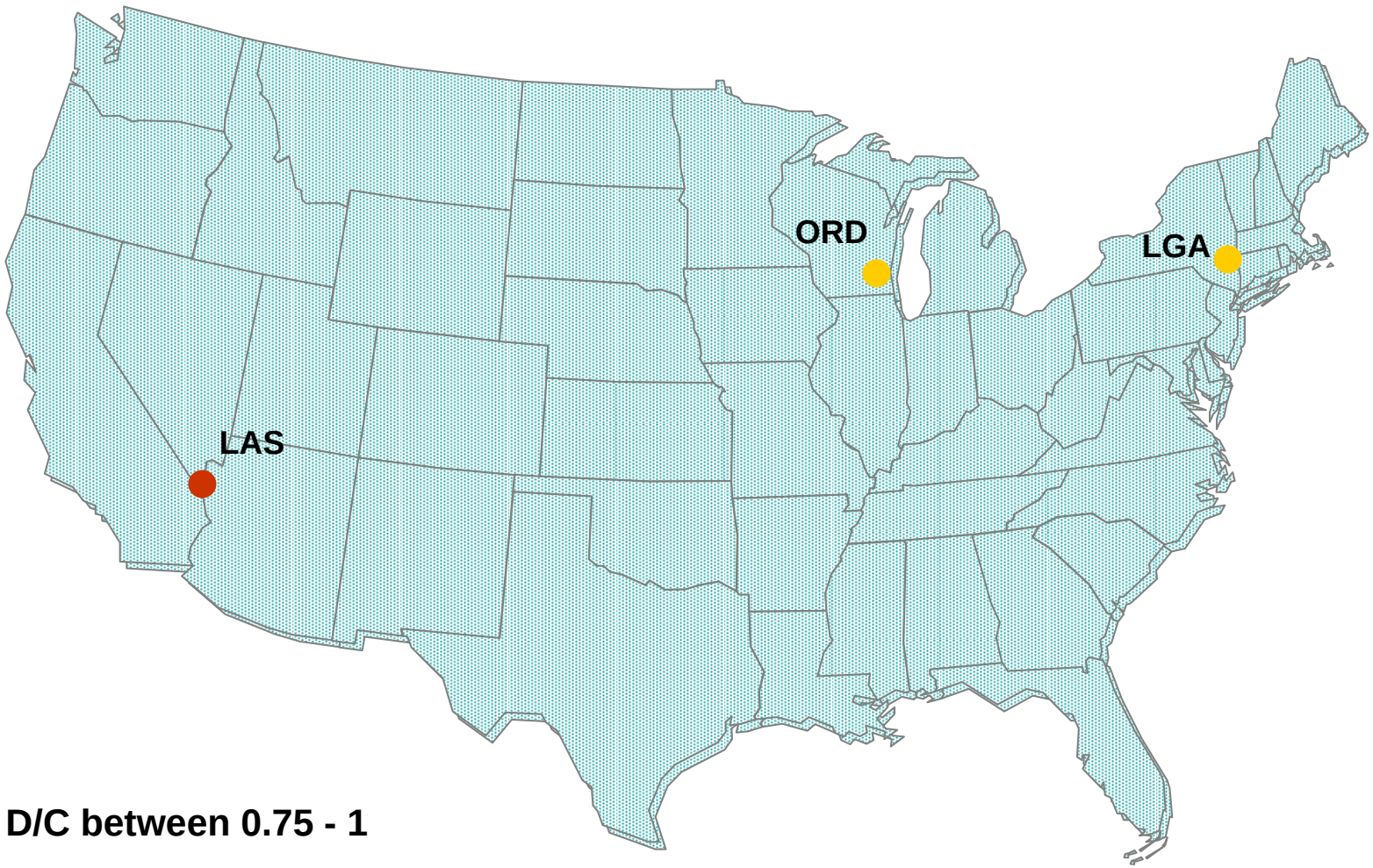
2004 Baseline – Airports at Capacity



D/C between 0.75 - 1

D/C above 1

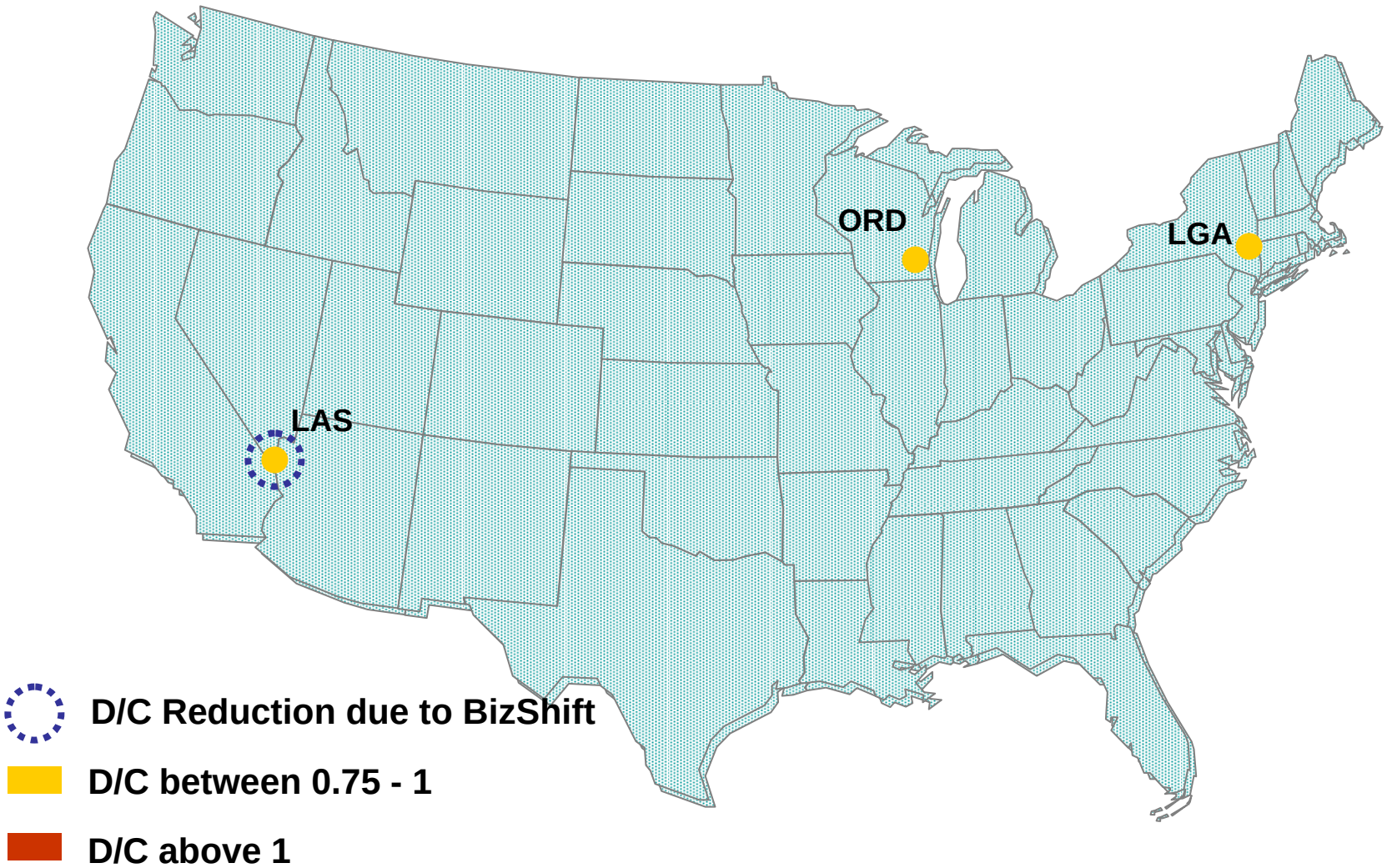
2014 Baseline – Airports at Capacity



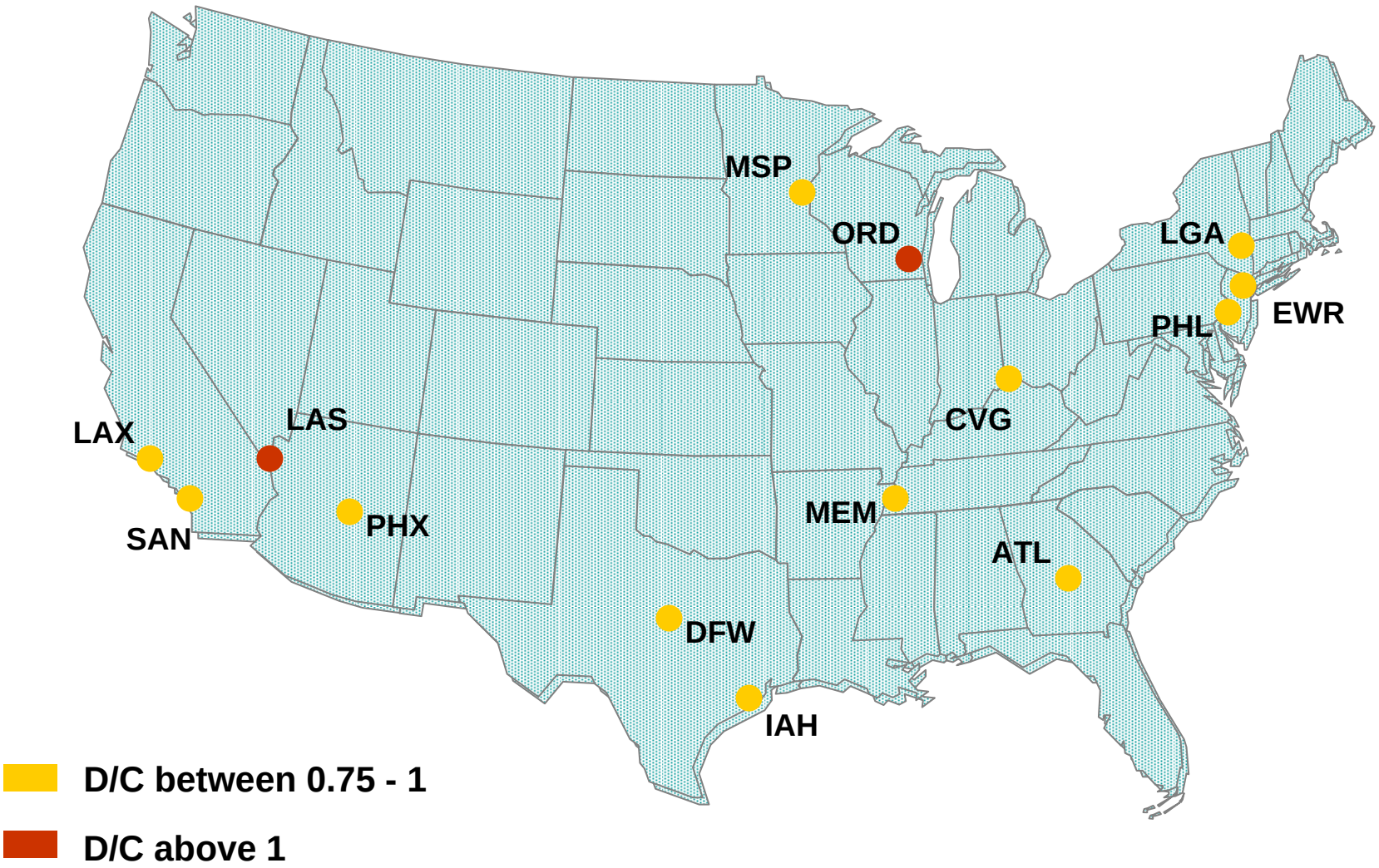
D/C between 0.75 - 1

D/C above 1

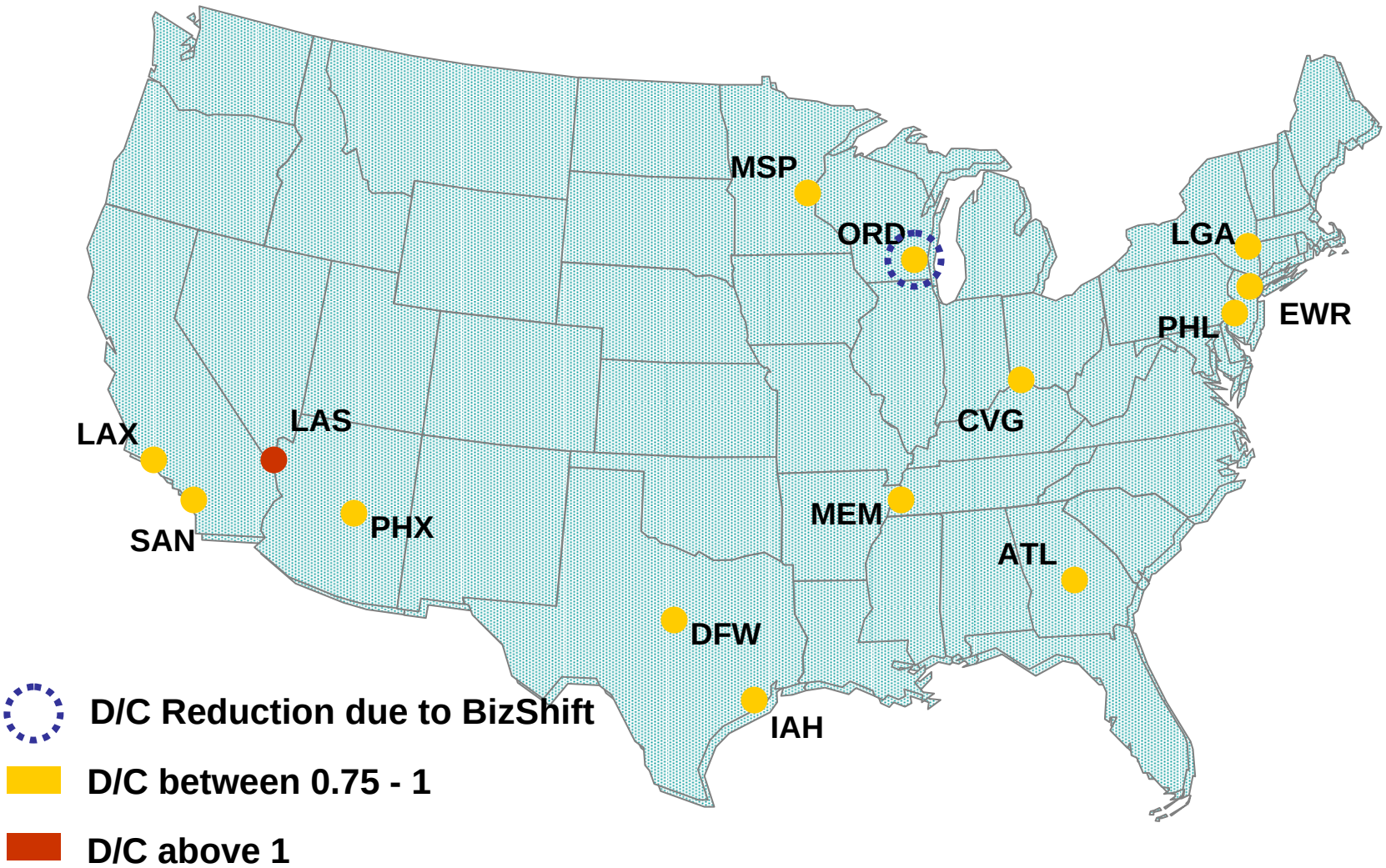
2014 Bizshift1 – Airports at Capacity



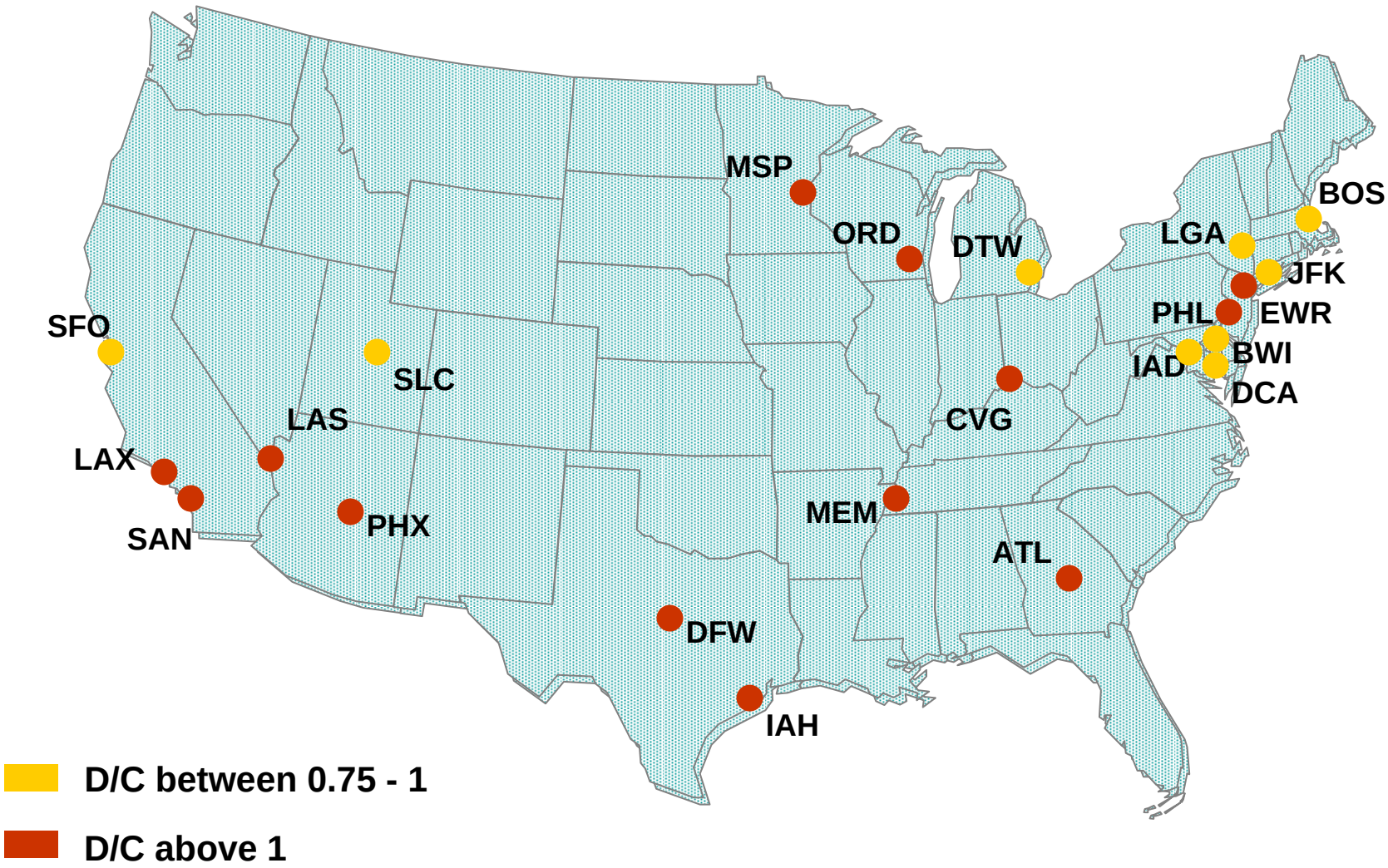
2025 Baseline – Airports at Capacity



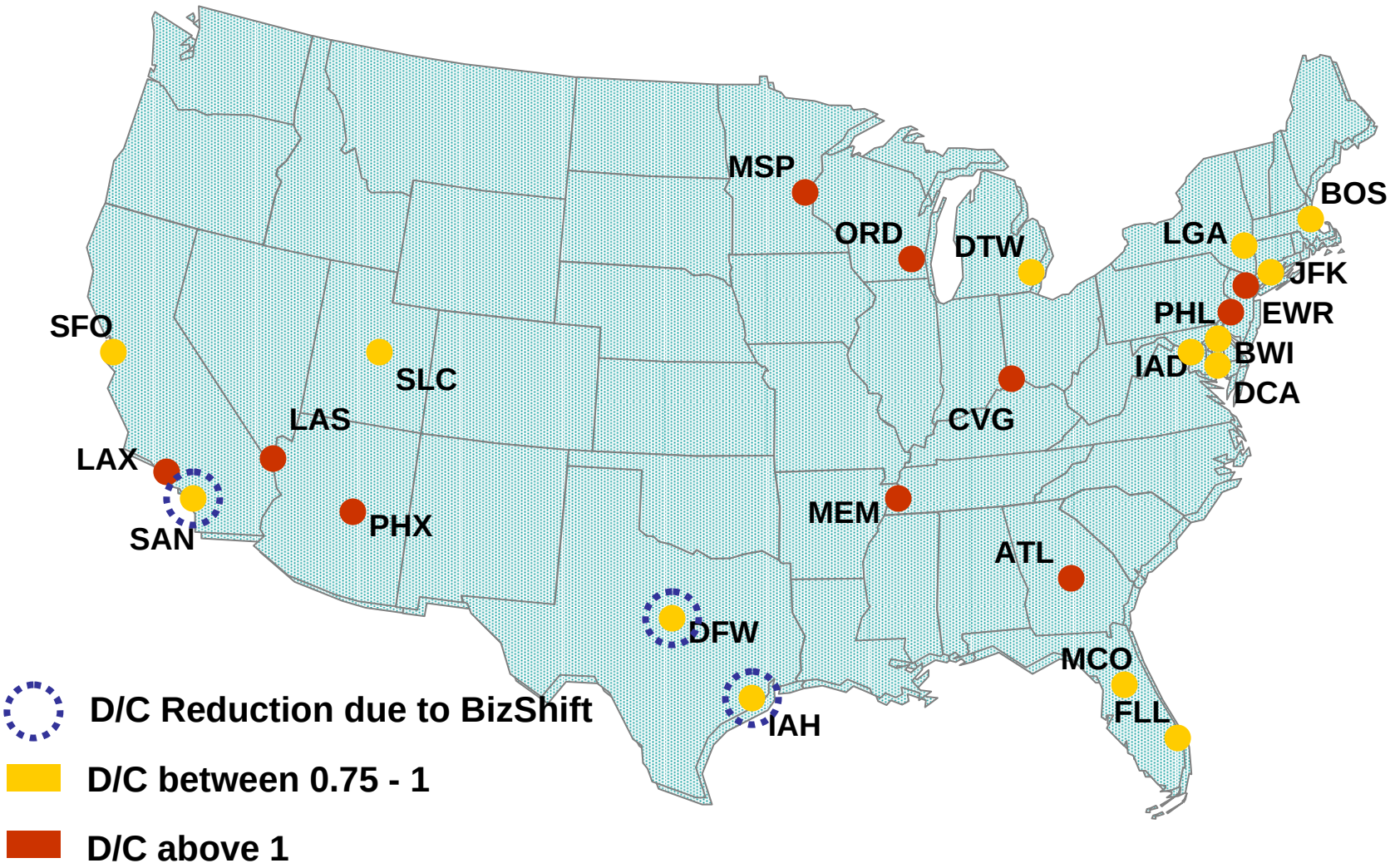
2025 Bizshift1 – Airports at Capacity



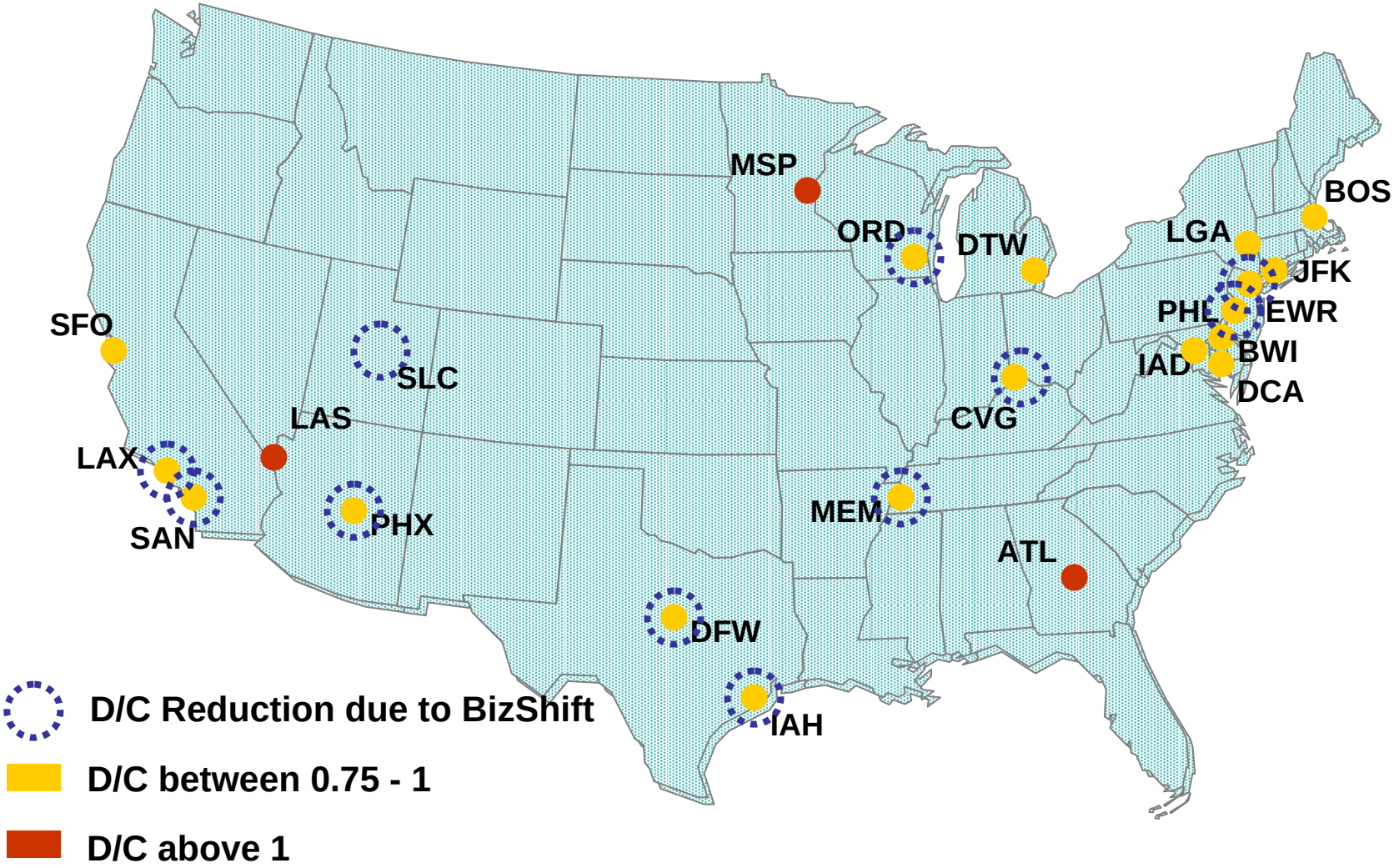
2X Baseline – Airports at Capacity



2X Bizshift1 – Airports at Capacity

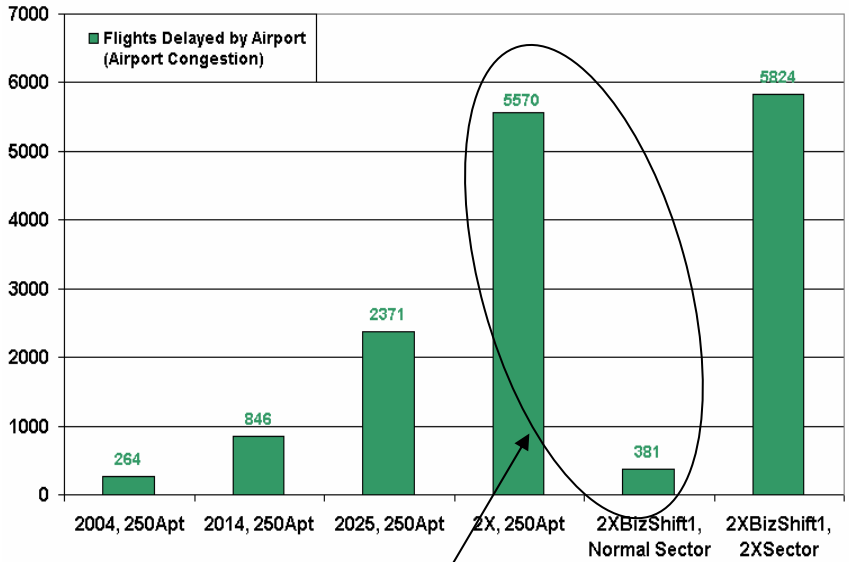


2X Bizshift1 with 0.75 D/C Ratio – Airports at Capacity

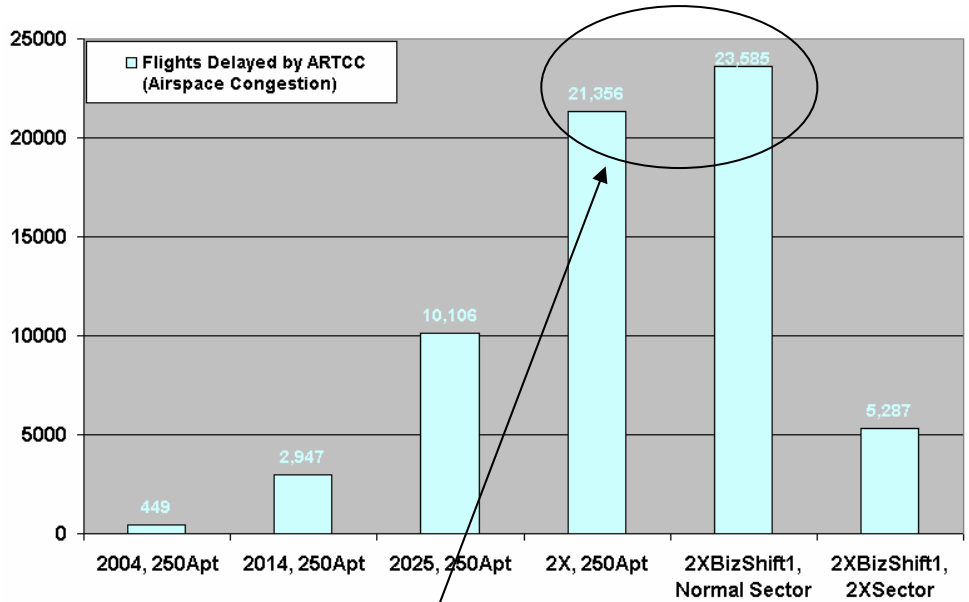


Delay Causes
(Airport vs. Airspace Congestion)

Airport Congestion



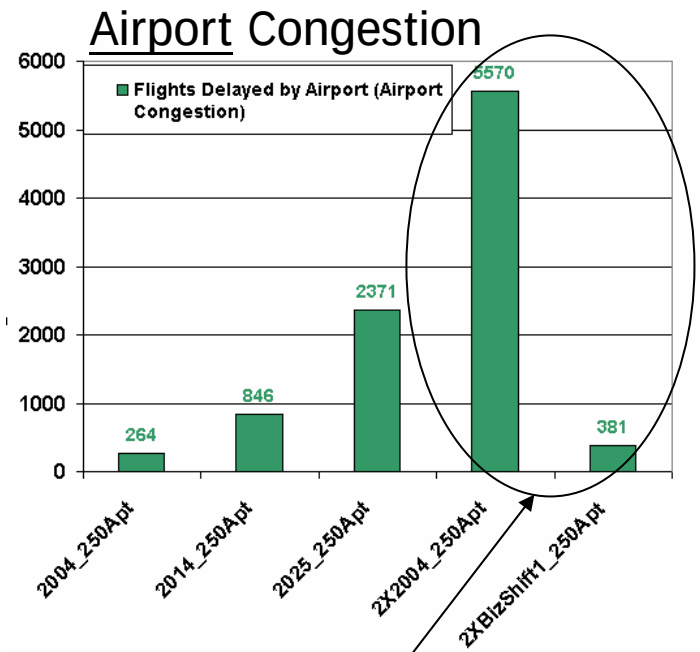
Airspace Congestion

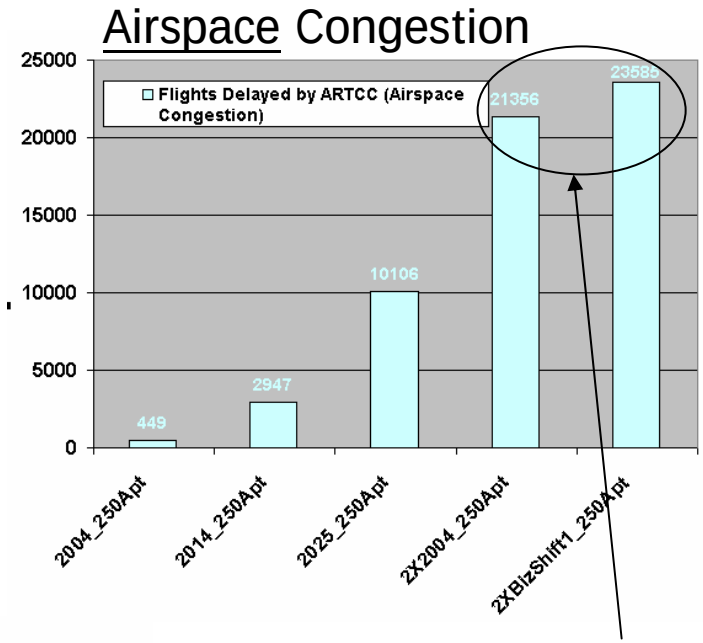


BizShift1 airspace congestion dominates causing airport induced delays to drop

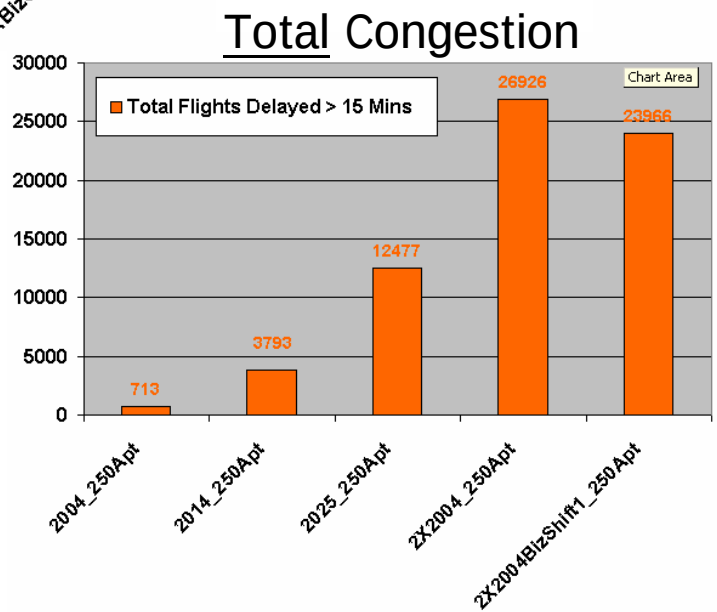
Bizshift1 causes slight increase in airspace congestion

Delay Causes
(Airport vs. Airspace Congestion)



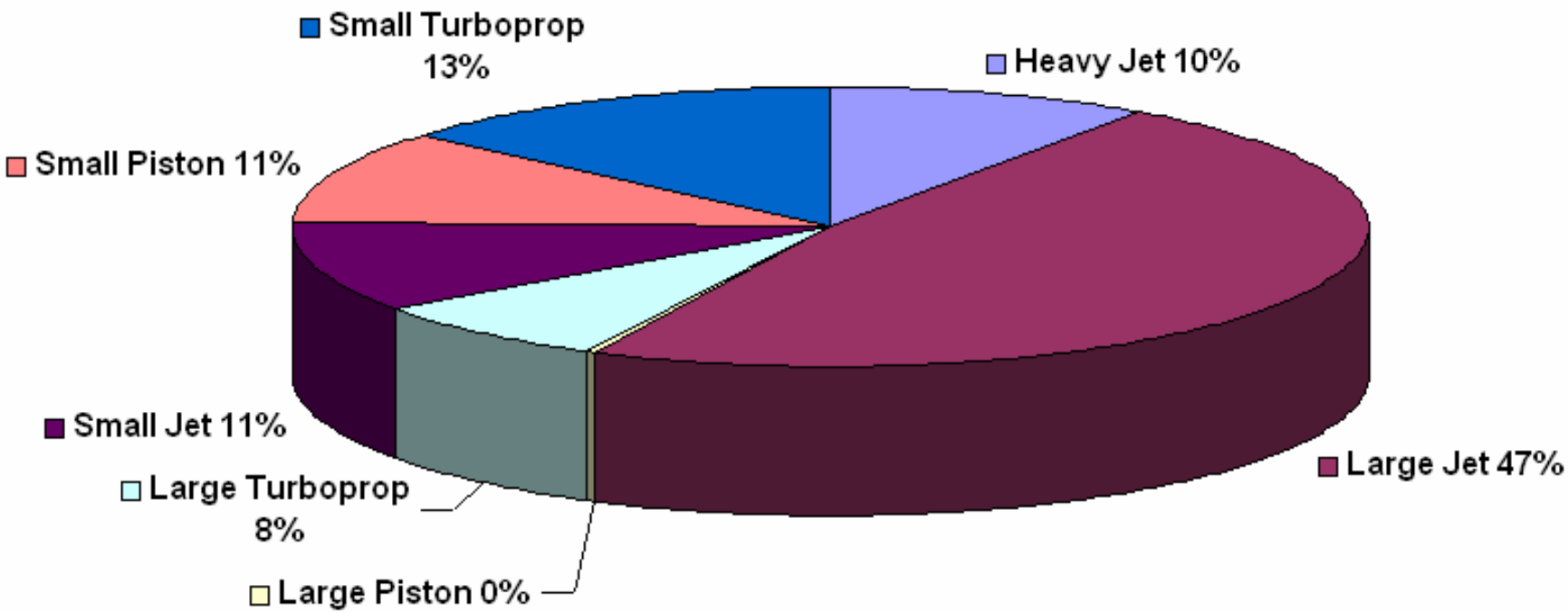


BizShift1 relieves airport congestion

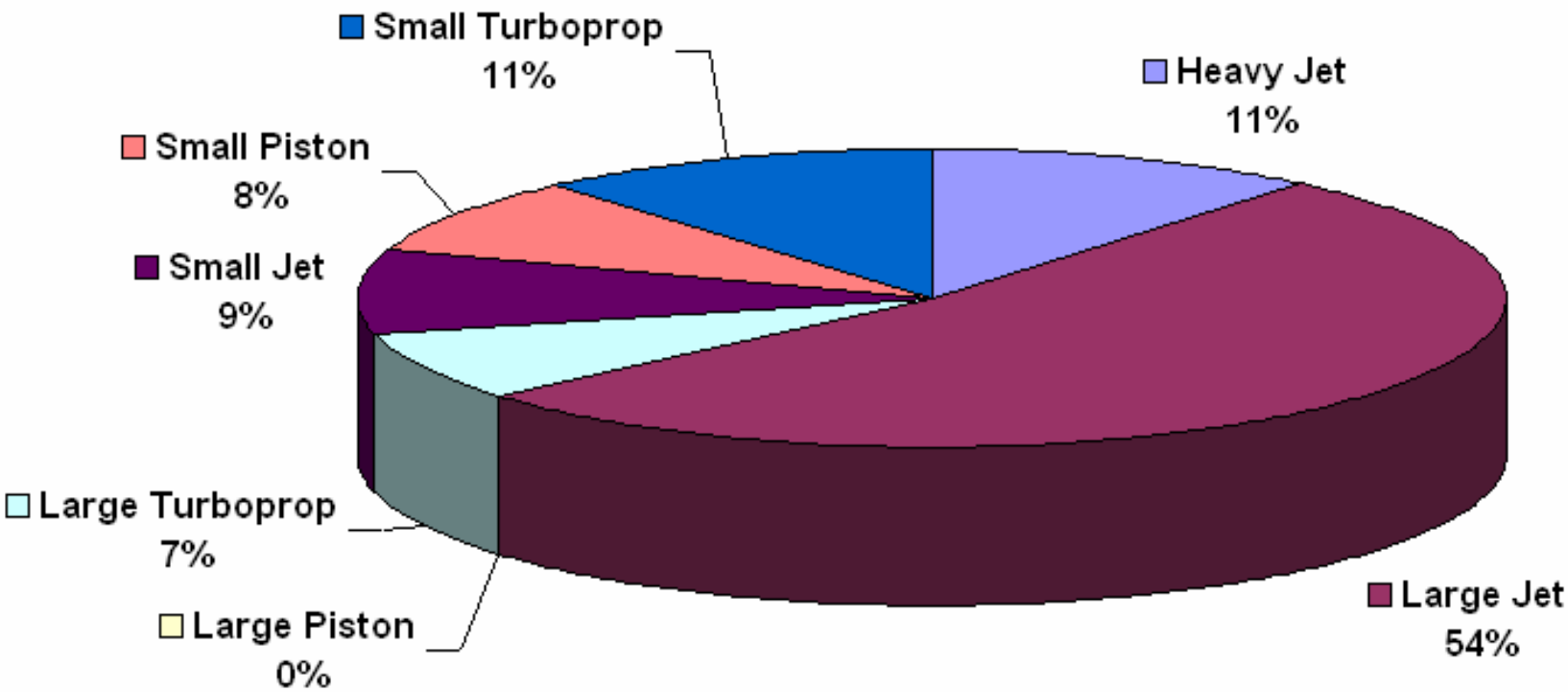


Bizshift1 causes slight increase in airspace congestion

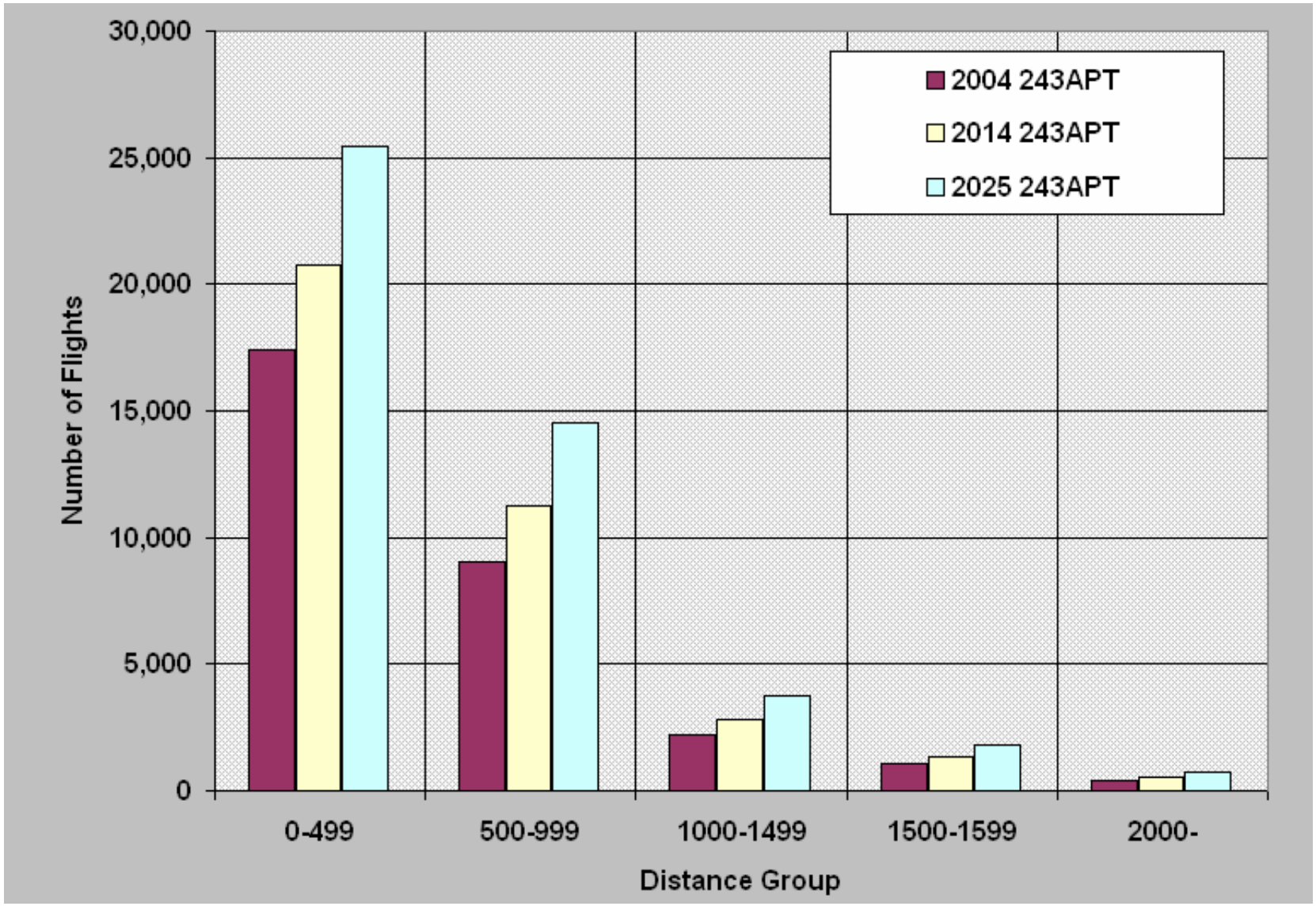
2004 Aircraft Type Composition



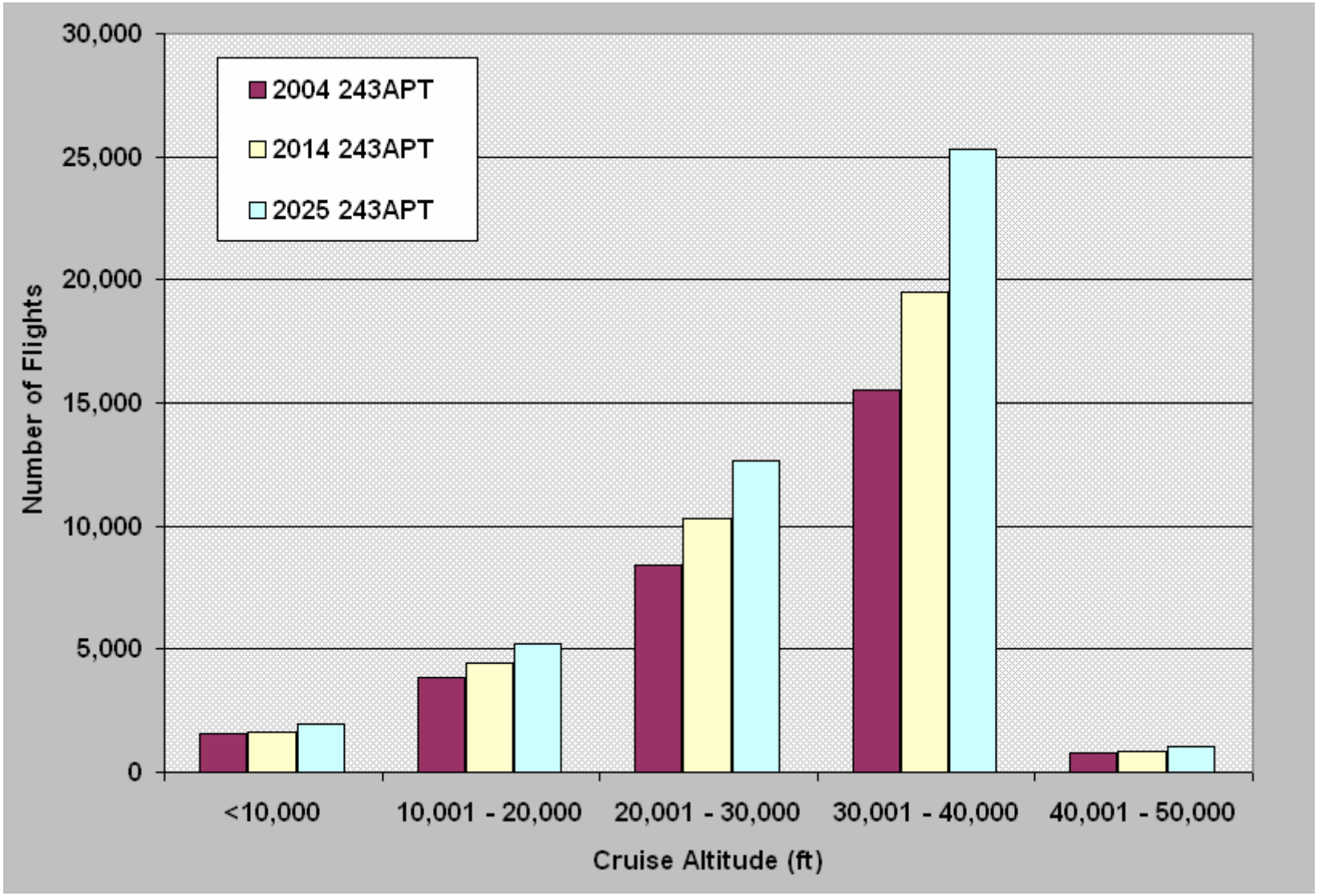
2025 Aircraft Type Composition



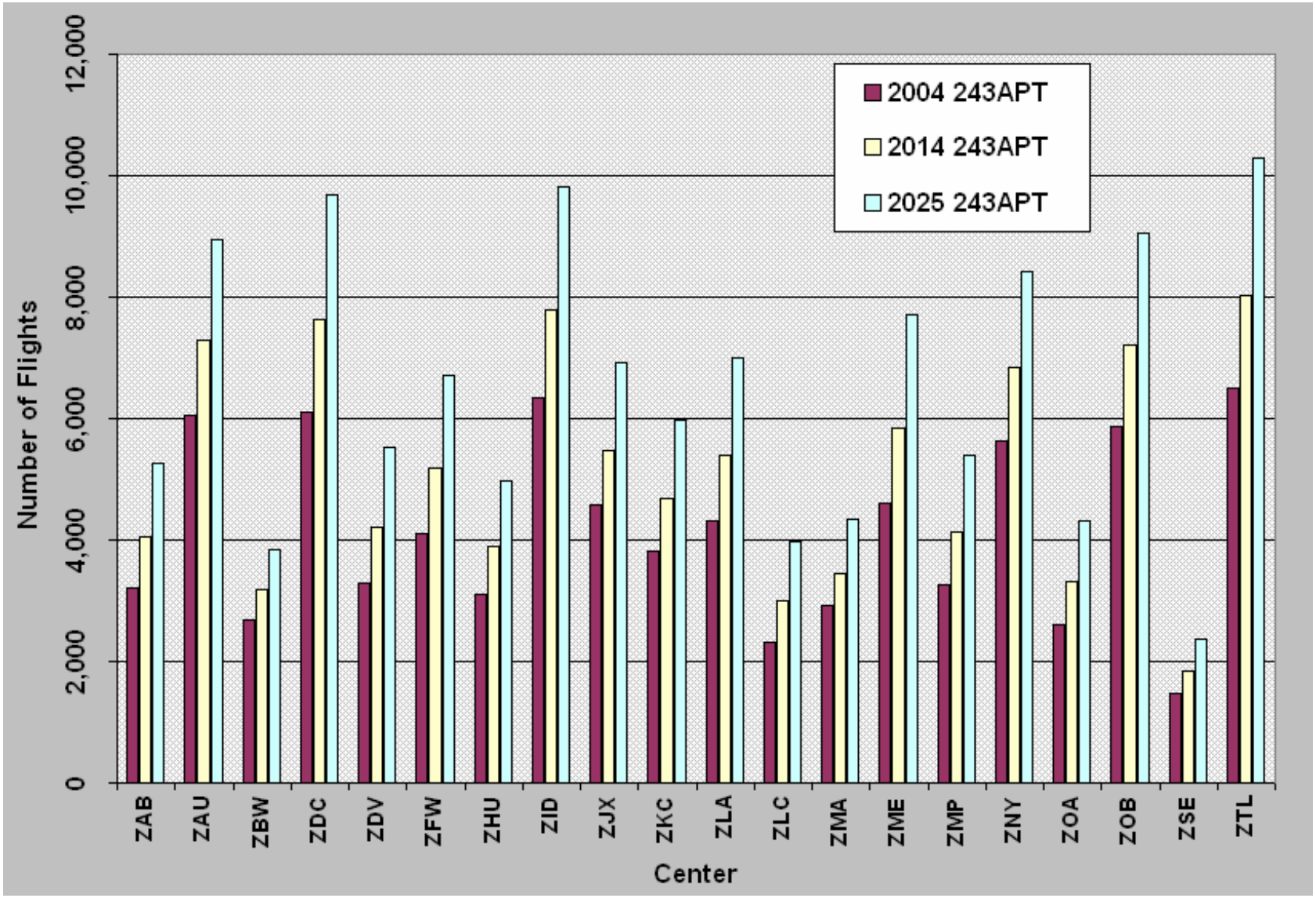
2004, 2014 and 2025 Flight Counts by Distance



2004, 2014 and 2025 Flight Counts by Cruise Altitude



2004, 2014 and 2025 Flight Counts by Center



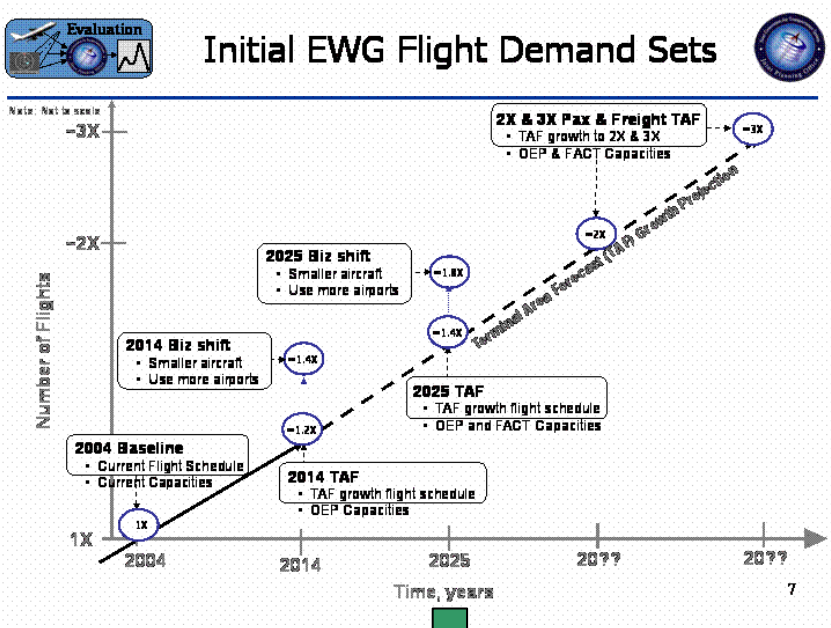
Flight Demand Comparison: Overall Throughput

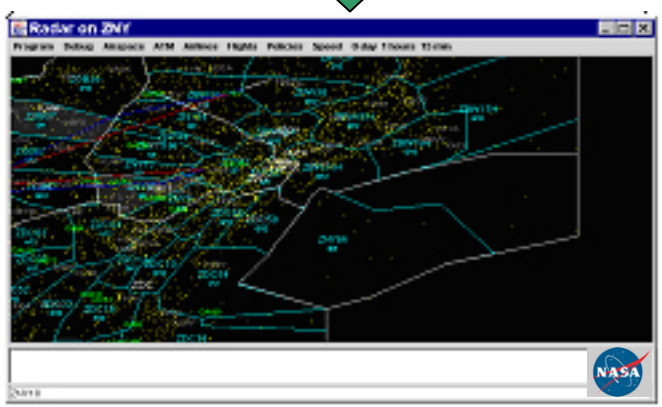
Demand Scenario	2004	2014	2025
Set Type	International	International	International
Available Seats	4,337,857	5,251,601	6,696,281
Available Seat Miles	4,415,381,346	5,243,752,240	6,795,199,142
Total Ops*	55,998	64,983	79,290
TAF Gross Growth	1.00	1.19	1.43
Flight Growth	1.00	1.16	1.42
Available Seat Growth	1.00	1.21	1.54
ASM Growth	1.00	1.19	1.54
Average Stage Length (mile)	1,018	999	1,015

*The 2004 International Set has 57,093 flights, only 55,998 flights are included in the demand generation process. The filtered flights are due to the following three reasons:

1) Flights with unknown departure and/or arrival airport, and
2) Round-robin flights

NAS Transformation in Environment



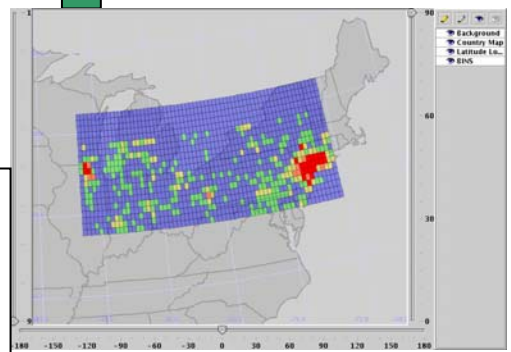


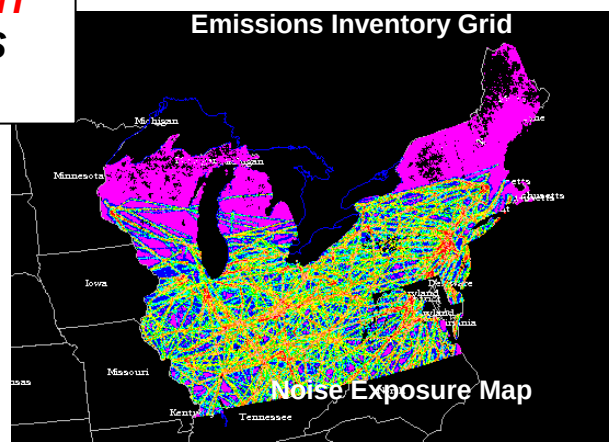
Simulate NAS Using ACES

FEEDBACK TO THE TRANSFORMATION PROCESS

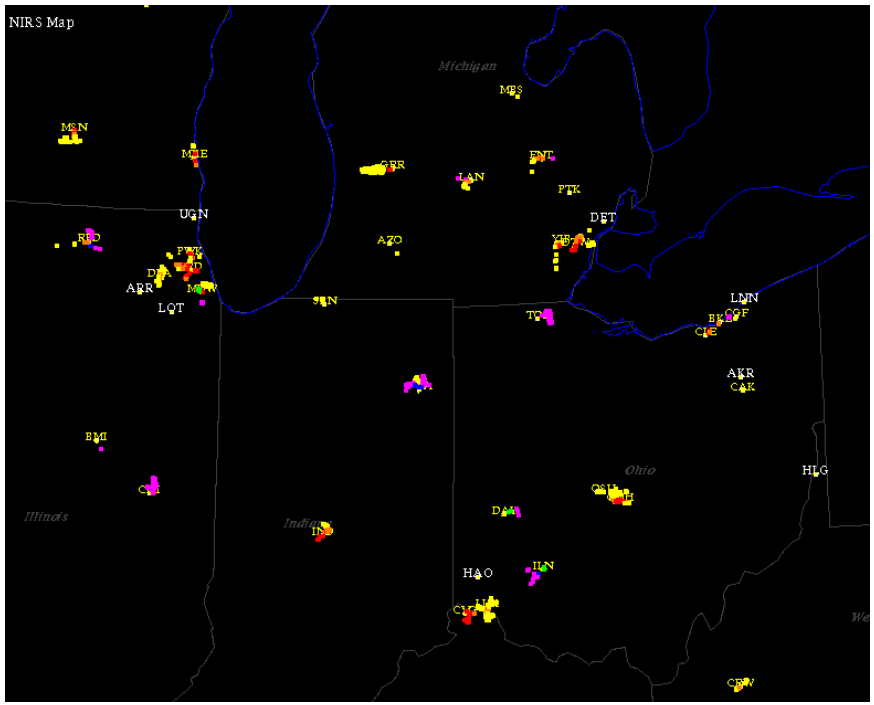
IMPACTS ON

SAFETY
CAPACITY
ENVIRONMENT
ECONOMICS





2X Business Shift Noise Results



	1X_C (pop.)	2X_B (pop.)	Change
ABOVE 65 dB	117K	163K	+ 39%
ABOVE 55 dB	1237K	1757K	+ 42%

Distribution of Population by DNL for PhaseOne_2X_BusinessShift1 Versus PhaseOne_Base_Const

BASELINE

ALTERNATE

DNL	<45 dB	45 - <50 dB	50 - <55 dB	55 - <60 dB	60 - <65 dB	65 - <70 dB	>70 dB	Alt Totals
<45 dB	33039488	281297	24349	90	0	0	0	33345224
45 - <50 dB	1596278	2075893	97680	13704	0	0	0	3783555
50 - <55 dB	35499	981256	1329132	52532	2393	0	0	2400812
55 - <60 dB	0	52165	522561	603007	9793	653	0	1188179
60 - <65 dB	0	0	13834	170771	217792	2696	0	405093
65 - <70 dB	0	0	0	2653	47024	62209	1933	113819
>70 dB	0	0	0	0	86	15175	34210	49471
Base Totals	34671265	3390611	1987556	842757	277088	80733	36143	41286153

Total Population above 65 DB : 163290 PhaseOne_2X_BusinessShift1, 116876 PhaseOne_Base_Const

Change of Exposure by Population of DNL for PhaseOne_2X_BusinessShift1 Versus PhaseOne_Base_Const

BASELINE DNL (dB)

ALT DNL (dB)

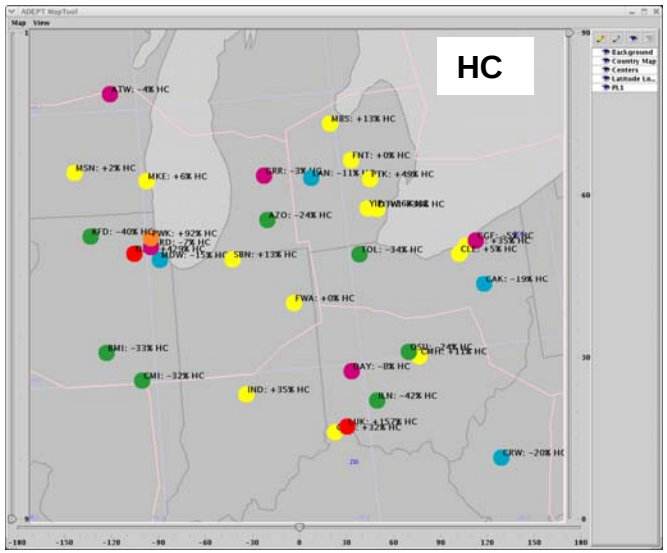
ALT DNL (dB) \ BASELINE DNL (dB)	0	40	45	50	55	60	65	70
0	33039488		80150	24349	90	0	0	0
40								
45	152838	1443440	2075893	201147	21766	13704	0	0
50	35499		981256	851355	75914	8997	2393	0
55	0		52165	129901	1329132	43535	0	0
60	0		0	13834	479692	603007	1440	653
65	0		0	0	42869	109458	8353	0
70	0		0	0	2653	61313	206531	2581
						11261	37502	42536
						115	3523	1094
							185	1933
							79	0
							2987	339
							86	12188
								26819
								7052

- 45dB <= Base < 60dB; Alt <= (Base-5dB)
- 60dB <= Base < 65dB; Alt <= (Base-3 dB)
- 65dB < Base; Alt <= (Base-1.5dB)
- 45dB <= Alt < 60dB; Alt >= (Base+5dB)
- 60dB <= Alt < 65dB; Alt >= (Base+3dB)
- 65dB <= Alt; Alt >= (Base+1.5dB)

	INC	DEC	NC
> 65 dB	78060	6600	72342
TOTAL	577740	159489	40548924

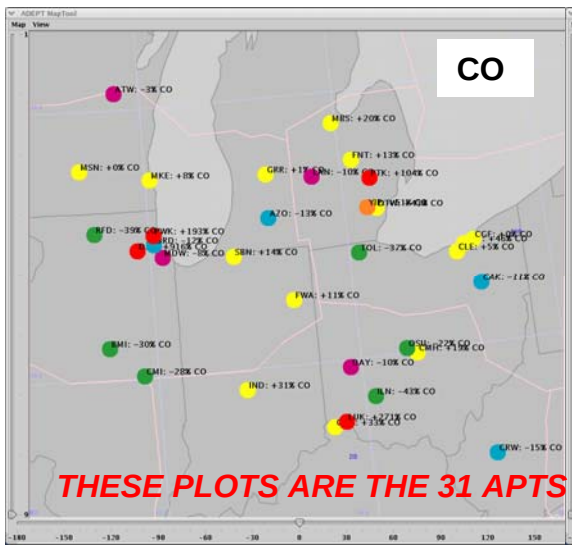
TOTAL ABOVE 65 DB:
Baseline = 116876
Alternative = 163290

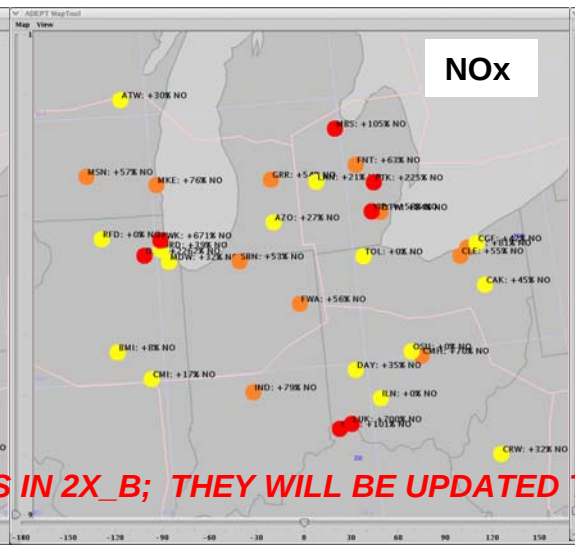
2X Business Shift Emissions Results

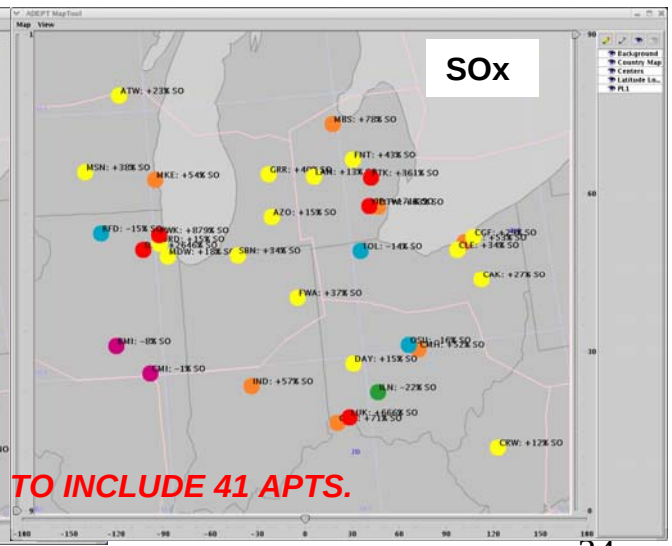


	1X_C (kT/yr)	2X_B (kT/yr)	Change
HC	1.4	2.5	+ 79%
CO	9.8	18.8	+ 92%
NOx	8.9	16.0	+ 80%
SOx	0.8	1.5	+ 88%

PURPLE	-50 to -21 %
BLUE	-20 to -11
GREEN	-10 to 0
YELLOW	+1 to +50
ORANGE	+51 to +100
RED	+101 and above

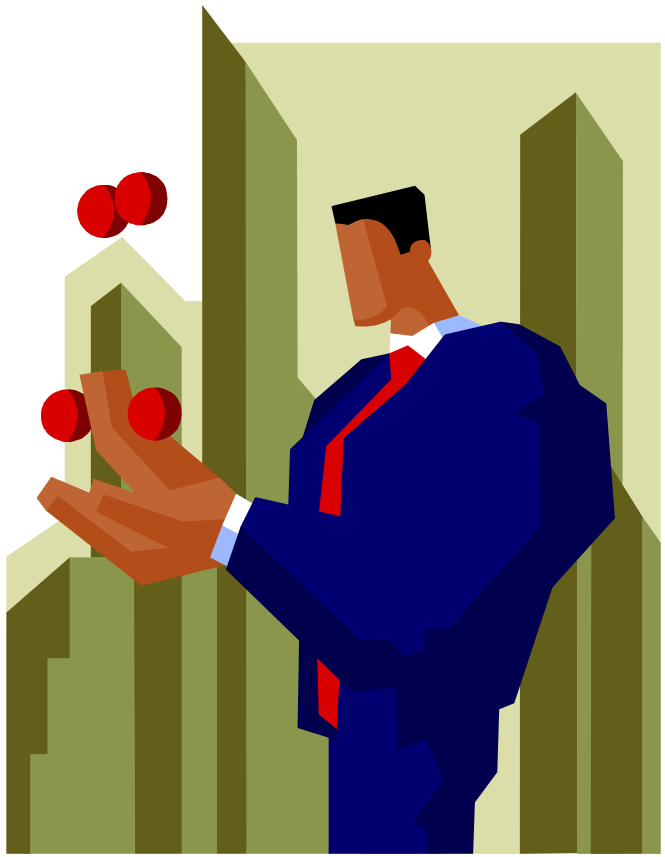






THESE PLOTS ARE THE 31 APTS IN 2X_B; THEY WILL BE UPDATED TO INCLUDE 41 APTS.

Summary



- All demand set shifts indicate significant constraints in both airspace and runway capacity
- Fleet and biz model changes point to congestion and delay relief but with significant cost and environmental implications

JPDO Mission

- Develop a national plan that improves performance of the system on as many of goals as possible -
- Engage all stakeholders in the transformation process