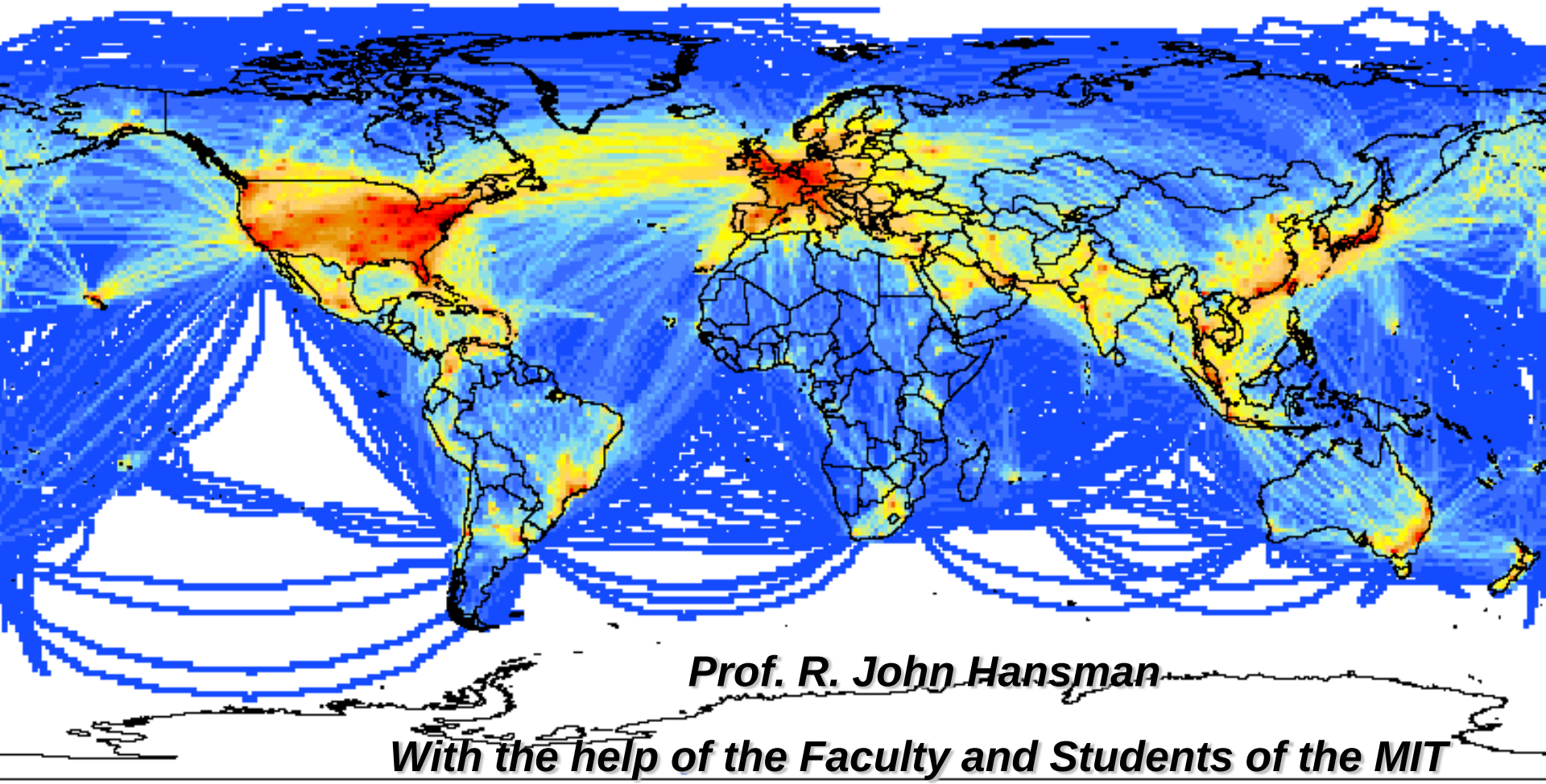
Current Challenges and Opportunities in Commercial Aviation



Prof. R. John Hansman

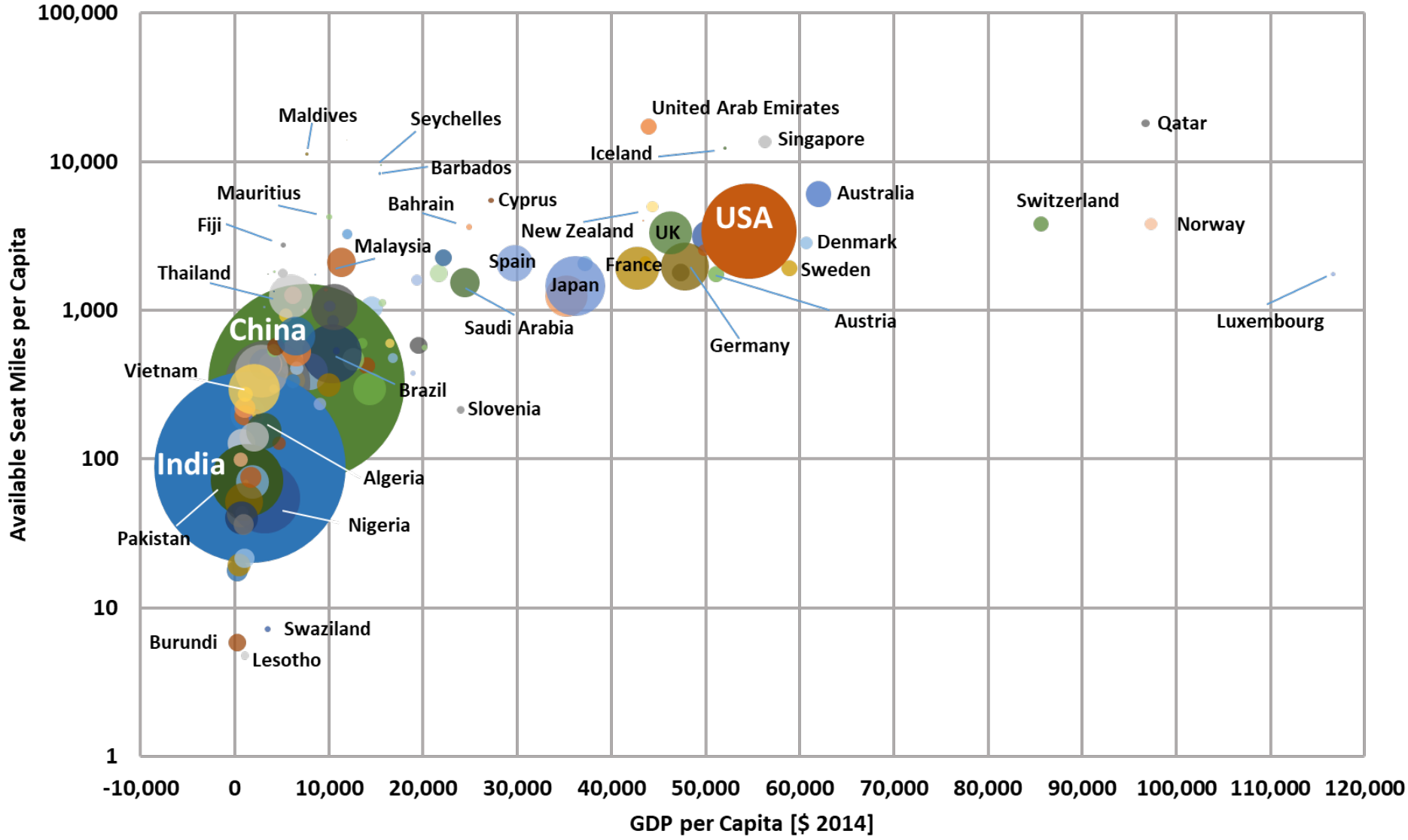
With the help of the Faculty and Students of the MIT International Center for Air Transportation

rjhans@mit.edu

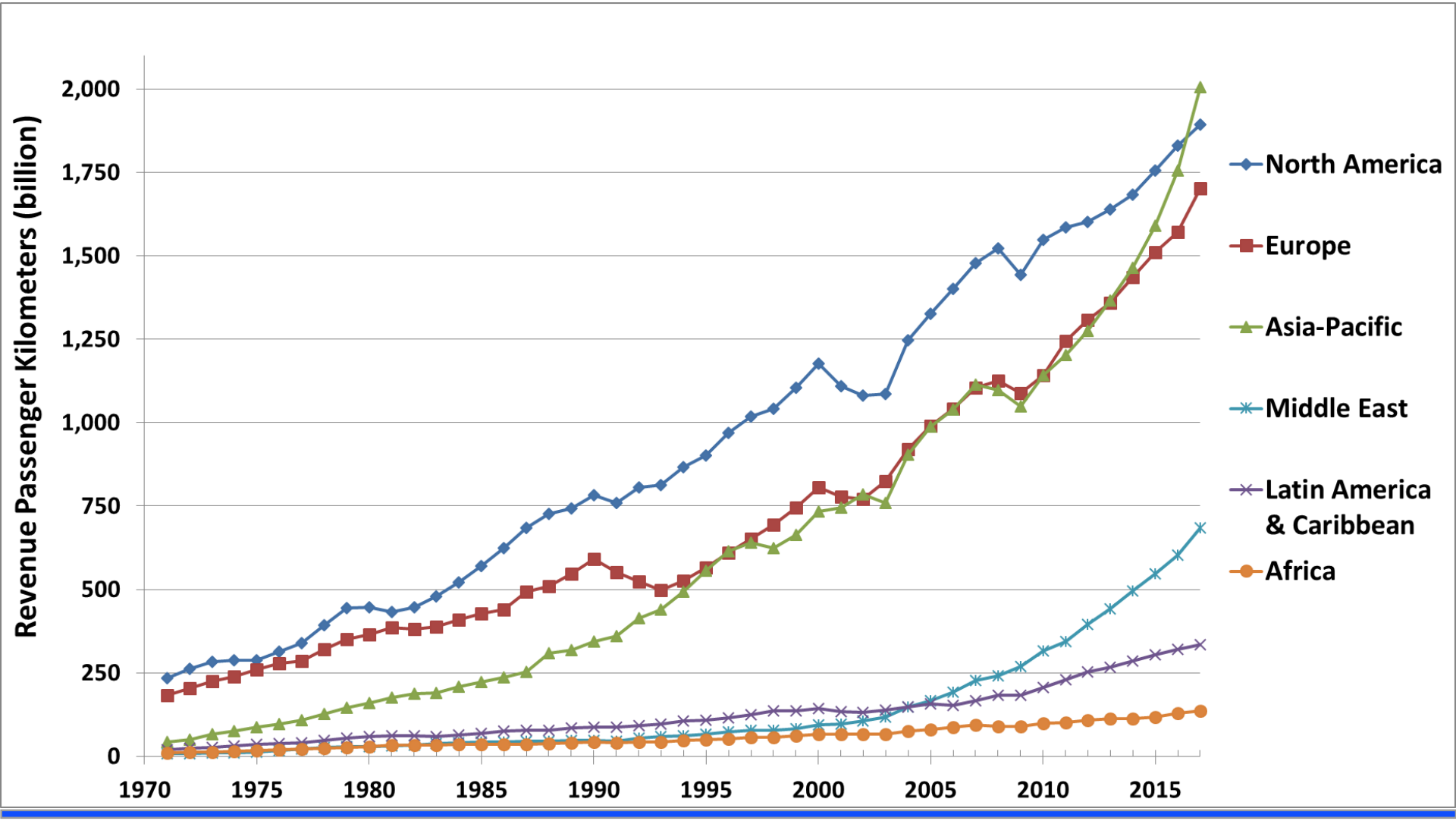
Traffic Source: Sage Analysis courtesy Prof Ian Waitz

Traditional Air Transportation Markets

2014 Data

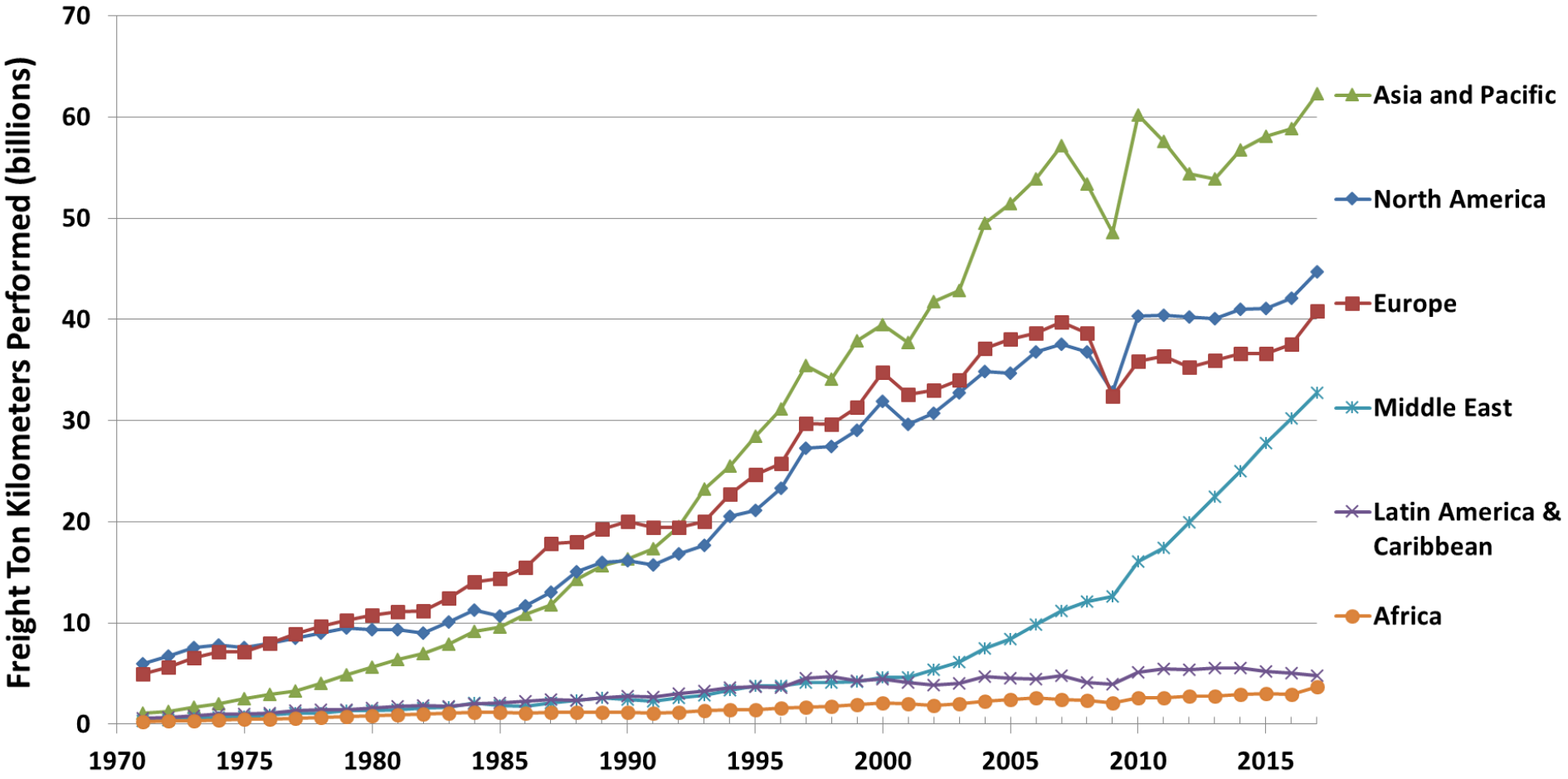


Traditional Air Transportation Markets
Revenue Passenger Kilometers (RPK)
by World Region



Data source: ICAO/IATA

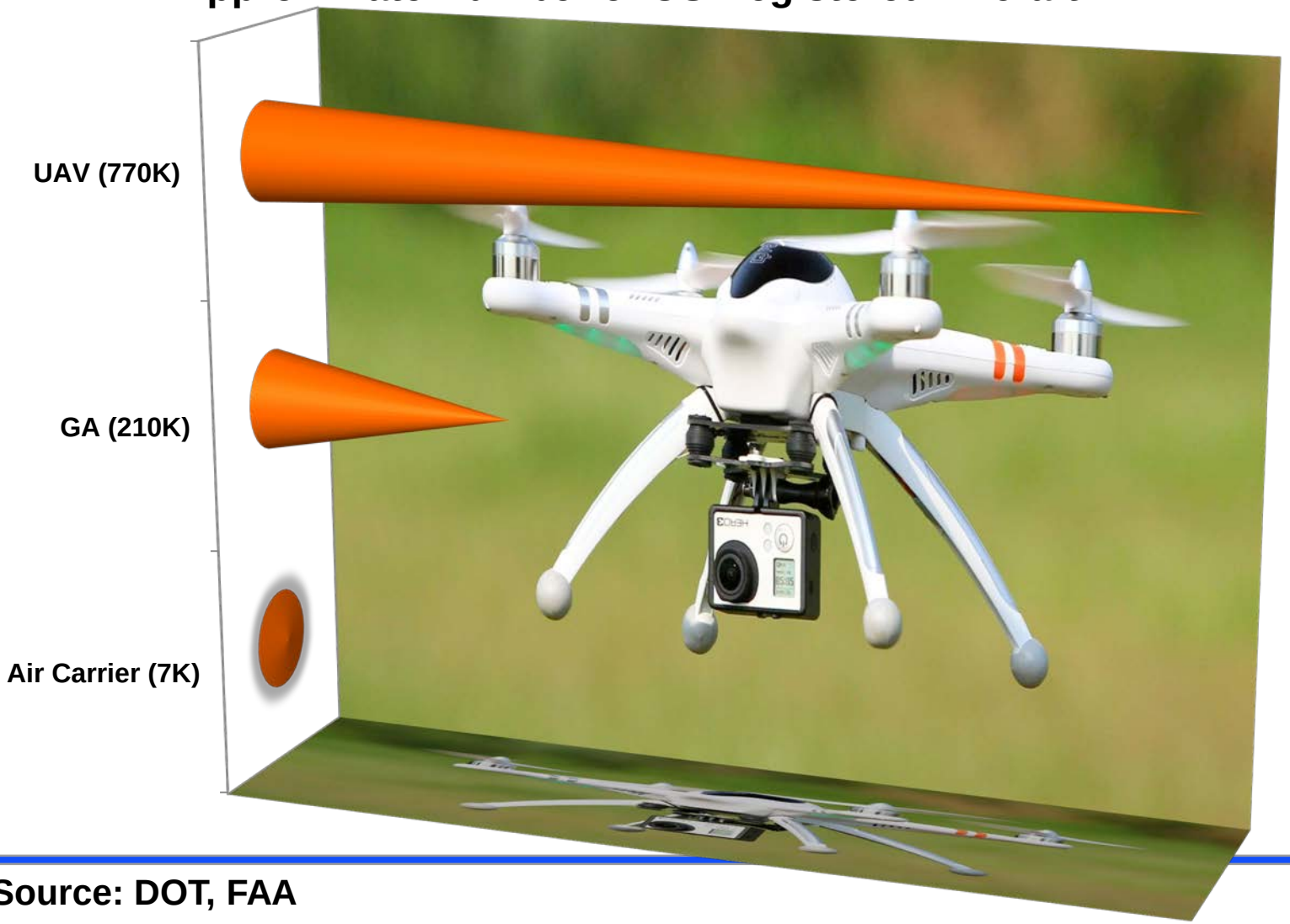
Freight Ton Kilometers (FTK)
by World Region



Data source: ICAO/IATA

Emerging Non Traditional Markets
UAS

Approximate Number of US Registered Aircraft

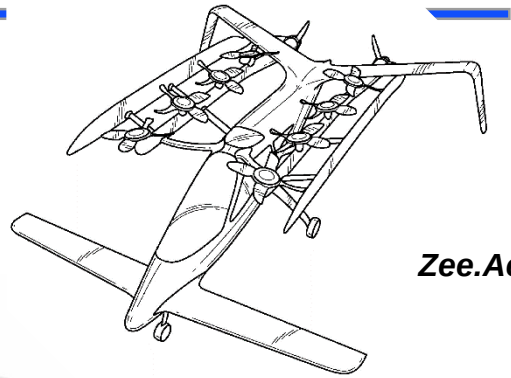


Source: DOT, FAA

Emerging Non Traditional Markets
(e)VTOL and Urban Air Mobility

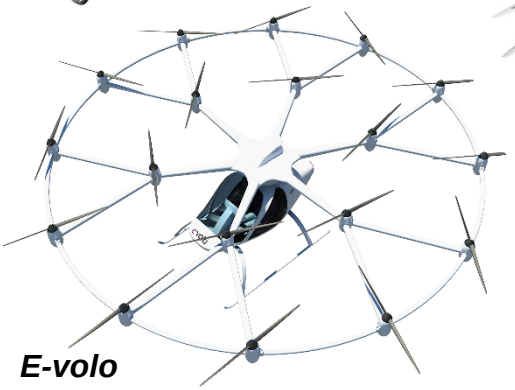
Joby Aviation

Airbus A^3



Zee.A

EHang



E-volo

Lilium Aviation

Airbus & Italdesign

Terrafugia

Kitty Hawk

Carter Aviation & Mooney International

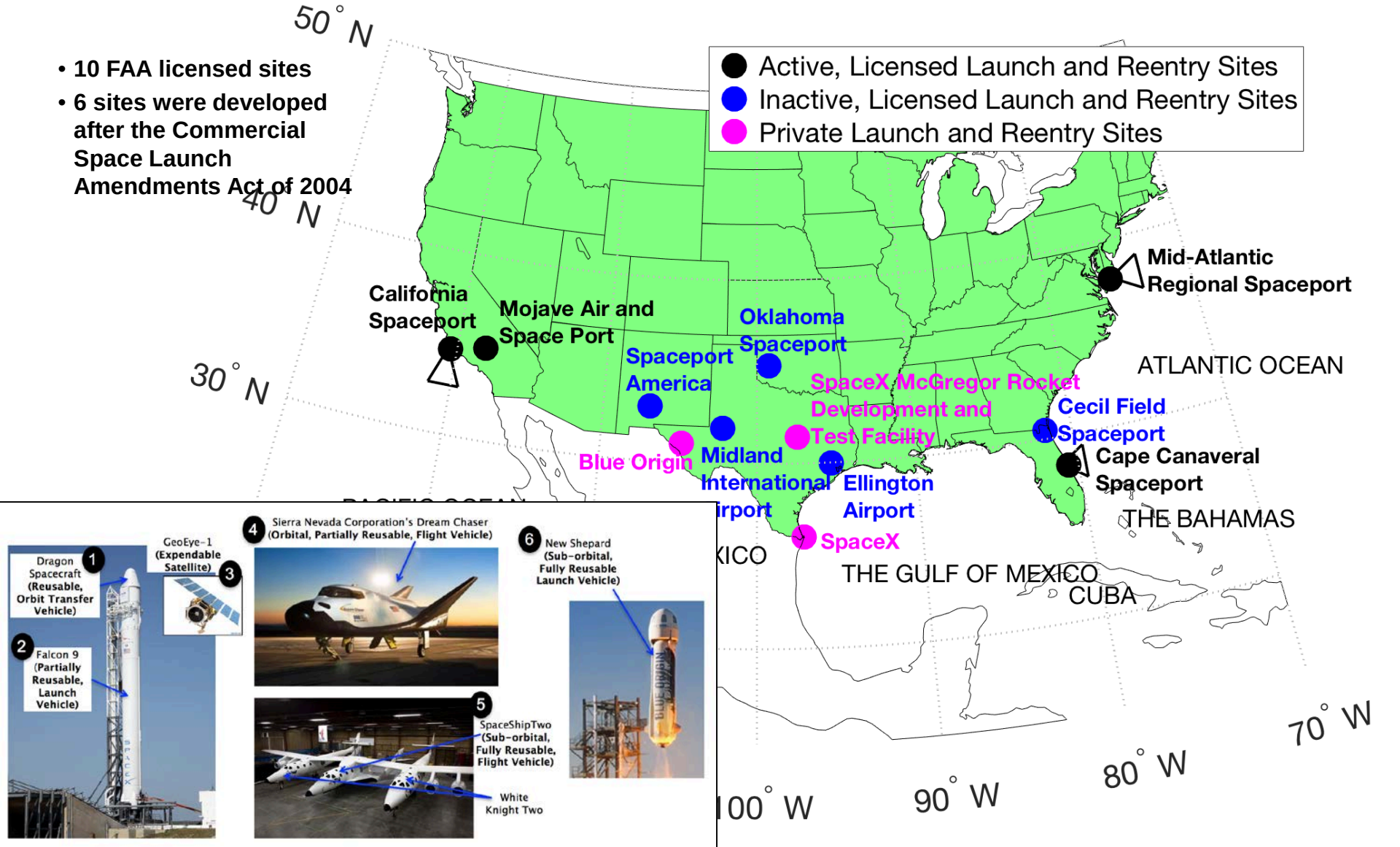
Aurora Flight Sciences

<u>Not Pictured</u>:

Bell Helicopter, NASA, Pipistrel, Embraer, Toyota, AirSpaceX, Jetpack Aviation, Elytron, Eviation, Yuneec Intl, Urban Aeronautics LTD, XTI Aviation AeroMobi, Flike, Flyboard, AirspaceX, DeLorean Aero, Flexcraft, hopFlyt, HoverSurf, JAXA, Bartini, Cartivator, Dekatone, Neva Airspace, Workhorse

Emerging Non Traditional Markets
Commercial Space

- **10 FAA licensed sites**
- **6 sites were developed after the Commercial Space Launch Amendments Act of 2004**



Challenge – Innovation in a High Integrity Product Duopoly

D-8

BWB

Hybrid Electric

Challenge - International Competition

Next Generation Narrow Body Aircraft

Bombardier C-Series

Seats: 100 – 145

Entry Into Service: 2016

Airbus:A320 NEO

Seats: 107 – 220

Entry Into Service: 2016

Boeing: B737 Max

Seats: 108- 189

Entry Into Service: 2017

Embraer:E190/170-E2

Seats: 90-144

Est. Entry Into Service: 2018

Irkut MC-21

Seats: 150-212

Est. Entry Into Service: 2019

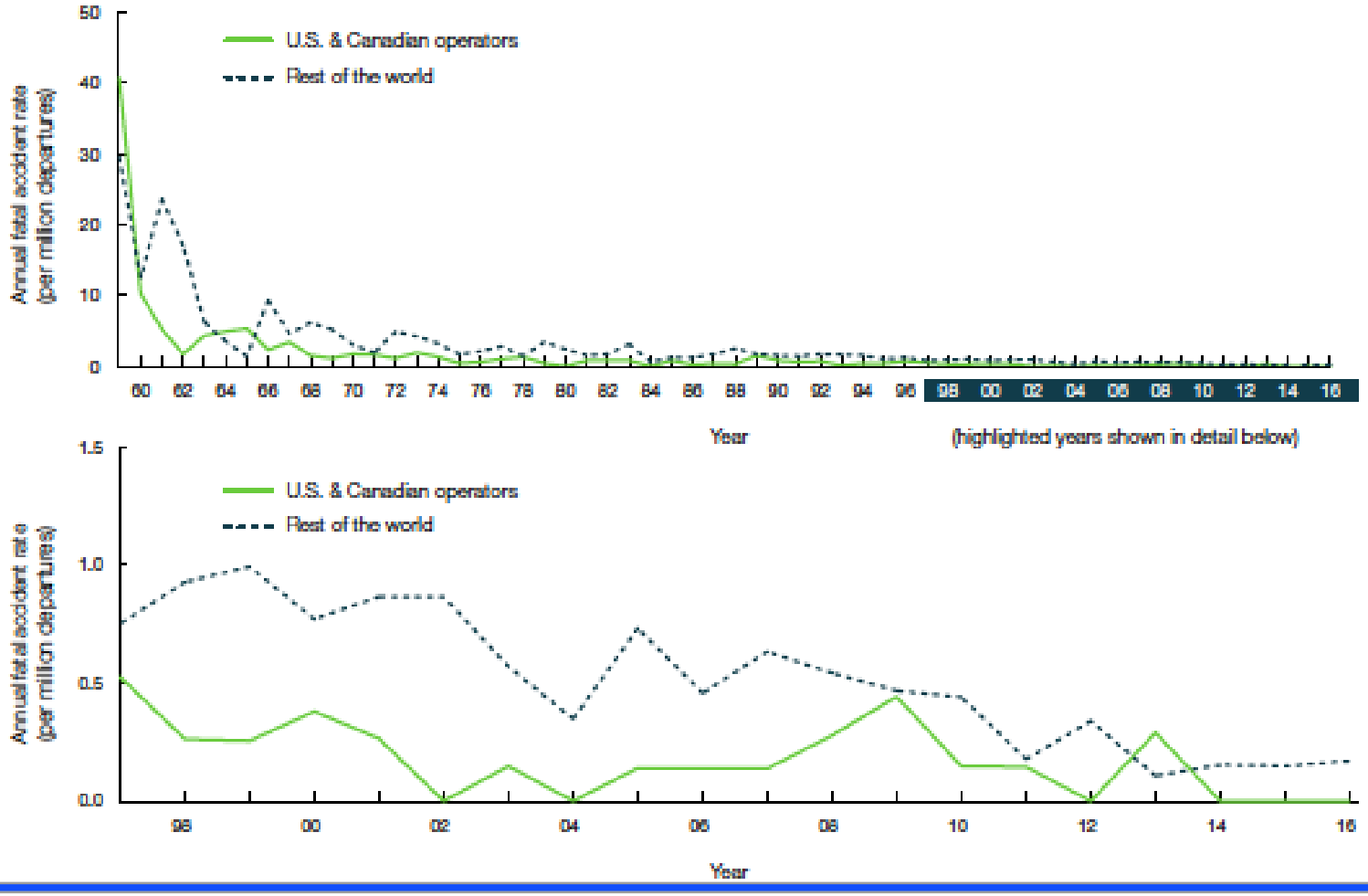
Comac C919

Seats: 156-168

Est. Entry Into Service: 2020

Challenge – Modernize the System while Maintaining and Improving Safety

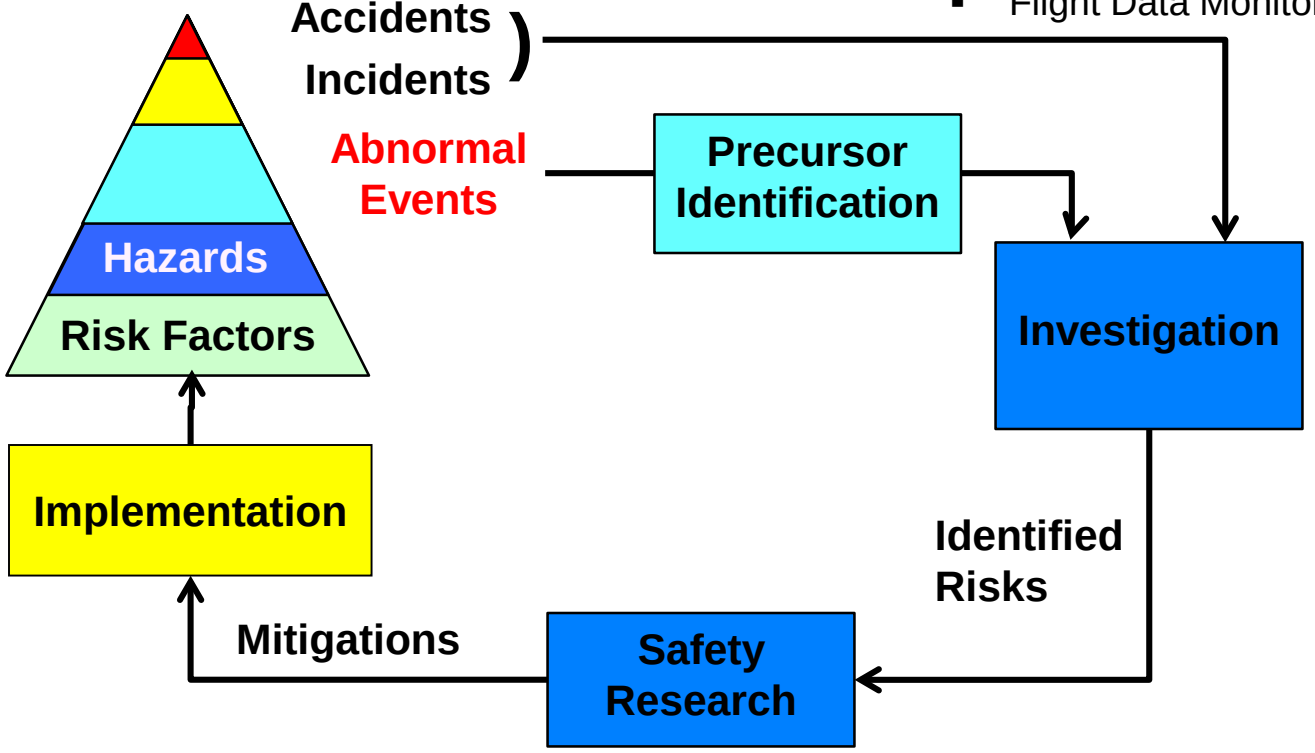
Fatal Accidents - Worldwide Commercial Jet Fleet



Statistical Summary of Commercial Jet Airplane Accidents, Boeing, July 2017

Challenge – Modernize the System while Maintaining and Improving Safety

- ICAO Annex 6
  - Safety Management Systems
  - Flight Data Monitoring



- Safety Management Systems
- Role of Data Analytics for Safety and Efficiency Monitoring (e.g. Cluster Techniques)

Emerging Safety Issues – Non Traditional Threats

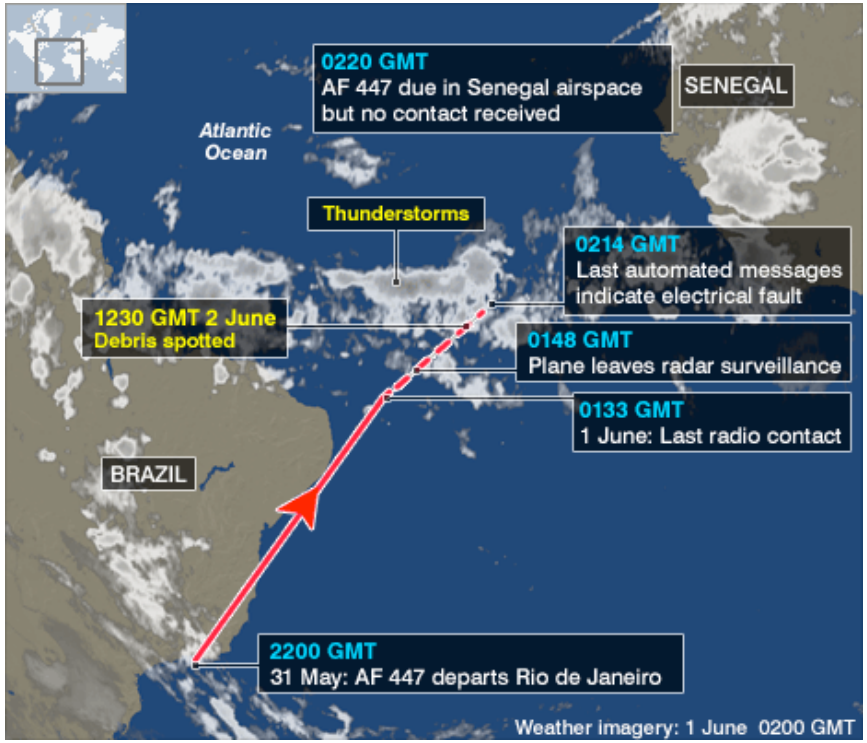
Surface to Air Missile
Malaysian 17 July 2015

Pilot Suicide
Germanwings 9525 March 2015

Airport Attacks
Brussels, Istanbul 2016

Cybersecurity Concerns

Emerging Safety Issues – Proficiency and Human Automation Interaction



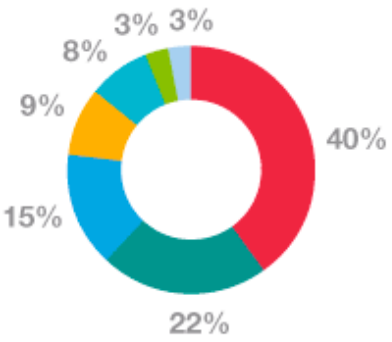
Air France 447, Aug 2009

Asiana 214, July 2013

Challenge - Pilot, Technician Pipeline and Training

Pilot & Technician Outlook
New pilots by region 2012–2031

Region	Pilots
Asia Pacific	185,600
Europe	100,900
North America	69,000
Latin America	42,000
Middle East	36,100
CIS	11,900
Africa	14,500
Total	460,000

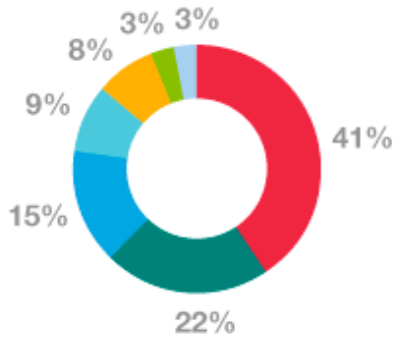


2012 to 2031
Pilots
460,000

Current Market Outlook
2012–2031

Pilot & Technician Outlook
New technicians by region 2012–2031

Region	Technicians
Asia Pacific	243,500
Europe	129,700
North America	92,500
Middle East	53,700
Latin America	47,300
CIS	18,100
Africa	16,200
Total	601,000



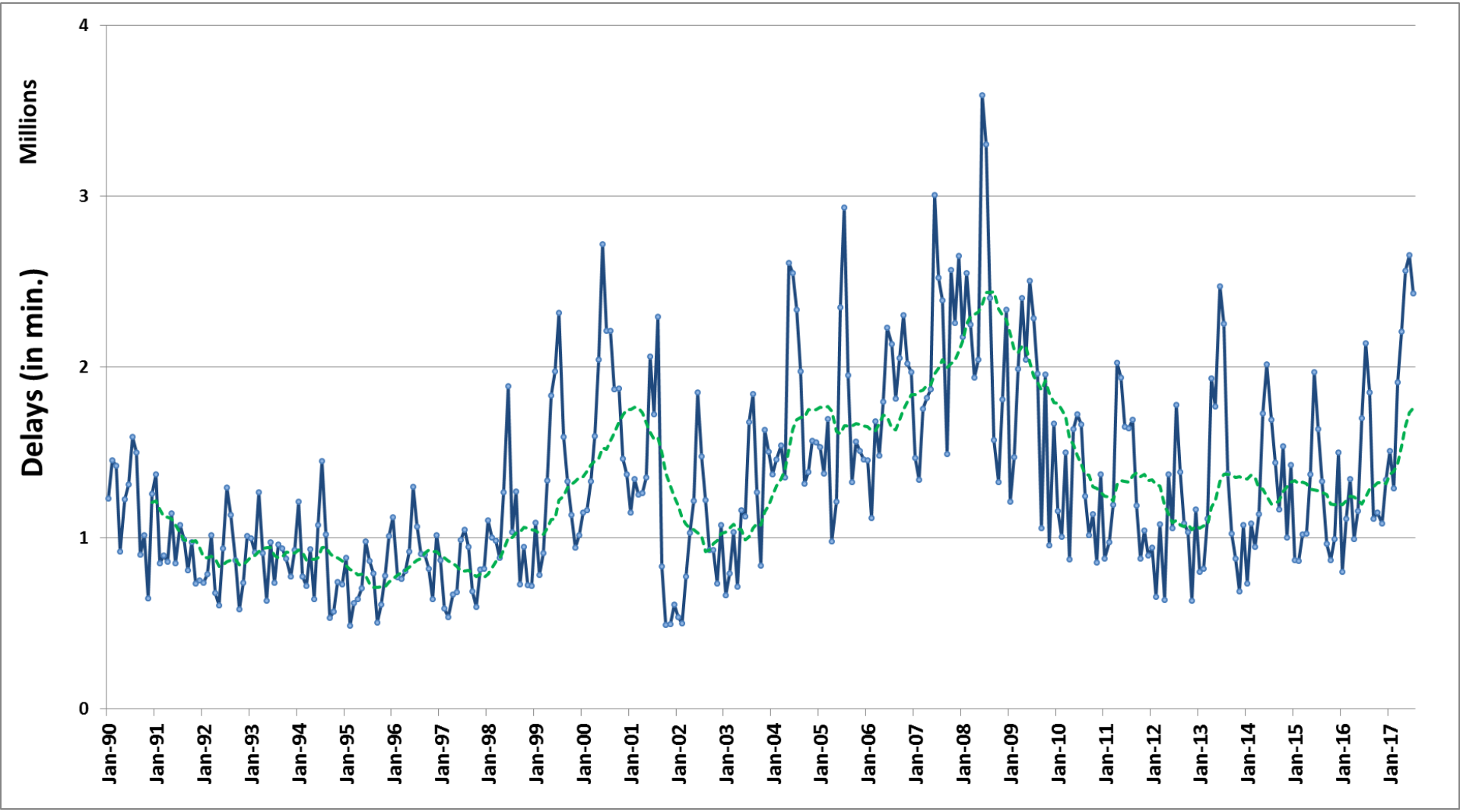
2012 to 2031
Technicians
601,000

Current Market Outlook
2012–2031

Source: Boeing Current Market Outlook

Challenge – NAS System Capacity

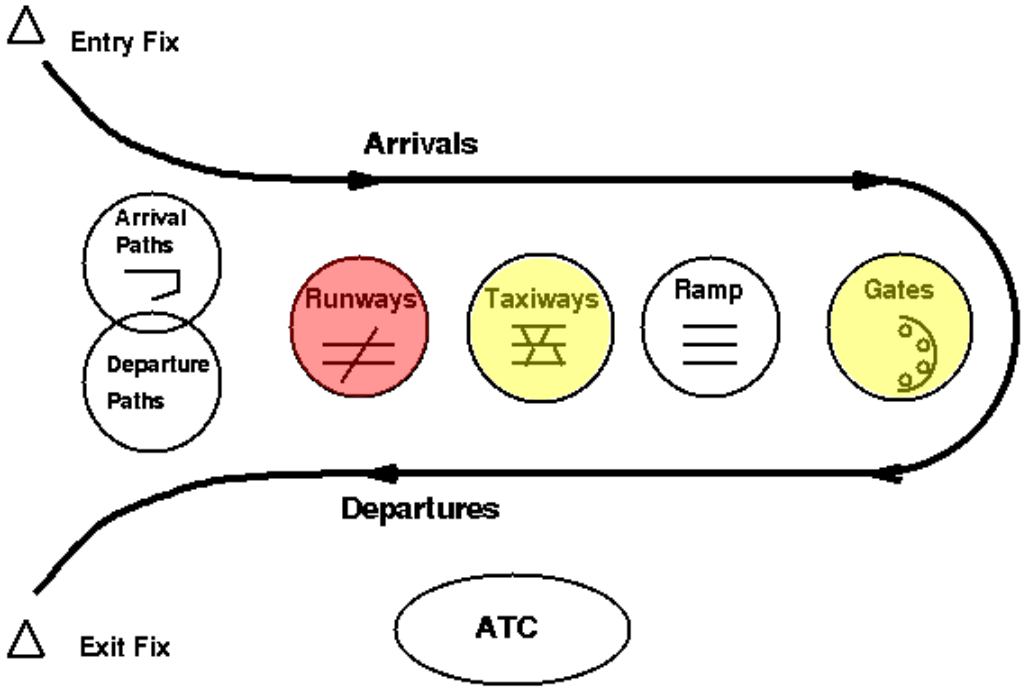
US Flight Delay Trends



Data source: FAA Operational Network (OPSNET) (data through June '17)

Airport System
Capacity Limit Factors

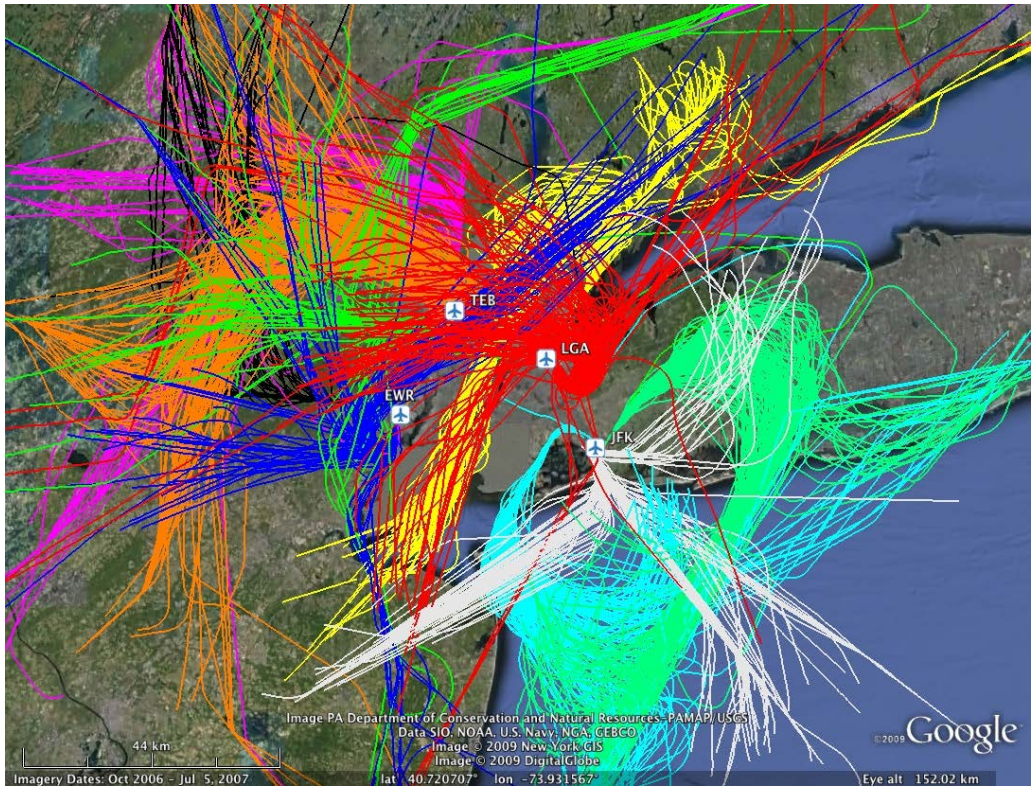
- **Runways**
- **Landside Limits**
  - Gates
  - Ramp Space
  - Terminals & Security
  - Road Access
- **Weather**
  - Capacity Variability
  - Convective Weather
- **Downstream Constraints**
- **Controller Workload**
- **Environmental**
  - Community Noise
  - Emissions
- **Safety**



Adaptive System - Impedance Matching

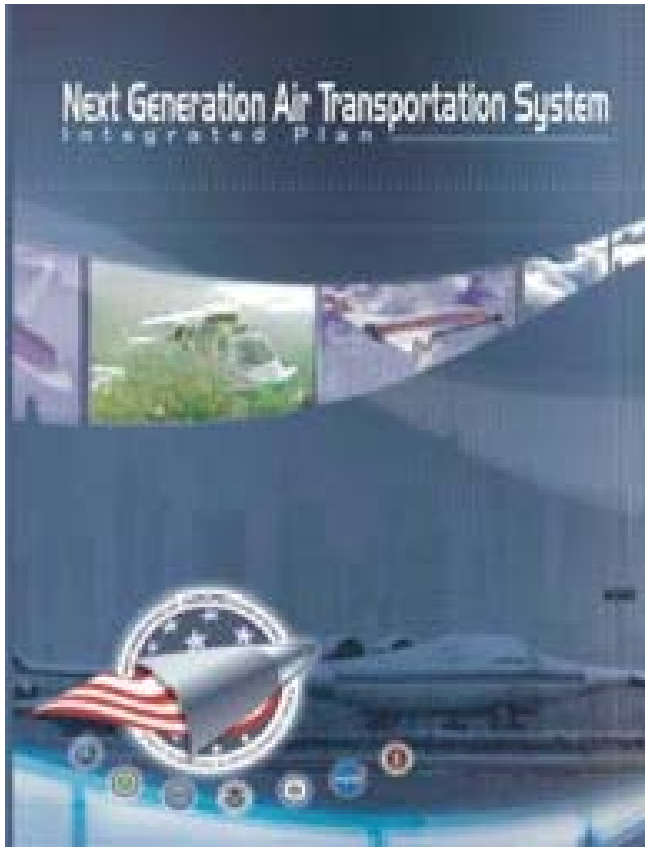
Challenge - Low Altitude Urban Airspace Capacity

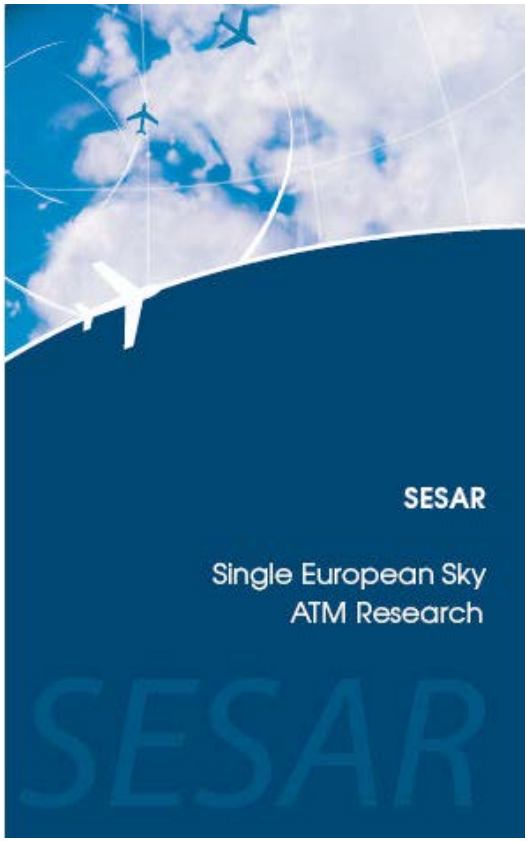
- **UAS and Urban Air Mobility (UAM) markets will pressure low altitude controlled airspace**



Implementation Challenge – Limited Benefits from ATM Modernization Efforts

- **Hypothesis: High safety performance of current system (with SMS) makes it difficult to implement real operational improvements.**

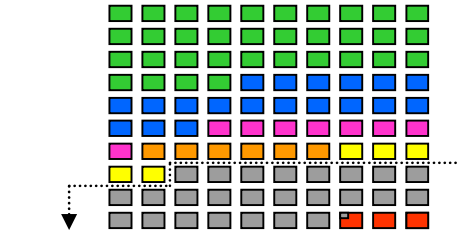




Challenge - Environmental Issues

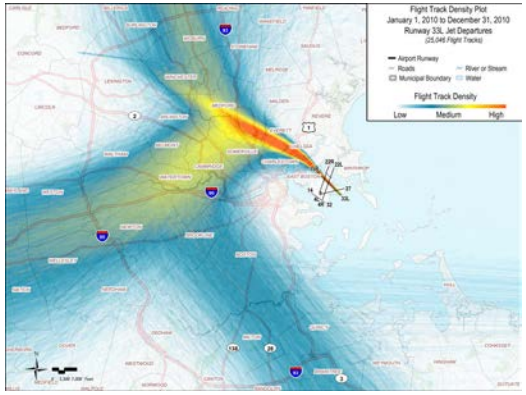
System Level

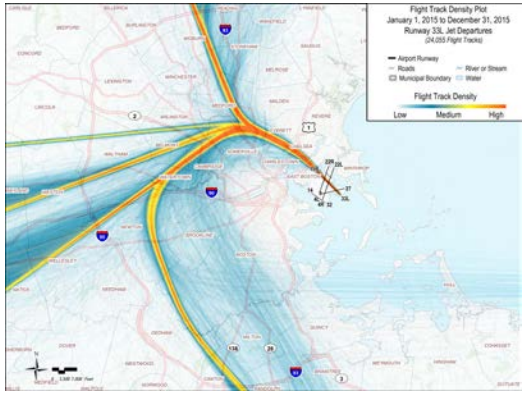
GHG



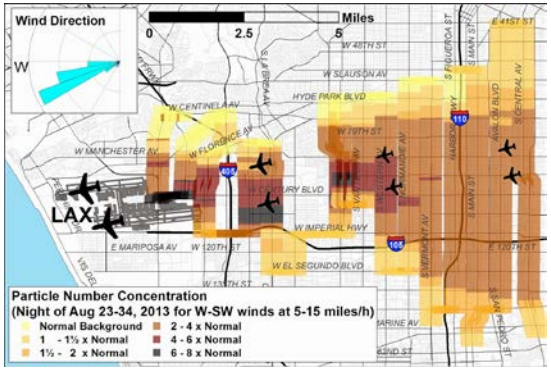
Airport Level

Noise





Ultrafine Particles



Source: Hudda et al *Environ. Sci. Technol.*, 2014, 48 (12), pp 6628–6635