



# Boeing Product Update

August 2018

# Agenda

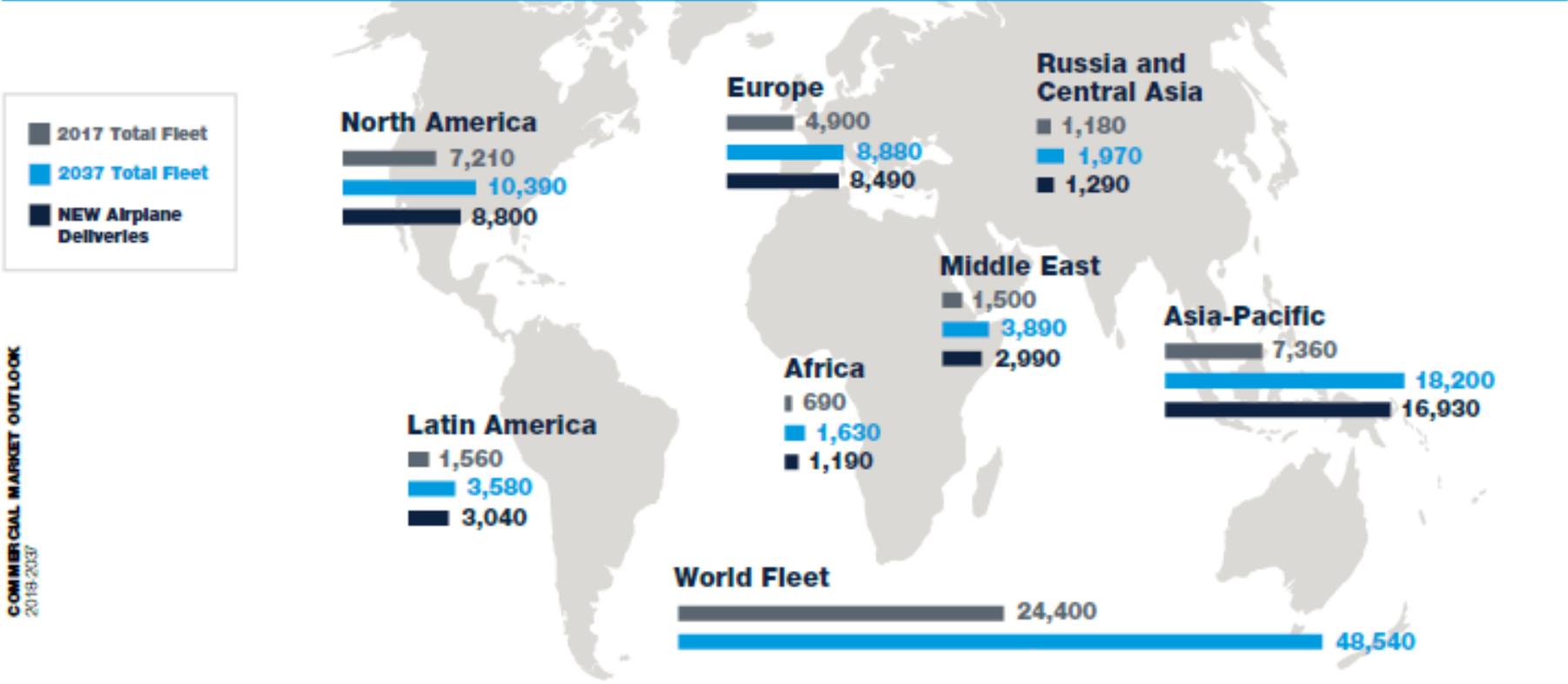
- Market Outlook
- Boeing Product
- Impact to Airports
- 777X – Folding Wingtip
- Boeing Airport Compatibility Group 2 – Regulatory Effort



# CURRENT MARKET OUTLOOK

2017–2036





COMMERCIAL MARKET OUTLOOK  
2018-2037

# Market Outlook (Latin America)

## LATIN AMERICA

3,040  
DELIVERIES



COMMERCIAL MARKET OUTLOOK  
2018-2037

**3.0%**  
GDP

**5.9%**  
TRAFFIC

**4.2%**  
FLEET

**\$360B**  
MARKET VALUE

The economic outlook for the Latin America region continues to improve after an extended period of challenges. Among the top countries in the region, Brazil and Argentina continue their post-recession rebounds and Mexico is experiencing modest economic growth. The long-term growth prospects for Colombia, Chile, and Peru remain strong.

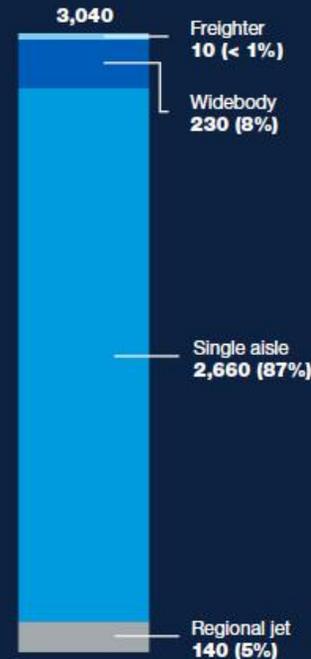
Aviation in Latin America is entering a dynamic period. The economic recovery and growth opportunities in air travel have generated renewed interest in low-cost carriers (LCC) in the region. The availability of competitive low-fare LCC flights, coupled with a larger middle-class population, fosters a shift from slower modes of transportation to air travel.

Further liberalization is on the horizon, and airlines are forming strategic relationships to take advantage of further growth. Mexico and the United States established an Open Skies agreement in 2017, and Brazil-US Open Skies approval is imminent. Numerous cross-airline joint ventures are being formed or planned. Aeroméxico and Delta Air Lines have already established a joint operating agreement under antitrust immunity, and the Brazil-US agreement is likely to pave the way for similar business arrangements. Partnerships and cross-airline equity arrangements are being formed or discussed between airlines in Latin America and other regions as well.

### DELIVERIES 2018-2037

**87%**

Deliveries into Latin America forecast to be single-aisle airplanes, the highest percentage among all regions



### FLEET COMPOSITION

2017

2037

Freighter

**6%**  
90



**4%**  
130

Widebody

**10%**  
160



**8%**  
300

Single aisle

**80%**  
1,240



**84%**  
3,010

Regional jet

**4%**  
70



**4%**  
140

### SHARE OF WORLD FLEET

**6%**  
1,560

2017

**7%**  
3,580

2037

The availability of single-aisle airplanes with increased capability and economics is forecast to shift the fleet mix toward the single-aisle category.

LATIN AMERICA 61

# Boeing Product

## 737 Family

Over 100 Customers & 4664 Orders



### 737-MAX 200

- MAX 8 with mid/aft exit door
- 200 PAX

The whole design matters



Less weight



Improved aerodynamics



New LEAP-1B engine

### 737 MAX 10

- 5 ft (1.6m) Longer
- 230 Pax
- 2020 EIS

# Boeing Product

## 787 Family Extending Capacity & Capability

787 Family: 71 Customers, Over 1,387 Orders  
787-10: Over 171 Orders



787-9  
290 passengers  
7,635 nmi (14,140 Km)  
EIS: Oct 2016



787-10  
330 passengers  
6,430 nmi (11,910 Km)  
EIS: Mar 2018



787-8  
242 Passengers  
7,355 nmi (13,620 Km)  
EIS: Dec 2014

# Boeing Product

## 787 Family Extending Capacity & Capability



Connecting the World *i*

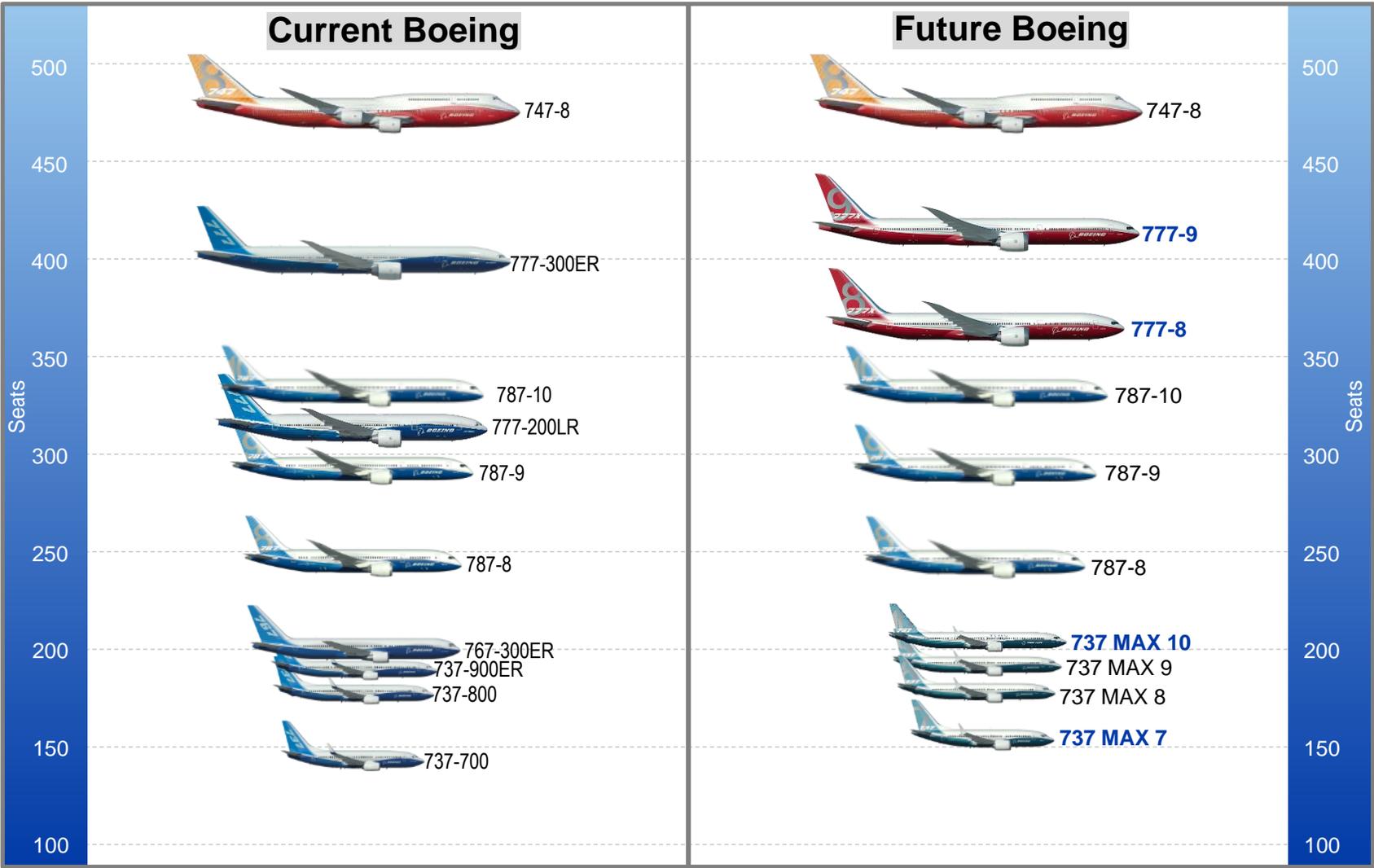
**Opening New Non-stops With the 787 Dreamliner Family**

With its unparalleled fuel efficiency and range flexibility, the 787 Dreamliner family is helping airlines open new nonstop routes profitably. With more than 170 new non-stops in service and announced — and counting, the 787 family is connecting people and cities around the world while meeting passengers' expectations to fly nonstop.

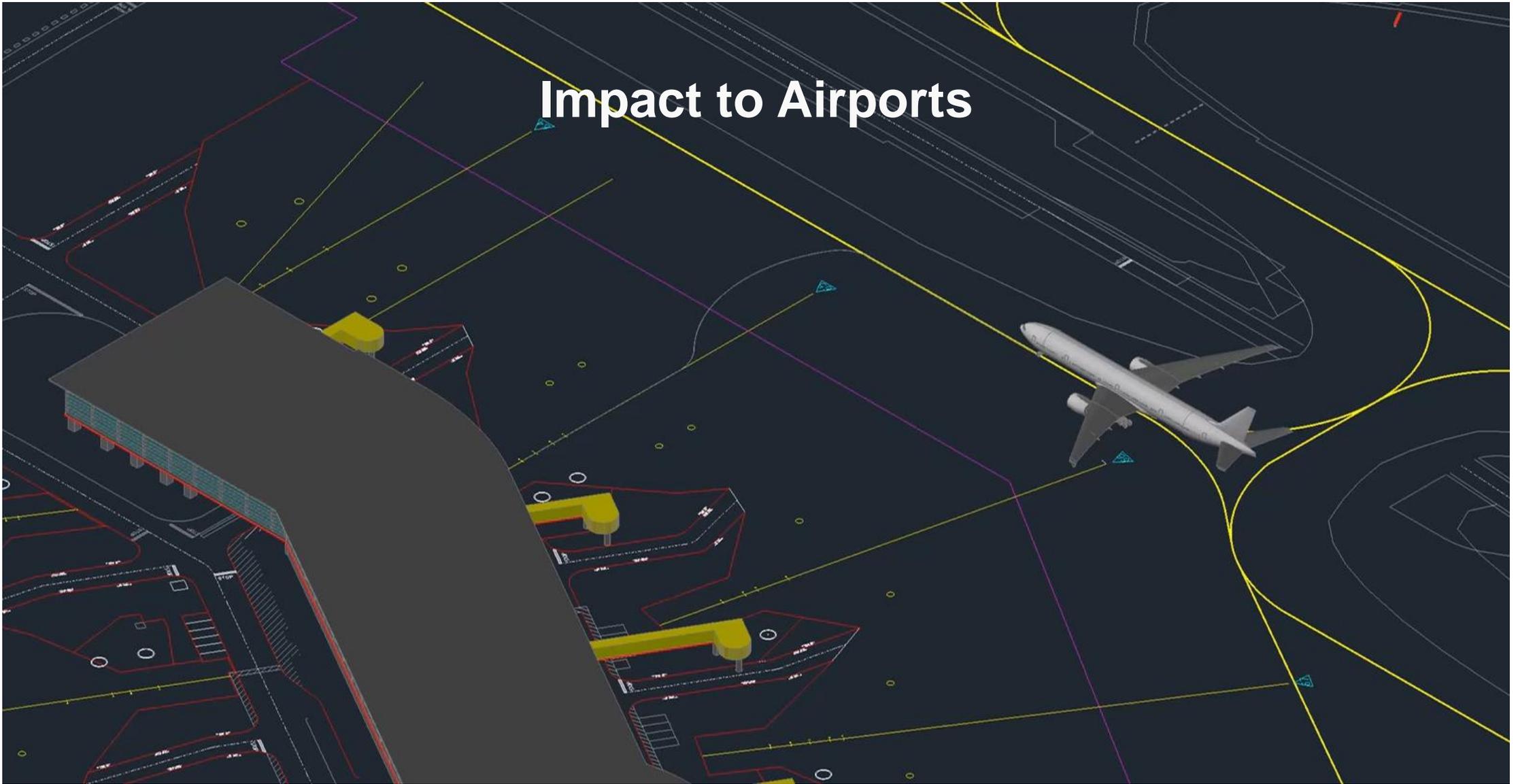
**170+ new routes as of 2017.**

# Boeing Product

## Demand for Capacity & Efficiency



# Impact to Airports



# Impacts to Airports



- Wingspan – separations and clearances
- Overall Length – TDG category, gate length, stop lines, PBB and servicing equipment, RFF
- Weight – pavement strength, runway length, approach category, wake turbulence

- Grp V (Code E) vs Grp VI (Code F)
- Cost of upgrades are prohibitive
- Physical restrictions – insufficient land area, surrounding communities
- Over 200 airports accommodate Grp VI (Code F) operations today using exceptions and operational plans
- Today's approach of accommodation may not be sufficient as quantity of large aircraft increases

# Impacts to Airports

747-8

## Capability

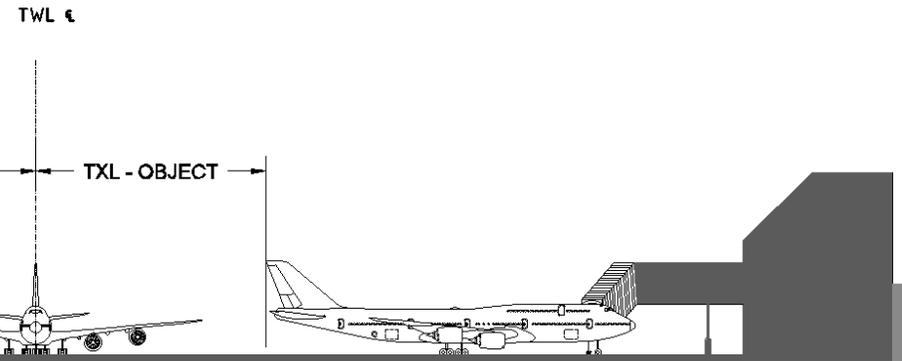
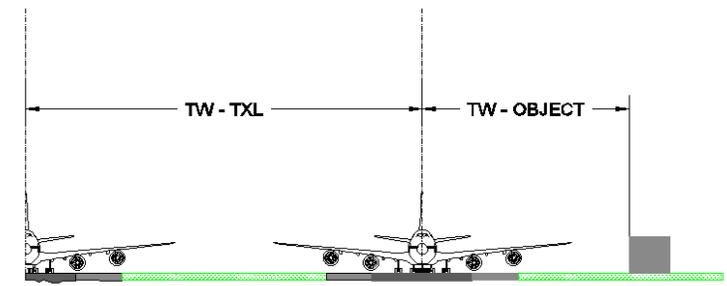
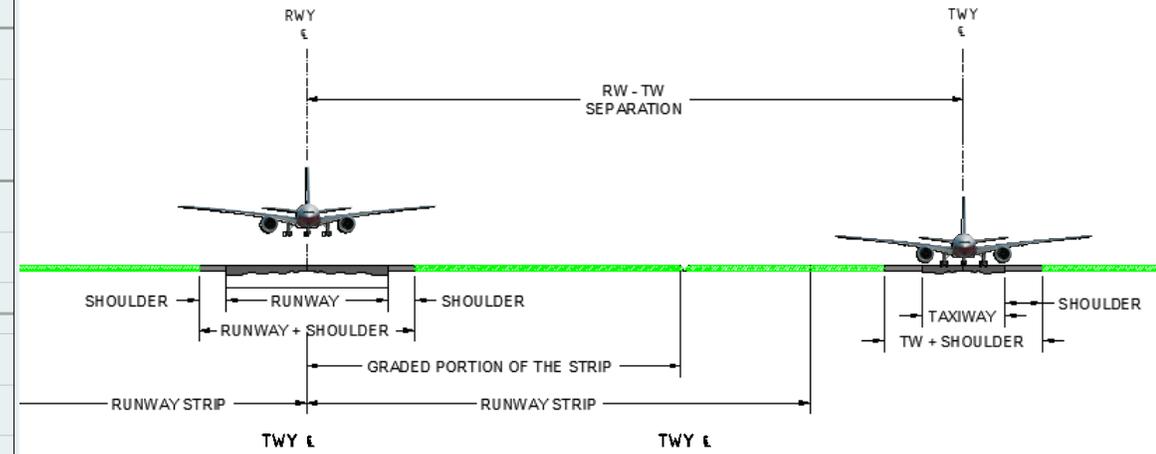
- Freighter EIS 2011 / Passenger 2012
- Increased Cargo / Passengers
- Increased fuel efficiency and range
- Lower emissions, noise and operating cost

## Challenges

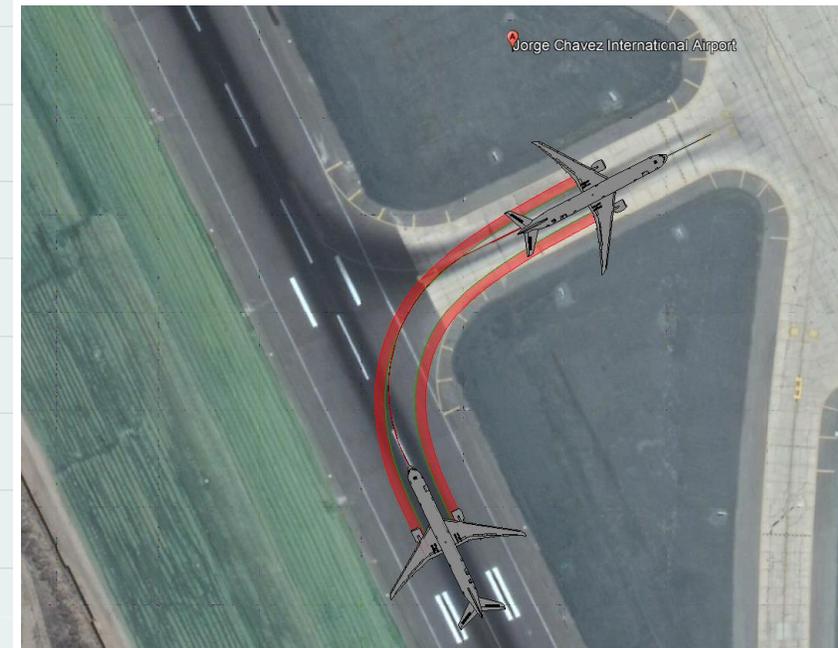
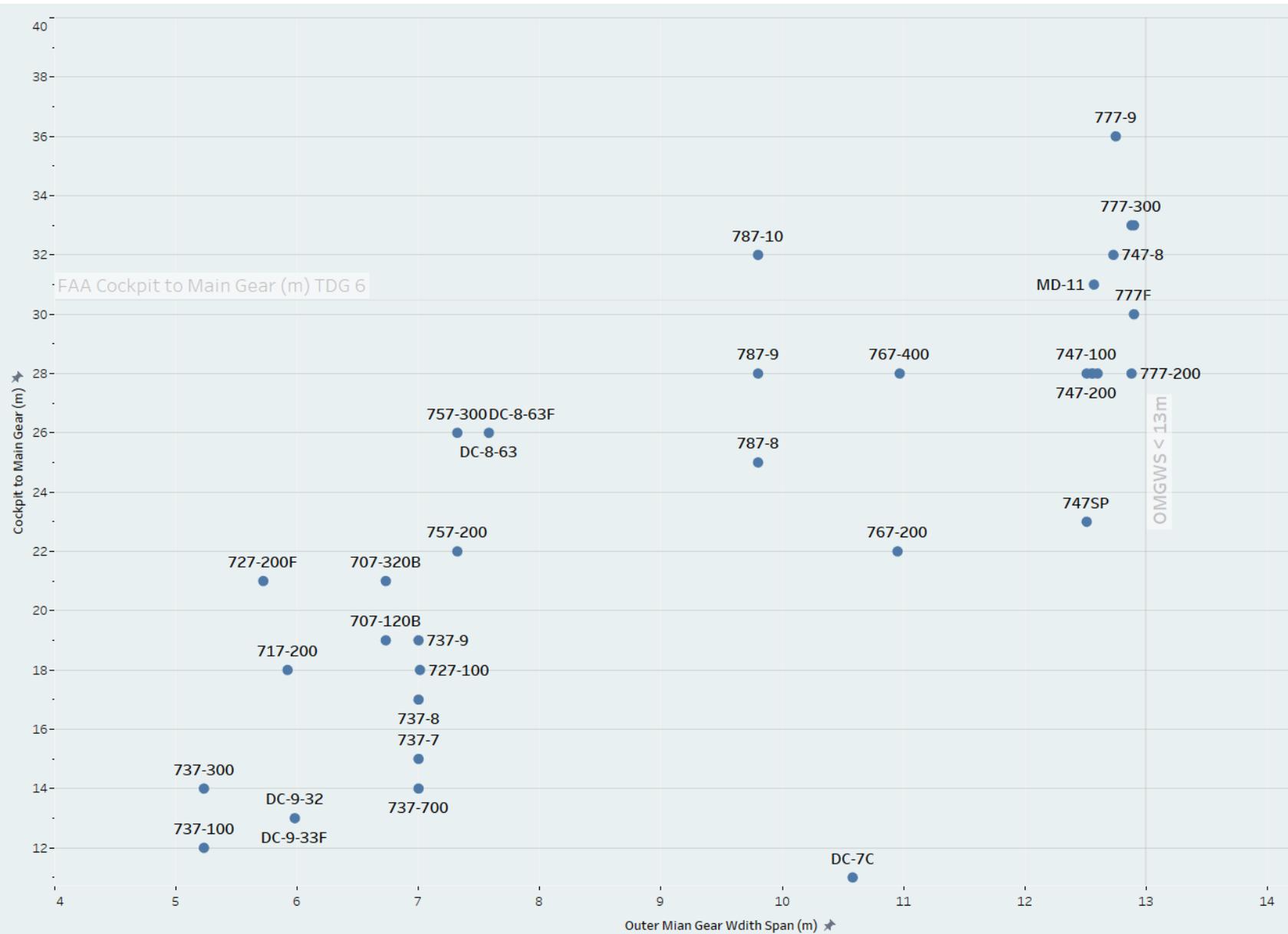
- 247 ft Length (+18 ft)
- 224 ft (68.4m) Wingspan (+13 ft, Group VI / Code F)
- 2008 - Airport assessments, Regulatory meetings
- 124 CAAs, Approval at 462 airports
- 17 Airline customers operating 124 aircraft
- Regular revenue service into 213 airports



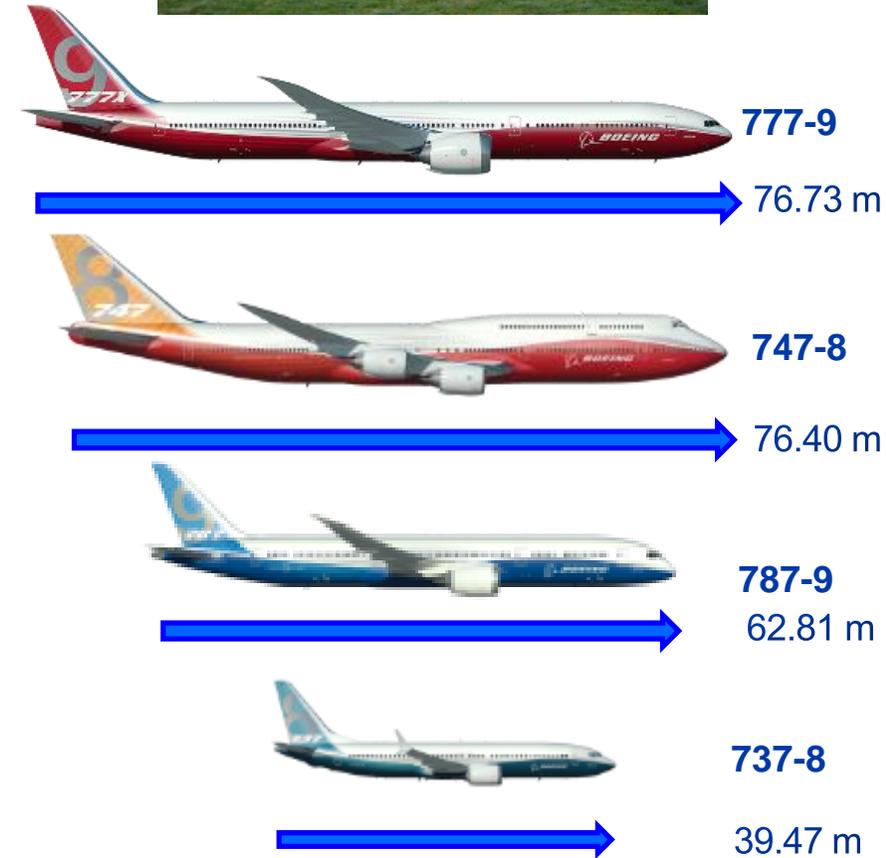
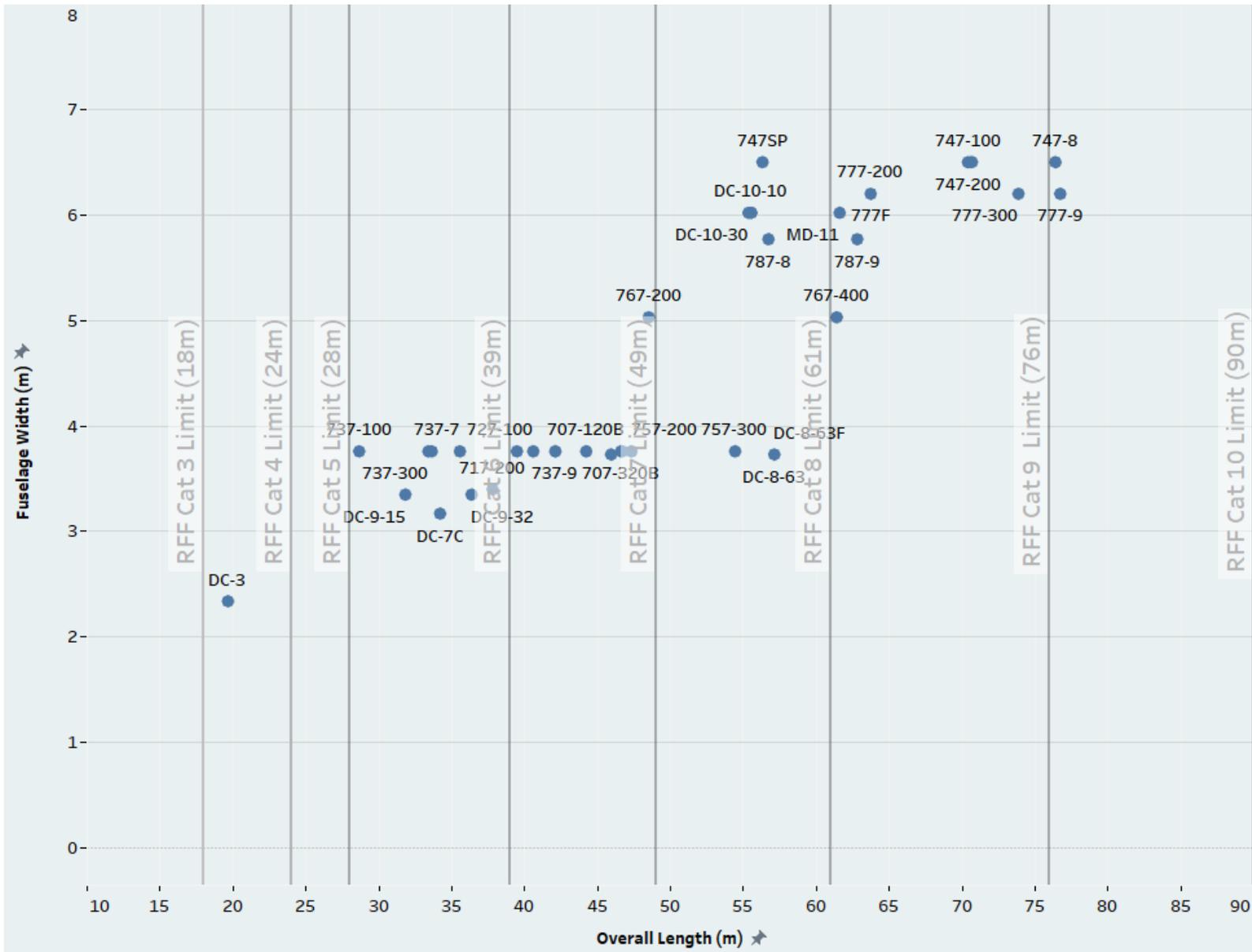
# Wingspan vs Entry into Service Year (Separations)



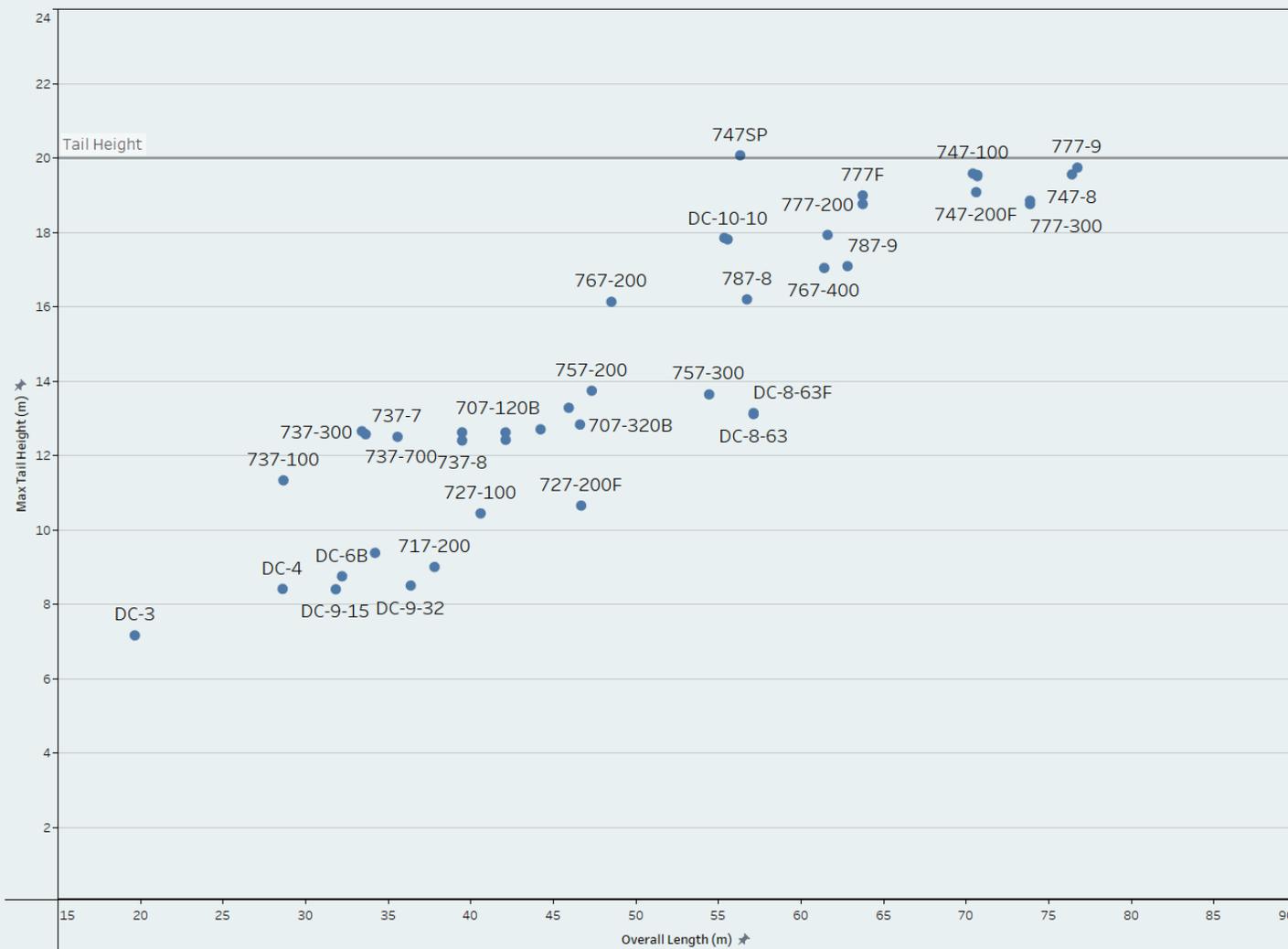
# Outer Main Gear Wheel Span (OMGWS) vs Cockpit to Main Gear (CMG)



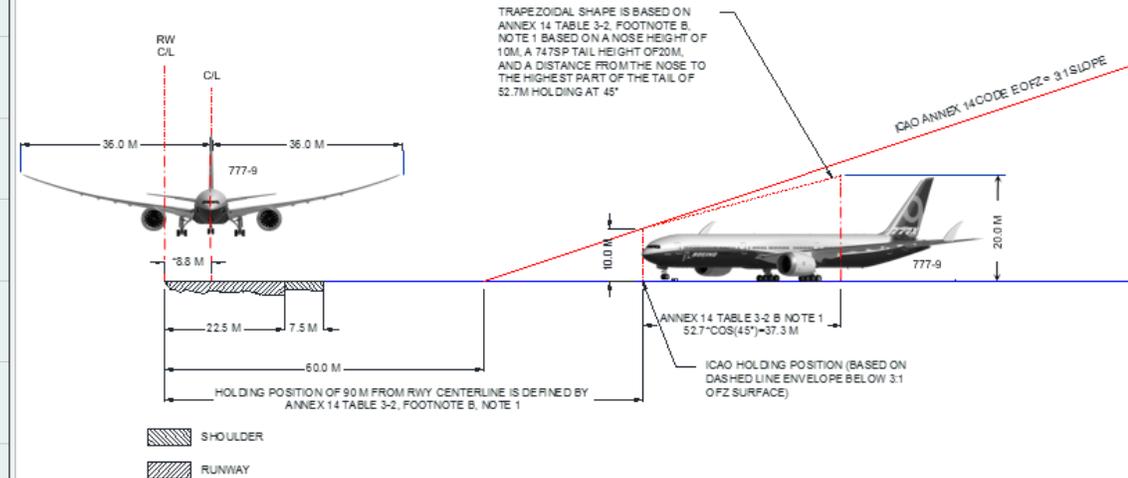
# Overall Aircraft Length vs Width (RFF)



# Tail Height vs Overall Length



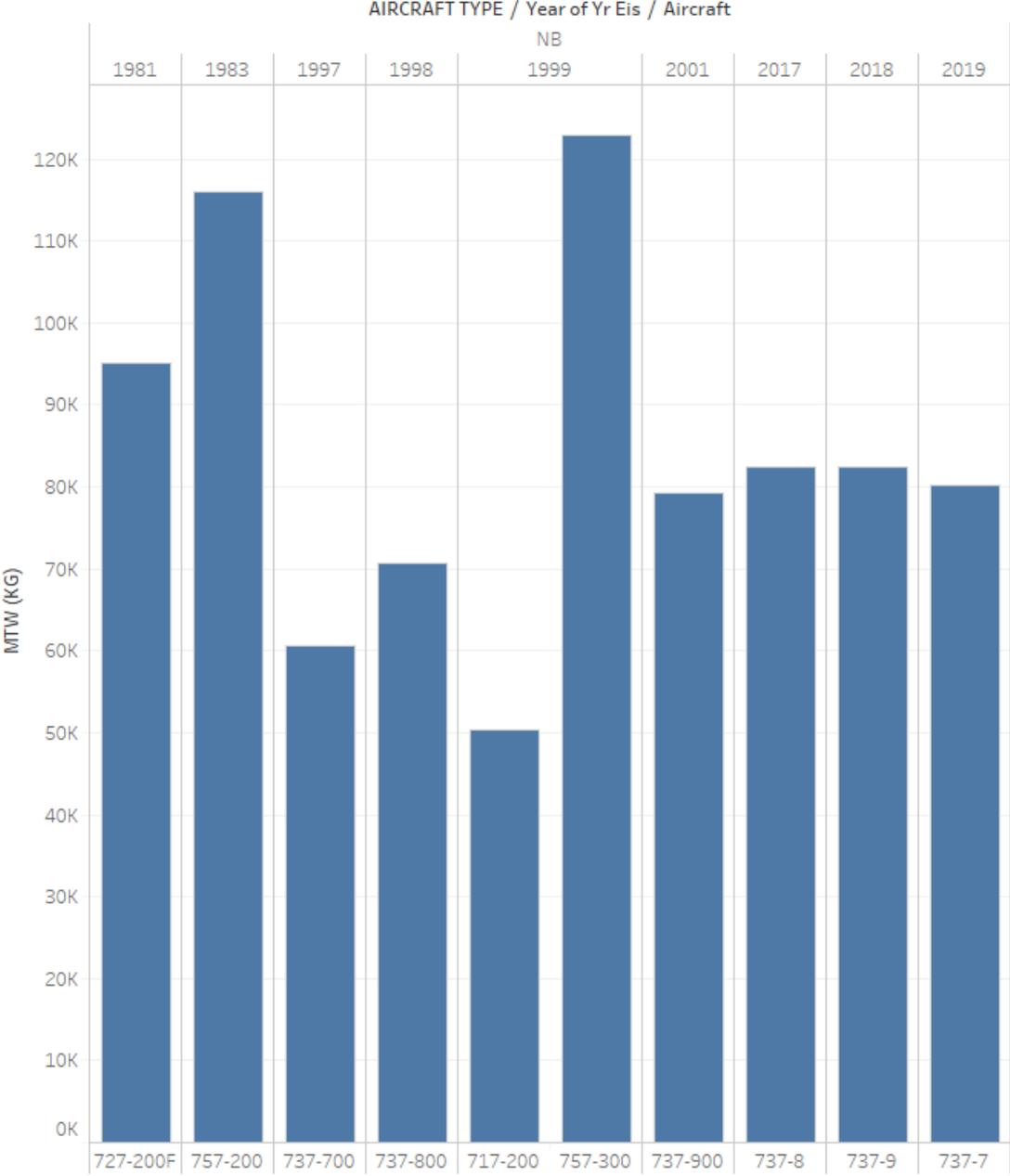
## OBSTACLE FREE ZONE CODE E 90 M HOLD LINE POSITION



\* MAXIMUM OFFSET (ON GROUND, ONE EVENT) FROM 2148 AIRCRAFT CERTIFICATION FLIGHT TESTS (LANDINGS, TAKEOFFS, TOUCH AND GOES) CONDUCTED BY BOEING, FAA, AND EASA PILOTS.

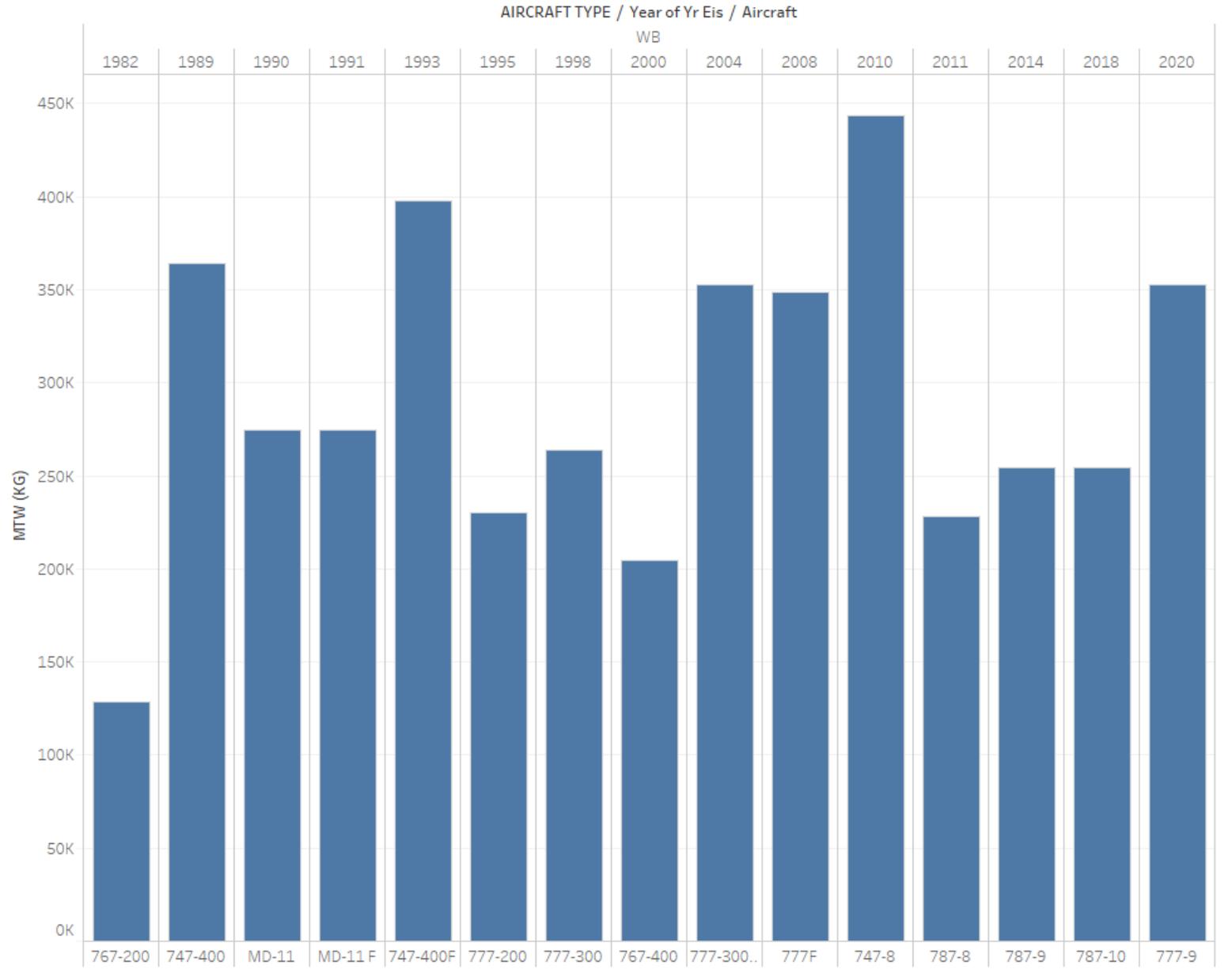
BALKED LANDING STUDY RESULTS SHOW CODE F AIRCRAFT WITH MODERN DIGITAL AUTOPILOT WITH TRACK HOLD GUIDANCE (777-9 IS SO EQUIPPED) USED FOR APPROACH IS CONTAINED WITHIN CODE E OFZ. ICAO CIRCULAR 301 (NEW LARGER AIRPLANES - INFRINGEMENT OF OBSTACLE FREE ZONE: OPERATIONAL MEASURES AND AERONAUTICAL STUDY)

# Narrow body Aircraft vs MTW

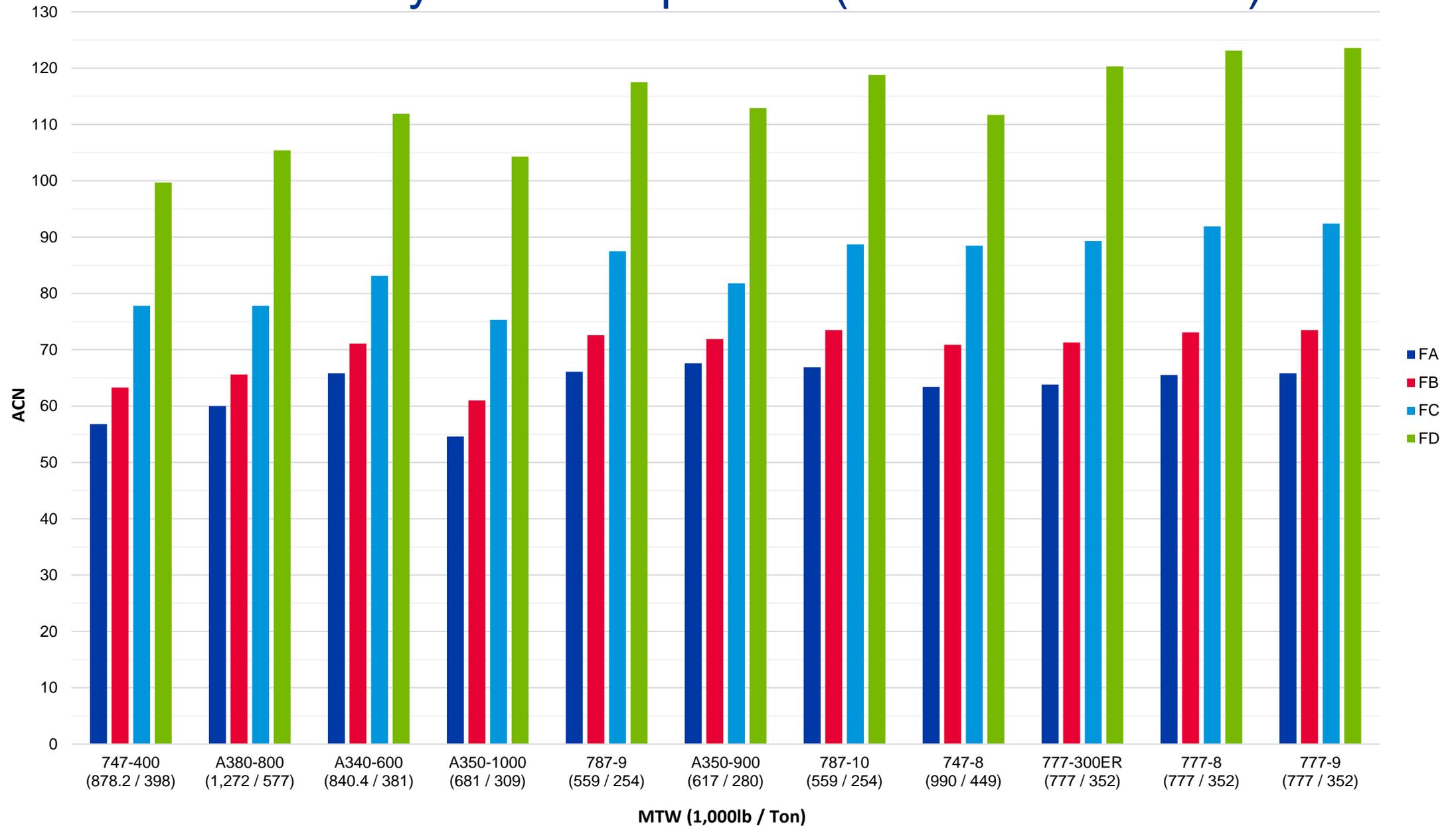


August 2018

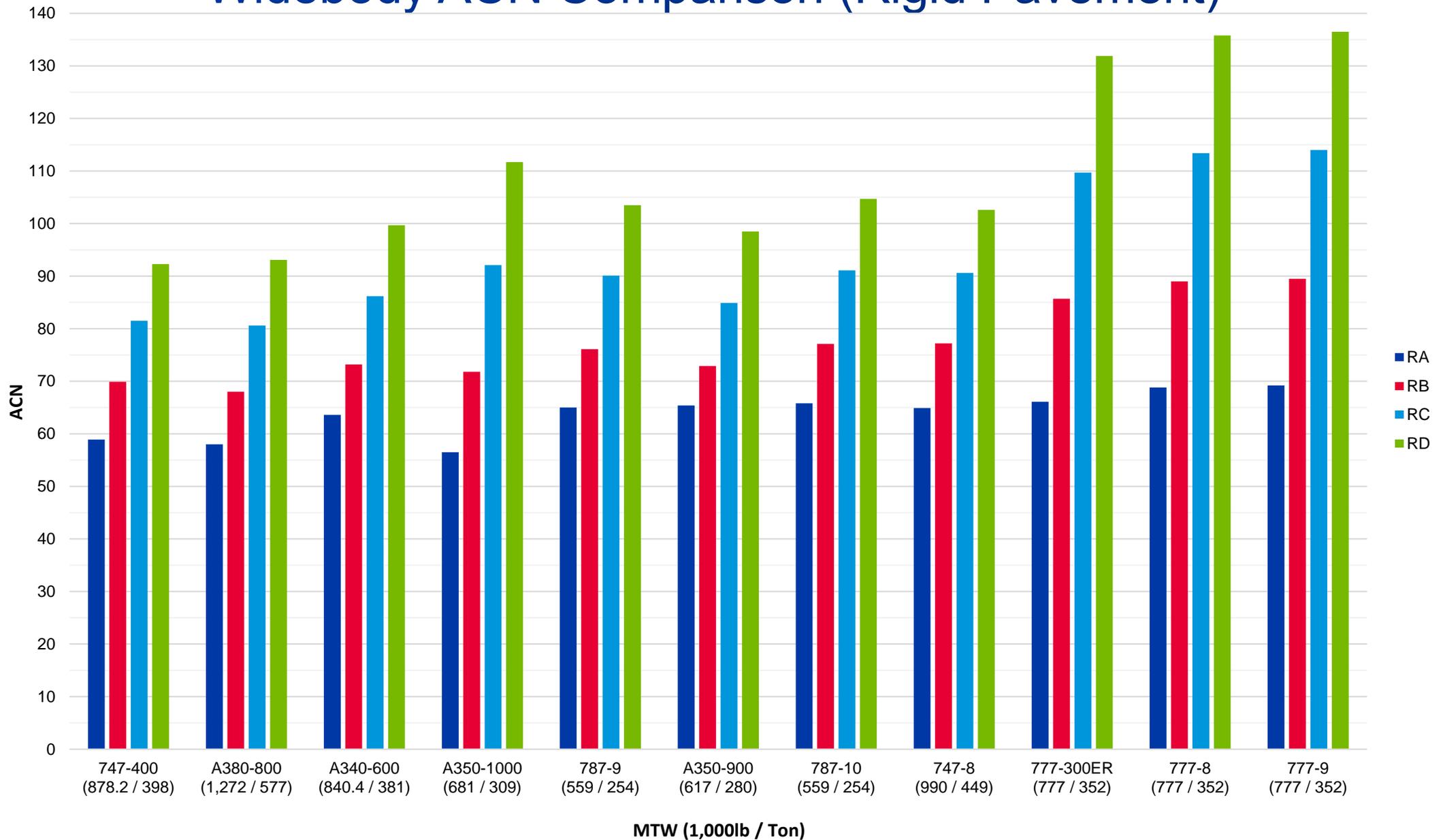
# Widebody Aircraft vs MTW



# Widebody ACN Comparison (Flexible Pavement)



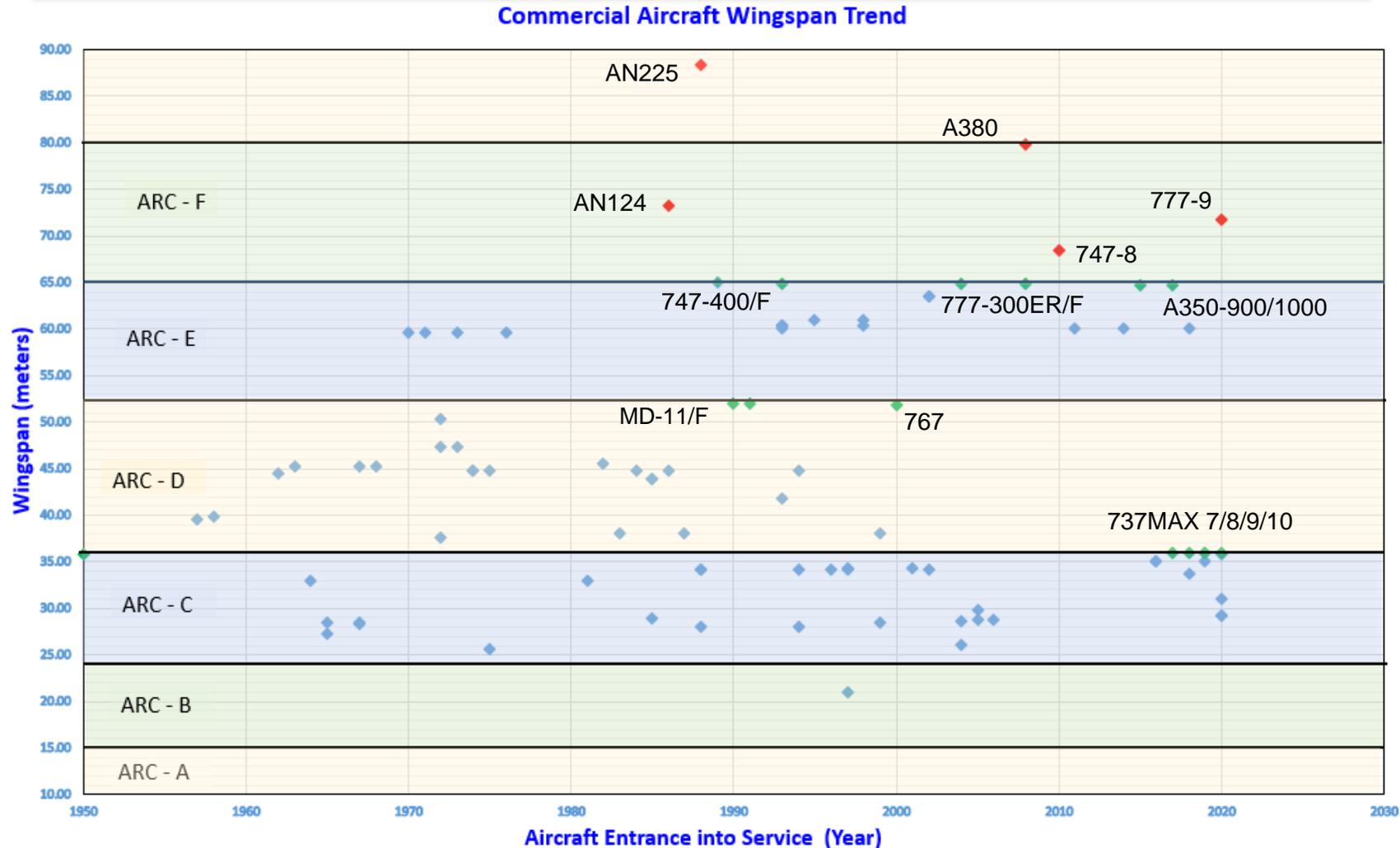
# Widebody ACN Comparison (Rigid Pavement)



# **777X – Folding Wingtip**

# Demand for Greater Operating Efficiency

As the demand for greater operating efficiency has driven manufacturers to combine technological advances with increases to wingspans, successive new aeroplane models in each code letter category have increased wingspan to the span limit of the corresponding Aerodrome Reference Code letters.



# A Solution to Existing Aerodrome Infrastructure

## Folding Wing Tip

- Folding wing tips / wings have been found on military aircraft since the 1930s to offset the limited parking available aboard aircraft carriers.



- A folding wing was offered on the original 777-200 (mid-1990s), reducing the wingspan from Code letter E to Code letter D so that it could fit into a gate designed for DC-10.

# A Solution to Existing Aerodrome Infrastructure

In order to balance the improved benefits to the airlines with any potential impacts to the aerodrome infrastructures, manufactures have to incorporate aerodrome compatibility into the design of aeroplanes.

## Folding Wing Tip

- Longer wing spans improve aerodynamic efficiency and reduce fuel burn

*BUT...*

- Longer wing spans create aerodrome compatibility issues

*THEREFORE:*

- A Folding Wing Tip (FWT) maximizes aerodrome compatibility and retains aerodynamic efficiency and fuel burn reduction



# A balanced design approach, focused on efficiency

- Combining proven and leading edge technologies



## 777 Technologies

- Highly reliable systems architecture
- Composite floor beams and empennage
- Composite wing



## 787 Technologies

- Laminar flow nacelle
- Advanced flight controls and high lift design
- Flight deck displays and functionality
- Computing and Network Architecture



## NEW Technologies



High span composite wing with folding tip

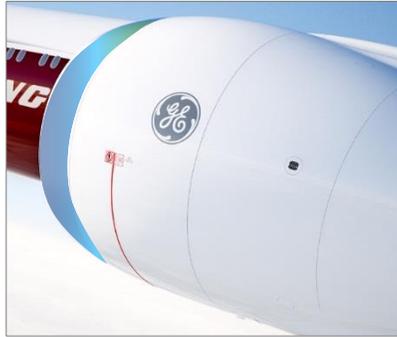
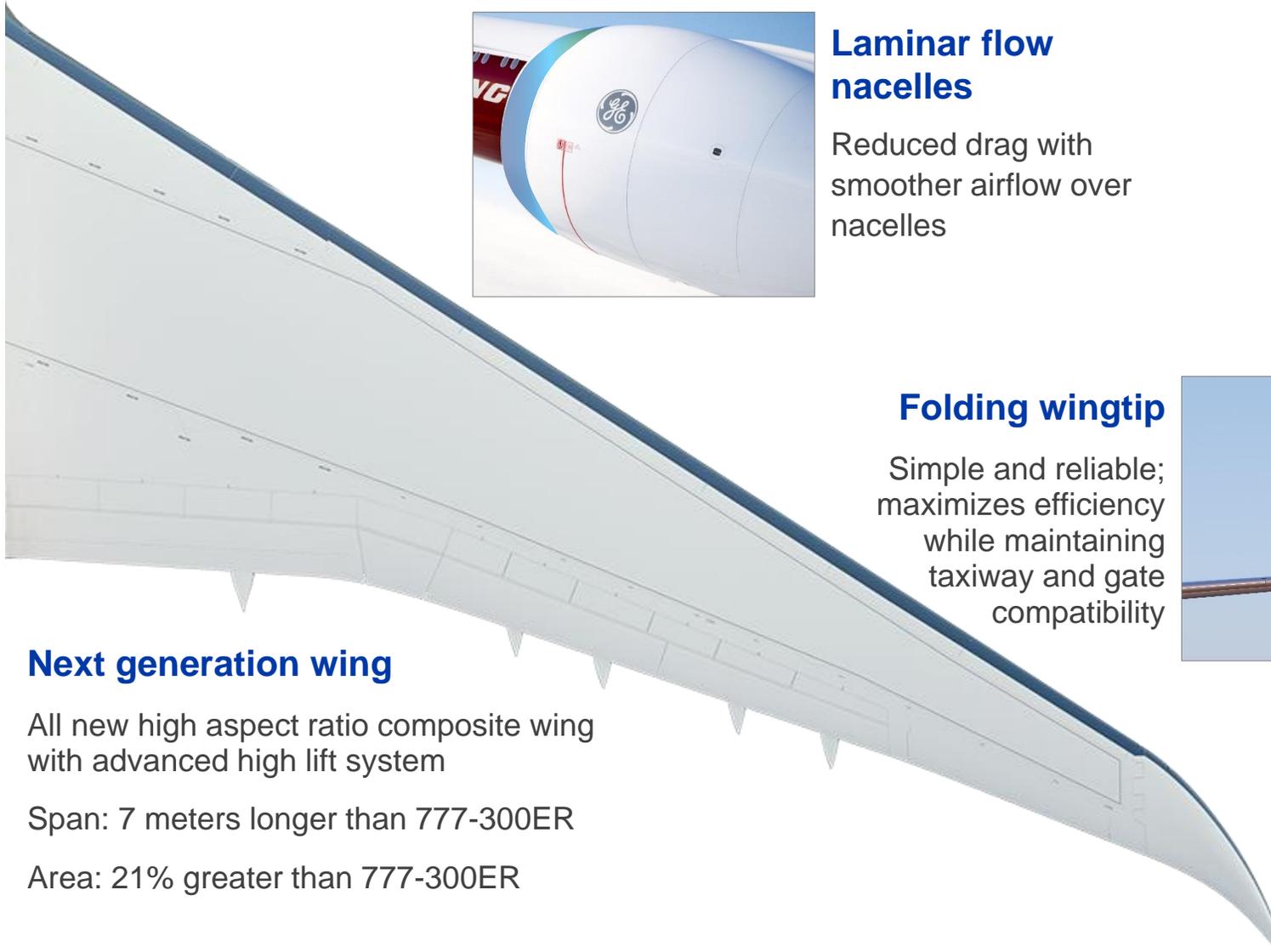


Clean sheet engine design



New passenger experience

# Unparalleled aerodynamic efficiency



## Laminar flow nacelles

Reduced drag with smoother airflow over nacelles

## Folding wingtip

Simple and reliable; maximizes efficiency while maintaining taxiway and gate compatibility



## Next generation wing

All new high aspect ratio composite wing with advanced high lift system

Span: 7 meters longer than 777-300ER

Area: 21% greater than 777-300ER

# 777X payload and range capability

## 777-8

351,530-kg (775,000-lb) MTOW  
350-375 passengers

## 777-200LR

347,450-kg (766,000-lb) MTOW  
300-325 passengers

## 777-9

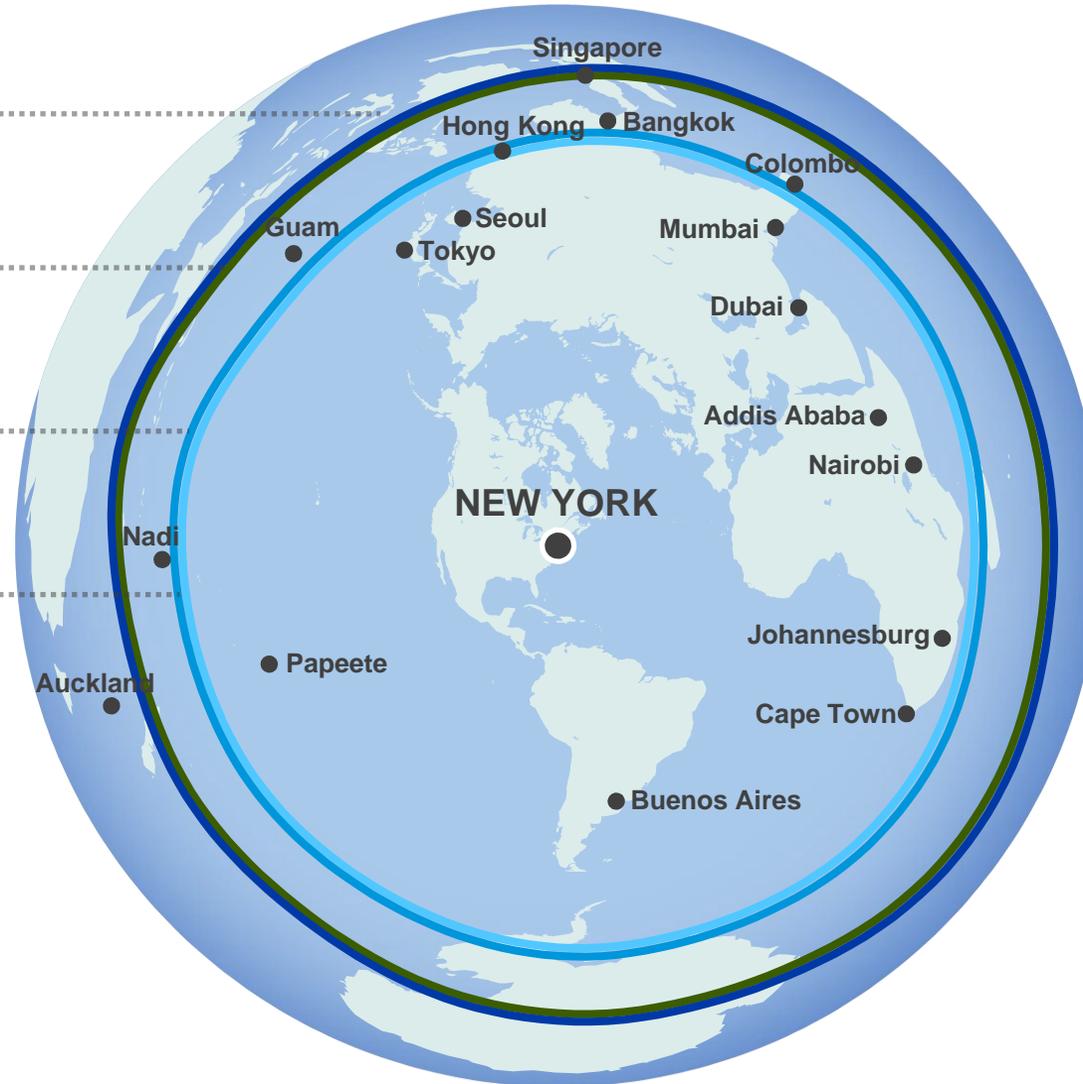
351,530-kg (775,000-lb) MTOW  
400-425 passengers

## 777-300ER

351,530-kg (775,000-lb) MTOW  
375-400 passengers

### While improving on today's gold standard 777-300ER:

- 20% fuel burn improvement
- Maintenance improvement
- Dispatch reliability
- Passenger experience



# GE9X advantage ... selected to power the 777X

**10%**  
versus  
-300ER  
**LOWER**  
Fuel Burn



**GE90**  
**COMPARABLE**  
Maintenance Cost  
\*GE90-115B

EXCLUSIVE GE TECHNOLOGIES

**Composite fan**

**16**  
BLADES

**Compressor**

**27:1**  
PRESSURE  
ratio

**Lean combustion**

**29%**  
NO<sub>x</sub>  
CAEP/8  
margin

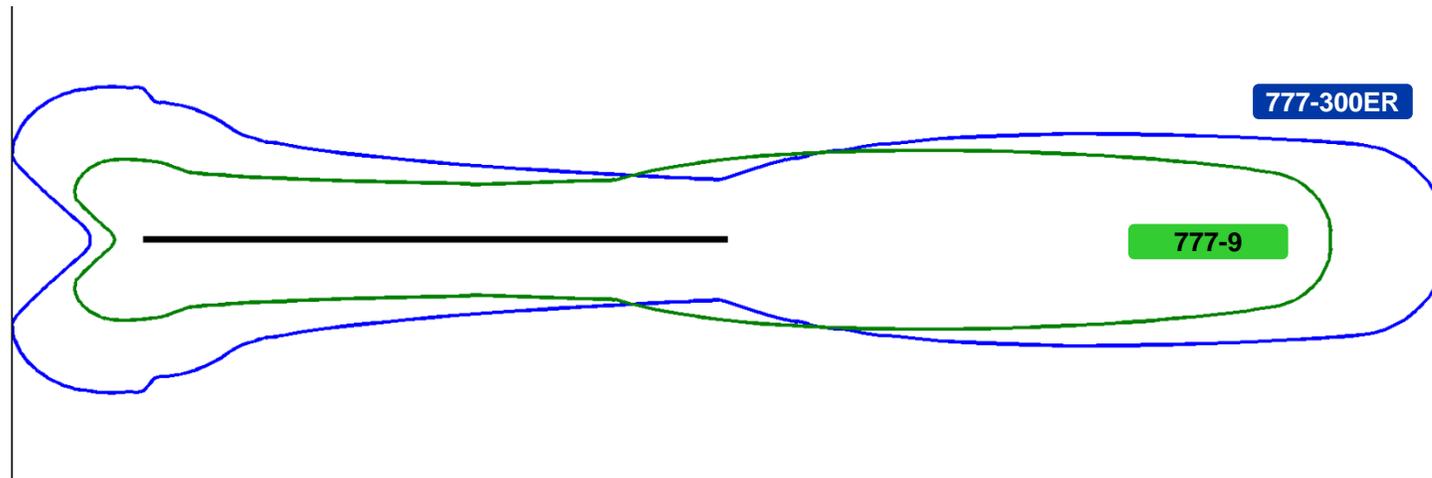
**Ceramic-matrix  
composites (CMCs)**

**20%**  
Greater  
thermal capability



# 777-9 Quieter for the Community

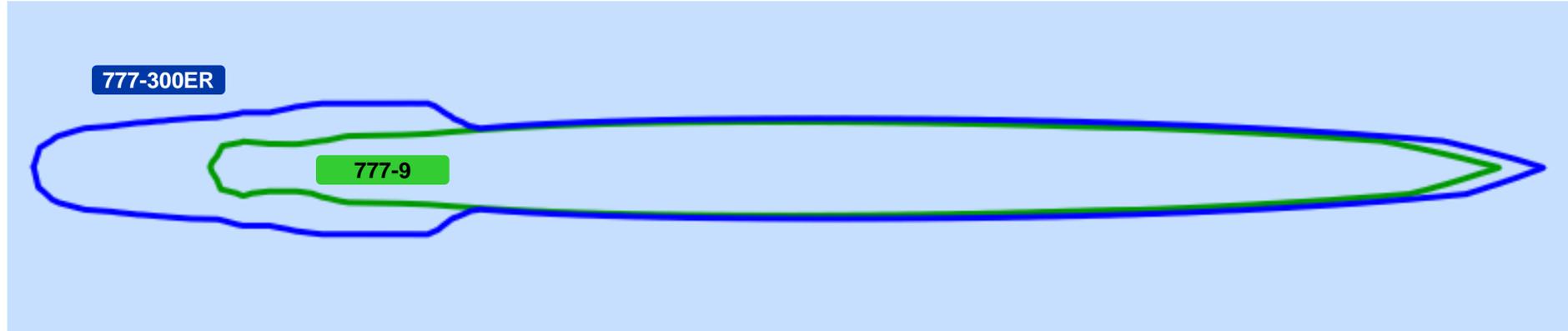
- 85dBA Takeoff Noise Contours, MTOW mission



- 777-300ER levels are based on Certified Noise database.
- 777-9 levels are predicted levels based on the noise model.
- Based on a 10,000 ft (3,048 meter) long runway.

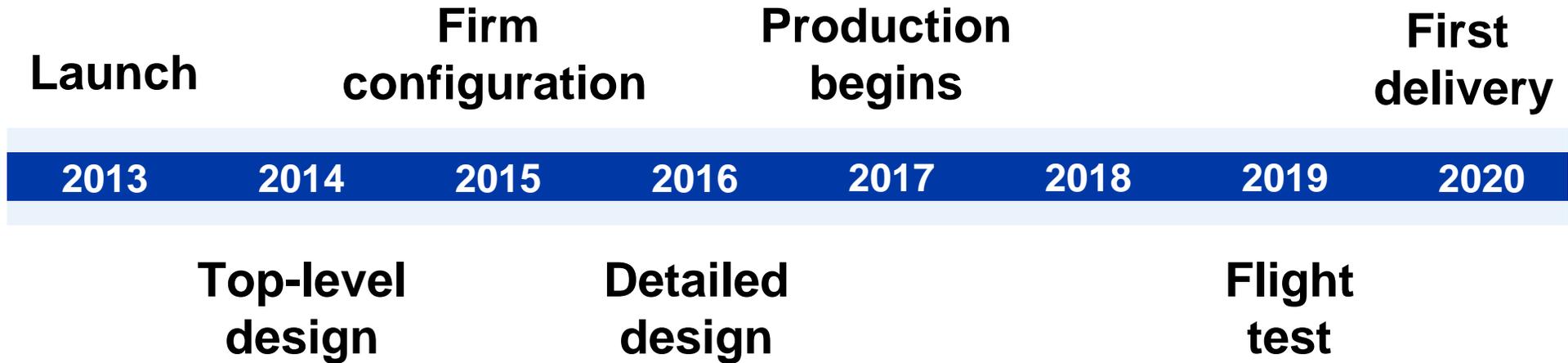
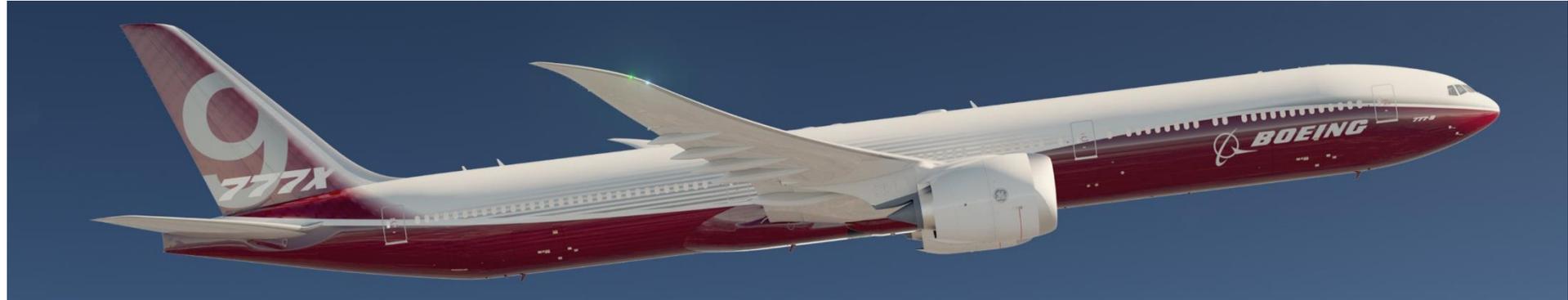
# 777-9 Quieter for the Community

- 85dBA Approach Noise Contours at MLW

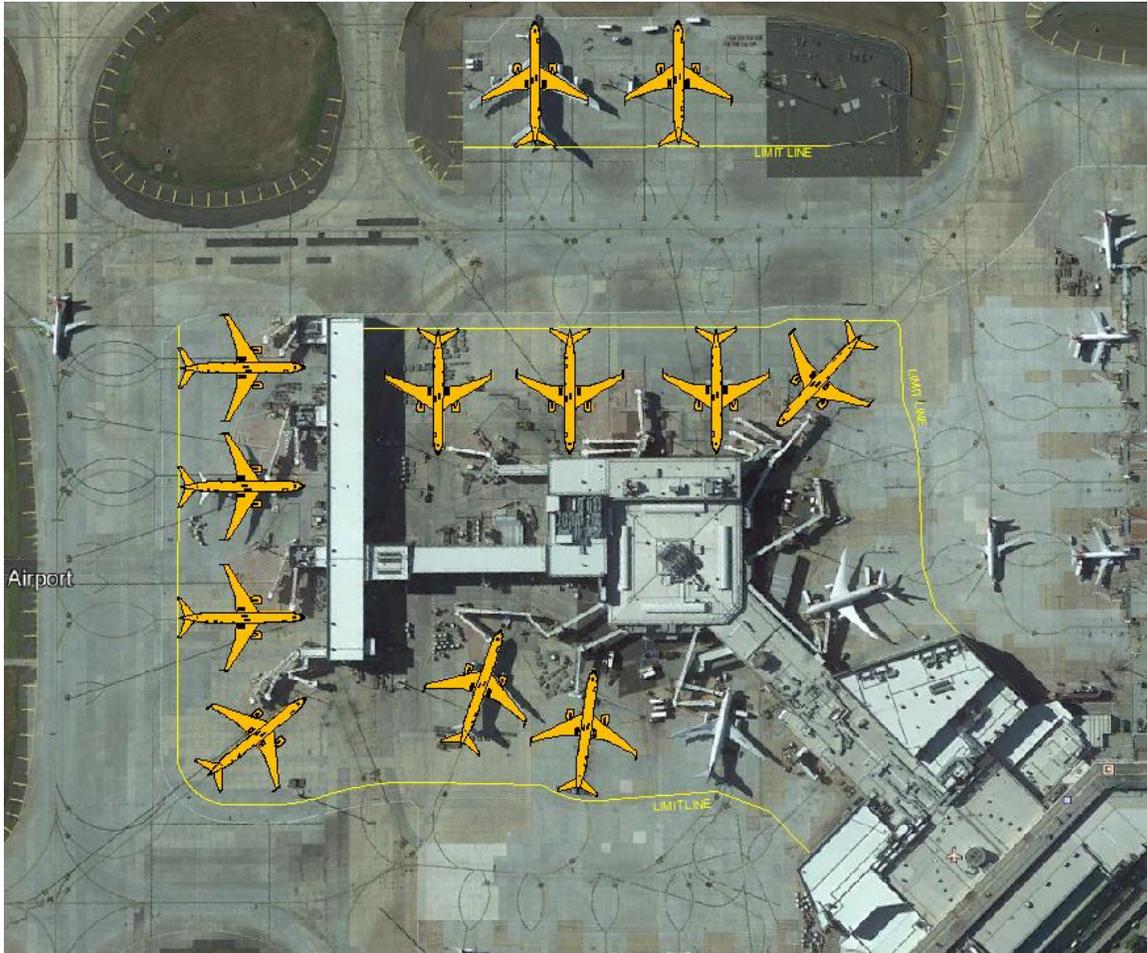


- 777-300ER levels are based on Certified Noise database.
- 777-9 levels are predicted levels based on the noise model.
- Based on a 10,000 ft (3,048 meter) long runway.

# 777X timeline



# 777X Airport Destinations



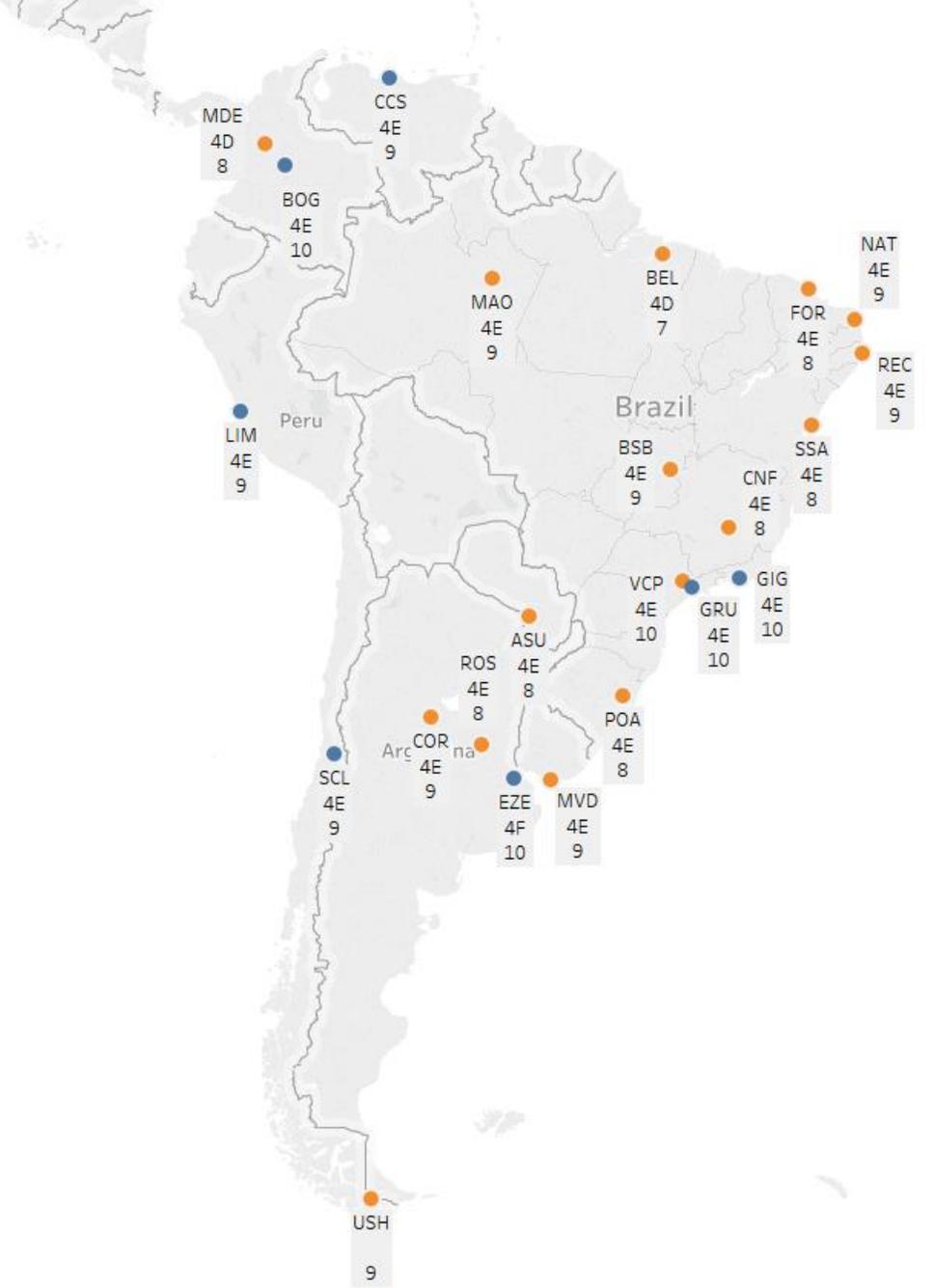
Dest/Alt

ALT

DEST

IPC

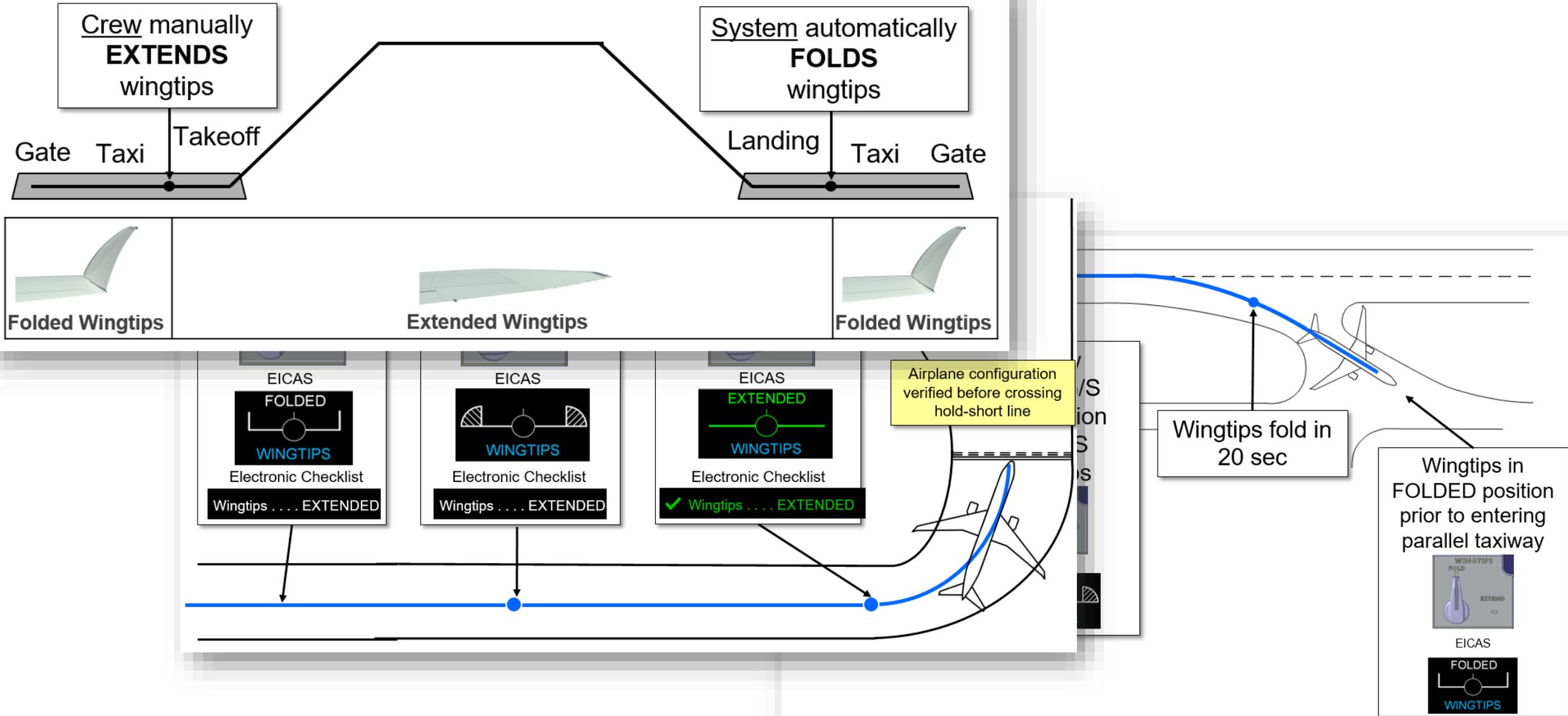
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# **Boeing Airport Compatibility Group 2 – Regulatory Effort**

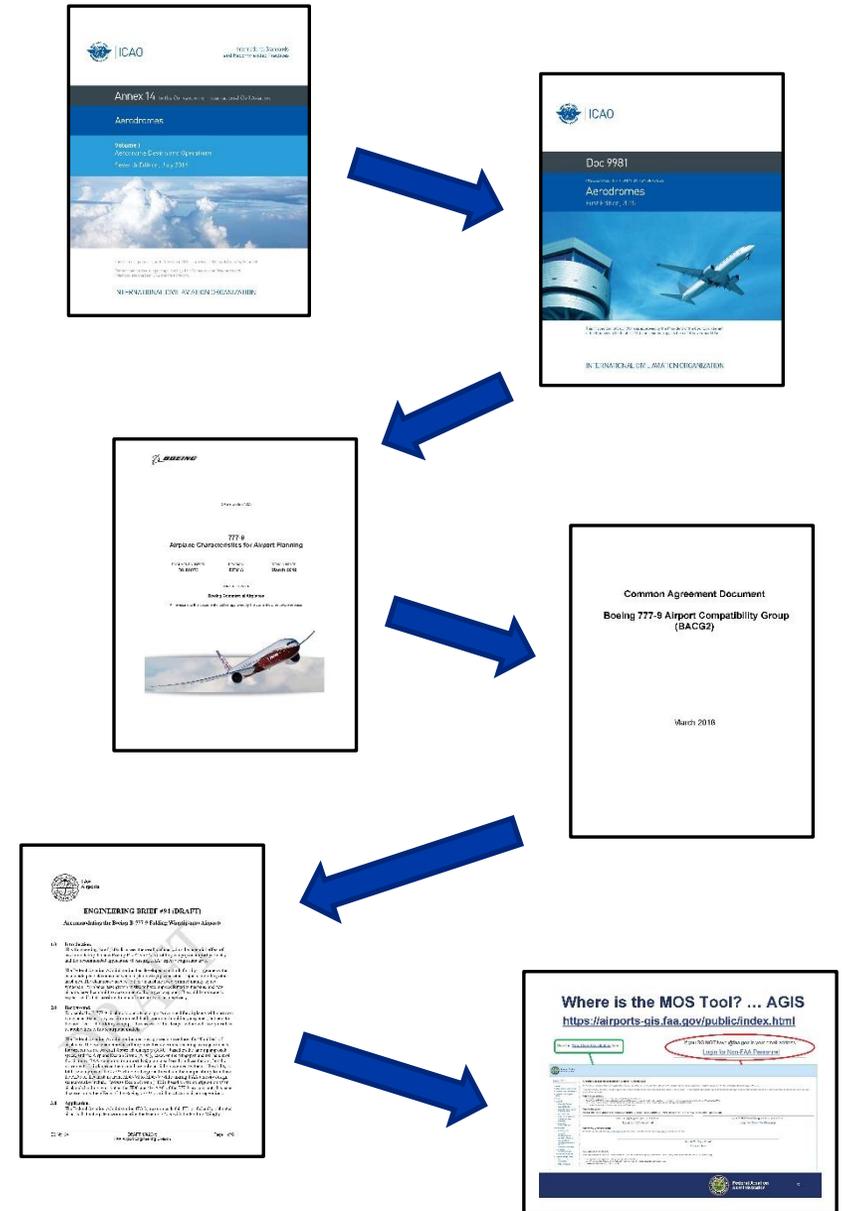
# Boeing Airport Compatibility Group 2 (BACG2)

777-9 – Folding Wingtip Concept of Operations (Available @ ACI – World website)



# Regulatory Updates

- ICAO Annex 14 Aerodrome Design Document – Proposed language that will refer to PANS-Aerodrome (ICAO Doc 9981), and Annex 4 (Ground Maneuvering Charts)
- PANS-Aerodrome contains guidance and processes for larger-coded aircraft operating into lesser-coded airports, and will refer to manufacturers' ACAP documentation
- 777X ACAP contains the Folding Wing Tip Concept of Operations (FWT ConOps), Functional/Operational specifications, and Recommended operations at airports (Standard and Non-normal)  
[http://www.boeing.com/resources/boeingdotcom/commercial/airports/acaps/777-9\\_RevA.pdf](http://www.boeing.com/resources/boeingdotcom/commercial/airports/acaps/777-9_RevA.pdf)
- Boeing BACG2 document for the 777X aircraft will provide assistance with regulatory compliance (Publication – Aug 2018)
- FAA EB94 will describe FWT operations at US airports  
[https://www.faa.gov/airports/engineering/engineering\\_briefs/media/EB-94-B-777-9-folding-wingtips.pdf](https://www.faa.gov/airports/engineering/engineering_briefs/media/EB-94-B-777-9-folding-wingtips.pdf)
- FAA Order 5300.1G, MOS process in effect (A-GIS on-line, 3/31/2018)





Please visit the Boeing Airport Compatibility Engineering website:

[www.boeing.com/airports](http://www.boeing.com/airports)

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