Emerging Considerations for NEXTGEN

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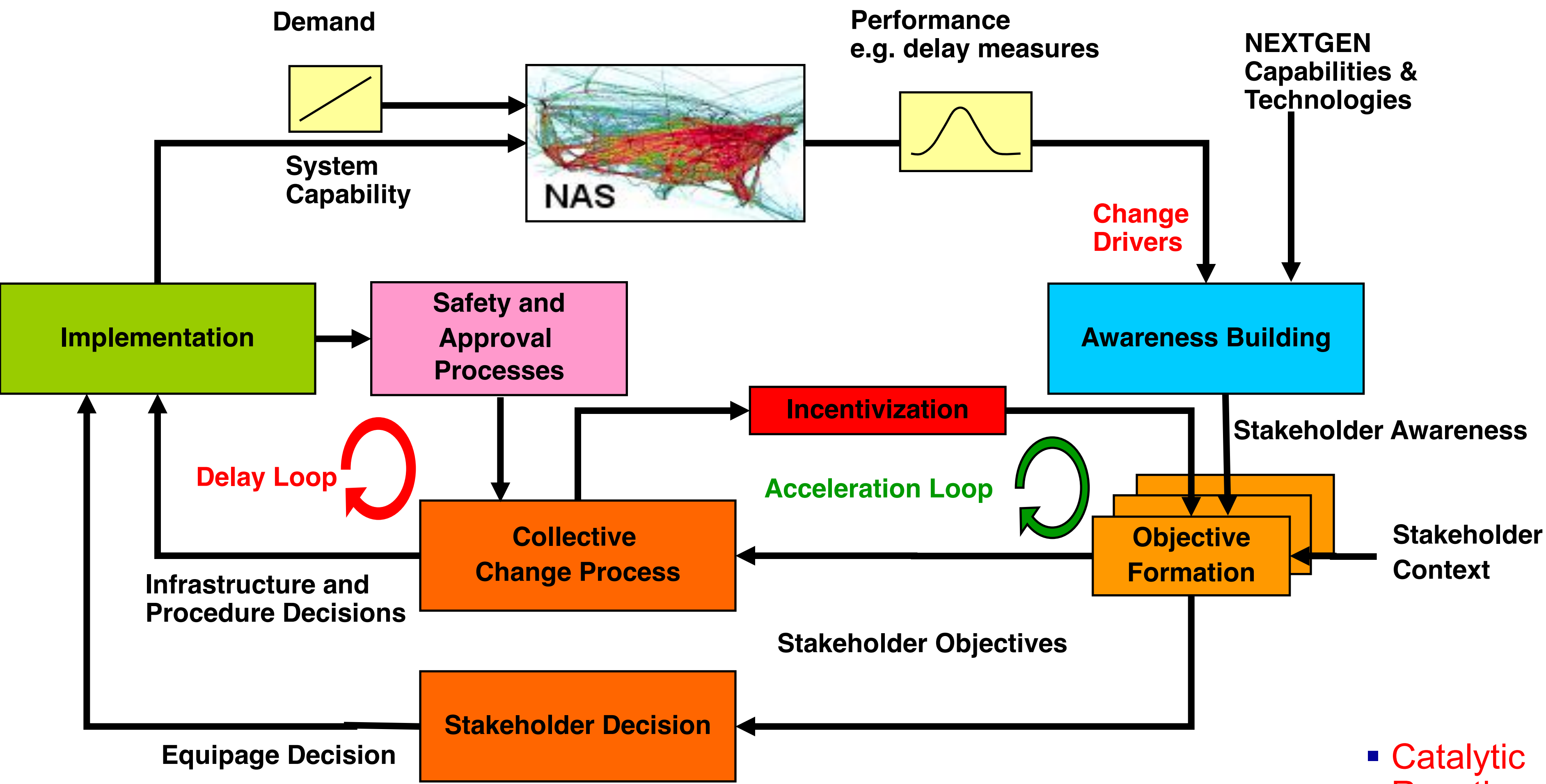
Model of System Transition

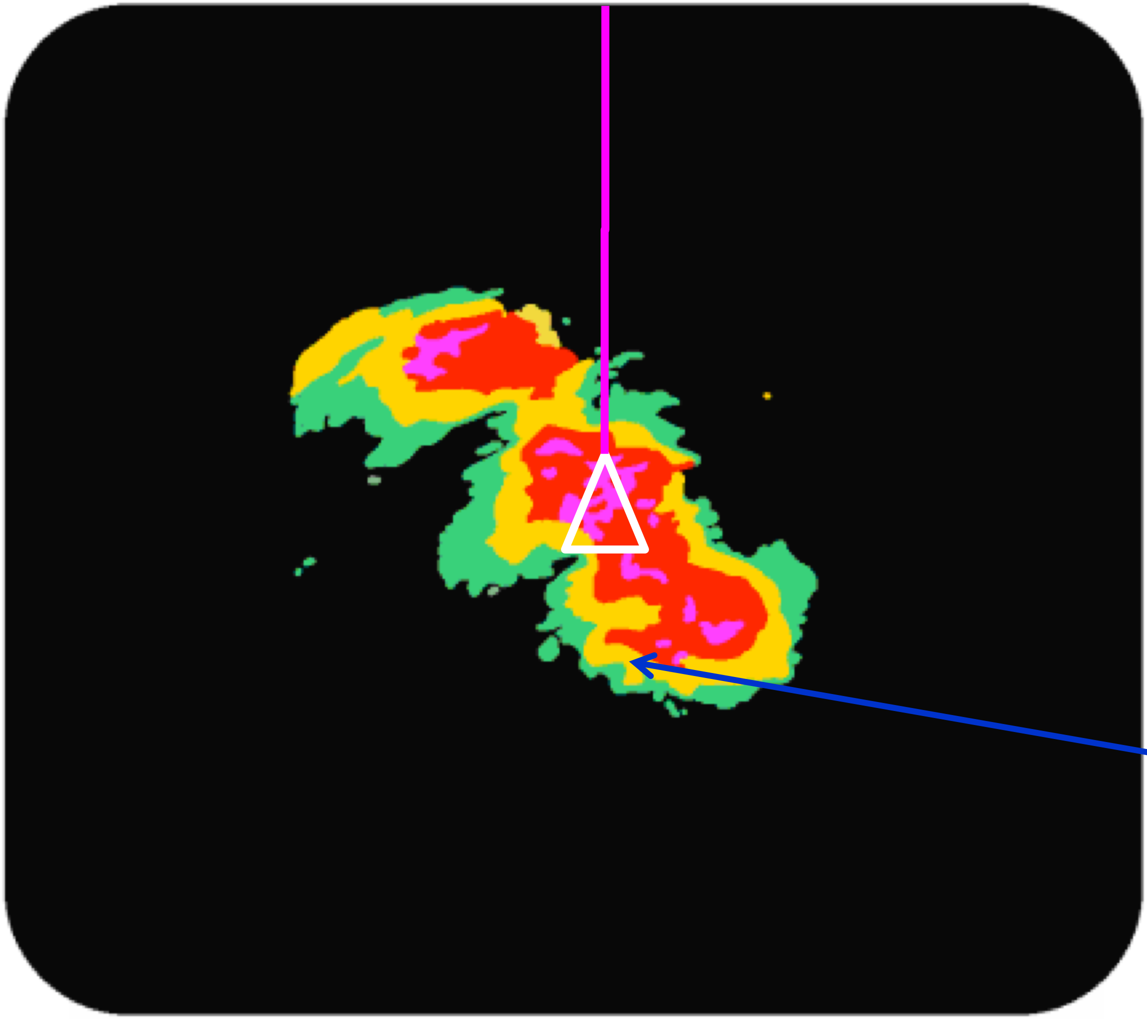
Adaptation to Change Drivers



- Catalytic
- Reactive
- Predictive

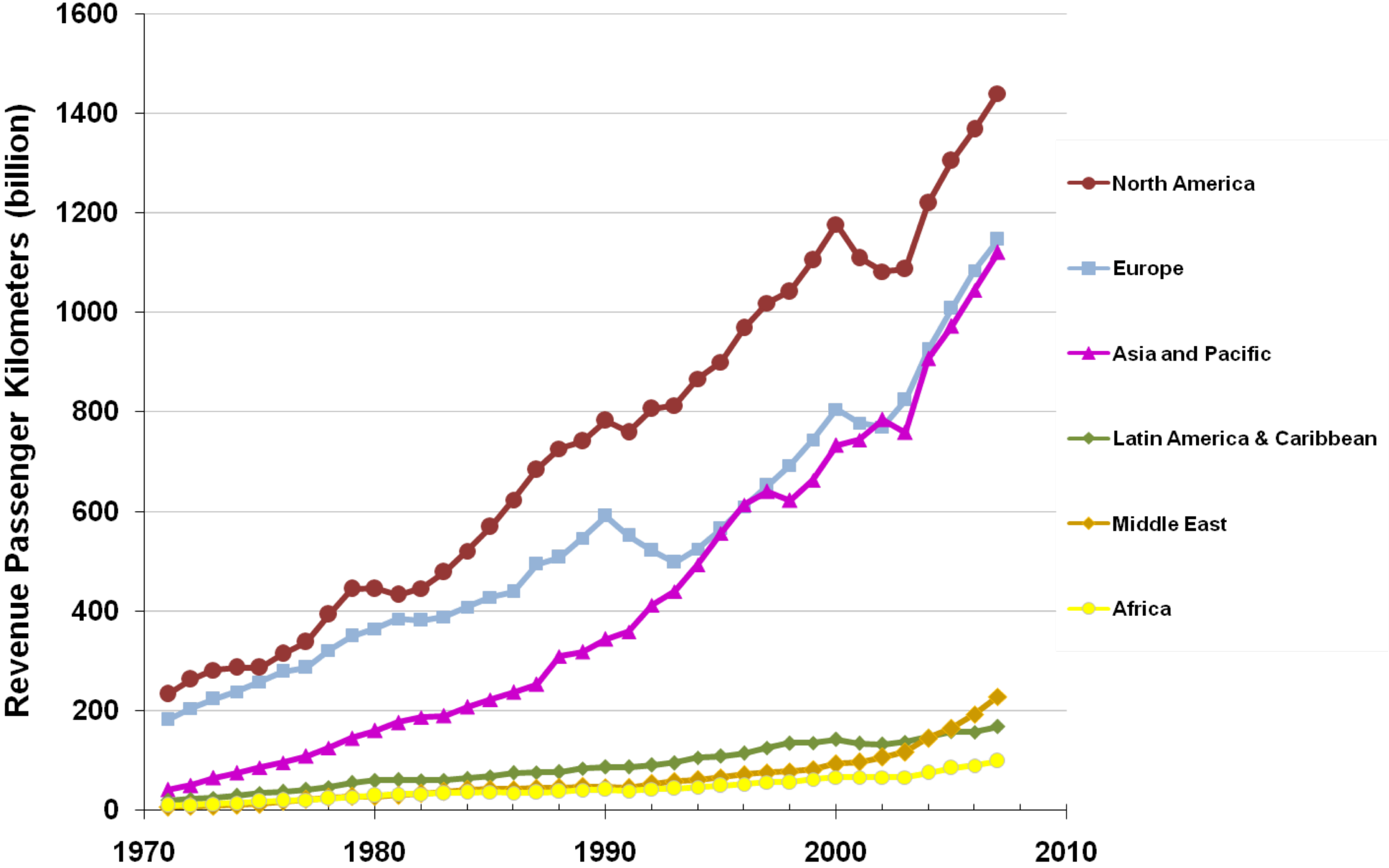
Model developed by Alexandra Mozdzanowska

Historical and Emerging Drivers



Capacity
Constraints

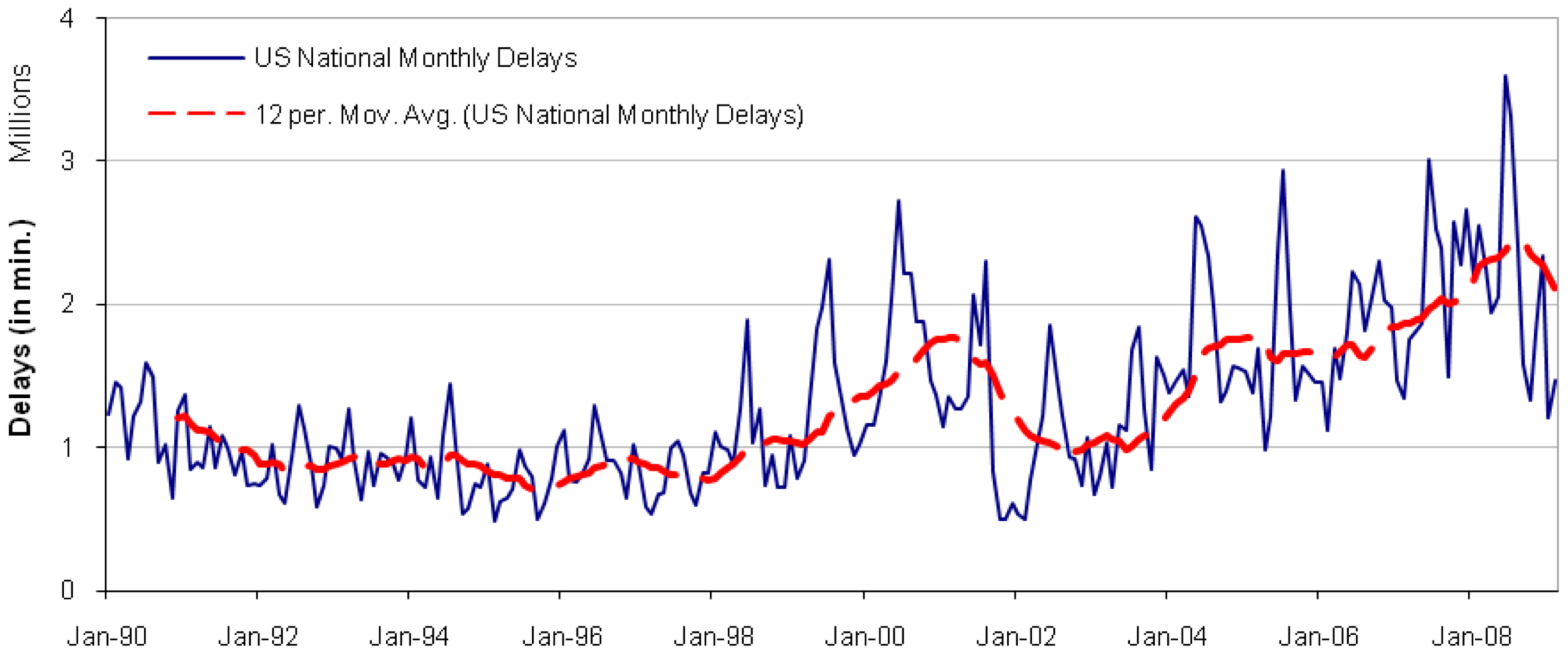
Passenger Traffic Trends (RPK) by World Region



Data source: ICAO, scheduled services of commercial air carriers (through 2006), IATA annual traffic growth data for year 2007 (Jan-Oct)

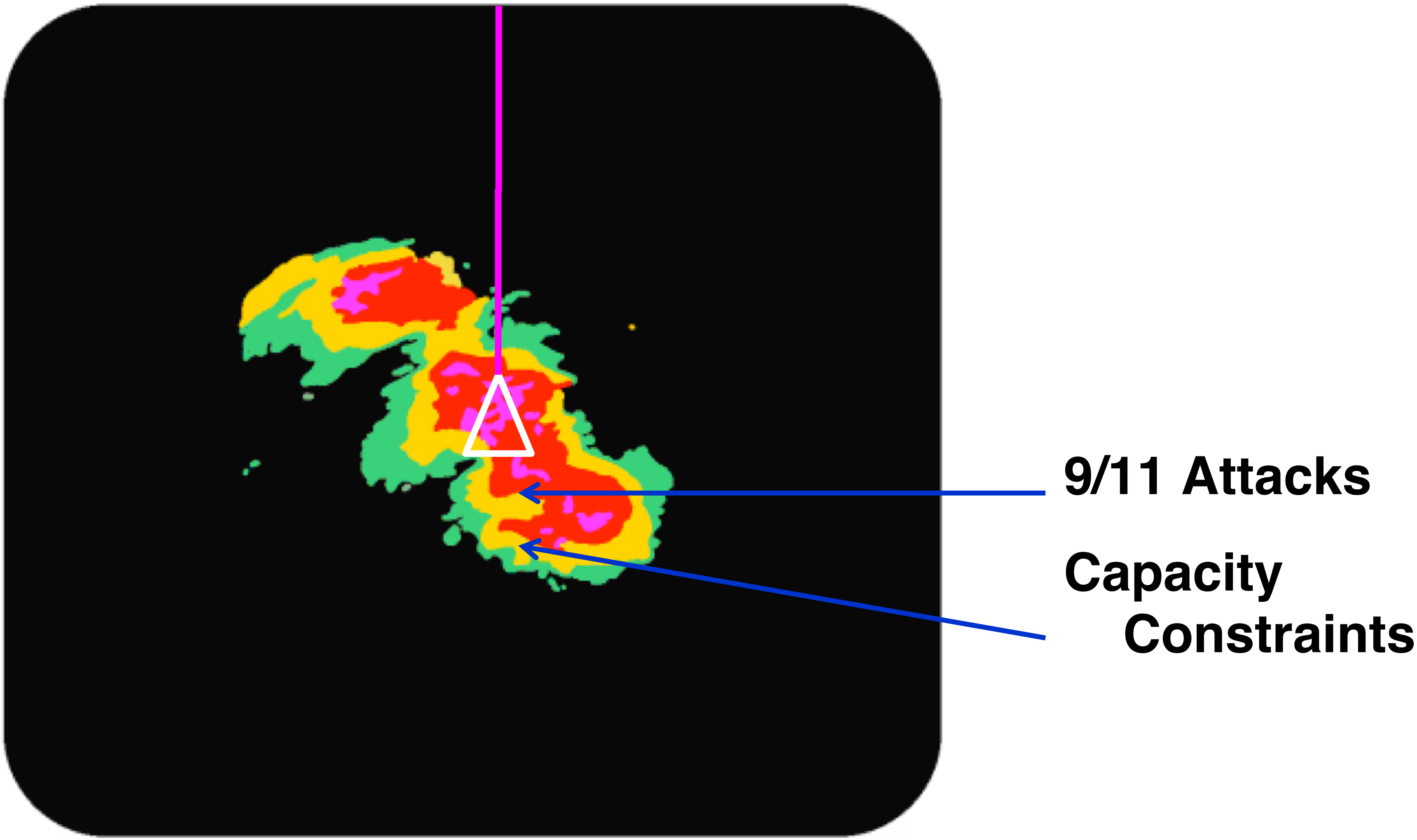
US Flight Delays

from 1995 to 2008



Data source: FAA Operational Network (OPSNET)

Historical and Emerging Drivers



US Flight Delays

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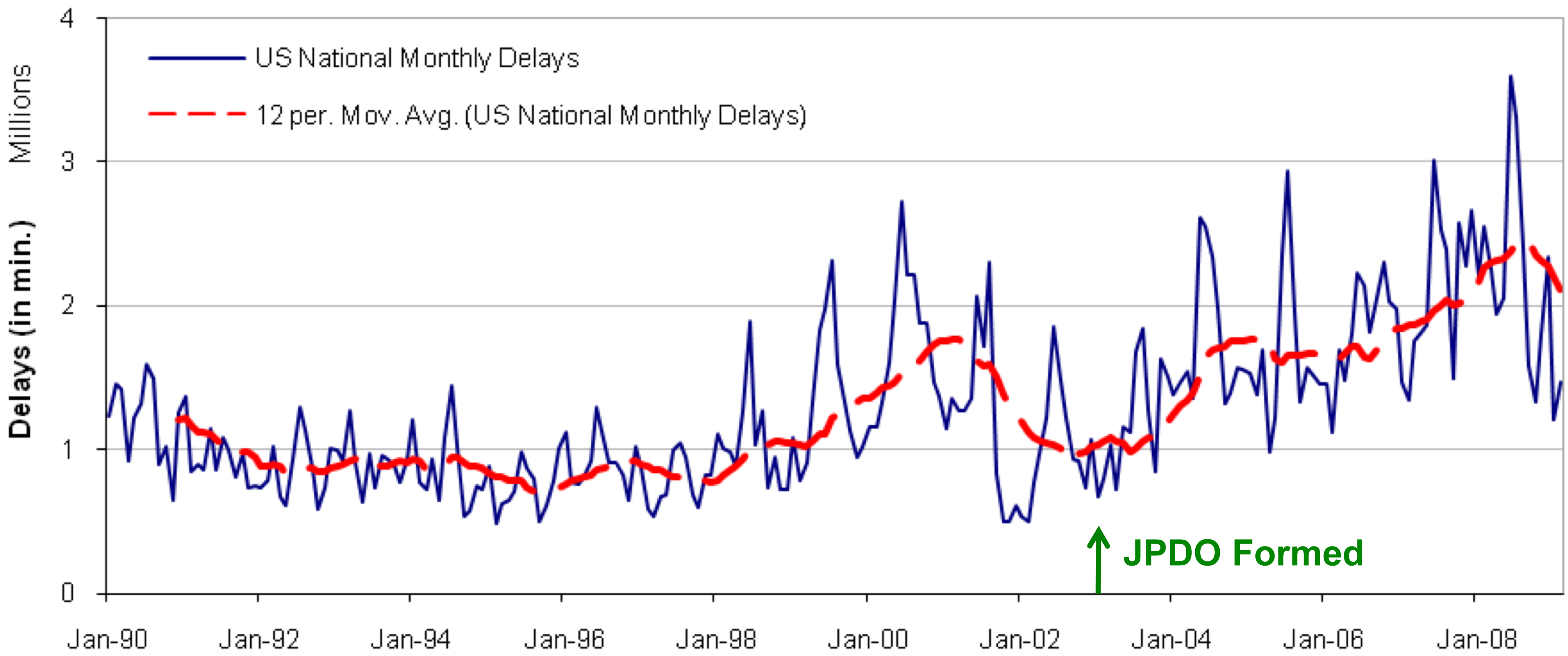
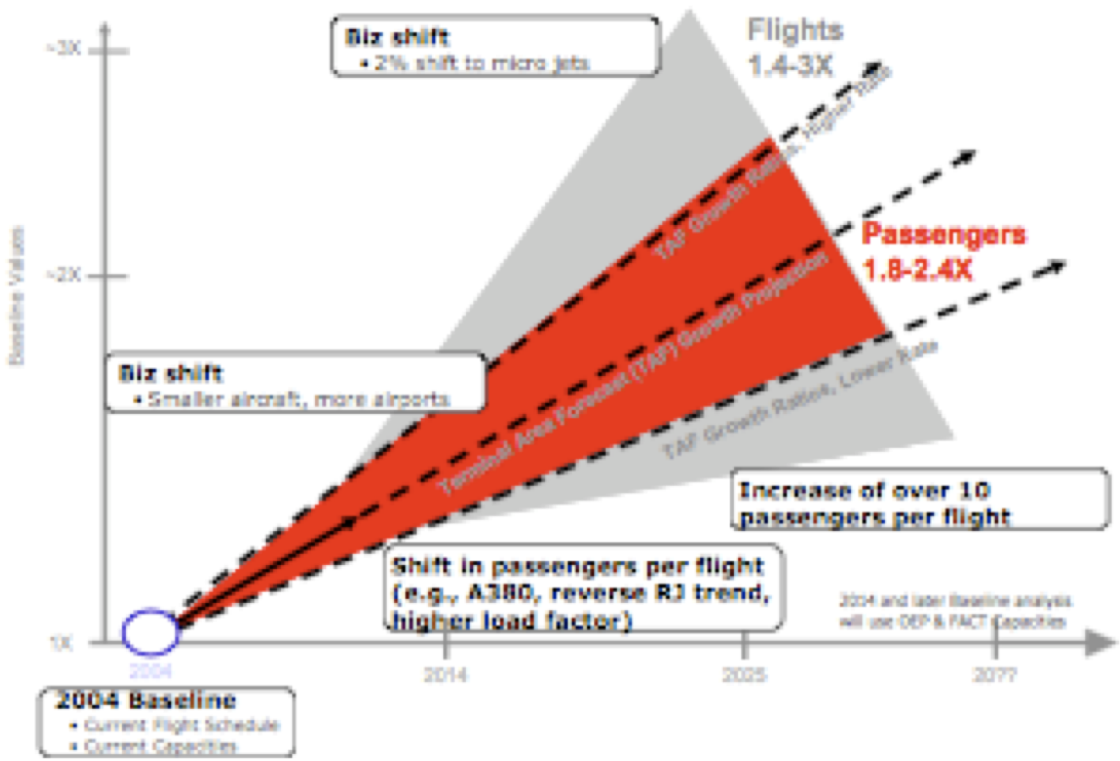


Data source: FAA Operational Network (OPSNET)

NextGen Integrated Plan

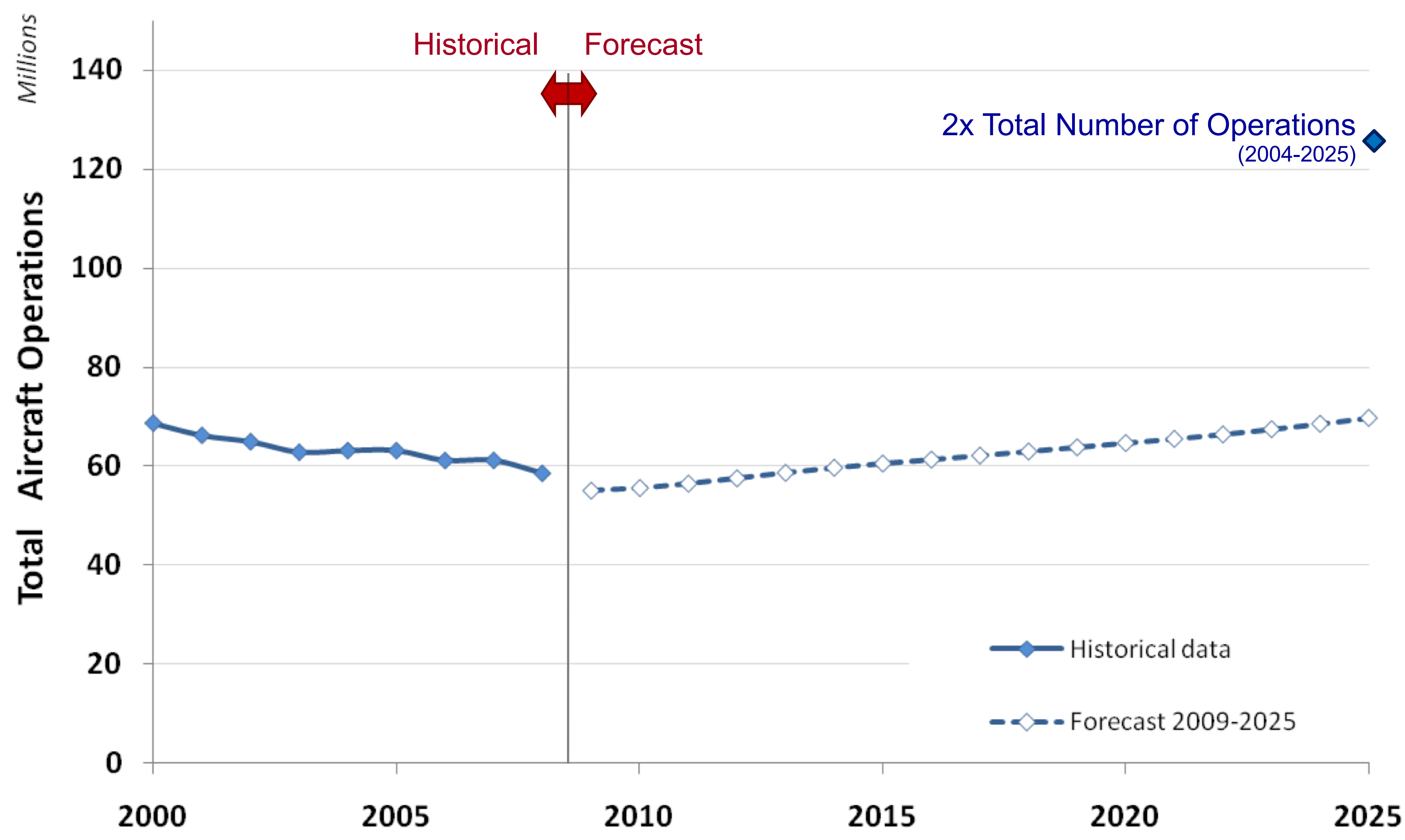
Dec 2004

Figure 1-2. Planning for a Range of Futures



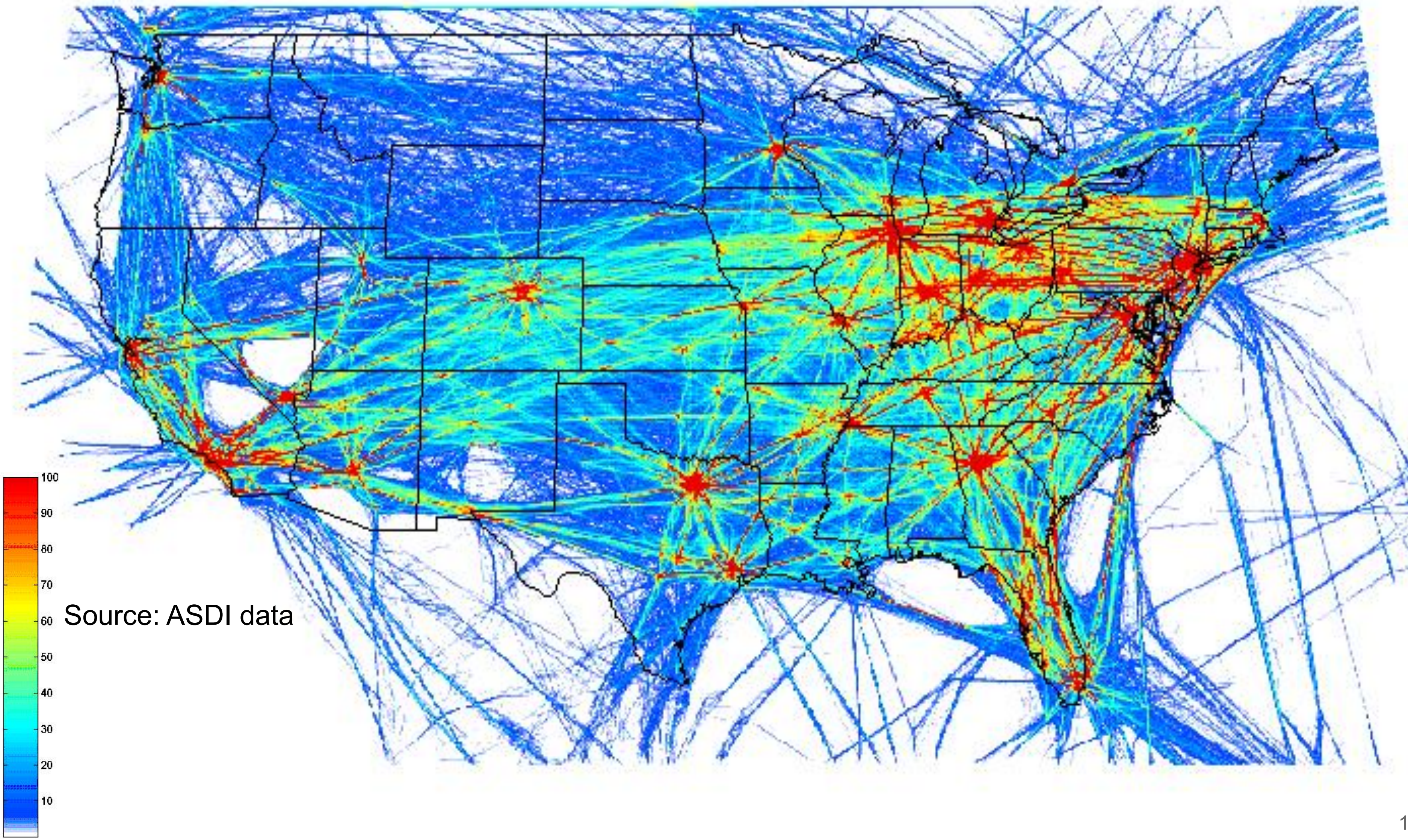
Source: NextGen Conops V 2.0

Total Combined Aircraft Operations at Airports with FAA and Contract Traffic Control Service (FAA 2009-2025)



Data sources: BTS Form 41 US Domestic for historical data from 1990-2008, FAA Forecast 2009-2025 available at:
http://www.faa.gov/data_research/aviation/aerospace_forecasts/2009-2025/,

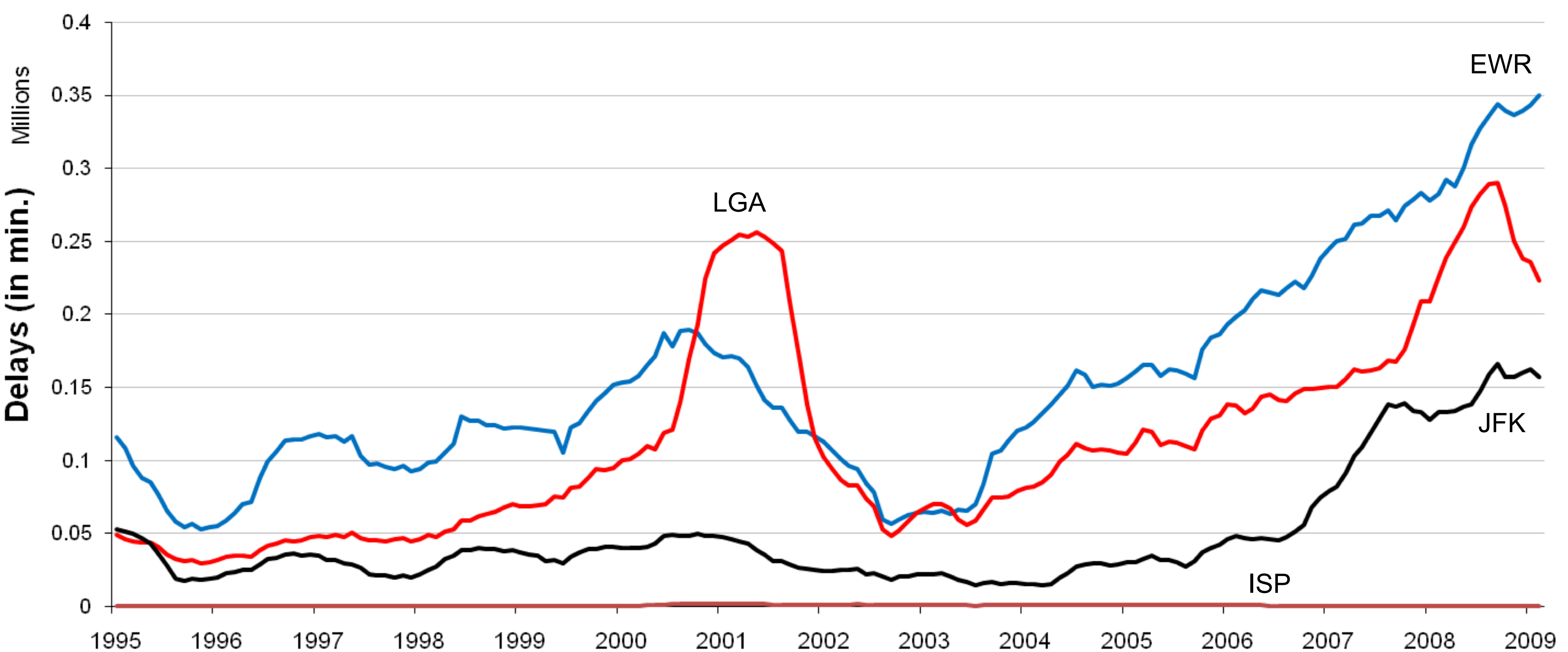
Congestion Focused at Key Points



Source: ASDI data

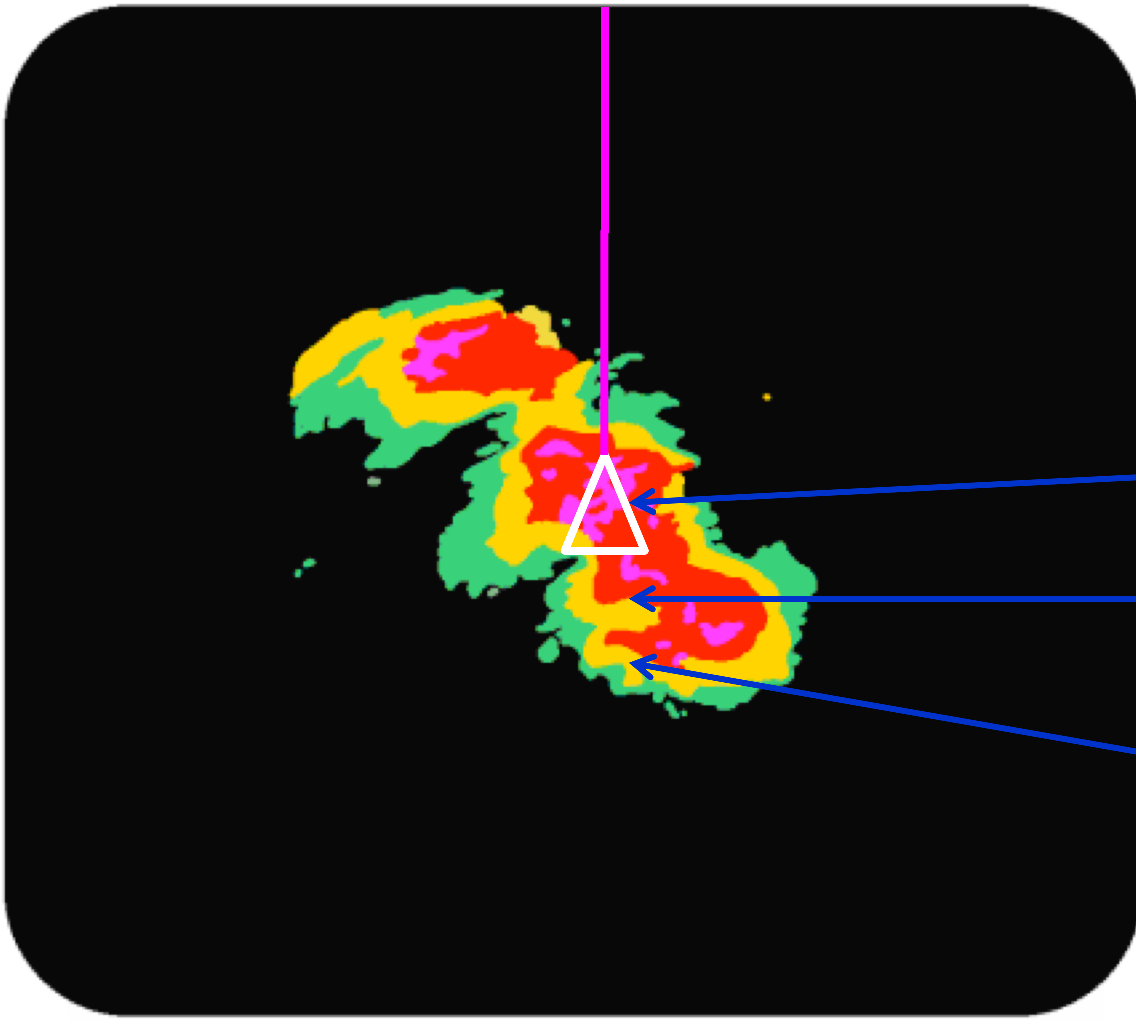
New York Airport Flight Delays*
from 1995 to 2007

* Note: 12 month moving average



Data source: FAA Operational Network (OPSNET)

Historical and Emerging Drivers

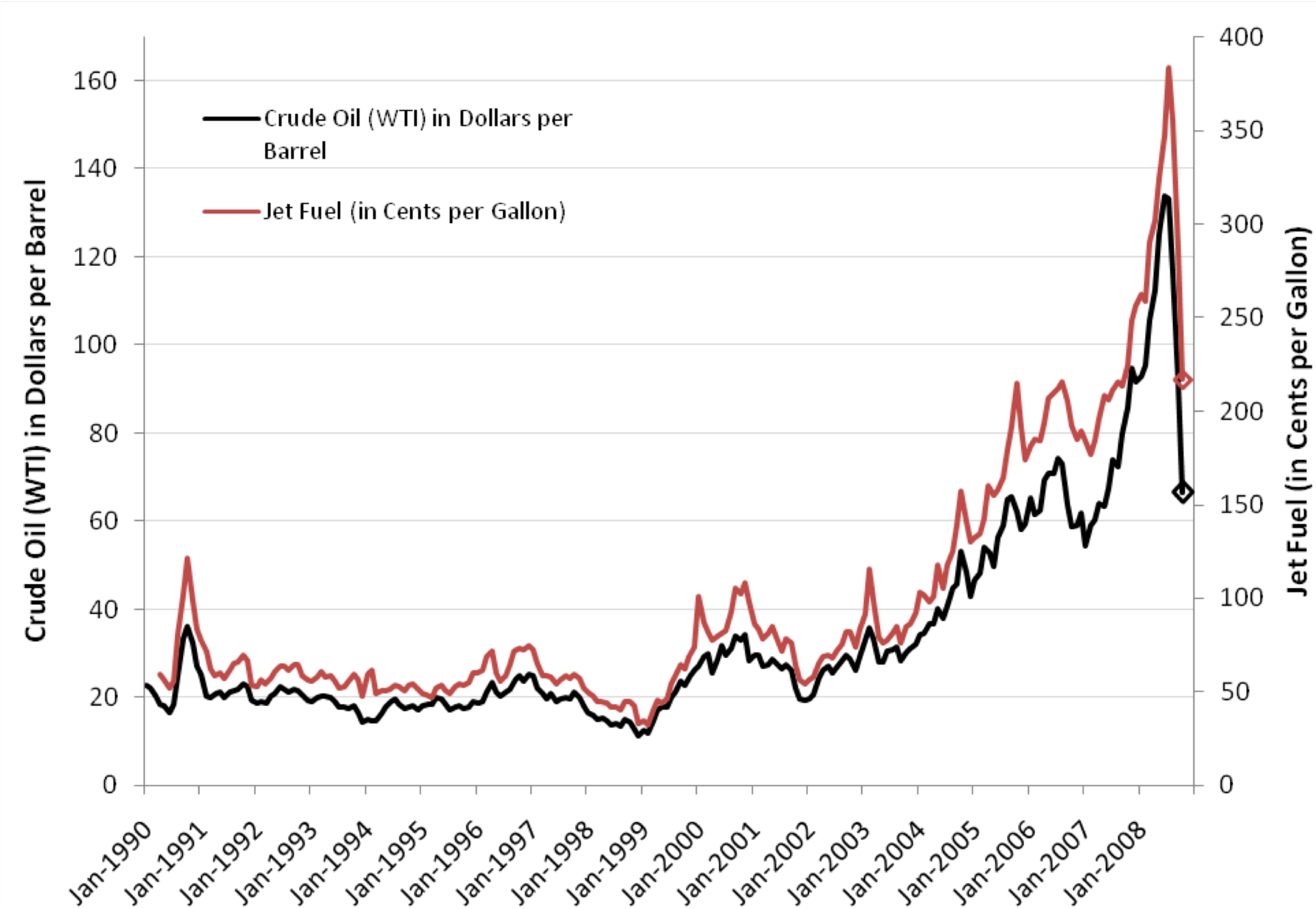


Fuel Cost

9/11 Attacks

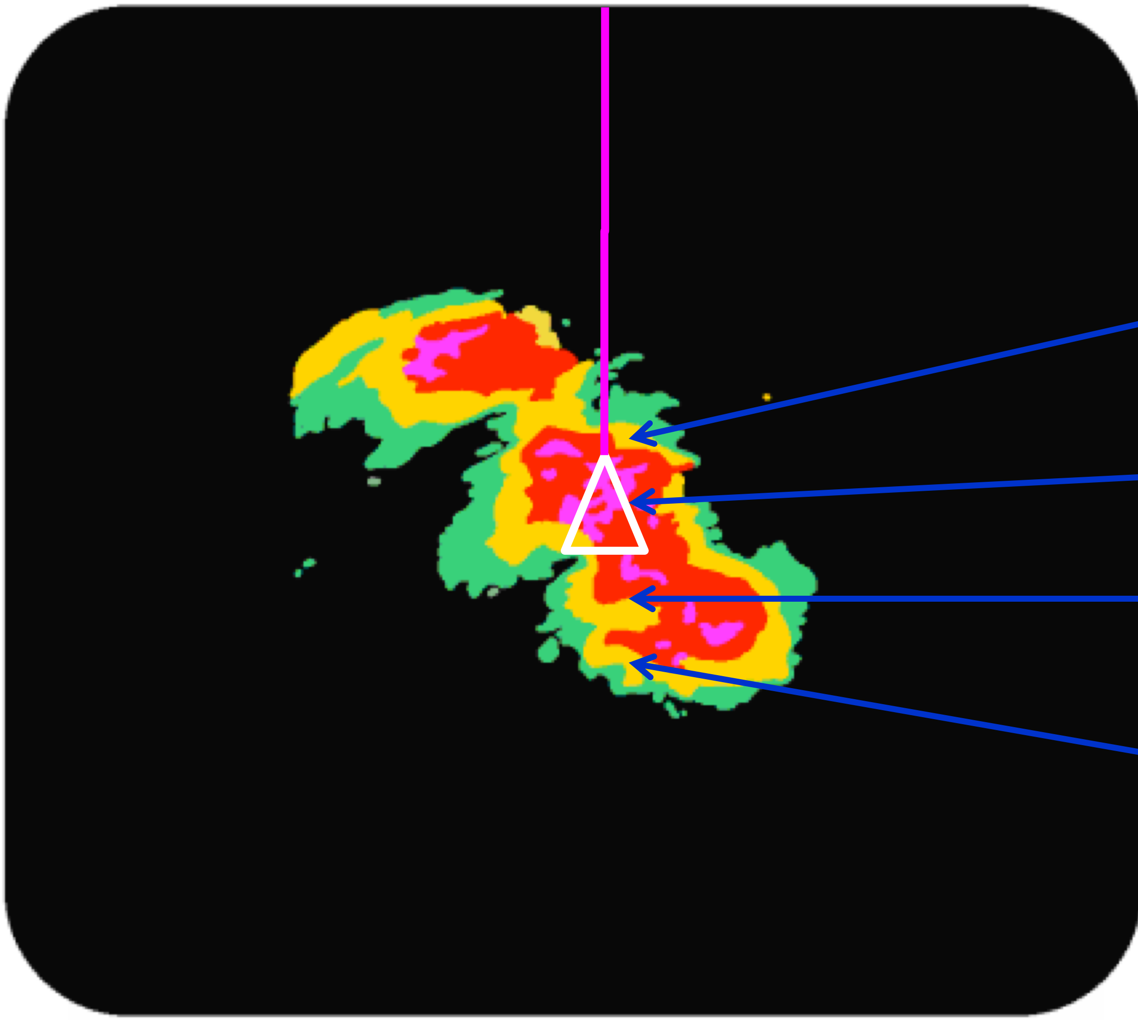
Capacity Constraints

Fuel Price Shock
Cost Uncertainty



Data sources: ATA Fuel Cost and Consumption (oil data through Aug 2008, jet fuel data through Aug 2008) – Data for Oct. 2008 – market price for Oct. 28th 08

Historical and Emerging Drivers



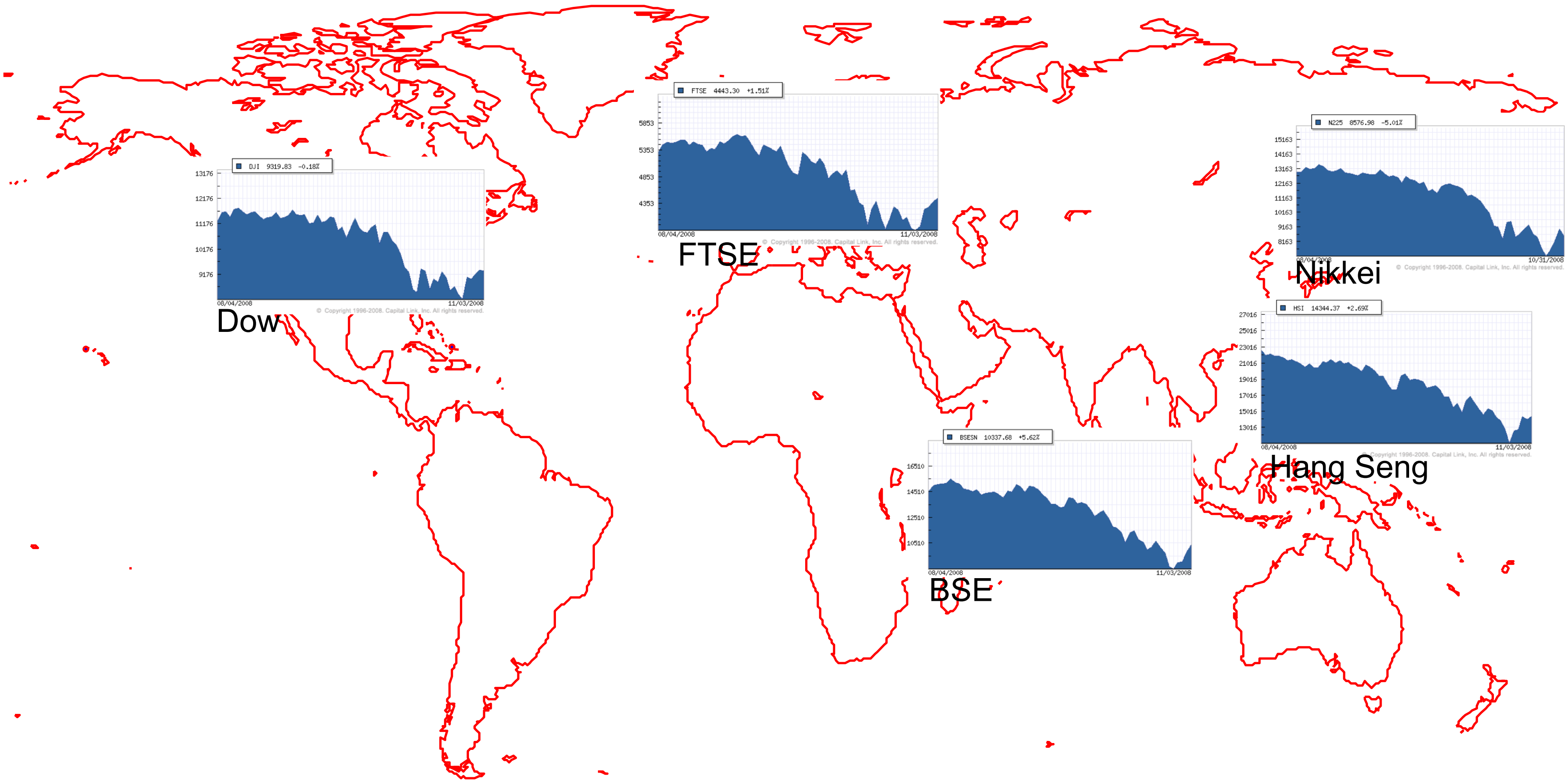
Economic Slowdown

Fuel Cost

9/11 Attacks

Capacity Constraints

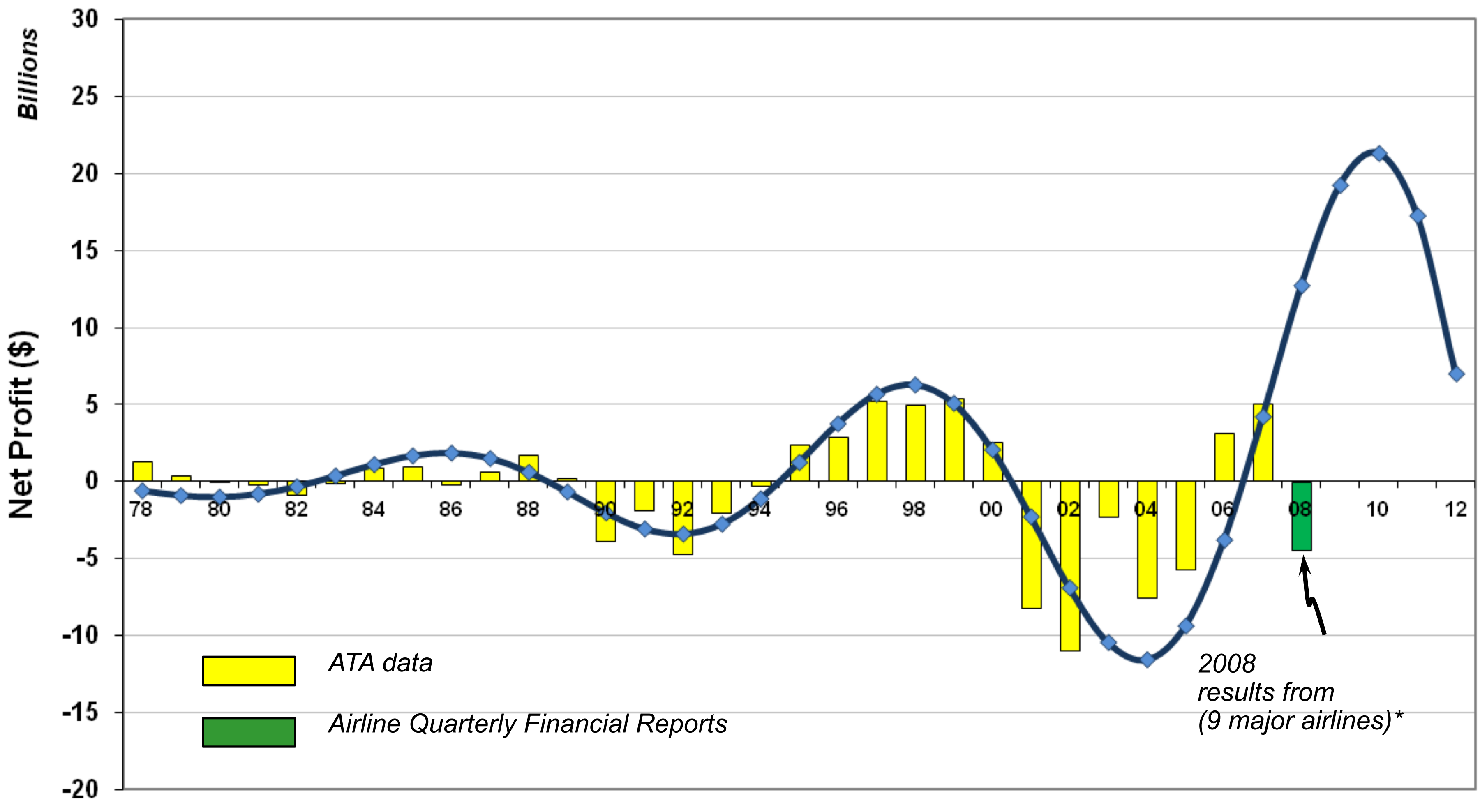
Economic Shocks
Demand Uncertainty



Market Indices 8/4/08-10/31/08

Source: Capital Link Shipping

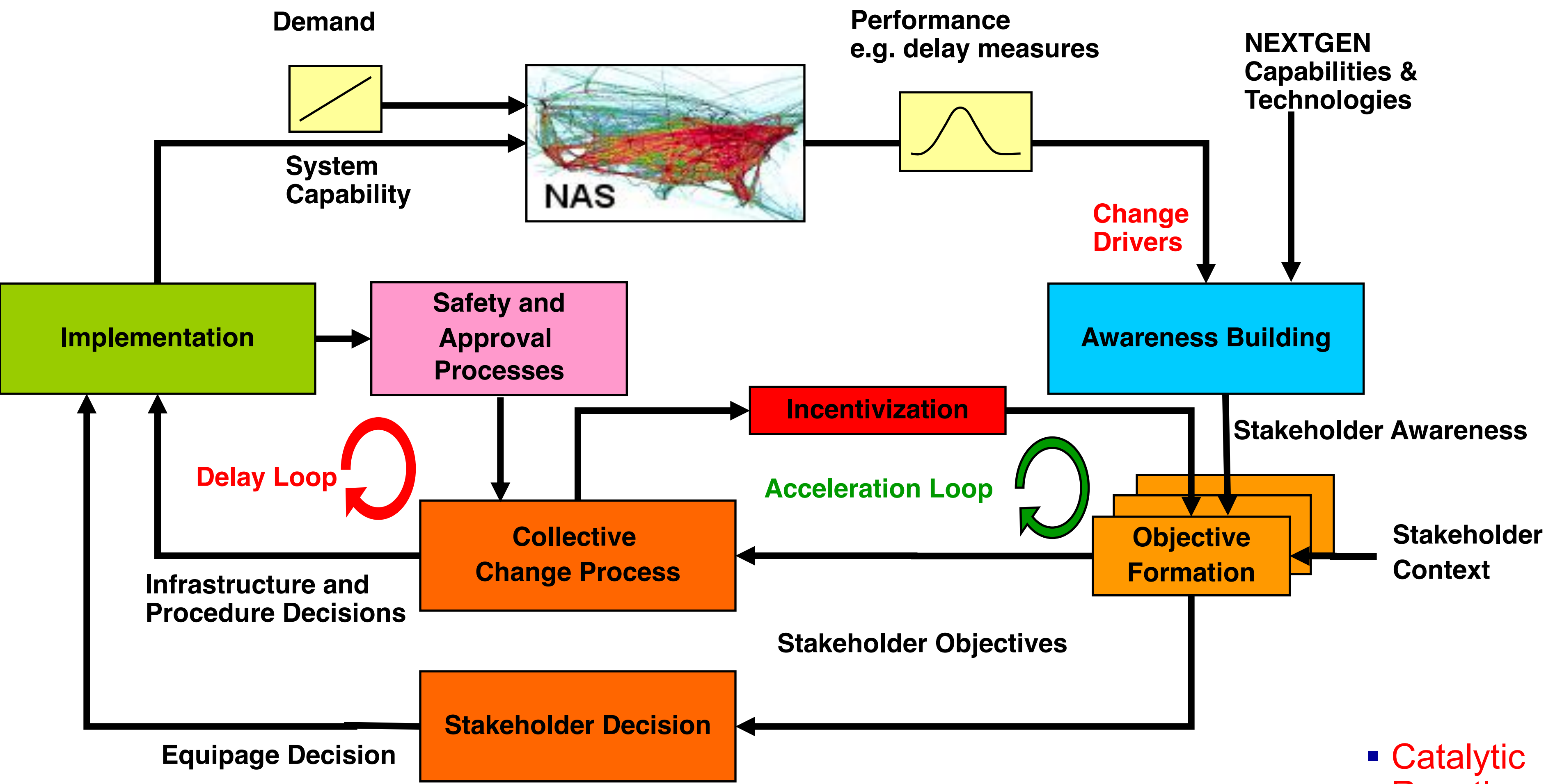
U.S. Airlines Net Profit
Best Fit of Undamped Oscillation
Cycle Period = 11.3 yr



Data source: ATA - available at: www.airlines.org & Airline Quarterly Reports (Net Profits and Losses Exclude Special Items)

**Note: Airlines: American Airlines, United Air Lines, Delta Air Lines, Northwest Airlines, Continental Airlines, US Airways, Southwest Airlines, JetBlue Airways, Alaska Airlines,*

Model of System Transition
Adaptation to Change Drivers



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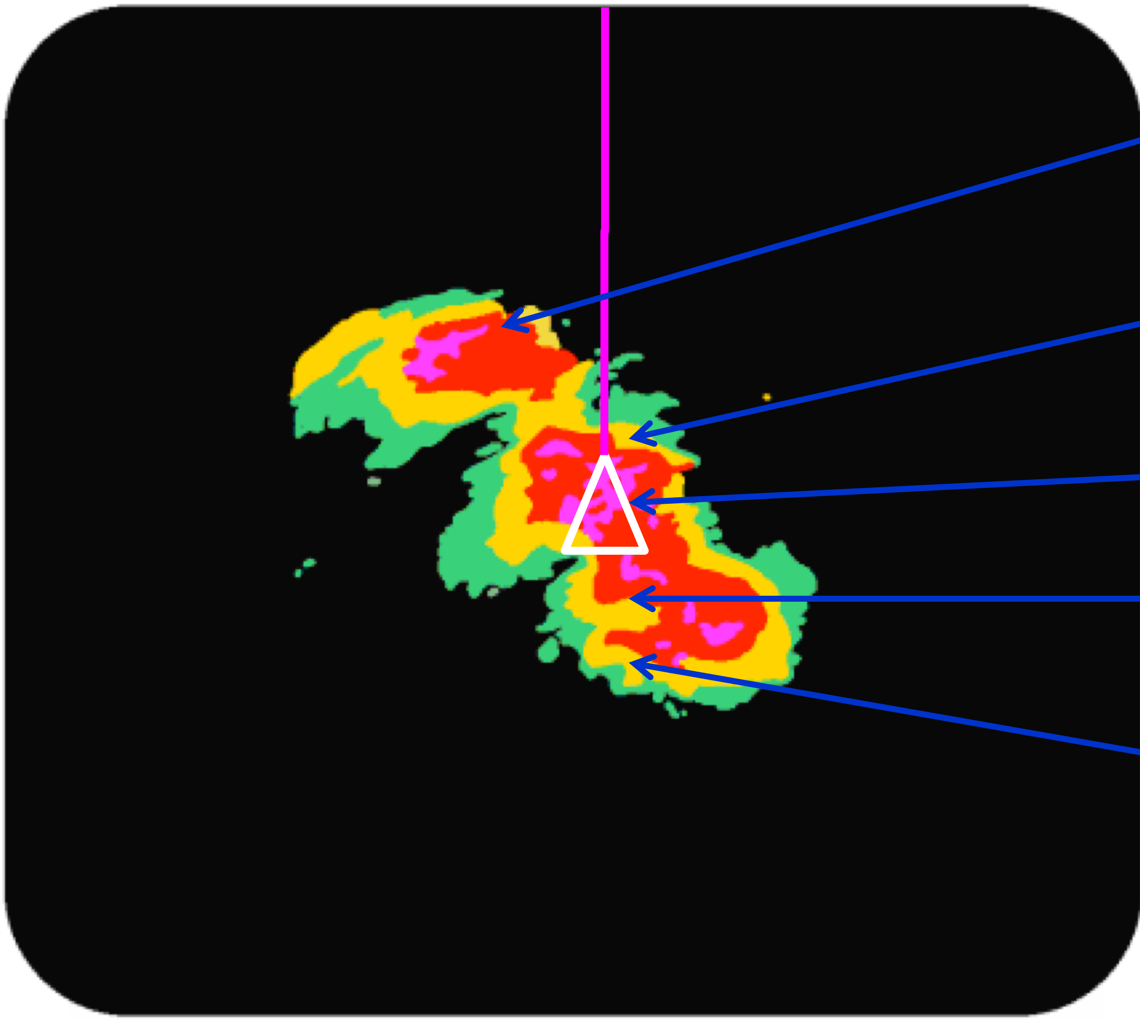
Historical and Emerging Drivers



Environmental Constraints

Economic Slowdown

Fuel Cost

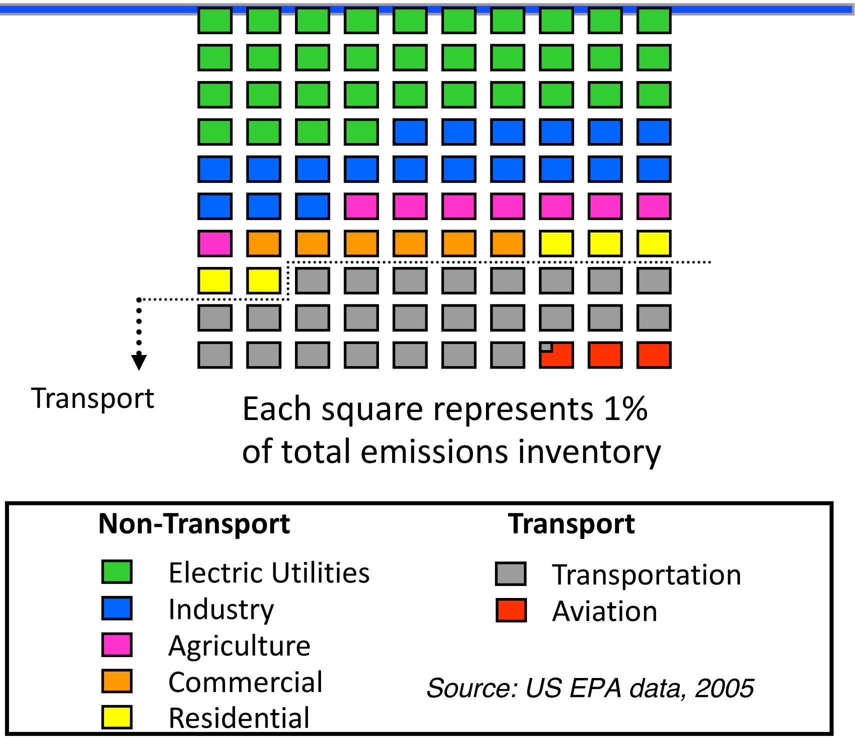
9/11 Attacks

Capacity Constraints

Emissions

- **Pressure to reduce emissions**
  - Global warming problem intensifies
  - Political pressure to "go green"
  - Future restrictions on carbon and NOx emissions
  - Increase in "effective" cost of fuel
  - Obama Target: Carbon emissions to 80% below 1990 levels by 2050
- **Challenges faced**
  - Other transport modes can transition more easily to lower carbon options
  - Aviation experiences a relative increase in emissions
  - Increased pressure on aviation to reduce emissions

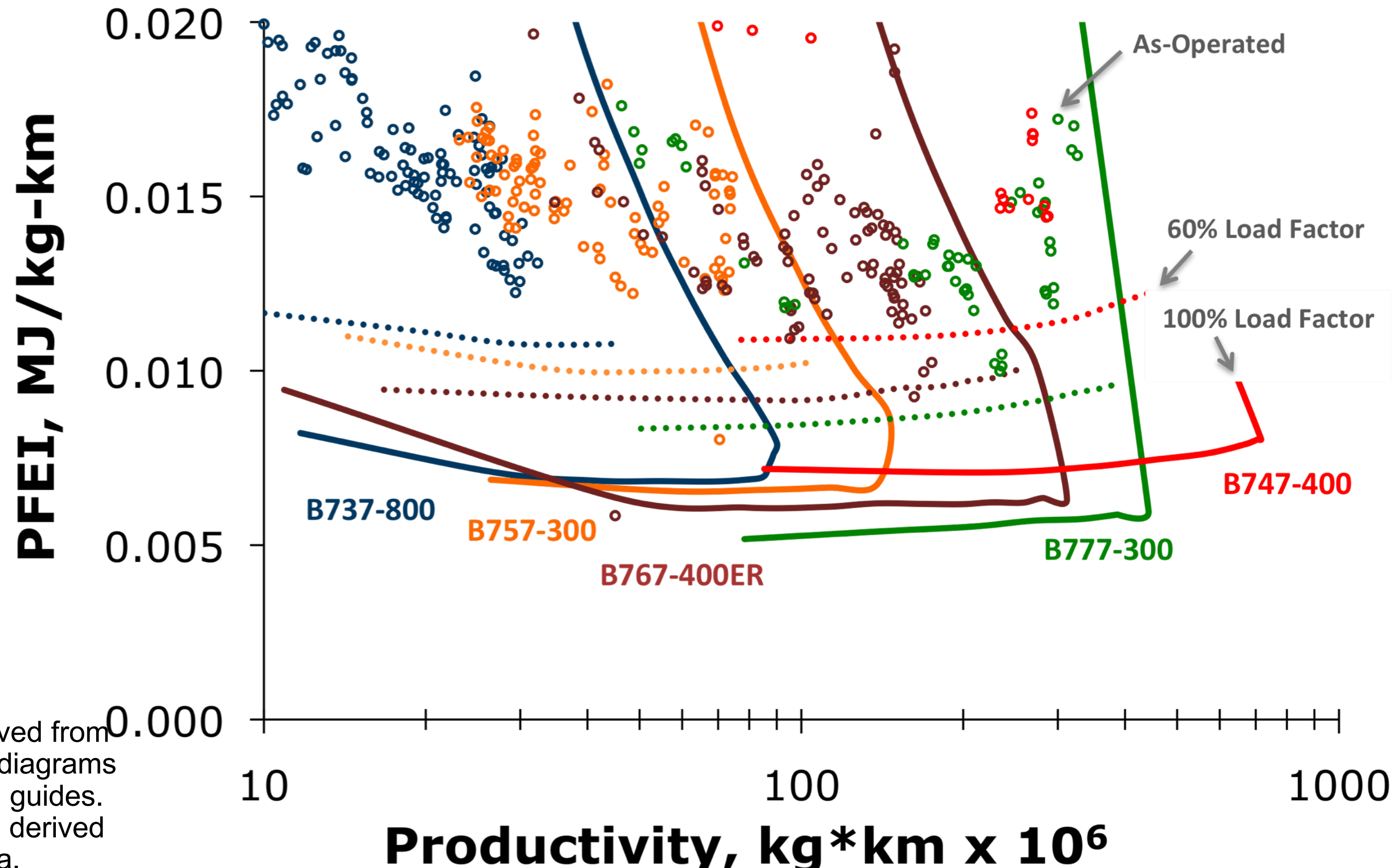
Greenhouse Gas Emissions



www.ebaumsworld.com

How Efficient are Current Operations?

PFEI = Fuel Energy Consumed/(Payload x Great Circle Distance)



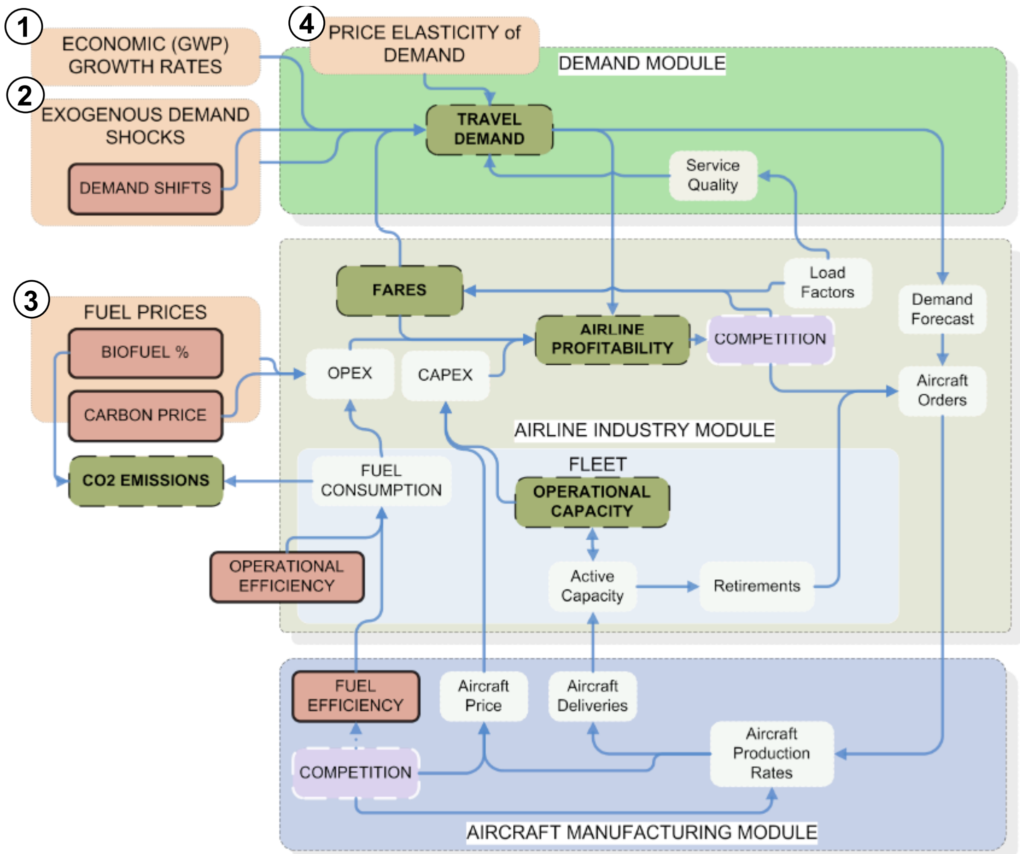
1. As designed PFEI derived from Boeing payload range diagrams in their airport planning guides.
2. As operated PFEI data derived from US DOT BTS data.

Hileman et al., (2008)

Productivity = Actual Distance Flown x Actual Payload Carried

Modeling Strategies for Reducing CO2 Emissions

Architecture of the System Dynamics Model*



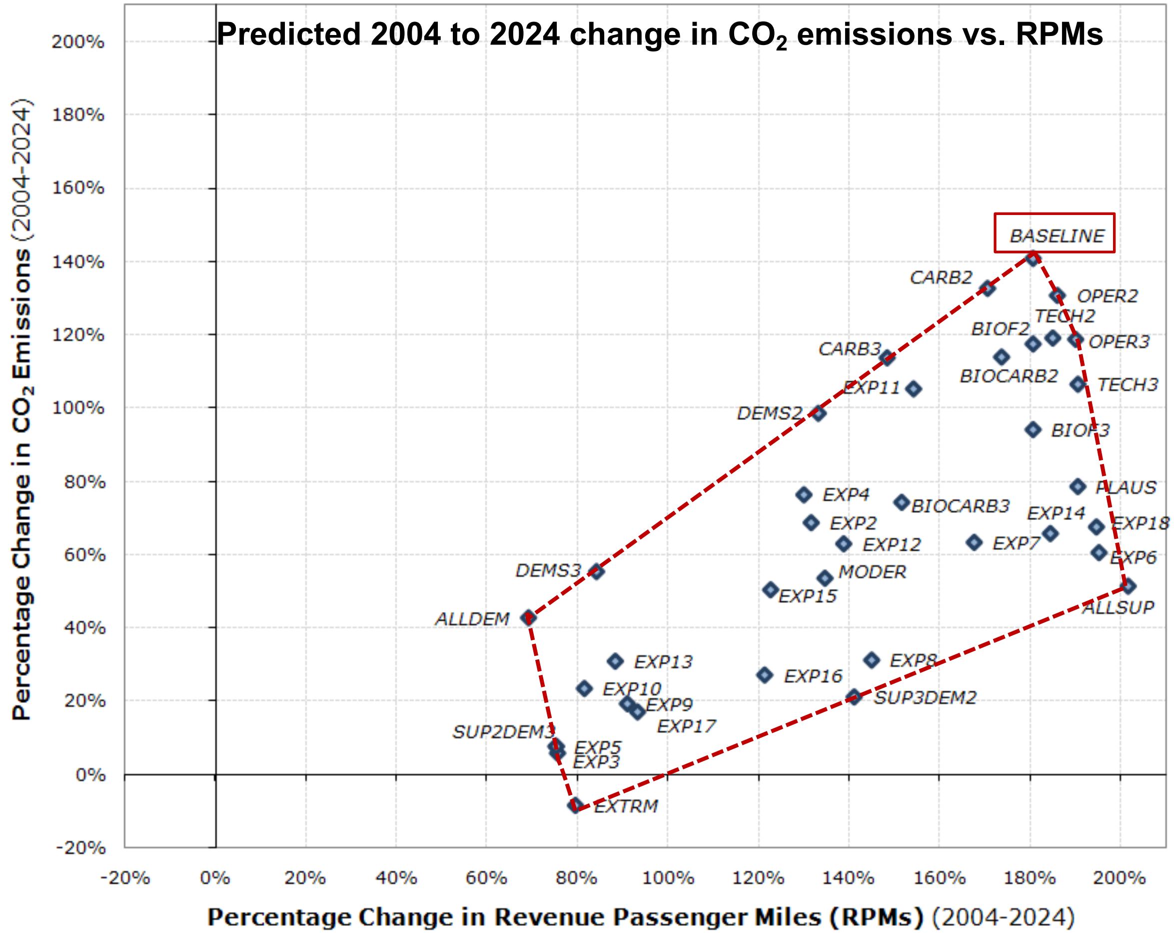
Scenarios & Assumptions*

Policy	Scenario	Quantified Effect
Technological *Efficiency Improvements*	Baseline	**1%** efficiency improvement per annum (p.a.)
	Moderate	**2.5** % p.a
	Aggressive	**3,5 %** p.a. (2008 to 2015) & 0.6% p.a. to 2024
Operational *Efficiency Improvements*	Baseline	**0%**
	Moderate	**6%**
	Aggressive	**12%**
Use of Alternative Fuels *(i.e. biofuels; 2nd gen. starting 2010 and 3rd gen. starting 2013)*	Baseline	**0%** (share of total fuel used by volume)
	Moderate	**1 %** p.a.
	Aggressive	**2 %** p.a.
Demand Shift *(flights below 1000 miles)*	Baseline	**0%**
	Moderate	**30%**
	Aggressive	**60%**
Carbon Pricing	Baseline	**$ 0** / metric ton
	Moderate	**$50** / metric ton
	Aggressive	**$200** / metric ton

* Source: Sgouridis S., Bonnefoy P. and Hansman R. J., "Air Transportation in a Carbon Constrained World: Long-term Dynamics of Policies and Strategies for Mitigating the Carbon Footprint of Commercial Aviation", to be submitted to Transport Research Part A., Feb. 2009.

Carbon Emissions under Different Carbon Management Scenarios

- Even with aggressive carbon management carbon emissions will increase

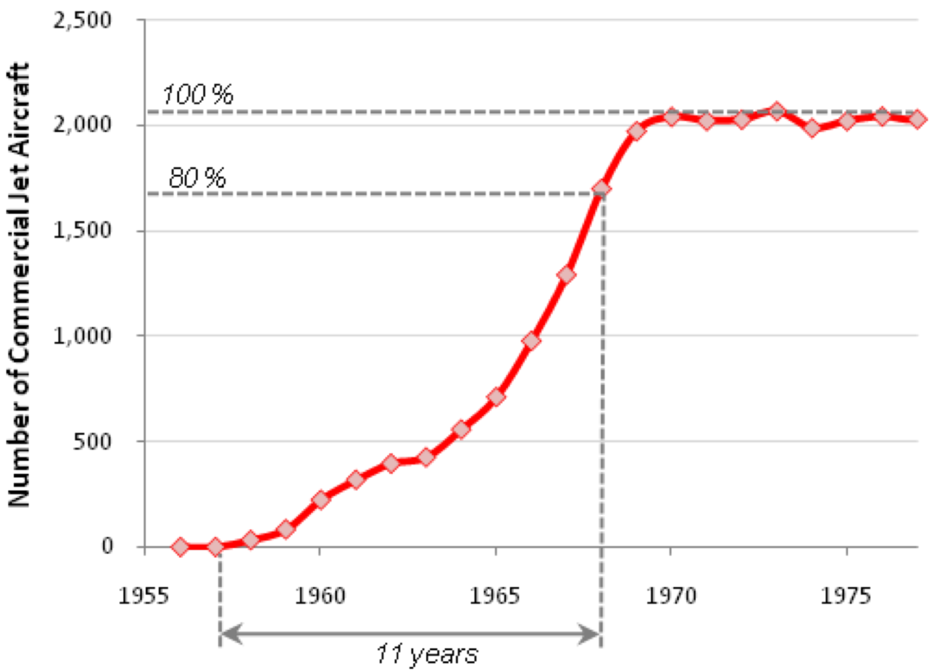


* Source: Sgouridis S., Bonnefoy P. and Hansman R. J., "Air Transportation in a Carbon Constrained World: Long-term Dynamics of Policies and Strategies for Mitigating the Carbon Footprint of Commercial Aviation", to be submitted to Transport Research Part A., Feb. 2009.

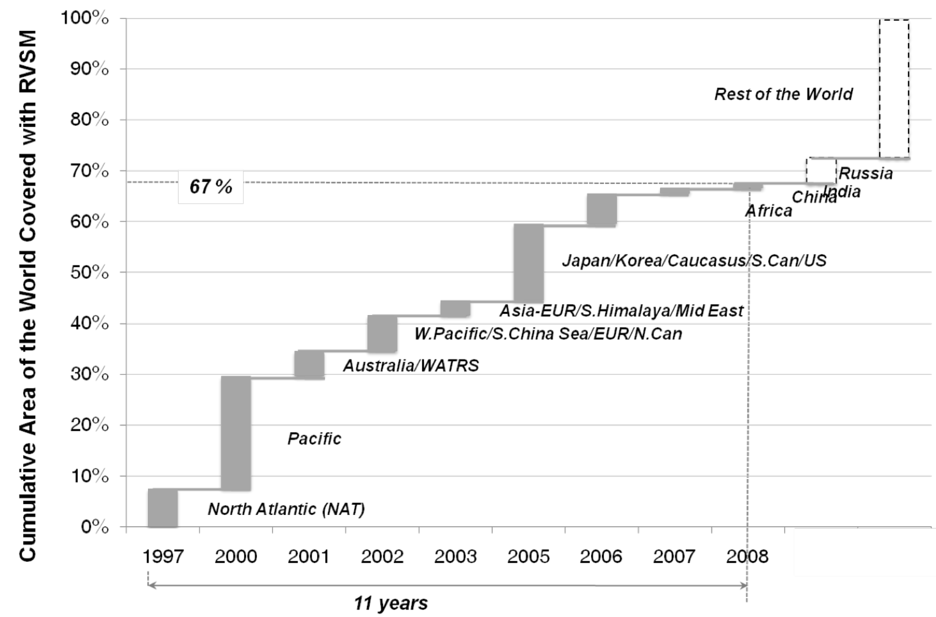
Time Constants for Implementation

Technology Example: Jet Engine

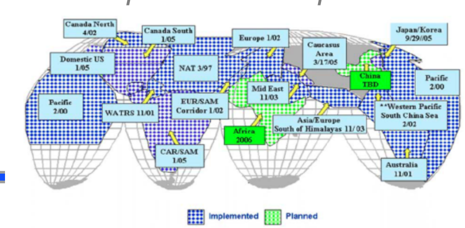
Commercial Jet Aircraft
in the United States from 1956 to 1977



Procedure Example: RVSM

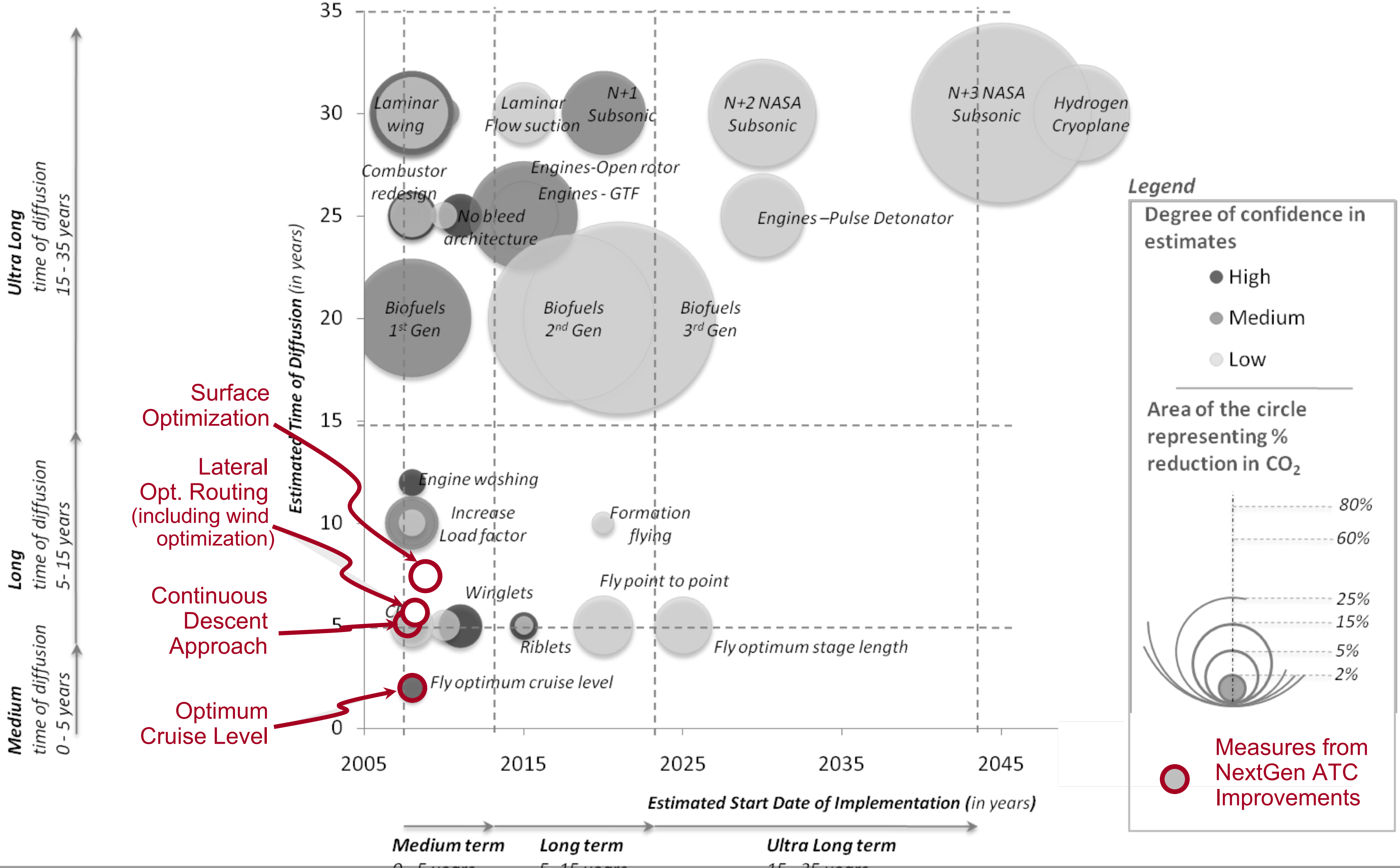


Map of world airspace areas and RVSM implementation phases



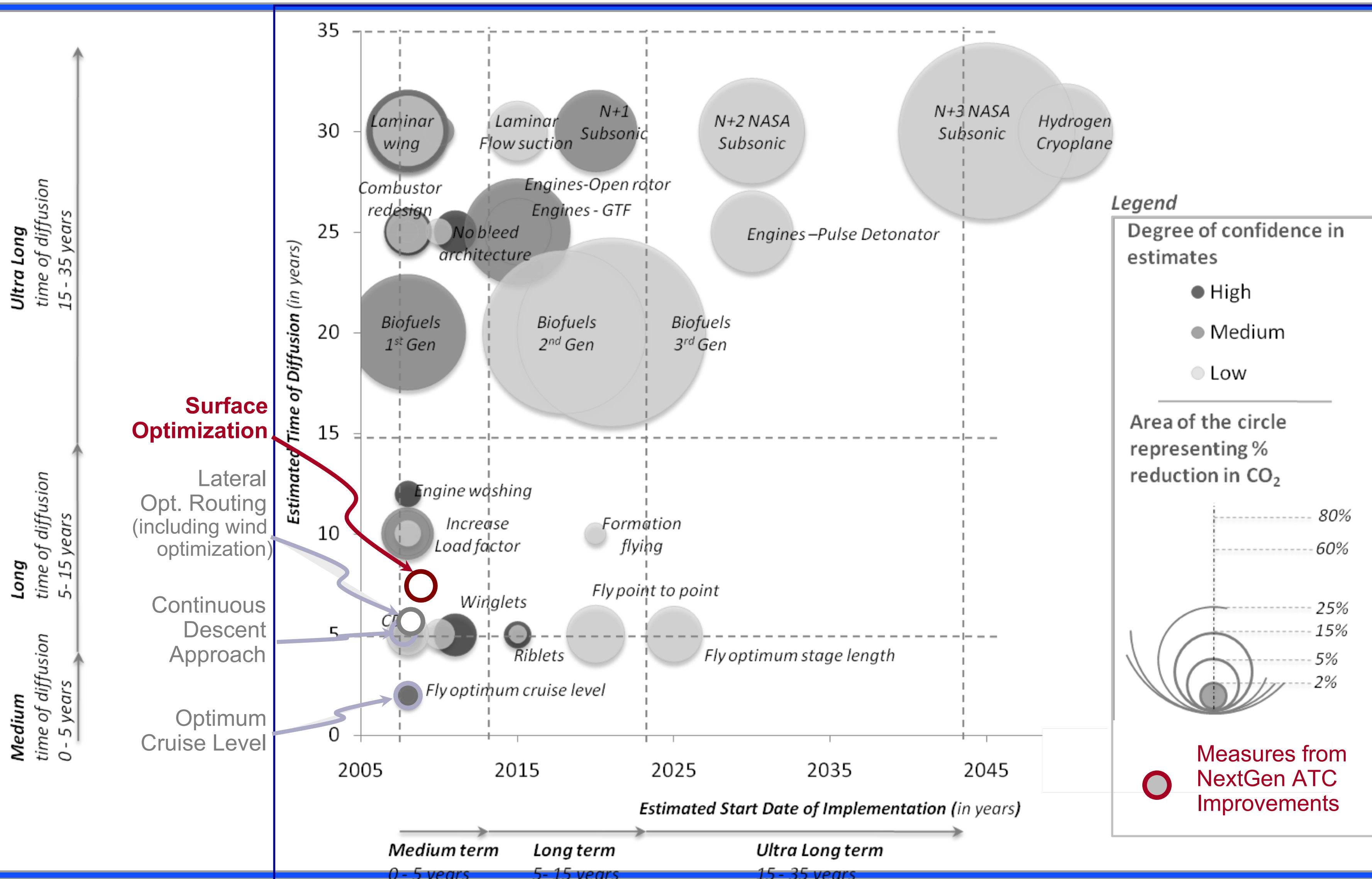
Data sources: [Commercial Jet Aircraft: ATA 1956-1977], [RVSM: FAA 2007, ICAO 2008]

Estimated Time Constant and Readiness of Proposed CO_2 Mitigation Measures



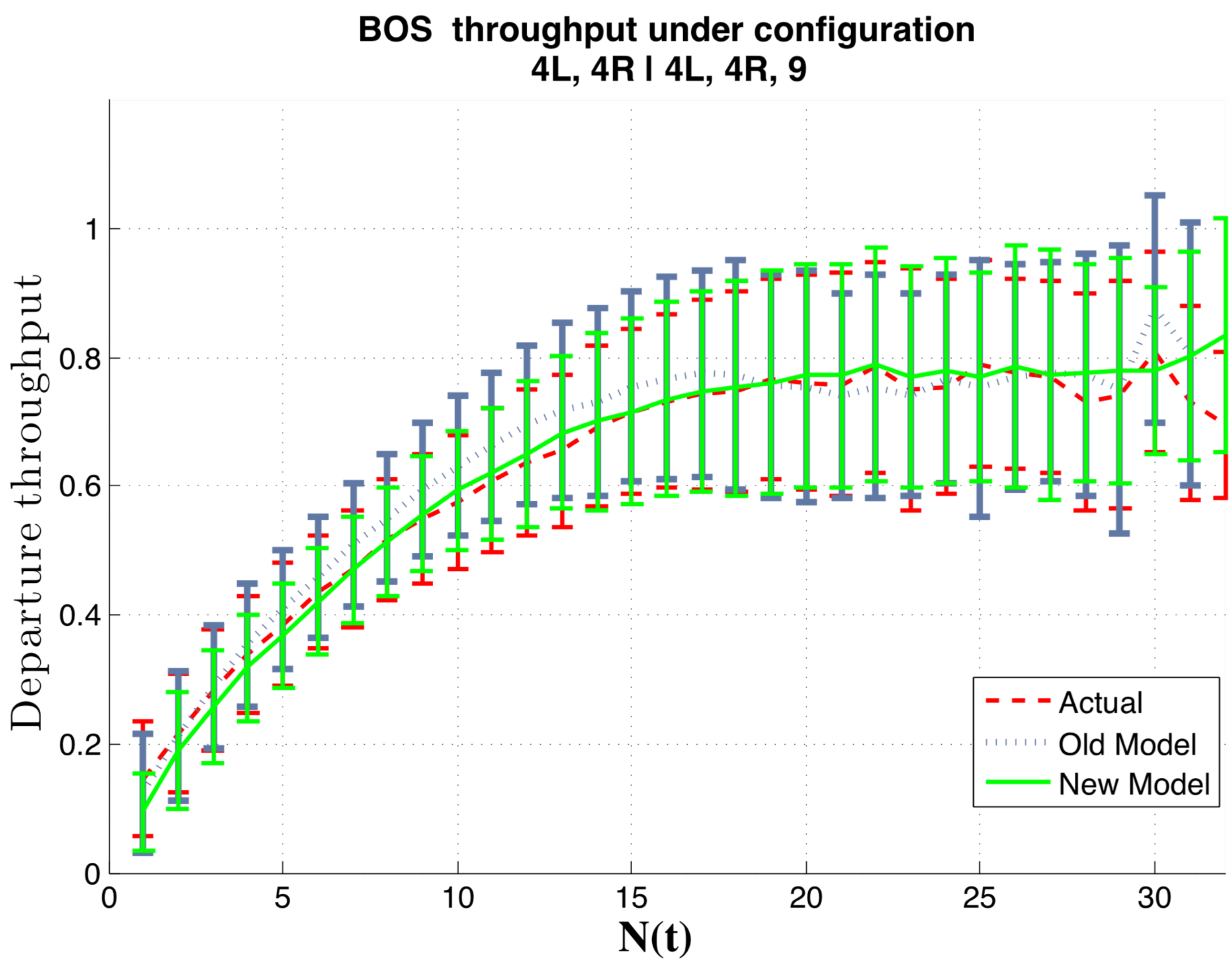
Data sources: Based on literature review of 49 mitigating measures covering 43 literature references (available from authors upon request)

Estimated Time Constant and Readiness of Proposed CO_2 Mitigation Measures



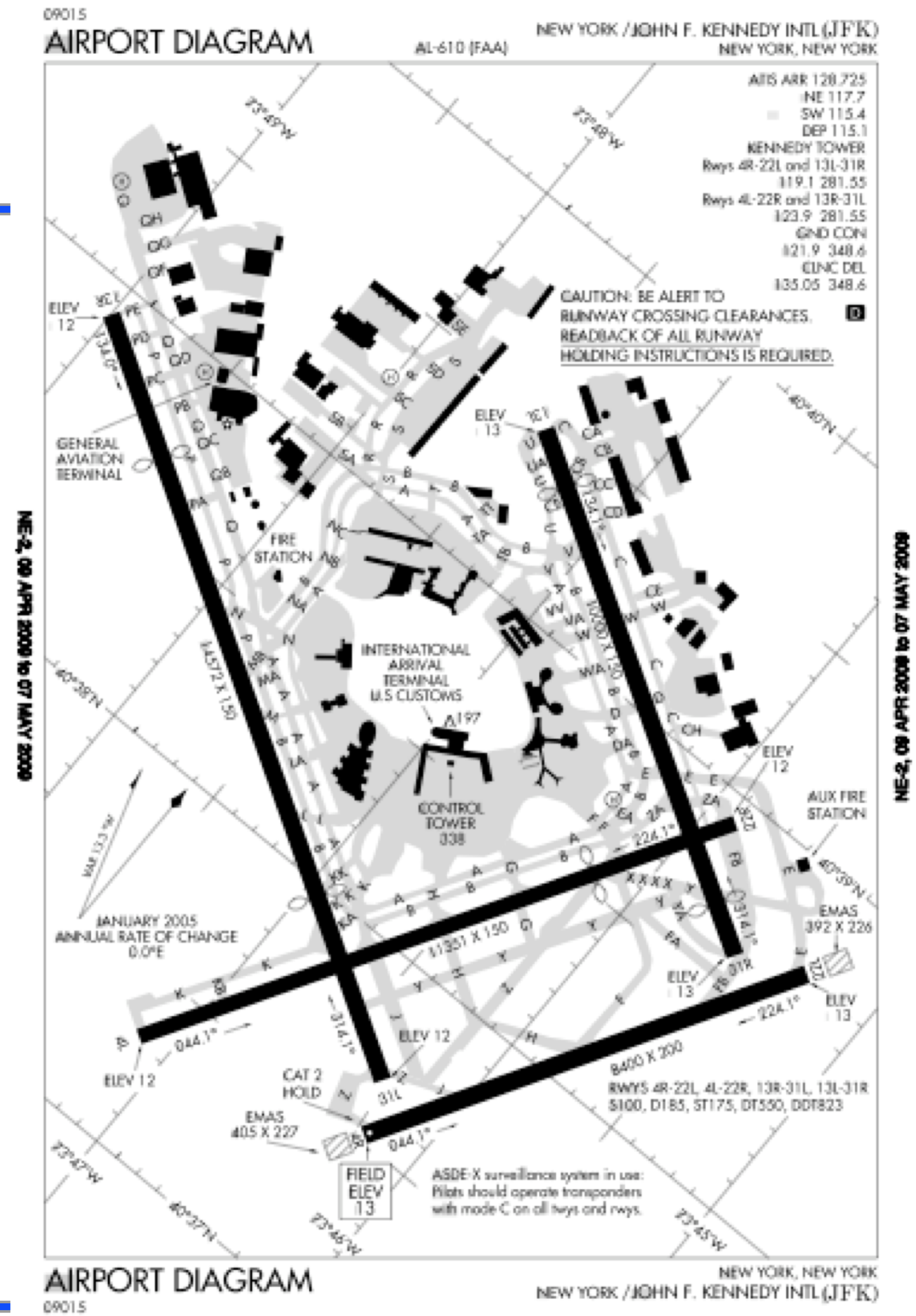
Data sources: Based on literature review of 49 mitigating measures covering 43 literature references (available from authors upon request)

Opportunities to Reduce Taxi Time and Surface Emissions
Outgrowth of NASA Departure Planner Work

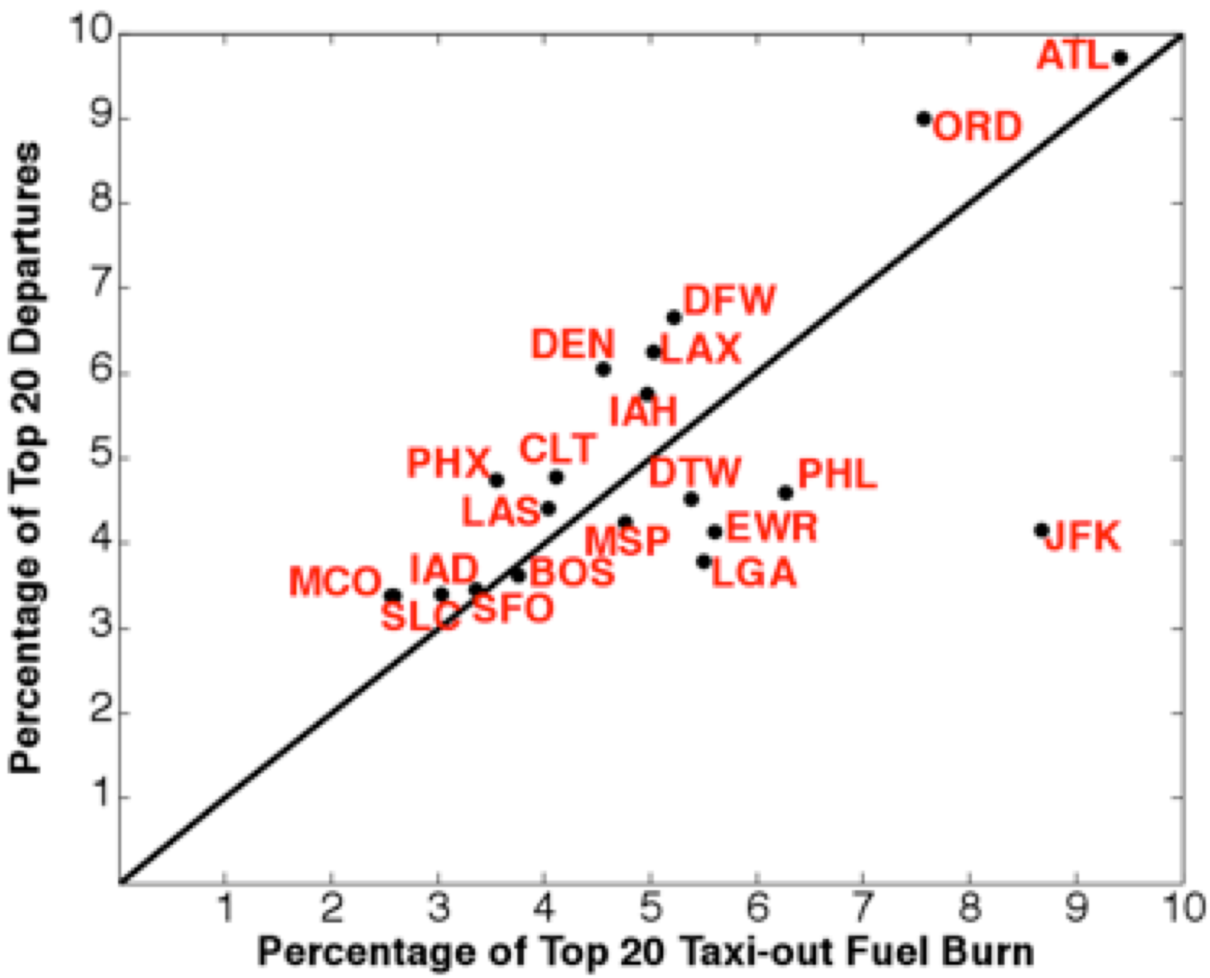


[Simaiakis and Balakrishnan, 2008]

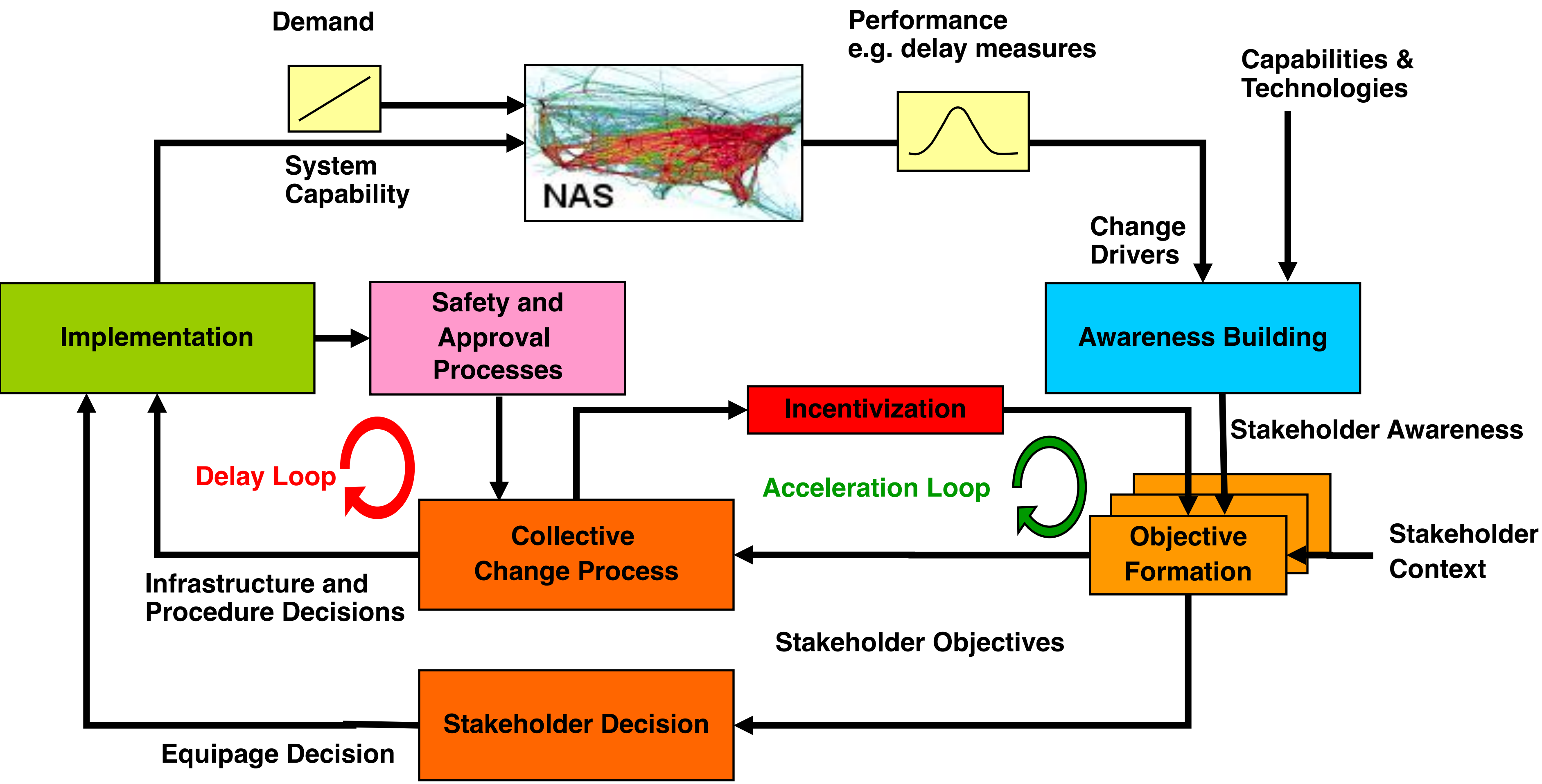
- **Proposed Demonstration of Surface Movement Optimization**
  - Evaluating Potential Sites



Taxi Fuel Burn Performance

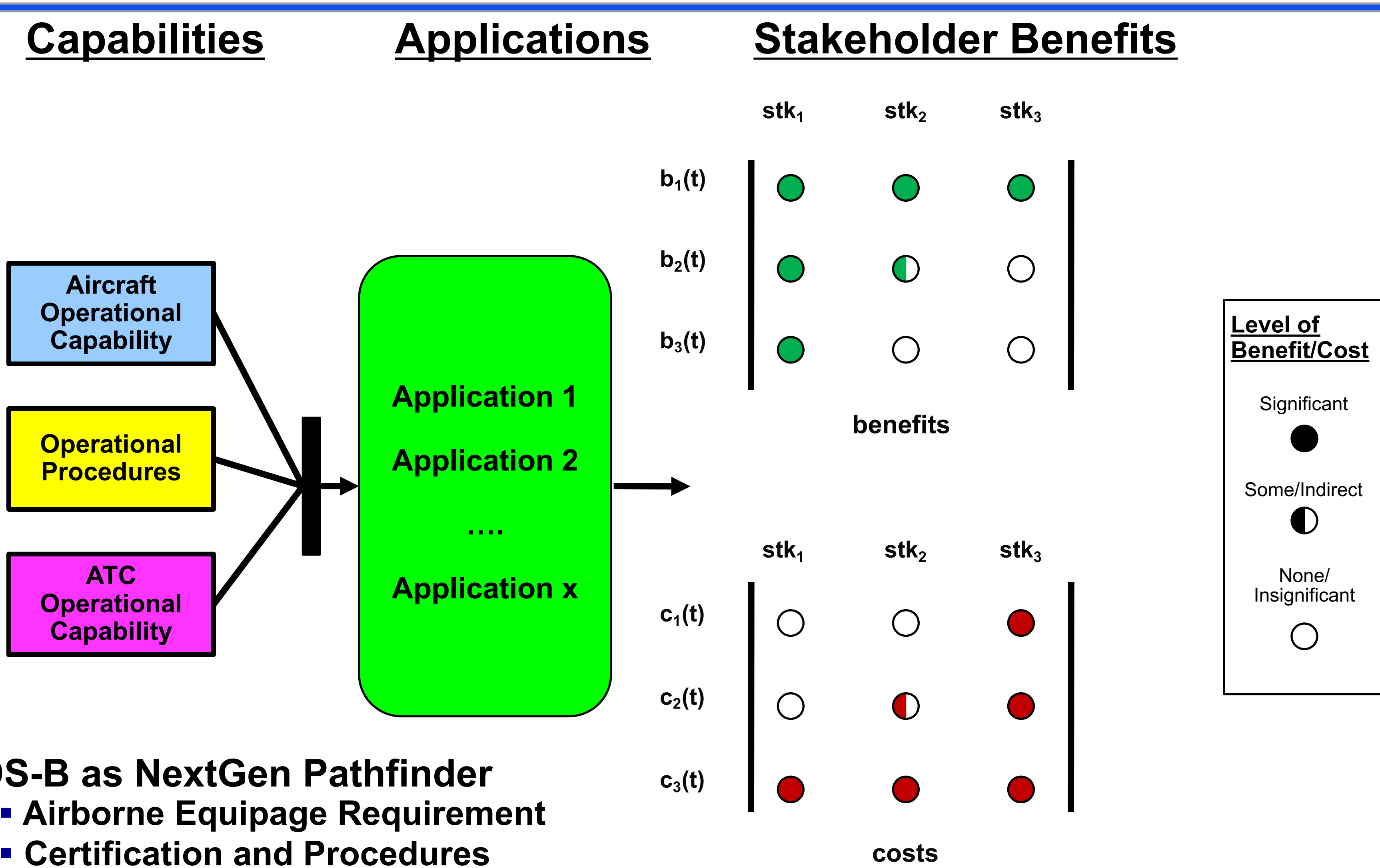


Emerging Implementation Issues



Model developed by Alexandra Mozdzanowska

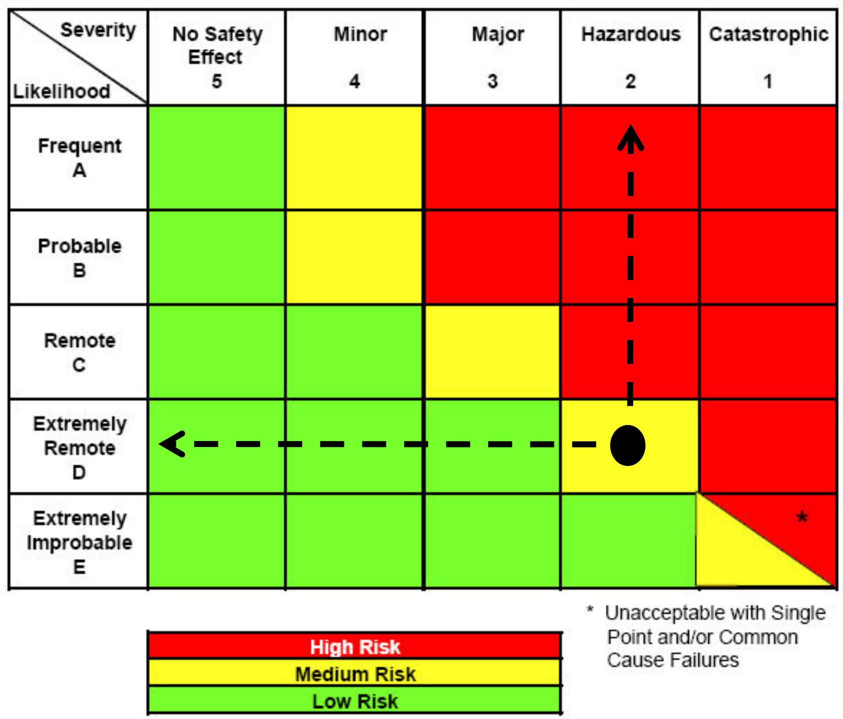
User Benefits Dependent Upon Approved Applications and Operational Capabilities



- **ADS-B as NextGen Pathfinder**
  - **Airborne Equipage Requirement**
  - **Certification and Procedures**

Disaggregate benefit/cost approach adapted from Marias and Weigel

Safety Management System SMS Challenges

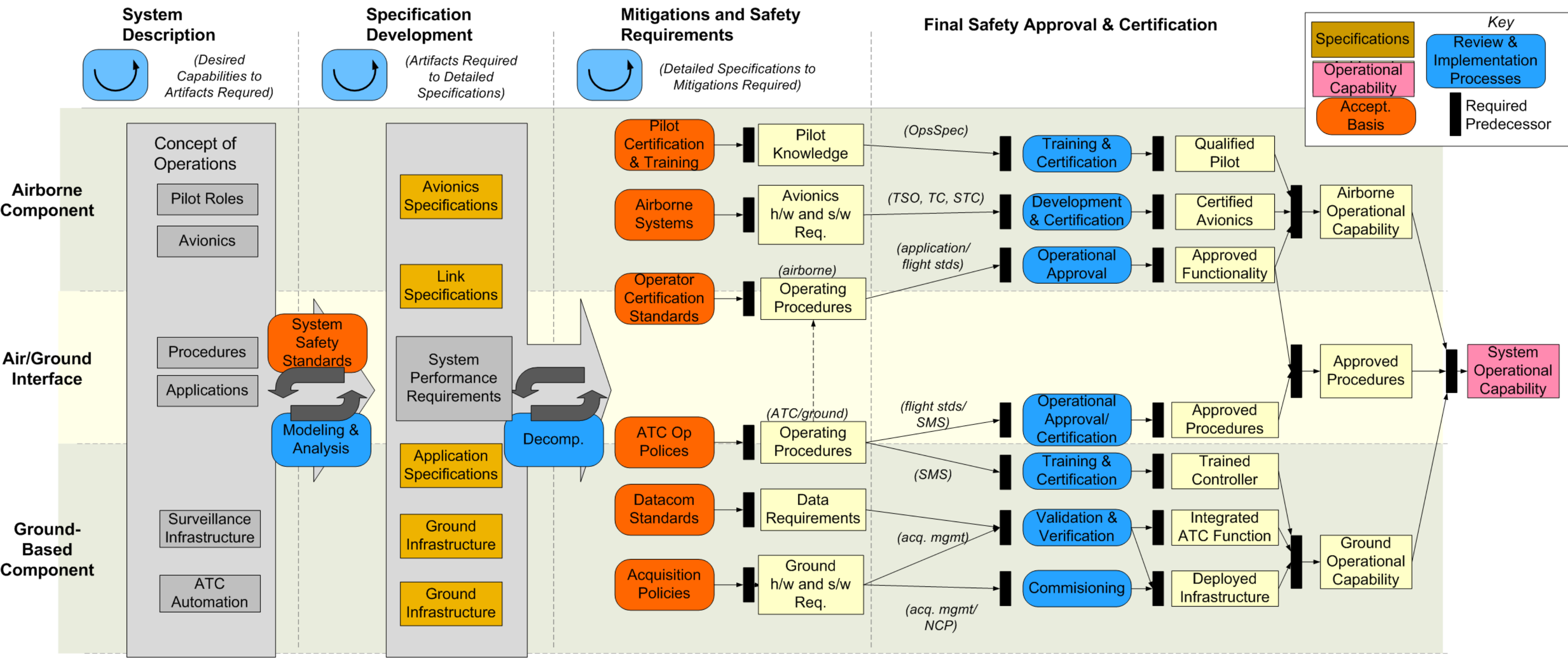


Extremely Remote = (quantitative) $1x10^{-7}$ to $1x10^{-9}$

Hazardous = "Serious or fatal injury to small number of occupants or cabin crew"

- **Target risk classified by ATO Safety Management System standards**
  - Hazardous assumption & 10^{-7} assumption

Simplified Air/Ground Operational Capability Process



Operational Approval Risks in NextGen Operational Improvements

- NextGen OIs analyzed from Integrated Work Plan (2008)
  - based on OI Descriptions in Appendix I
- Preliminary categorization of operational approval risk

Code		*Definition & Basis*
NA	○ (empty circle)	**No operational approval required** Non-operational or process improvements (e.g. scheduling, security, environment, SMS, etc.)
Green (G)	● (green circle)	**Minimal risk of operational approval** No significant safety impact or depends on approved capabilities or operations already approved
Green/Yellow (GY)	● (green/yellow circle)	**Minor risk of operational approval** Similar application/operation already approved, or minor safety impacts
Yellow (Y)	● (yellow circle)	**Major risk of operational approval** Large changes, but limited to one domain (e.g. airborne, ATC, etc.) and hazardous or major safety consequences
Red (R)	● (red circle)	**Significant risk of operational approval** Large amount of analysis required, limited operational experience with concept, or significant change in roles (human/automation)

Preliminary OI Analysis (1)

303	TMI with Flight-Specific Trajectories	R
304	Flexible Entry Times for Oceanic Tracks	G
305	Continuous Flight Day Evaluation	G
306	Provide Interactive Flight Planning from Anywhere	G
307	Integrated Arrival/Departure Airspace Management	GY
309	Use Optimized Profile Descent	GY
310	Improved GA Access to Traverse Terminal Areas	G
311	Increased Capacity and Efficiency Using RNAV and RNP	G
316	Enhanced Visual Separation for Successive Approaches	R
317	Near Zero Ceiling/Visibility Airport Access	Y
318	Arrival Time-Based Metering - Controller Advisories	G
319	Time-Based Metering into En Route Streams	G
320	Initial Surface Traffic Management	G
321	Enhanced Surface Traffic Operations	Y
322	Low-Visibility Surface Operations	R
325	Time-Based Metering Using RNP and RNAV Route Assignments	G

326	Airborne Merging and Spacing - Single Runway	GY
327	Surface Management - Arrivals/Winter Ops/Runway Configuration	G
329	Airborne Merging and Spacing with OPD	Y
330	Time-Based and Metered Routes with OPD	Y
331	Integrated Arrival/Departure and Surface Operations	G
332	Ground-Based and On-Board Runway Incursion Alerting	Y
333	Improved Operations to Closely Spaced Parallel Runways	Y
334	Independent Converging Approaches in IMC	Y
337	Flow Corridors - Level 1 Static	Y
338	Efficient Metroplex Merging and Spacing	GY
339	Integrated Arrival/Departure and Surface Traffic Management for Metroplex	G
340	Near-Zero-Visibility Surface Operations	Y
341	Limited Simultaneous Runway Occupancy	Y
343	Reduced Separation - High Density En Route, 3-mile	R
344	Reduced Oceanic Separation - 30 Miles for Pair-Wise Maneuvers	R
346	Improved Management of Airspace for Special Use	G

Preliminary OI Analysis (2)

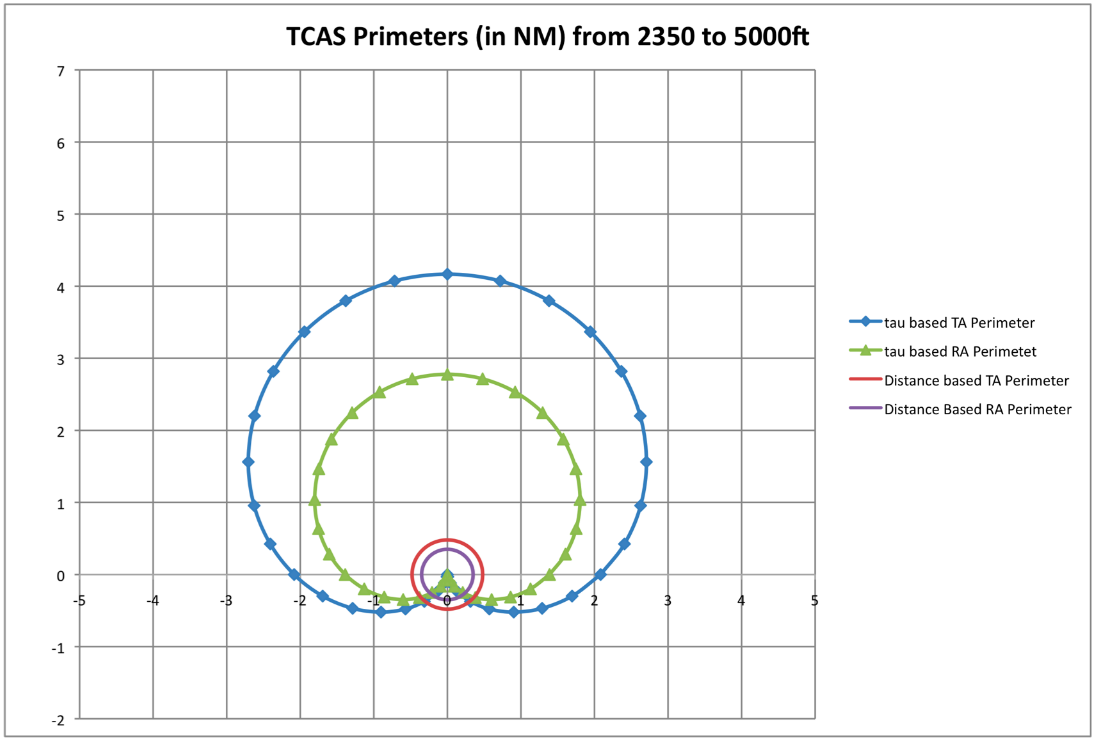
347	Air Traffic Control Surveillance Service in Non-Radar Areas (ADS-B)	R
348	Reduce Separation - High Density Terminal, Less Than 3-miles	R
349	Automation Support for Mixed Environments	G
350	Flexible Routing	GY
351	Flexible Airspace Management	GY
352	Automated Clearance Delivery and Frequency Changes	Y
353	Reduced Oceanic Separation - Altitude Change Pair-Wise Maneuvers	GY
354	Reduced Oceanic Separation - Co-Altitude Pair-Wise Maneuvers	Y
355	Delegated Responsibility for Horizontal Separation	R
356	Delegated Separation - Pair-Wise Maneuvers	R
358	Trajectory Flight Data Management	Y
359	Self-Separation Airspace - Oceanic	R
360	Automation-Assisted Trajectory Negotiation	Y
361	Resource Planning	G
362	Self-Separation Airspace Operations	R
363	Delegated Separation - Complex Procedures	R

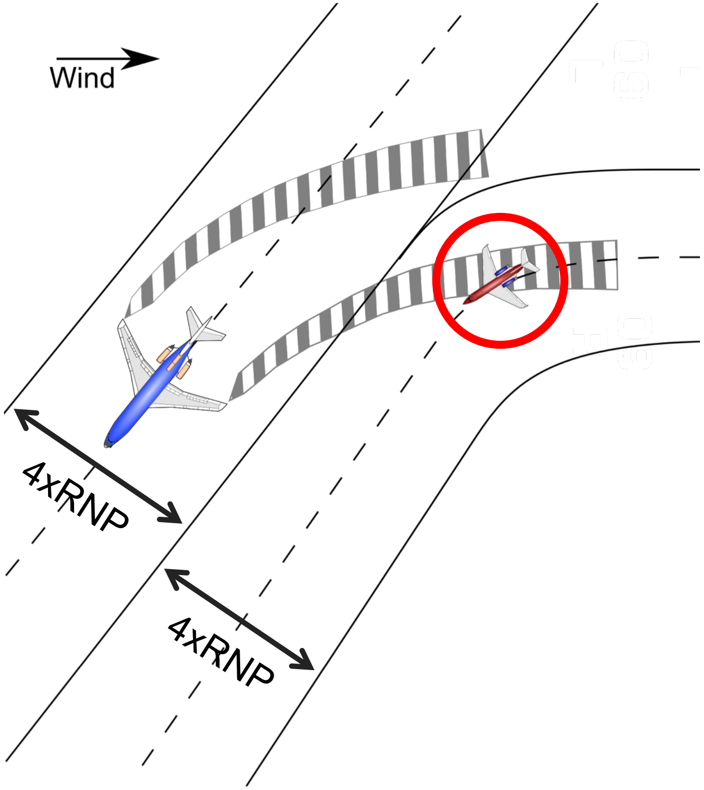
365	Advanced Management of Airspace for Special Use	G
366	Dynamic Airspace Reclassification	G
368	Flow Corridors - Level 2 Dynamic	Y
369	Automated Negotiation/Separation Management	R
370	Trajectory-Based Management - Full Gate-To-Gate	Y
381	GBAS Precision Approaches	Y
400	Wake Turbulence Mitigation: Departures - Wind-Based Wake Procedures	Y
401	Wake Turbulence Mitigation: Arrivals - Wind-Based Wake Procedures	Y
402	Wake Turbulence Mitigation: Departures - Dynamic Wind Procedures	Y
403	Wake Turbulence Mitigation: Arrivals - Dynamic Wind Procedures	Y
406	NAS Wide Sector Demand Prediction and Resource Planning	G
408	Provide Full Flight Plan Constraint Evaluation with Feedback	G
409	Net-Centric Virtual Facility	R
410	Automated Virtual Towers	R
2010	Net-Enabled Common Weather Information Infrastructure	GY
2020	Net-Enabled Common Weather Information - Level 1 Initial Capability	GY
2021	Net-Enabled Common Weather Information - Level 2 Adaptive Control/Enhanced Forecast	GY
2022	Net-Enabled Common Weather Information - Level 3 Full NextGen	GY

OI Operational Approval Risk
(preliminary results, not validated)

Code	Number of OIs	Percent of OIs
NA	53	45%
G	19	16%
GY	11	9%
Y	21	18%
R	15	13%
Total	119	

Emerging System Constraints

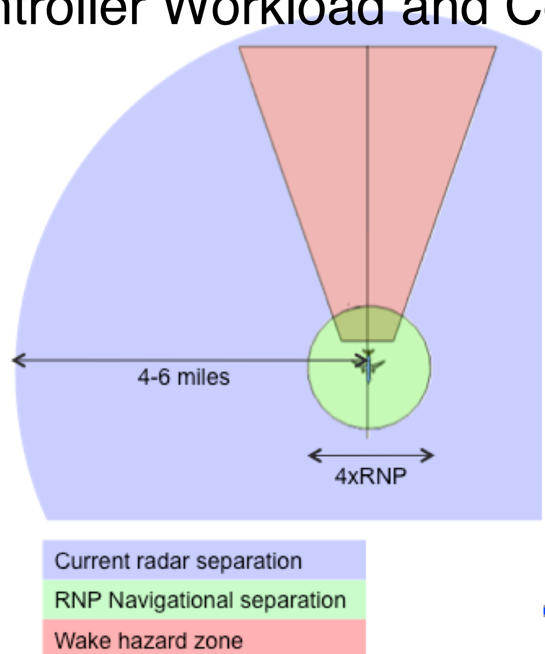


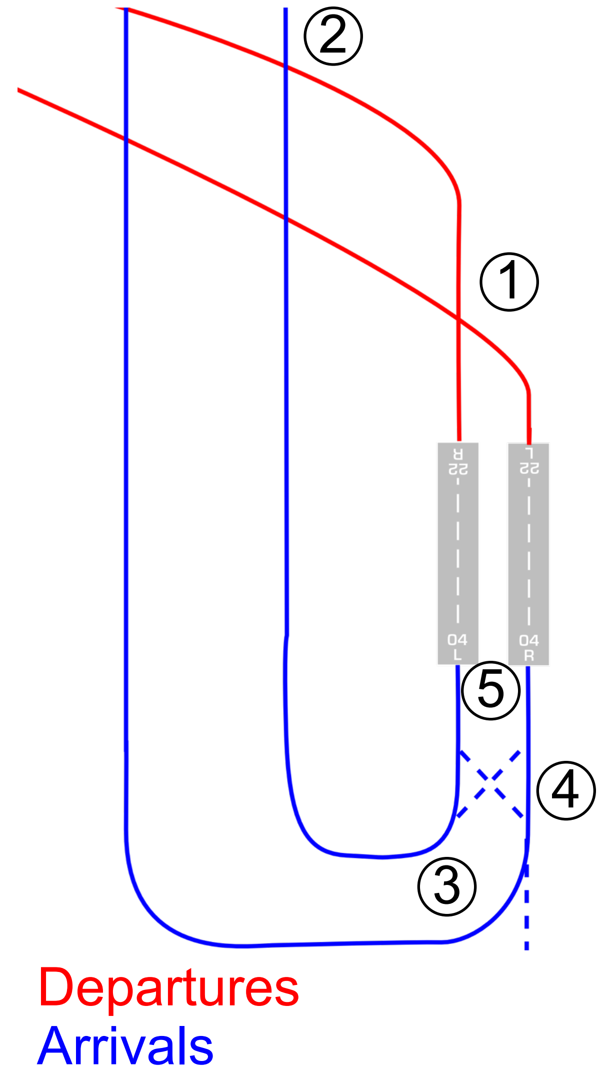


- ❑ **TCAS**
- ❑ **Wake Vortex**

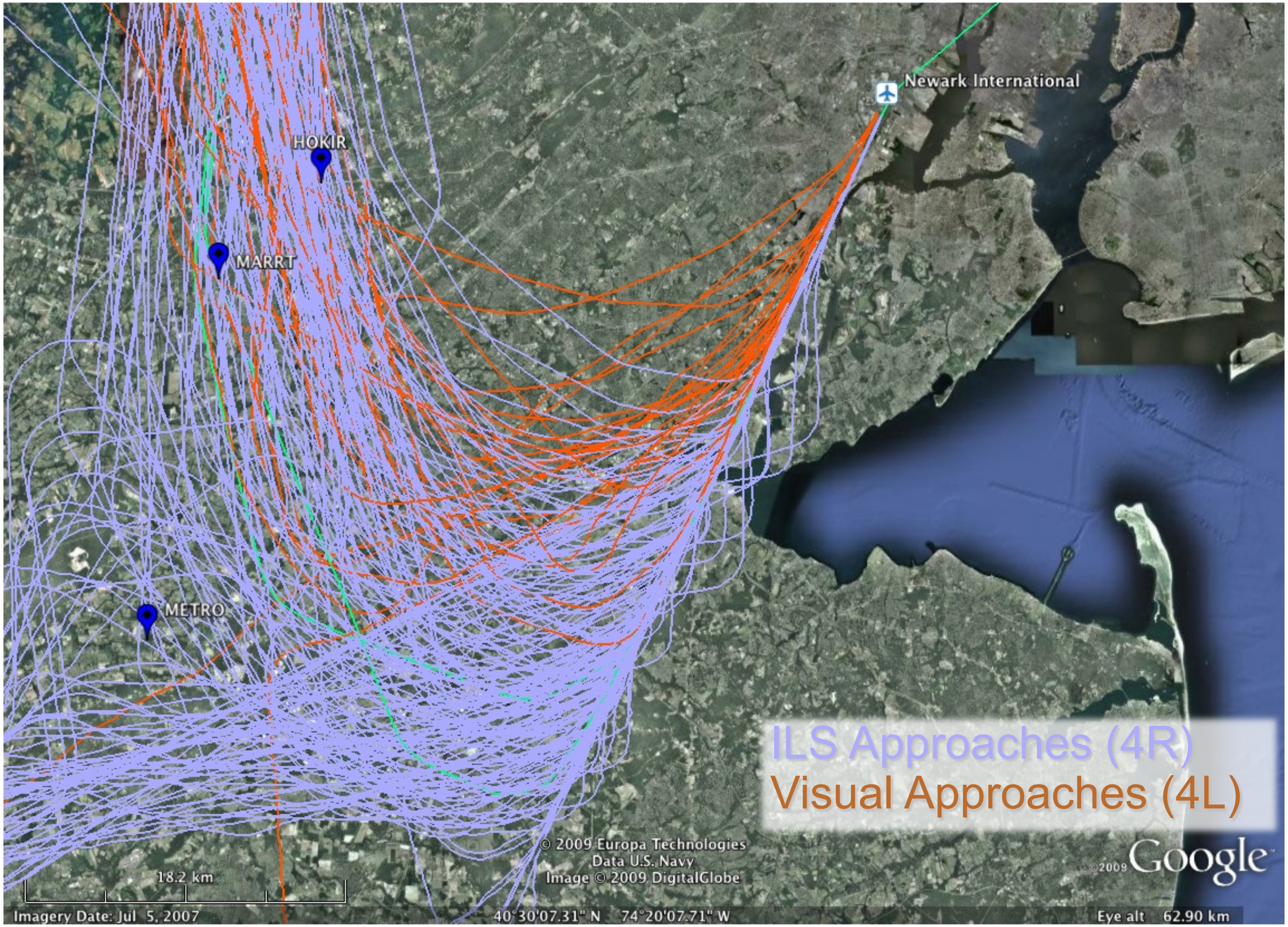
Evaluating Wake Vortex Risk in NextGen

- **Evaluated NextGen Ops Cons**
- **Example Key Areas**
  - Tight Routes in Transition Airspace
  - Closely Spaced Parallel Approaches
  - 4DT Separation Criteria
  - Controller Workload and Complexity



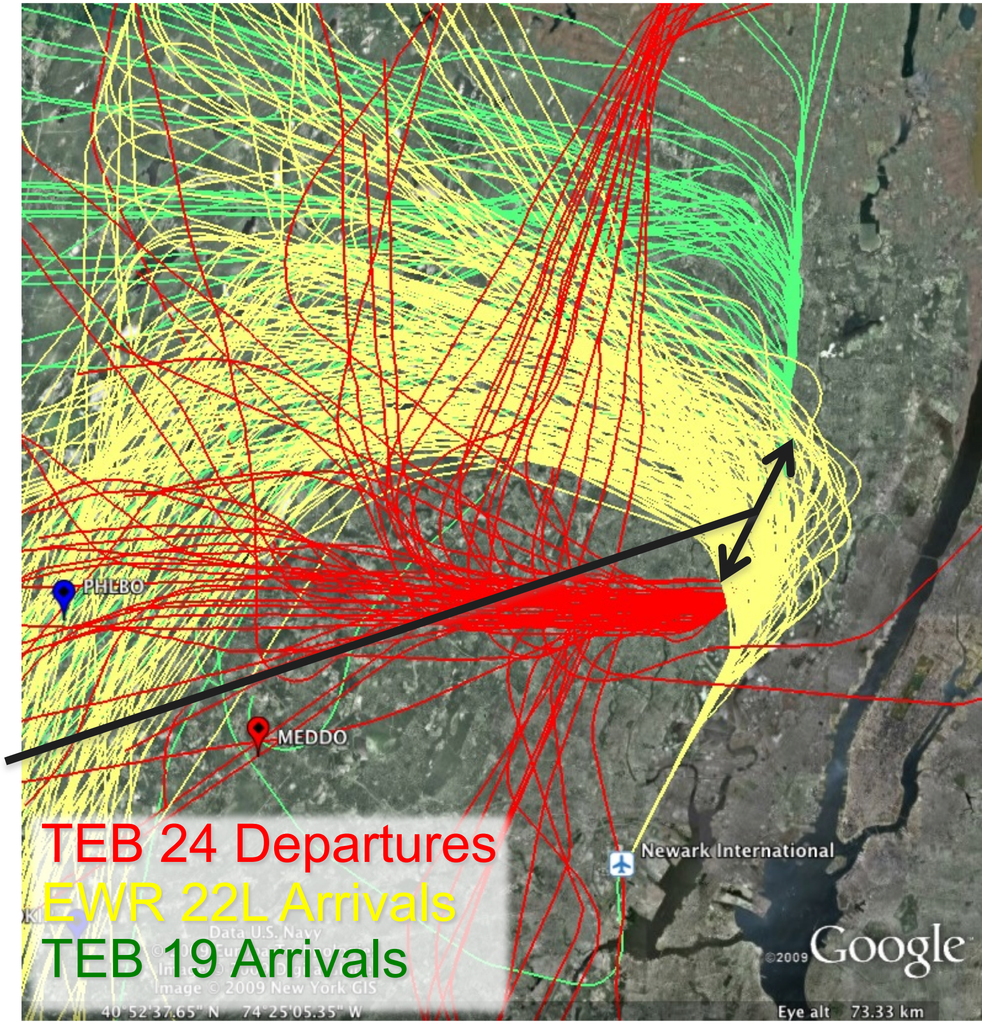


EWR CSPA


Newark International
HOKIR
MARRT
METRO
ILS Approaches (4R)
Visual Approaches (4L)
© 2009 Europa Technologies
Data U.S. Navy
Image © 2009 DigitalGlobe
18.2 km
Imagery Date: Jul 5, 2007
40°30'07.31" N 74°20'07.71" W
Eye alt 62.90 km
©2009 Google

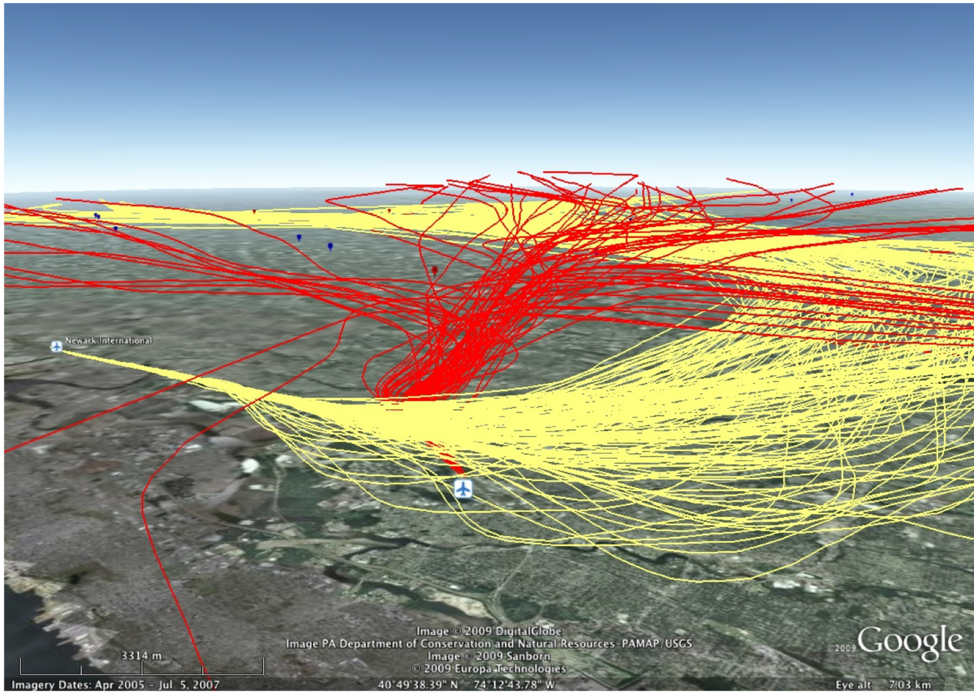
EWR 22L,R – TEB 24 Interaction

- Further examination of the data PDARS data showed that approaches to the 22s may provide a more tightly constrained scenario.
- TEB 24 departures currently **prevent use of EWR 22R for arrivals**
- Arrivals to EWR 22L must cross TEB and maintain safe separation from TEB 19 & 24 arrivals and departures.



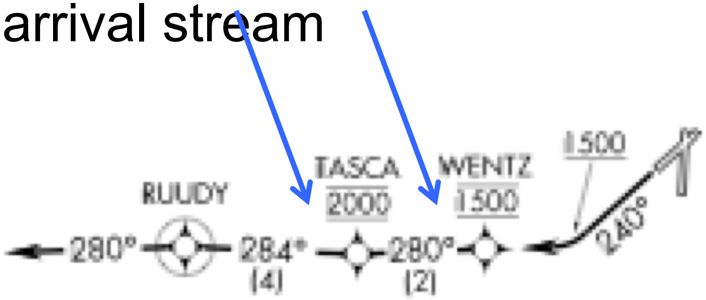
EWR 22L Arrivals and TEB 24 Departures

- Currently TEB 24 departures must snake under then over the ILS arrivals to 22L.
- EWR 22L approaches at ~3000 ft over TEB



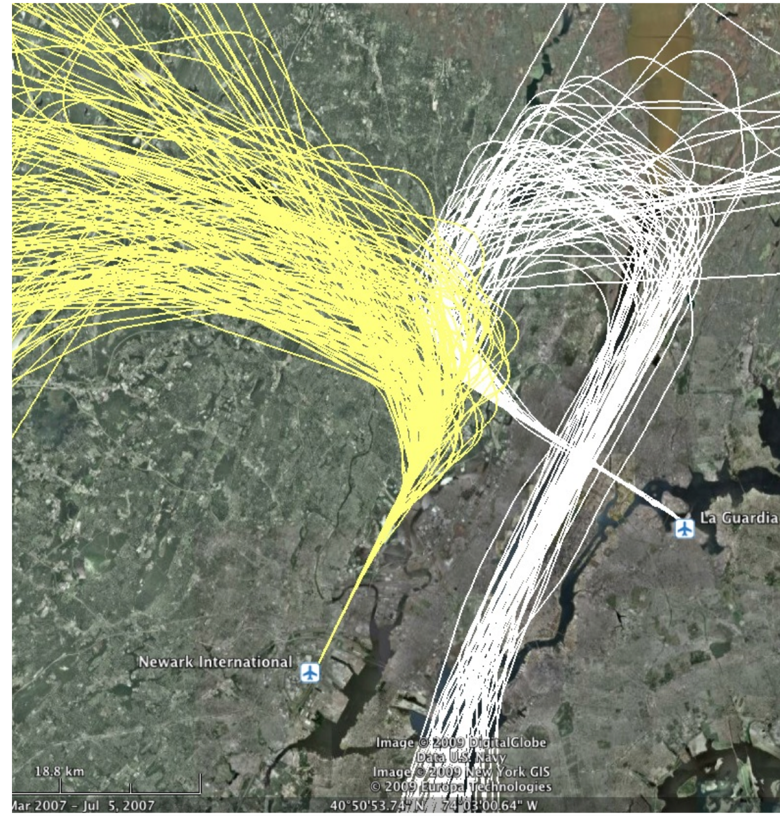
TEB 24 Departures
EWR 22L Arrivals

TEB departures are held-down until clear of the EWR arrival stream



EWR 22 – LGA 13 CDA Interaction

- Future arrivals may use continuous descent approaches (CDAs) to improve fuel efficiency and reduce environmental impacts.
- A CDA to EWR 22s would conflict (only ~450ft vertical separation) with a CDA to LGA
- Currently the two approaches are vertically separated



EWR 22L Arrivals
LGA 13 Arrivals

Questions