



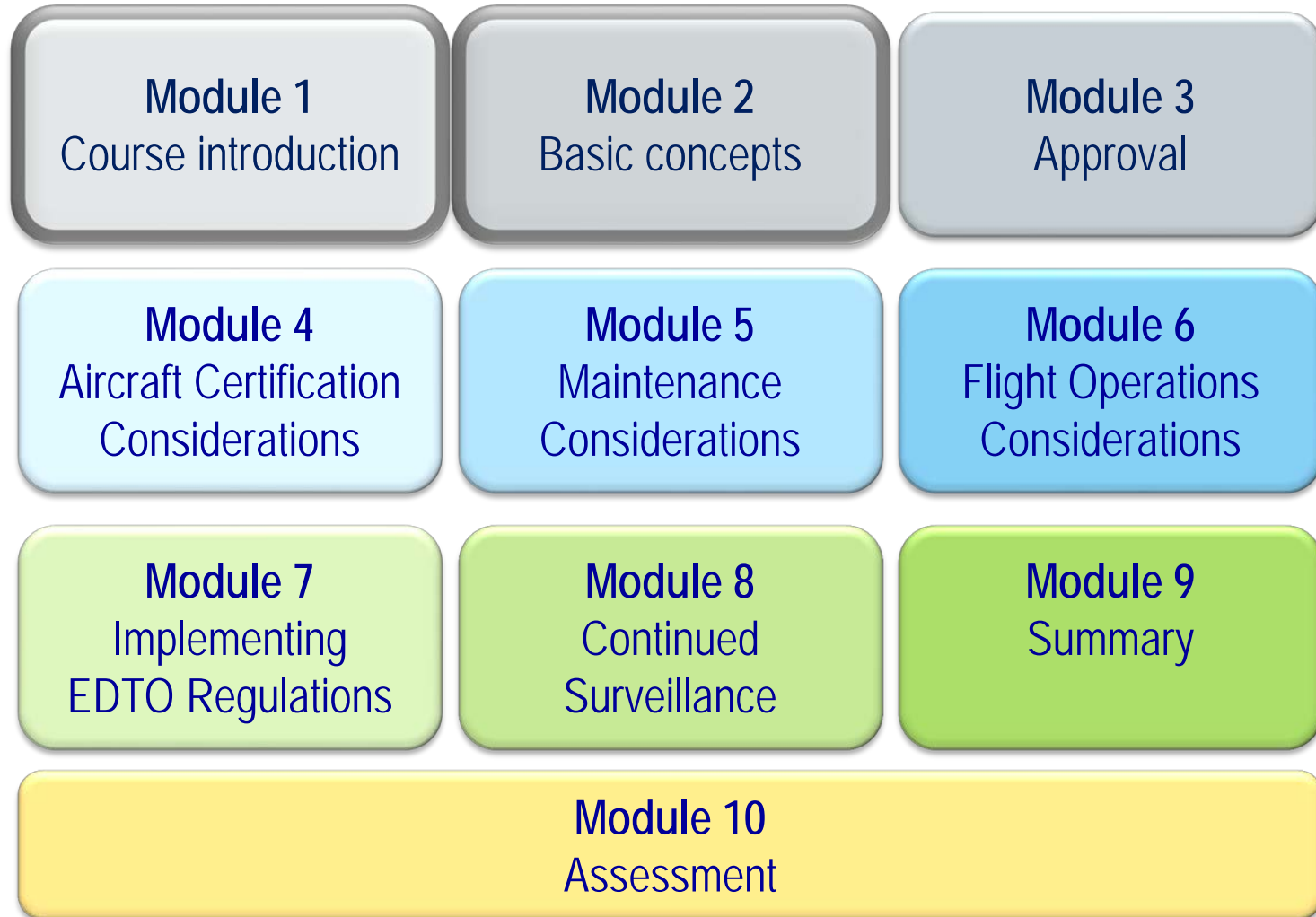
ICAO

UNITING AVIATION

# EDTO Workshop

## Module N° 2 –Basic Concepts







- ❖ *At the end of this module, participants will be able to understand the fundamentals concepts of EDTO.*

## ❖ Introduction

## ❖ ETOPS vs EDTO

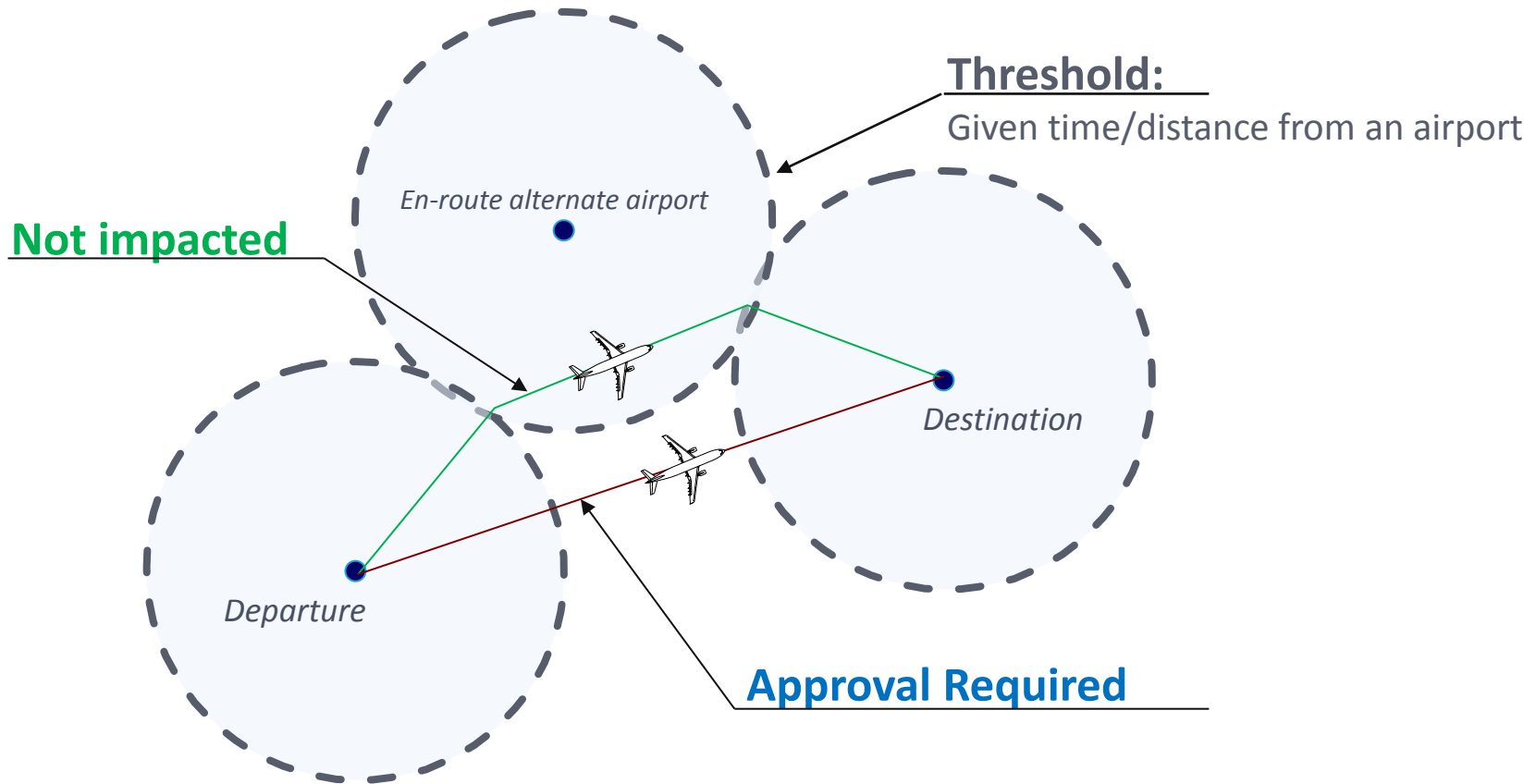
## ❖ EDTO timeline

## ❖ Intent of ETOPS / EDTO rules

## ❖ EDTO Important concepts

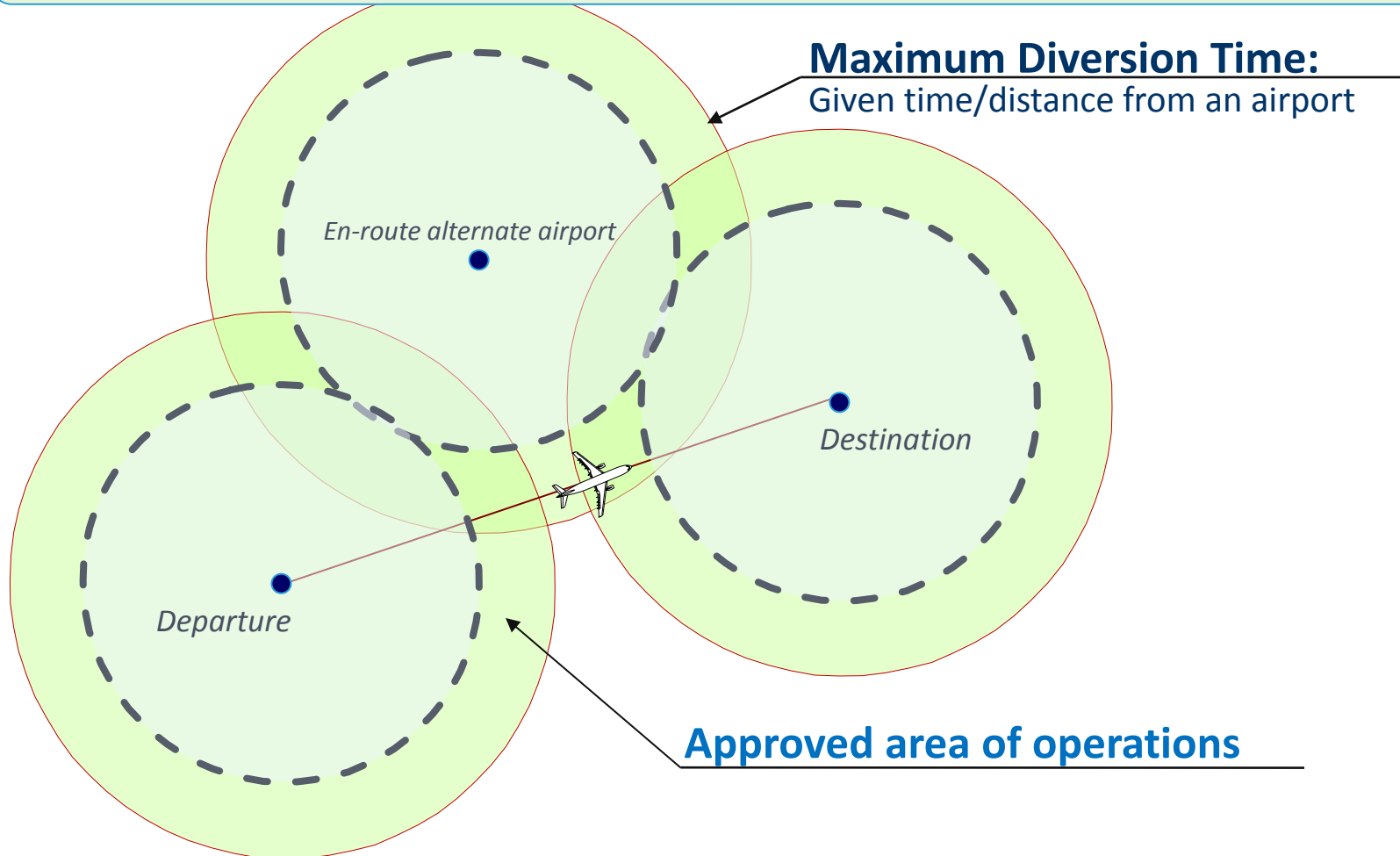
- Threshold time
- Maximum Diversion Time
- EDTO specific approval

There are sets of **Certification** & **Operational** requirements which apply when an aircraft is operated **beyond applicable threshold**

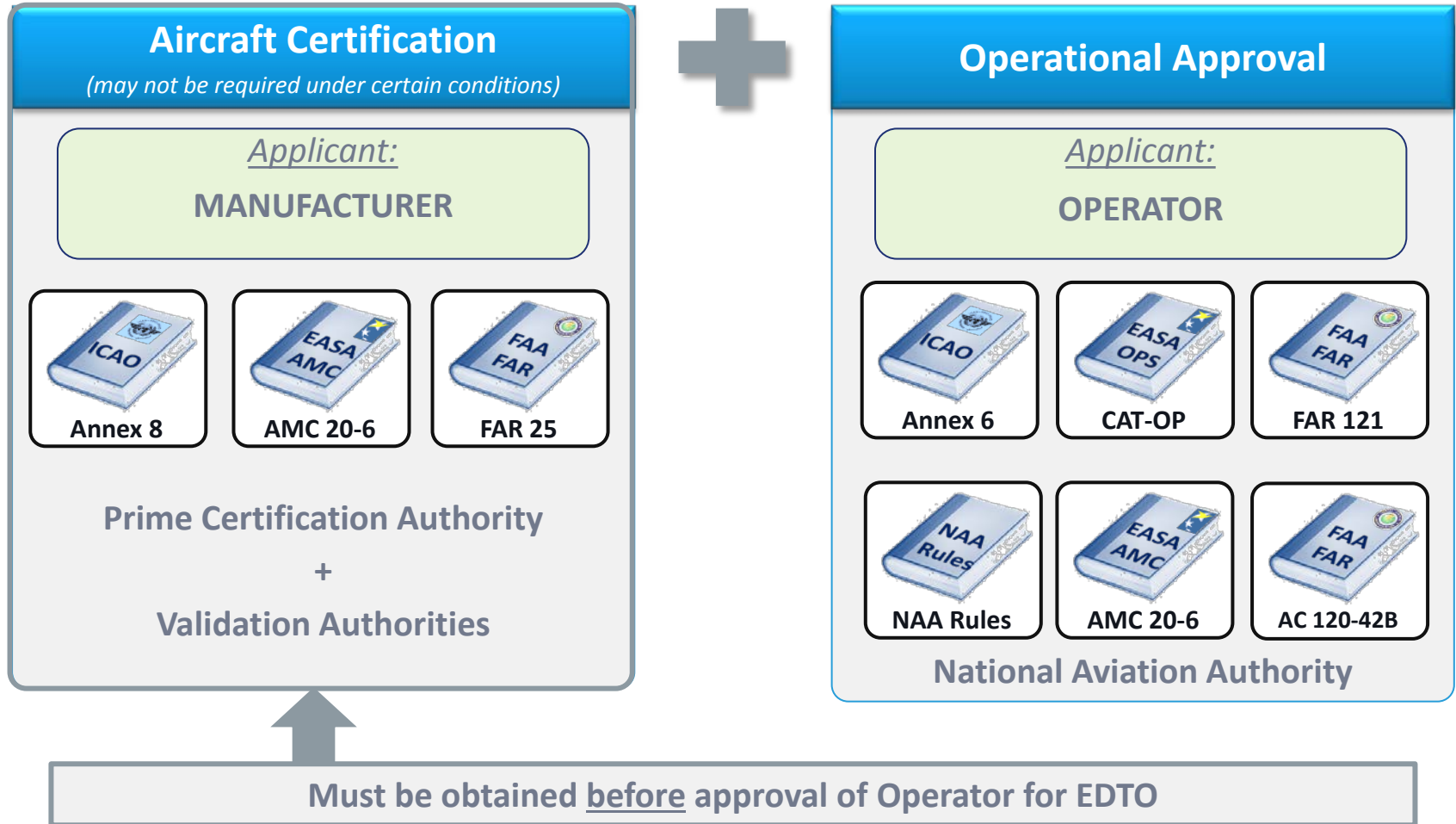


# Concept of Maximum Diversion Time

These **Certification & Operational** requirements, called **EDTO** or **ETOPS** or **LROPS** also introduce the concept of **Maximum Diversion Time**, thus defining an approved authorized area of operations



To operate beyond threshold, two conditions must be met:



## ❖ Introduction

### ❖ ETOPS vs EDTO

#### ❖ EDTO timeline

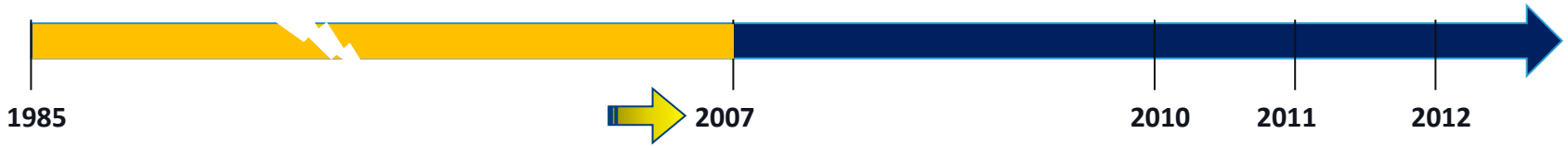
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- EDTO specific approval



# Different acronyms for the same subject



 ICAO		 EASA		 FAA	
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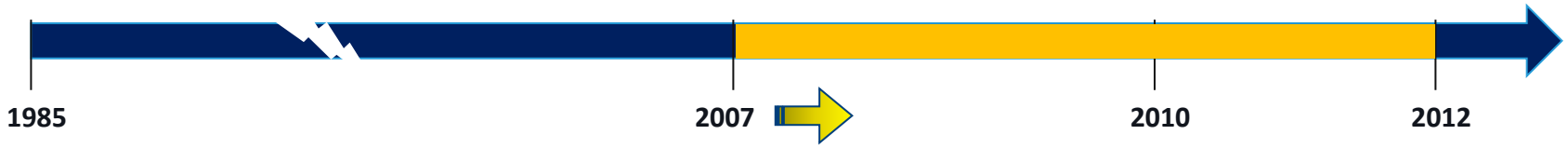
**ETOPS**







**Extended Twin Operations**  
*Applicable to Twins only*

**Up to 180 min DT**


# Different acronyms for the same subject



 ICAO 



 EASA 

**ETOPS\***





**Extended Twin Operations**  
*Applicable to Twins only*

**\* Up to 180 min DT**

 FAA 

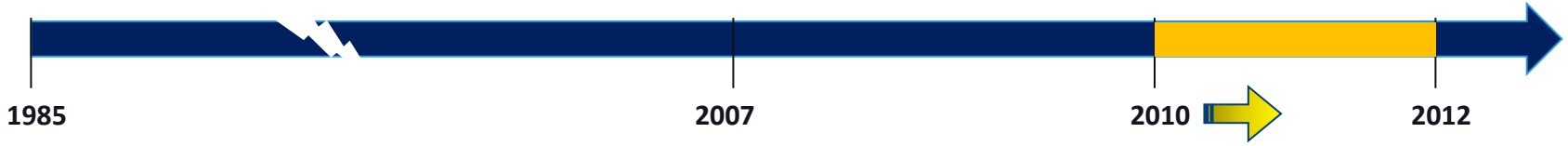
**ETOPS\***





**ExTended Operations**  
*Applicable to Twins, Tris and Quads*


**\* Includes DT > 180 min**

# Different acronyms for the same subject





 **ICAO** 

**ETOPS\***




**Extended Twin Operations**  
*Applicable to Twins only*

**\* Up to 180 min DT**



 **EASA** 

**ETOPS\***





**Extended Twin Operations**  
*Applicable to Twins only*

**\* Includes DT > 180 min**

 **FAA** 

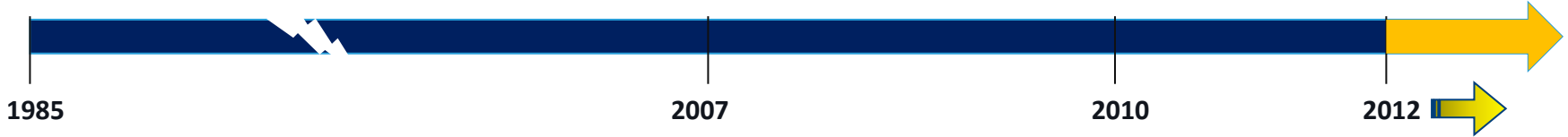
**ETOPS**



**ExTended Operations**  
*Applicable to Twins, Tris and Quads*



# Different acronyms for the same subject





 **ICAO** 

**EDTO\***


 

**Extended Diversion Time Operations**  
*Applicable to Twins, Tris and Quads*

\* *Includes DT>180 min*


 **EASA** 

**ETOPS**





**Extended Twin Operations**  
*Applicable to Twins only*



**LROPS (tbc)**



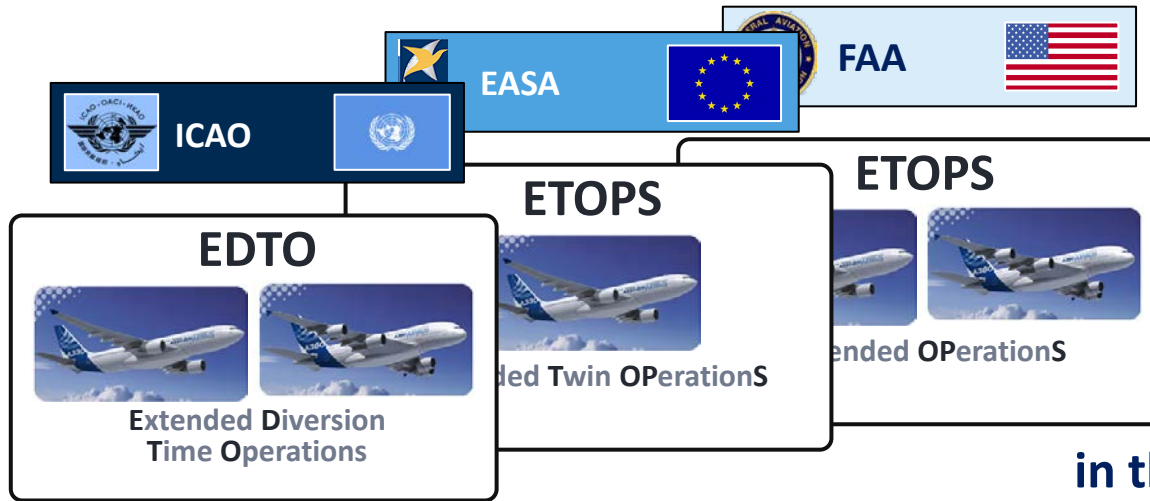
**Long Range Operations**  
*Applicable to Tris & Quads only*

 **FAA** 

**ETOPS**

**ExTended Operations**  
*Applicable to Twins, Tris and Quads*



Use of the term  
“ETOPS” or “EDTO”

in the aircraft documentation:

- Most of the Authorities in the world are still using the term “ETOPS”
  - It is not planned to replace the term “ETOPS” with “EDTO” in existing docs
  - This is in line with the note introduced in the new Annex 6 §4.7 which clarifies that the term “ETOPS” may still be used instead of “EDTO”  
(see Note 1 in the Annex 6 extract copied below).

4.7.2.3 When approving the appropriate maximum diversion time for an operator of a particular aeroplane type engaged in extended diversion time operations, the State of the Operator shall ensure that:

- for all aeroplanes:* the most limiting EDTO significant system time limitation, if any, indicated in the aeroplane flight manual (directly or by reference) and relevant to that particular operation is not exceeded; and
- for aeroplanes with two turbine engines:* the aeroplane is EDTO certified.

Note 1.— EDTO may be referred to as ETOPS in some documents.



- Basically a twin engine aircraft is limited to 60 min flying time with one engine out from an adequate airport.
  - This limit dates back from the 50's when the reliability of piston engine was 100 times worse than today's jet engines...
- This economically penalizing rule (preventing direct routings over oceans) was relieved in 1985 through enhanced requirements on:
  - A/C equipment and design including engine demonstrated reliability (Type design approval)
  - A/C maintenance programs
  - Airline experience and processes (e.g. selection of en-route alternates, critical fuel scenario, pre-departure service check, oil consumption monitoring)
- These requirements, called ETOPS, initially allowed operations up to 120 min maximum diversion time.
  - They were revised in 1988 to allow operations up to 180 min
  - ETOPS became widely used, e.g. today 90% of A330 operators are ETOPS



- Since 2007, the ETOPS requirements have evolved to allow operations of twins beyond 180 min diversion time.
- The A330 was the first to receive an ETOPS beyond 180 min certification in November 2009
  - With this new capability, the A330 max diversion distance is extended to 1700 Nm which corresponds to an ETOPS diversion time slightly higher than 240 min
- The B777 and B787 received their ETOPS beyond 180 min certification in 2011 and 2014 respectively
  - ETOPS 330 min capability
- As of 2014, there are 2 A330 operators and 1 B777 operator with 240 min authority.
  - Majority of current ETOPS operations remains within 180 min authority
- New long range twins are all certified for ETOPS>180 min
  - A350 is designed to offer a basic 180 min ETOPS capability and two optional ETOPS capabilities: ETOPS 300 min (2,000 Nm) and ETOPS 370 min (2,500 Nm)



- These new ETOPS requirements are renamed EDTO by ICAO in 2012:
  - Applicability is extended to tris & quads for operations beyond 180 min (AEO speed):
    - No change for the vast majority of current long-range operators
    - No additional maintenance requirements nor additional certification requirements
    - Main novelties: consideration of Time Limited System / identification of en-route alternates and verification of weather
  - The term “ETOPS” may still be used instead of “EDTO”
  - Twins certificated under the previous rules can operate ETOPS up to 180 min DT.
- The new EDTO / ETOPS requirements are mainly an evolution of existing rules, adapted to address the specificities of long range flights when diversion time exceeds 180 min (OEI speed, ISA), through new/revised criteria on:
  - Engine reliability: world fleet IFSD rate less than 0.01/1000 EFH for an airplane/engine combination is required for >180'
  - Consideration at dispatch of time capability of the Time limited systems :
    - Cargo Fire Suppression vs diversion at AEO speed
    - Other most limiting Time Limited System vs diversion at OEI speed
  - Previous ETOPS requirements for A/C equipment redundancies, crew training, maintenance standards and operating rules are optimized and completed

## ❖ Introduction

## ❖ ETOPS vs EDTO

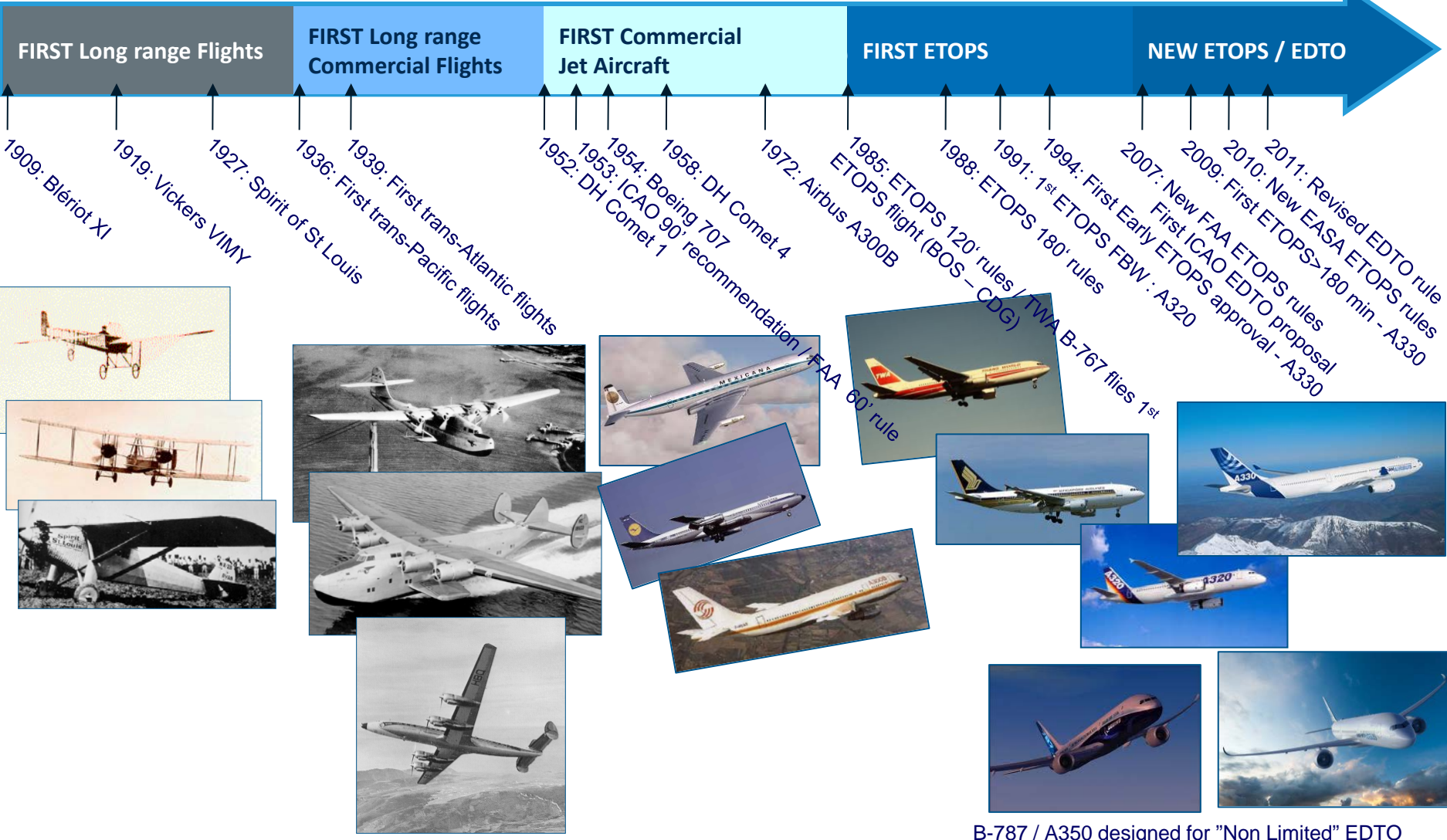
### ❖ EDTO timeline

## ❖ Intent of ETOPS / EDTO rules

## ❖ EDTO Important concepts

- Threshold time
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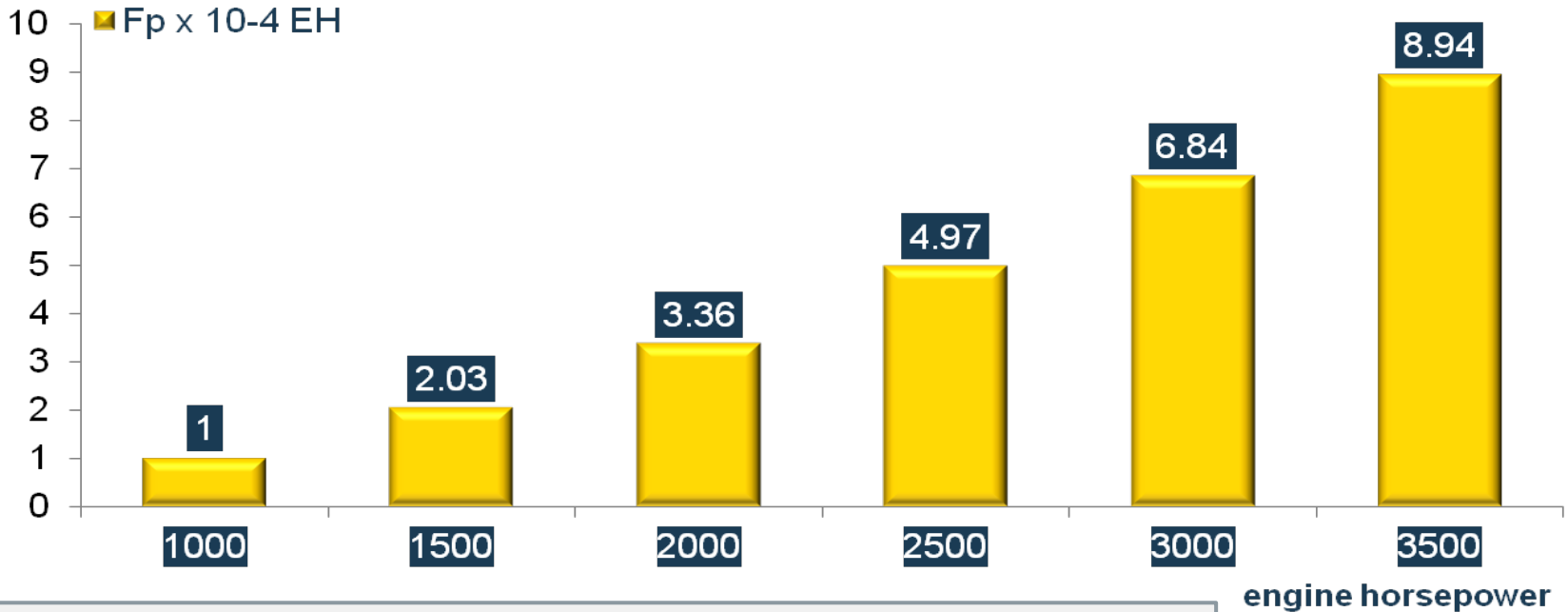
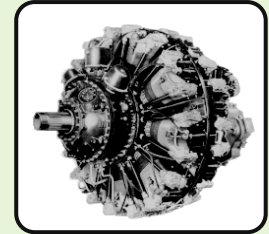
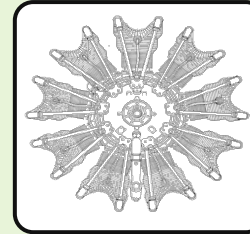
## Extended Diversion Time Operations : Past, Present & Future



B-787 / A350 designed for "Non Limited" EDTO

## Piston engine reliability

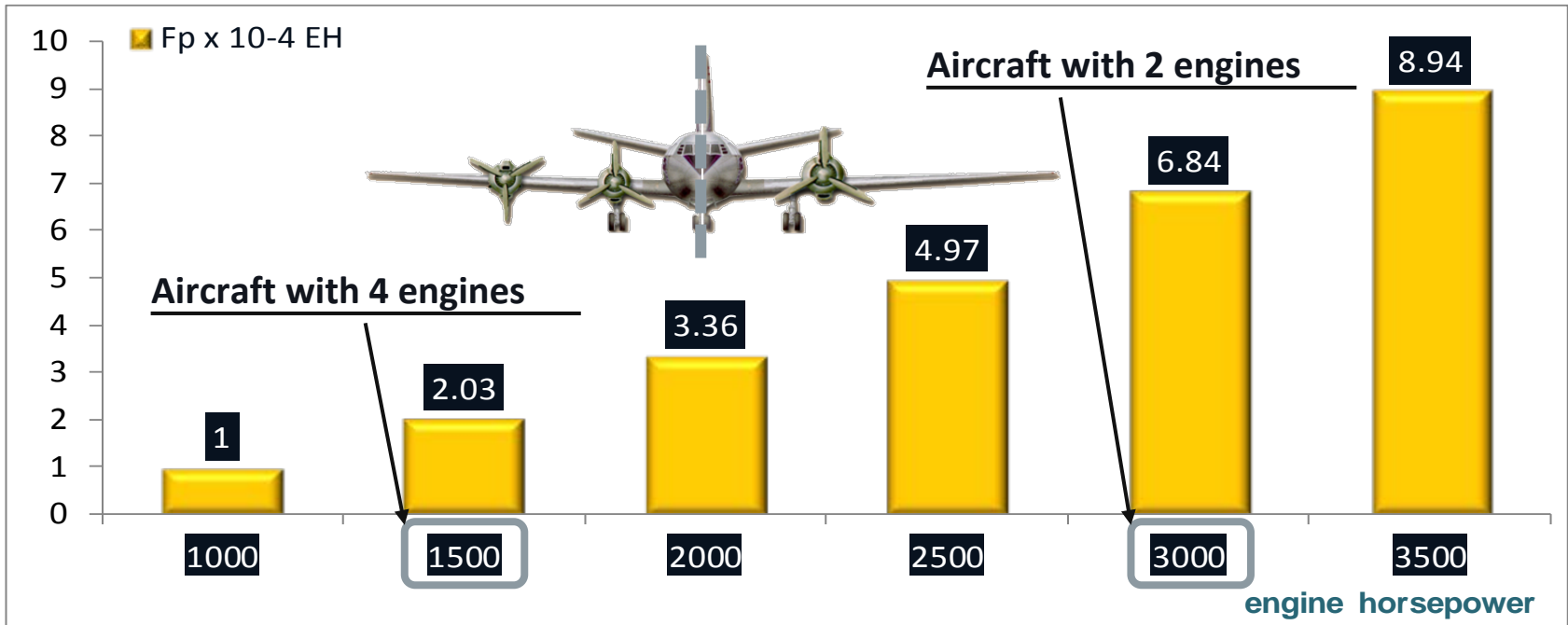
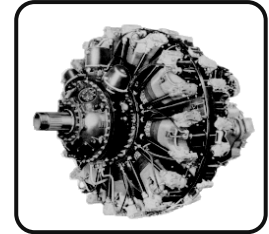
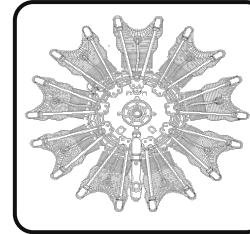
The following chart (1953 ICAO report) gives the probability of failure for piston engines vs. power at 1000 constant rpm:



The probability of failure increases as power is increased

## Probability of failure of first engine (Example)

- This probability is linked to the number of engines fitted on the A/C
- Let's do the comparison of this probability between two possible layouts, i.e. :



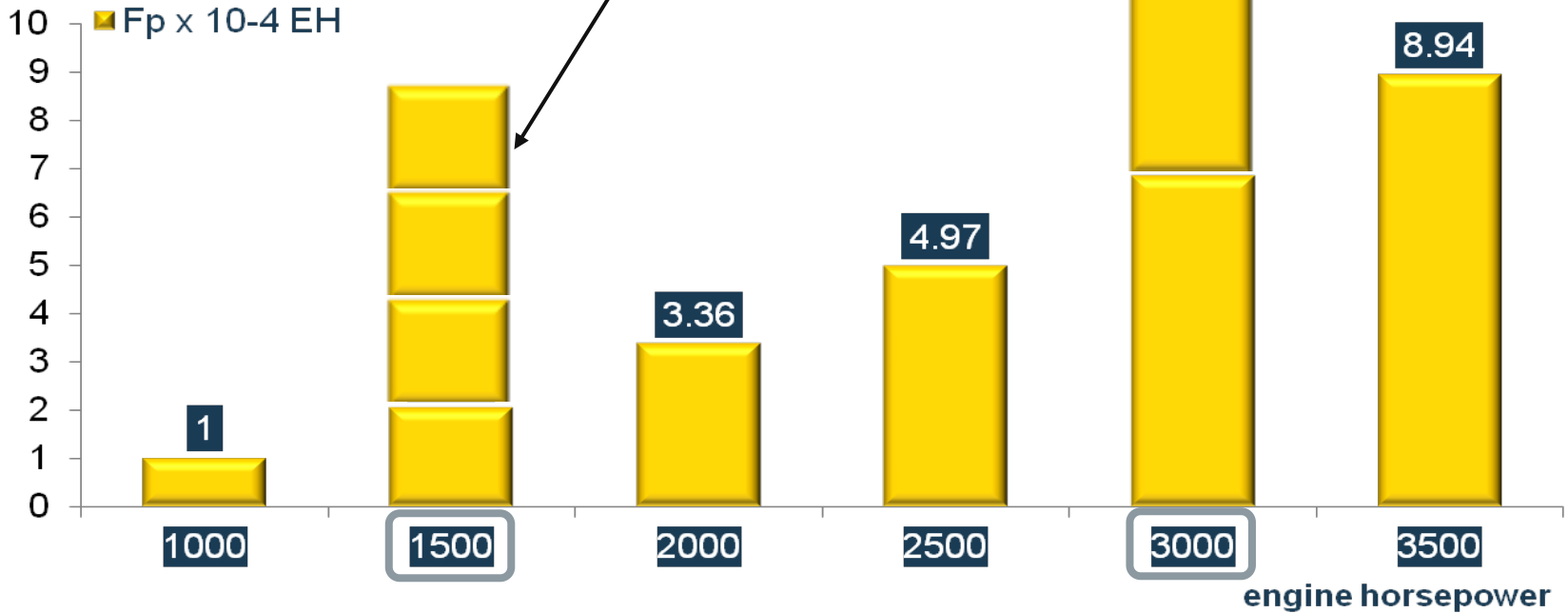
## Probability of failure of first engine (Example)



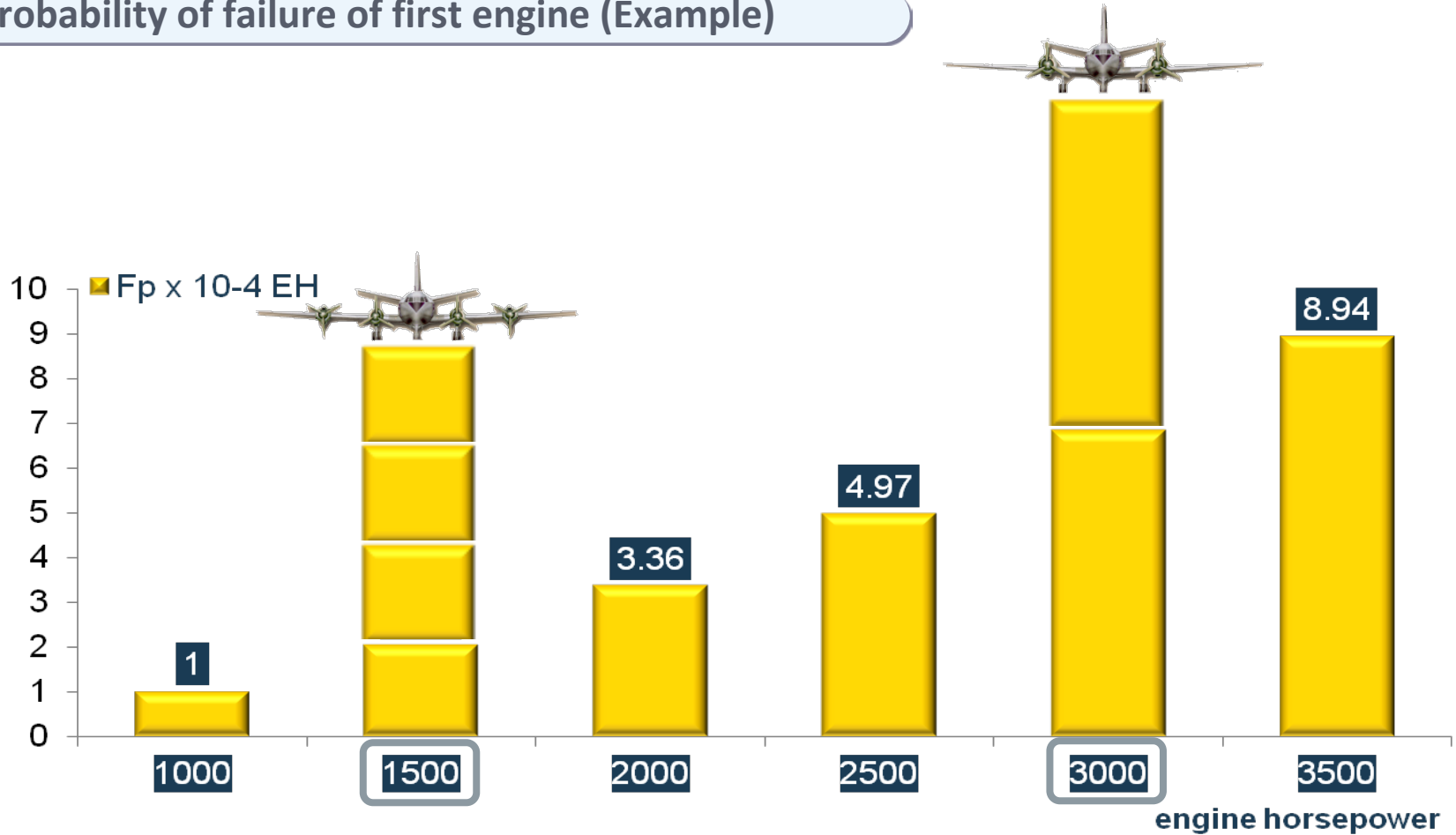
Twin: 2 times the probability of failure of one engine



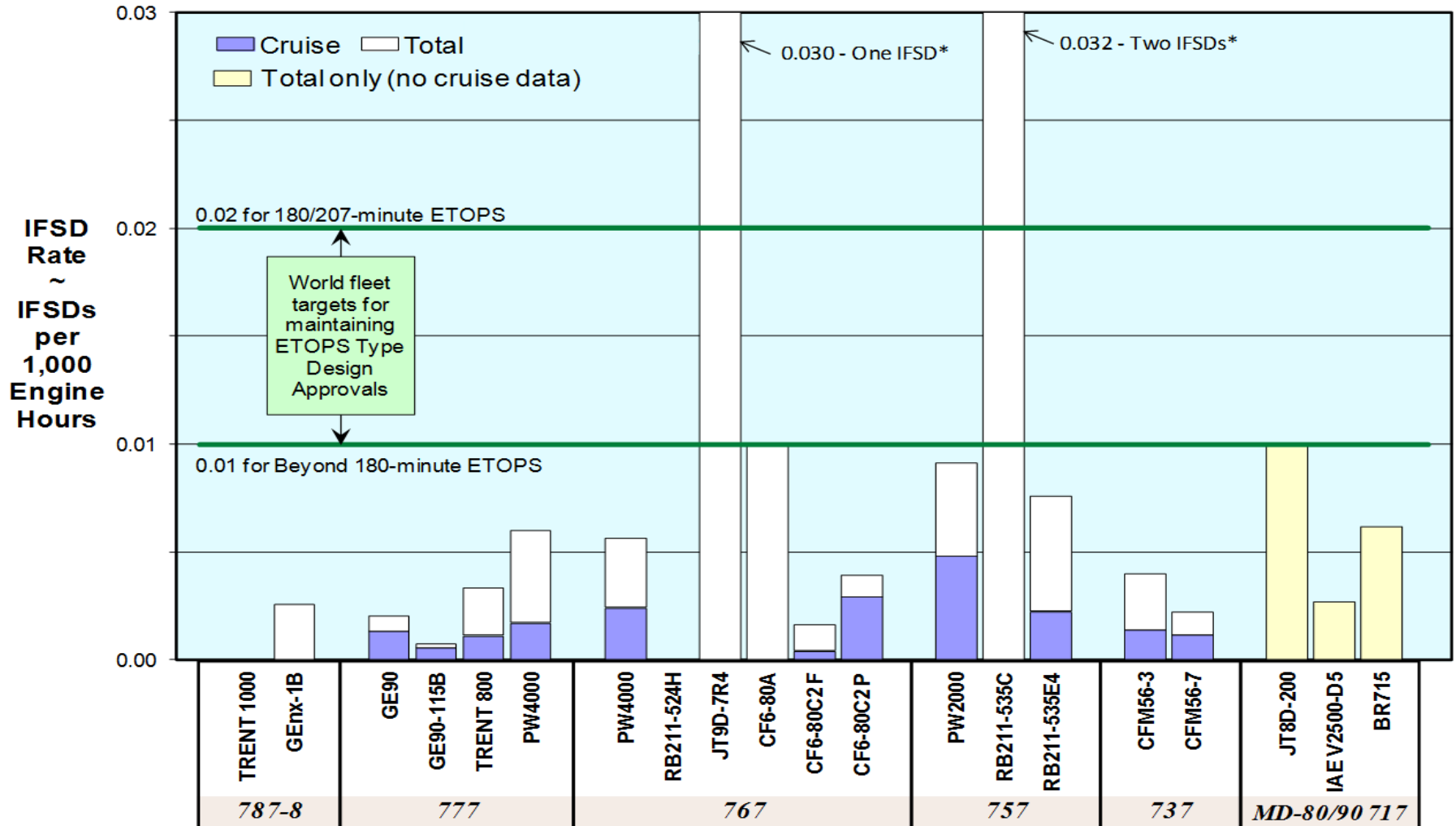
Quad: 4 times the probability of failure of one engine



## Probability of failure of first engine (Example)



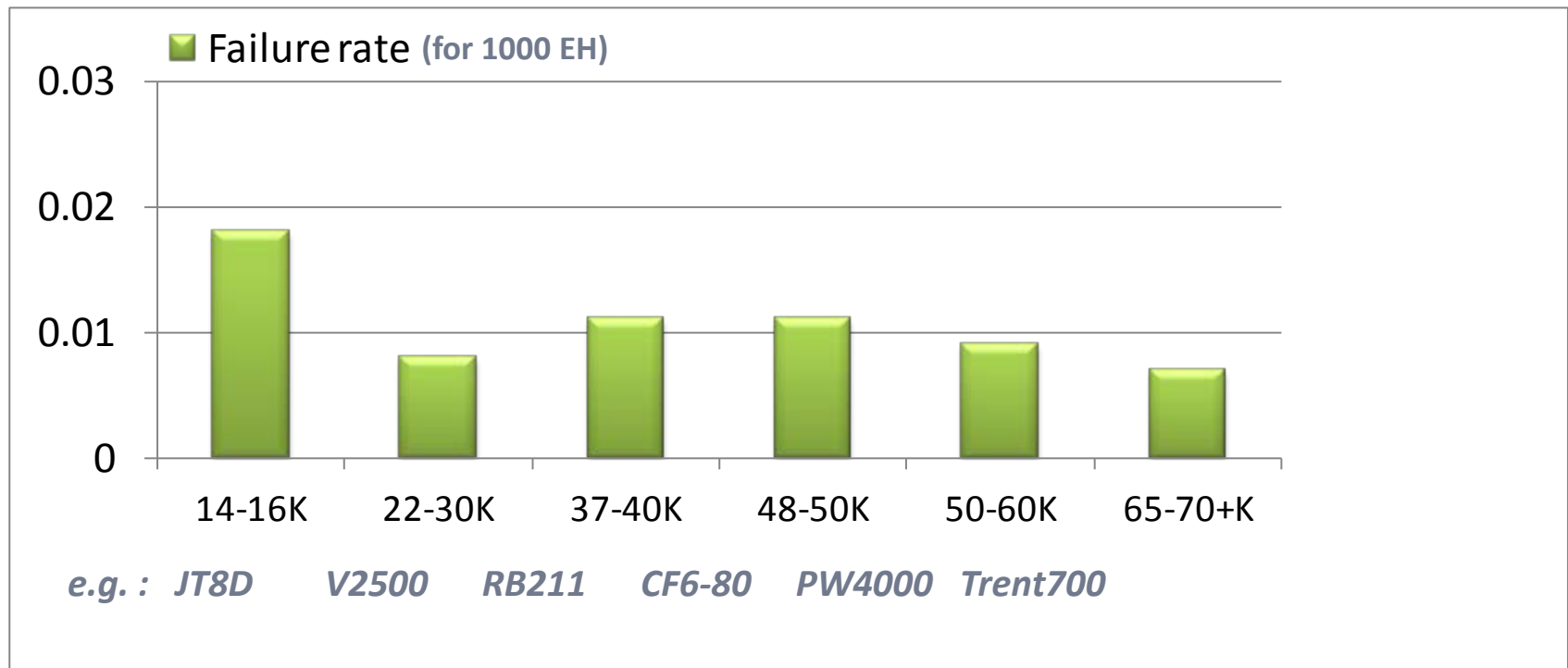
## World fleet IFSD rates - 12 month average as of March, 2014



\* High IFSD rate is insignificant - due to only one or two IFSDs in the period and few flight hours.

### Jet engine reliability

More than 40 years of jet operations have shown that unlike piston engines, jet engine failure probability is not affected by the thrust or the size of the engine:



Therefore, the probability of an engine failure is now higher on a quad-jet than on a twin-jet

The introduction in the 1980s of twin aircraft (A310, B767) powered with modern (fuel efficient) turbofan engines made the old 60/90 minute rules inadequate:

## 1984

- ICAO ETOPS study group amend Annex 6

## 1985

- FAA publishes first ETOPS regulation to address 120 min operations
- First ETOPS operation (SIA/A310 - TWA/B767)

## 1988

- The very good experience with 120 min operations allowed publication of 180 min ETOPS rules

## 2007

- January 2007 - FAA publishes new “Extended Operations” (ETOPS) regulation
- June 2007 – Transport Canada publishes new Extended Range Twin-Engine Operations (ETOPS)
- July 2007 – CASA publishes new “Extended Diversion Time Operations” (EDTO) regulation
- October 2007 – ICAO sent a State letter to introduce new “Extended Diversion Time Operations” (EDTO) regulation in its SARPs. Further to the numerous State replies, the ICAO has decided to postpone its implementation into the SARPs until at least end of 2009. A new Special Operations Task Force has been set-up to review the comments and propose new recommendations .

## 2010

- EASA publishes new ETOPS criteria (AMC 20-6 Rev 2)

## 2011/2012

- ICAO State Letter on new EDTO provisions (based on SOTF conclusions) – Implementation as of 2012



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## ETOPS objective

The objective of initial ETOPS rules (1985):

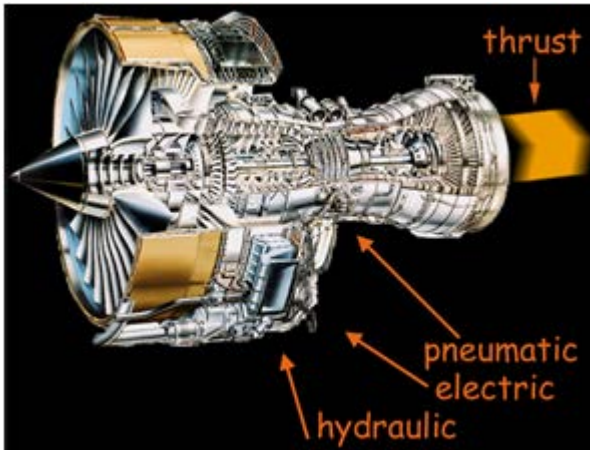
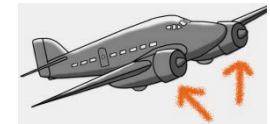
“Overall level of operational safety consistent with that of  
**modern 3 and 4 engine aircraft**”

Comparison of a basic (non ETOPS) twin engine aircraft with a modern 3 or 4 engine aircraft:

- to spot the main differences in their architecture, and
- to understand how these differences may impact the safety of extended diversion time operations...



The most obvious difference is indeed the number of installed engines...

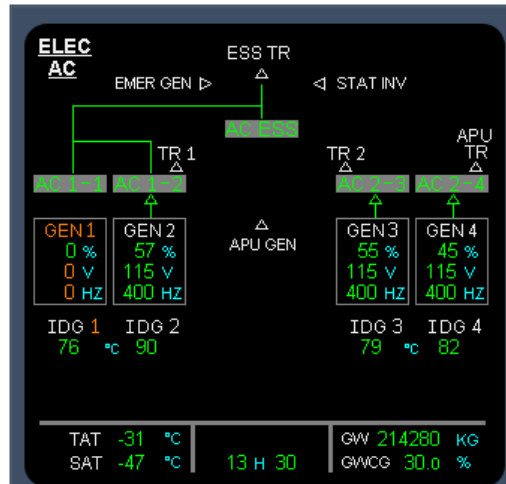
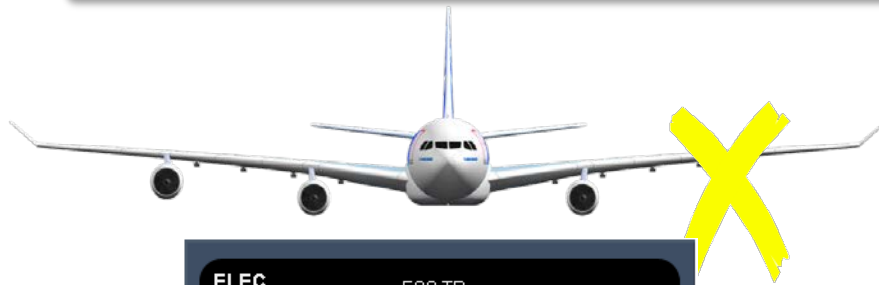


Recall: on top of thrust, engines provide as well:

- Electric power
- Hydraulic power
- Pneumatic power

### Systems independence

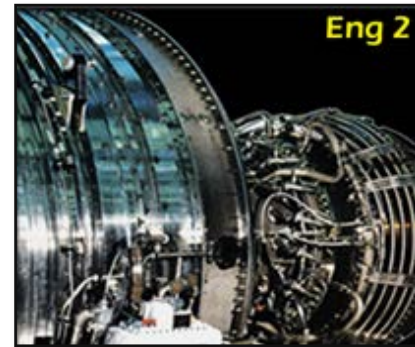
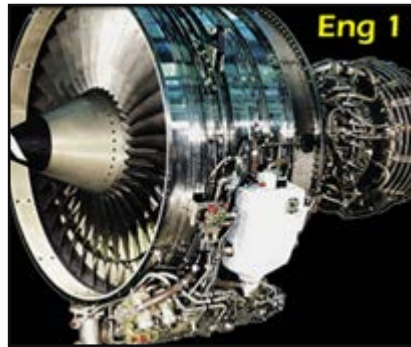
Independence of some major aircraft systems is directly linked to the number of engines installed



**Example of Electrical System:** Remaining source(s) after engine failure :  
3 sources on Quad / 1 source on Twin

### Maintenance actions

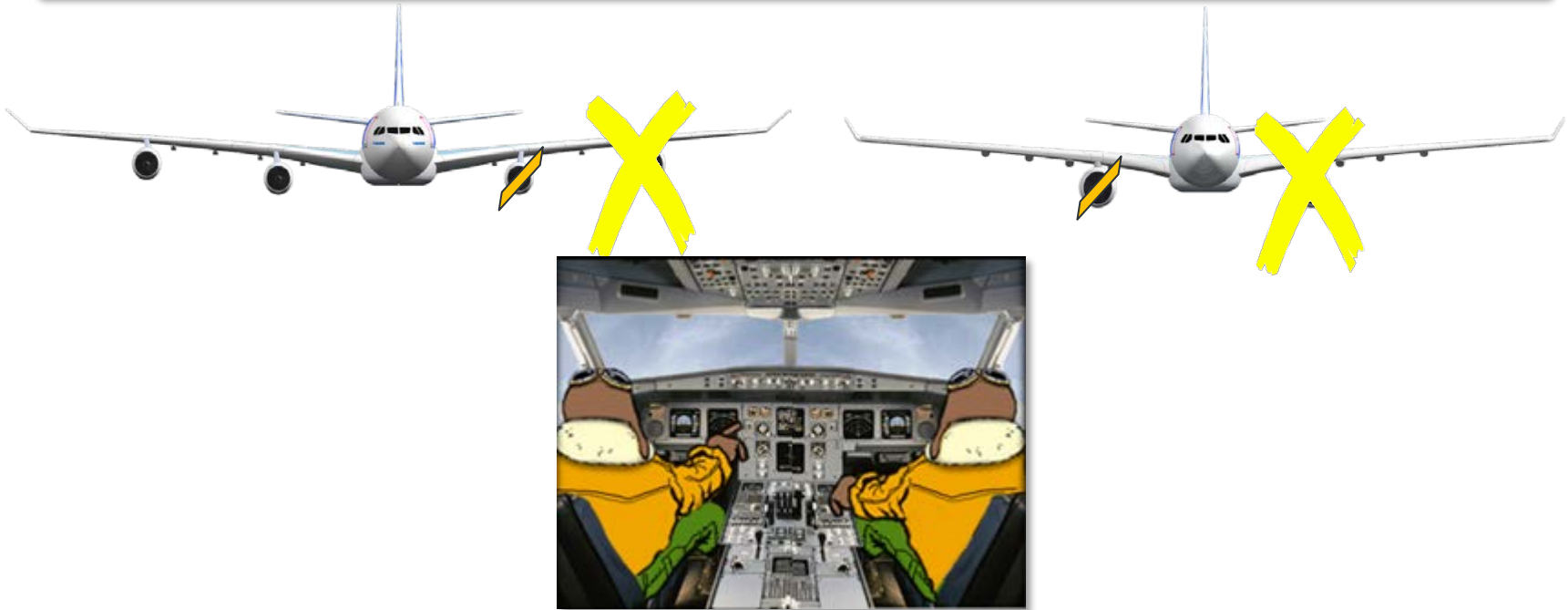
System redundancy has a direct impact on error consequence after simultaneous maintenance action on parallel systems



Example of dual maintenance on 2 identical engine mounted systems.  
Potentially affected systems: 2 out of 4 on Quad / 2 out of 2 on Twin

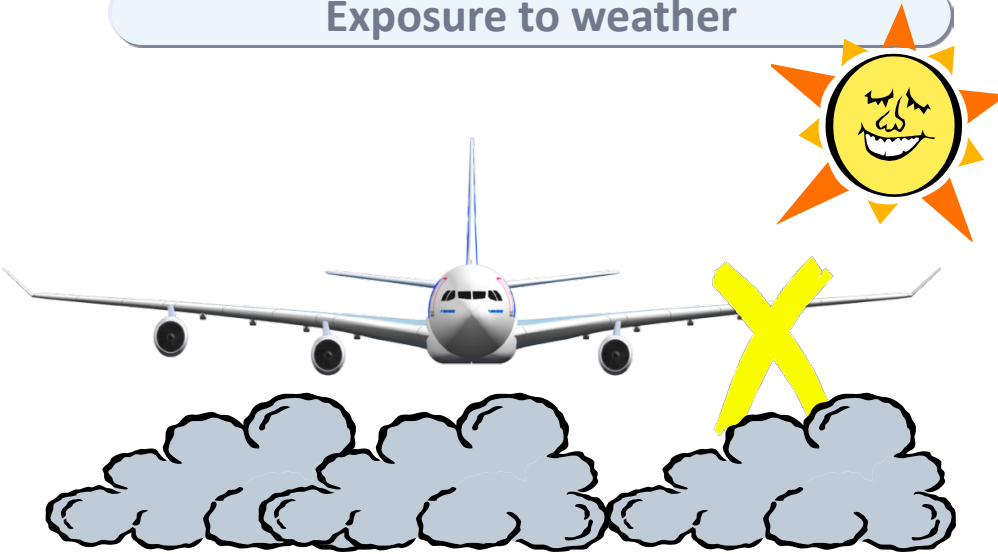
### Crew actions

System redundancy has also a direct impact on error consequence in system management after failure



Example of inappropriate course of action after system failure.  
Potentially affected systems: 2 out of 4 on Quad / 2 out of 2 on Twin

### Exposure to weather



Level off altitude after an engine failure is often lower on twin

It may expose the twin to **more adverse weather conditions...**

This fact, combined with lower redundancy in the systems of (basic) twins, may have an **adverse impact on crew workload.**



Basically, the ETOPS concept implemented 25 years ago is not changed:

**PRECLUDE a diversion by**

Designing reliable A/C engines & systems  
⇒ **minimize the occurrence** of degraded operating modes

**ETOPS Type Design & Reliability approval (Certification) of the Aircraft**

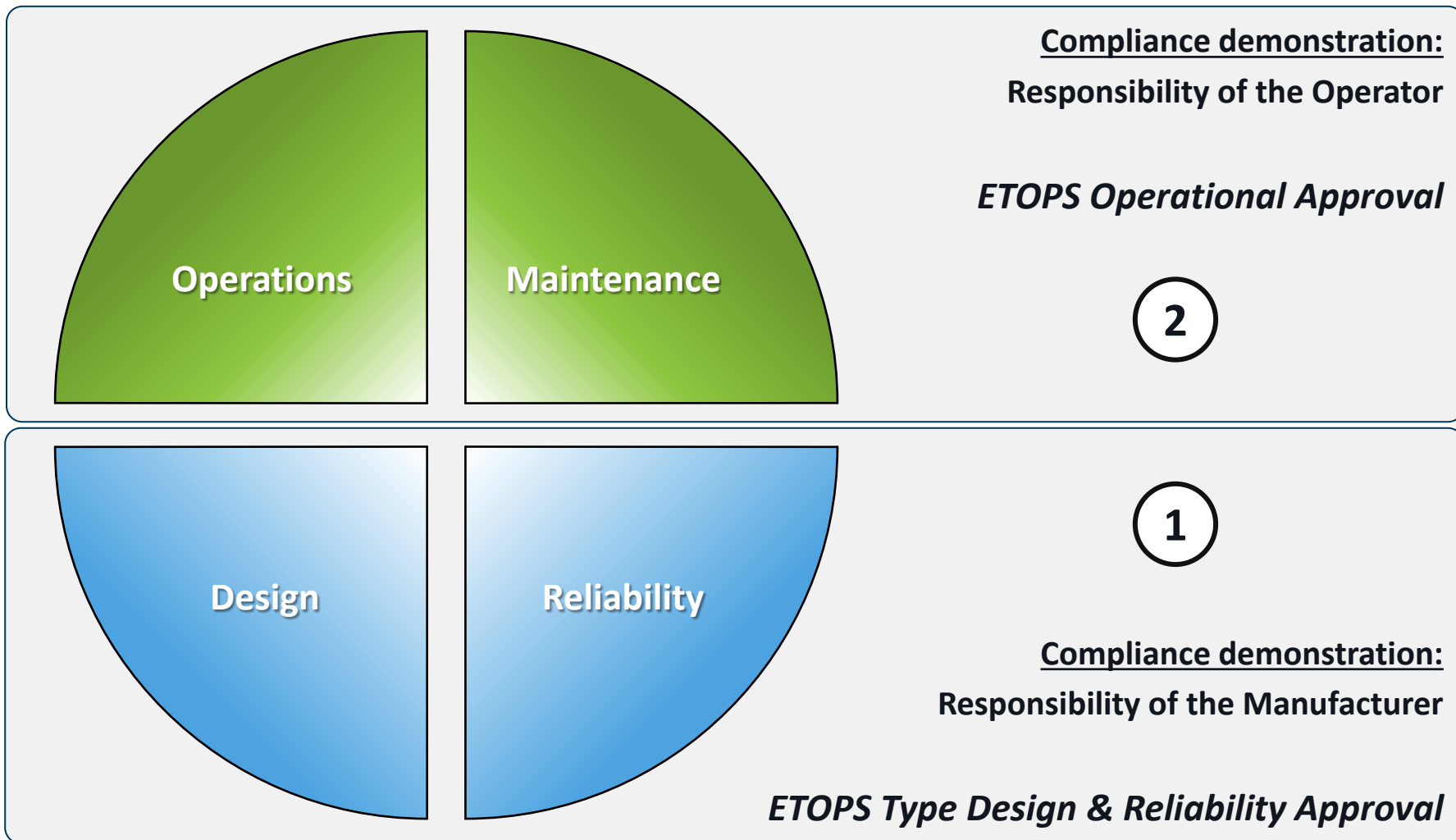
Implementing specific maintenance precautions, conservative practices & readiness demonstration  
⇒ **retain a high level of reliability**

**ETOPS Operational Approval of the Airline**

**PROTECT the diversion by**

Implementing systems/functions required for safe ETOPS diversion & landing  
⇒ **Ensure a high level of systems performance** in normal & degraded operational modes

Having operational plans in place for readiness demonstration, aiming at the protection of passengers and crew  
⇒ **cope with adverse operating conditions**



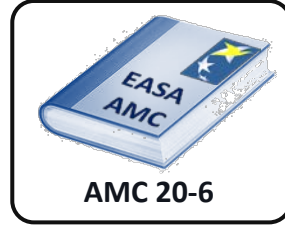


Examples of regulatory material for ETOPS Type Design & Reliability Approval :



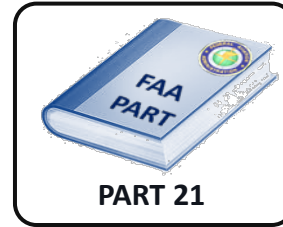
ICAO Annex 8

Additional guidance in A/W Manual 9760

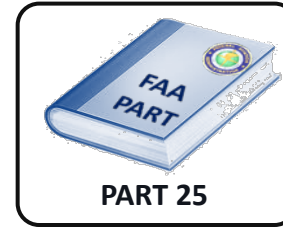


AMC 20-6

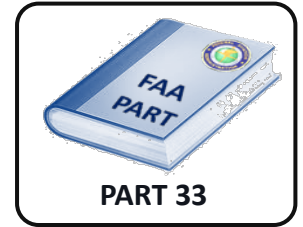
Only the paragraphs related to ETOPS Type Design & Reliability assessment



PART 21

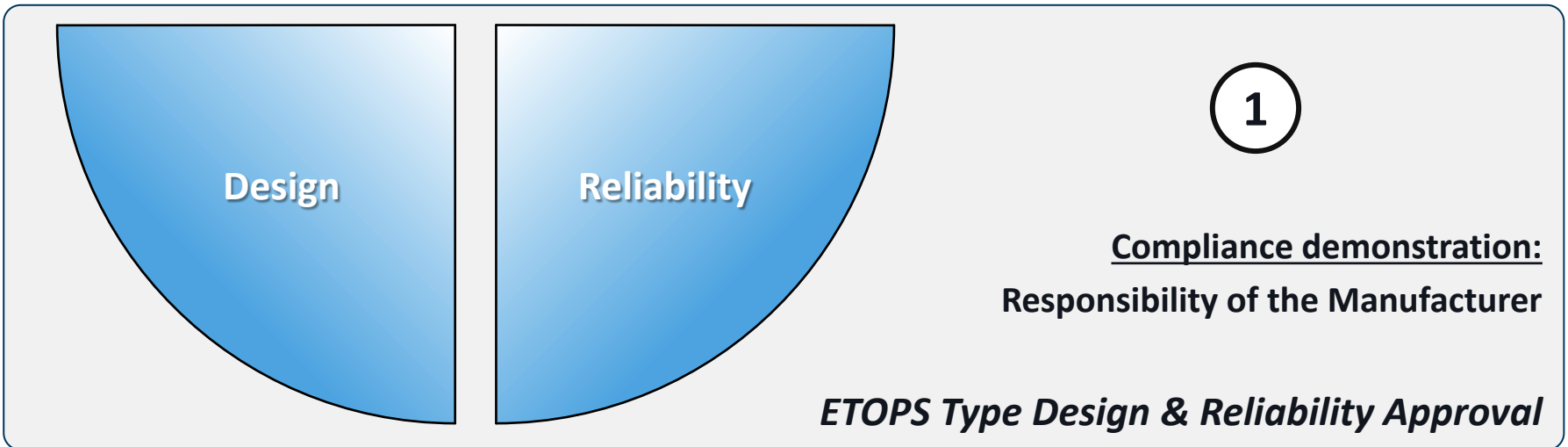


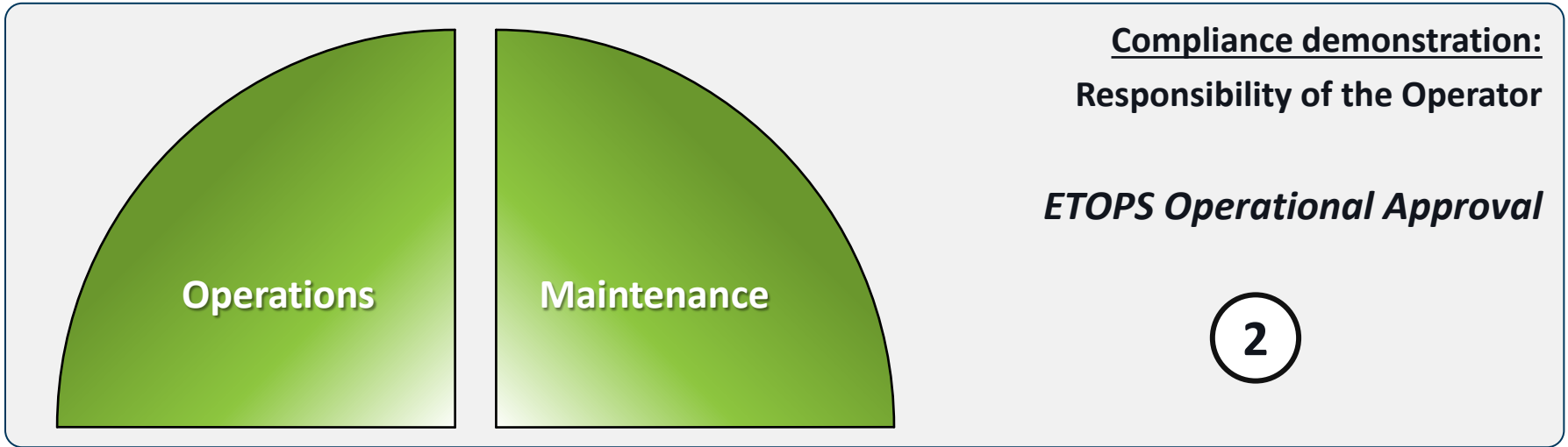
PART 25



PART 33

These FAA ETOPS Certification rules have superseded AC 120-42A in 2007  
Additional guidance in new AC for Part 25 still pending





### Examples of regulatory material for ETOPS Operational approval

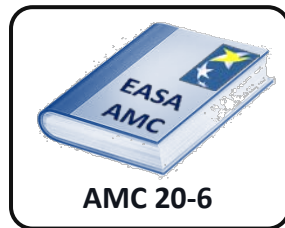


**ICAO Annex 6**  
Amdt. 36

Additional guidance  
in  
Attachment D

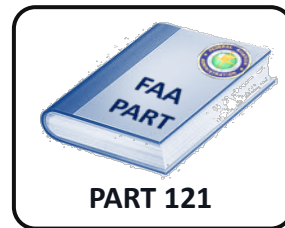


**EU-OPS 1**



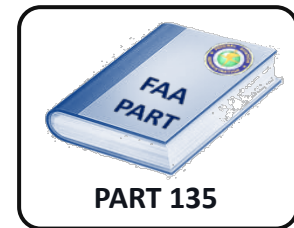
**AMC 20-6**

Only the paragraphs  
related to ETOPS  
operational  
approval



**PART 121**

These FAA ETOPS Ops rules have superseded AC 120-42A in 2007



**PART 135**

Additional guidance is now provided in AC 120-42B

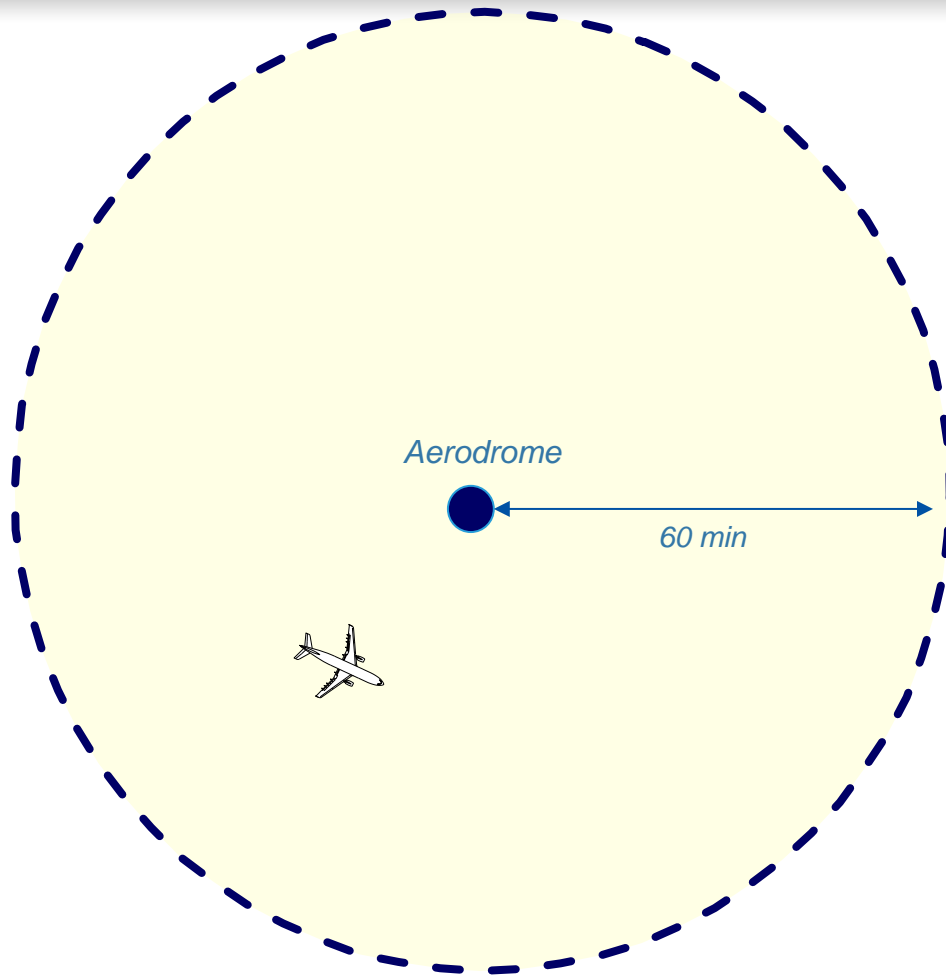
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- Operations beyond 60 min to an aerodrome
- Threshold time
- Maximum Diversion Time
- EDTO significant system time limitation



When under the established Threshold:

- Additional flight planning principles apply
  - Operational control and dispatch procedures
  - Identify alternate aerodromes
  - Information on those aerodromes
  - For Twins, that the aerodrome will be available
  - Training programmes

**Operations beyond the Threshold require a Specific Approval**

There are sets of Certification & Operational requirements which apply when an aircraft is operated beyond applicable threshold

Aerodrome



60 min

X min





**Maximum time (expressed in distance) that an aeroplane can be to an aerodrome**

*This defines the area of operation*

Aerodrome

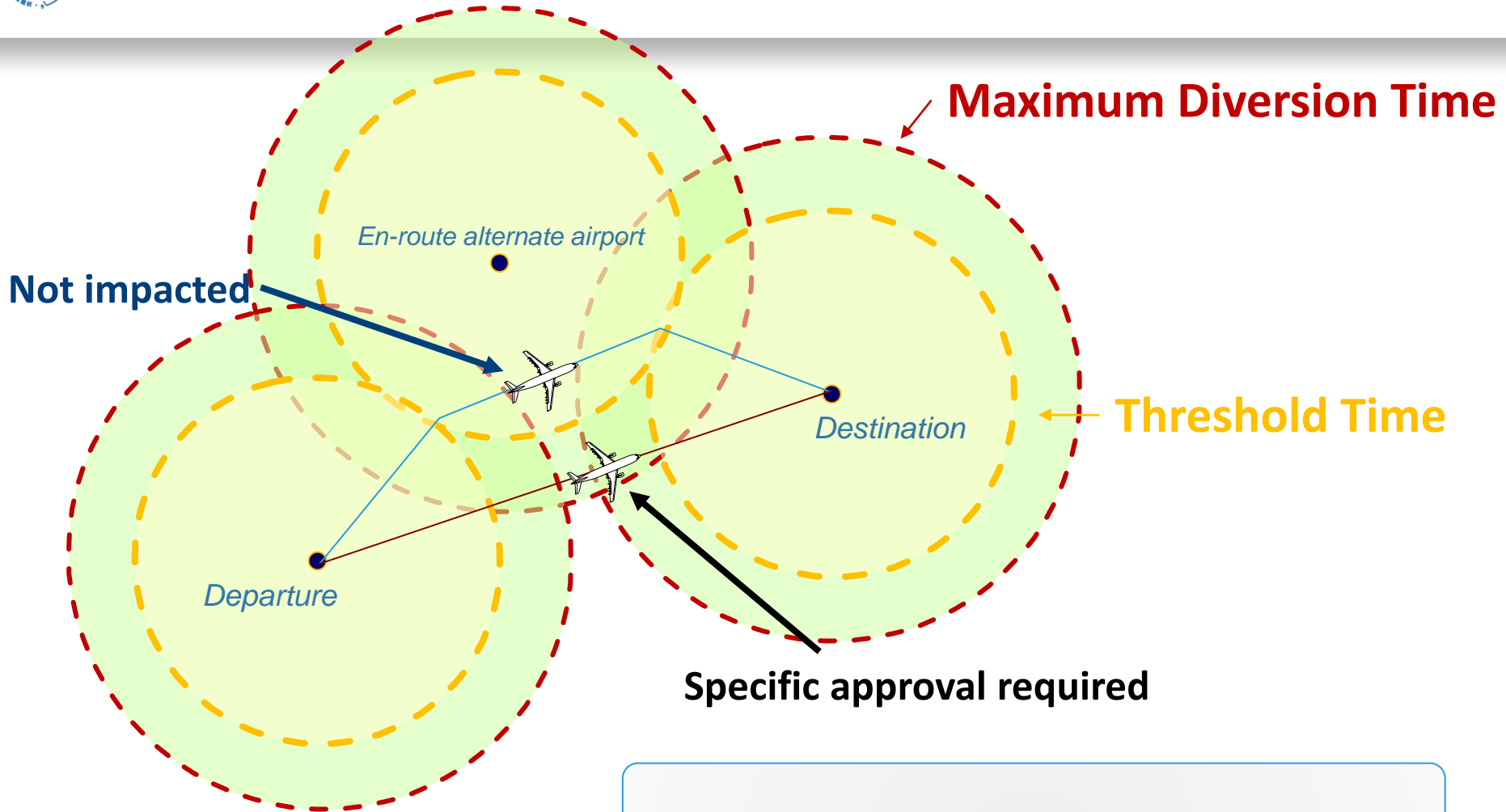


60 min

X min

X min

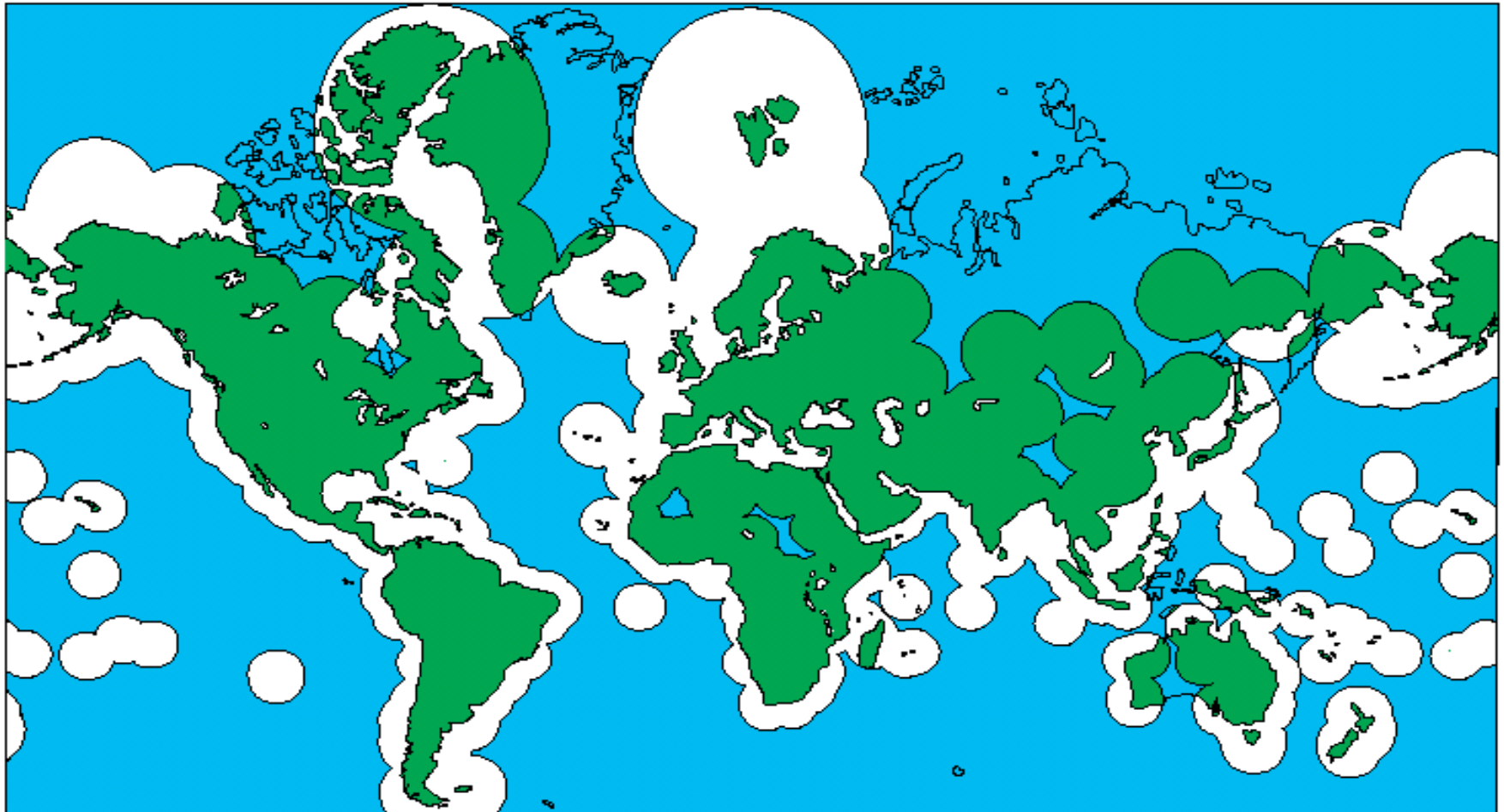




### The State of the Operator:

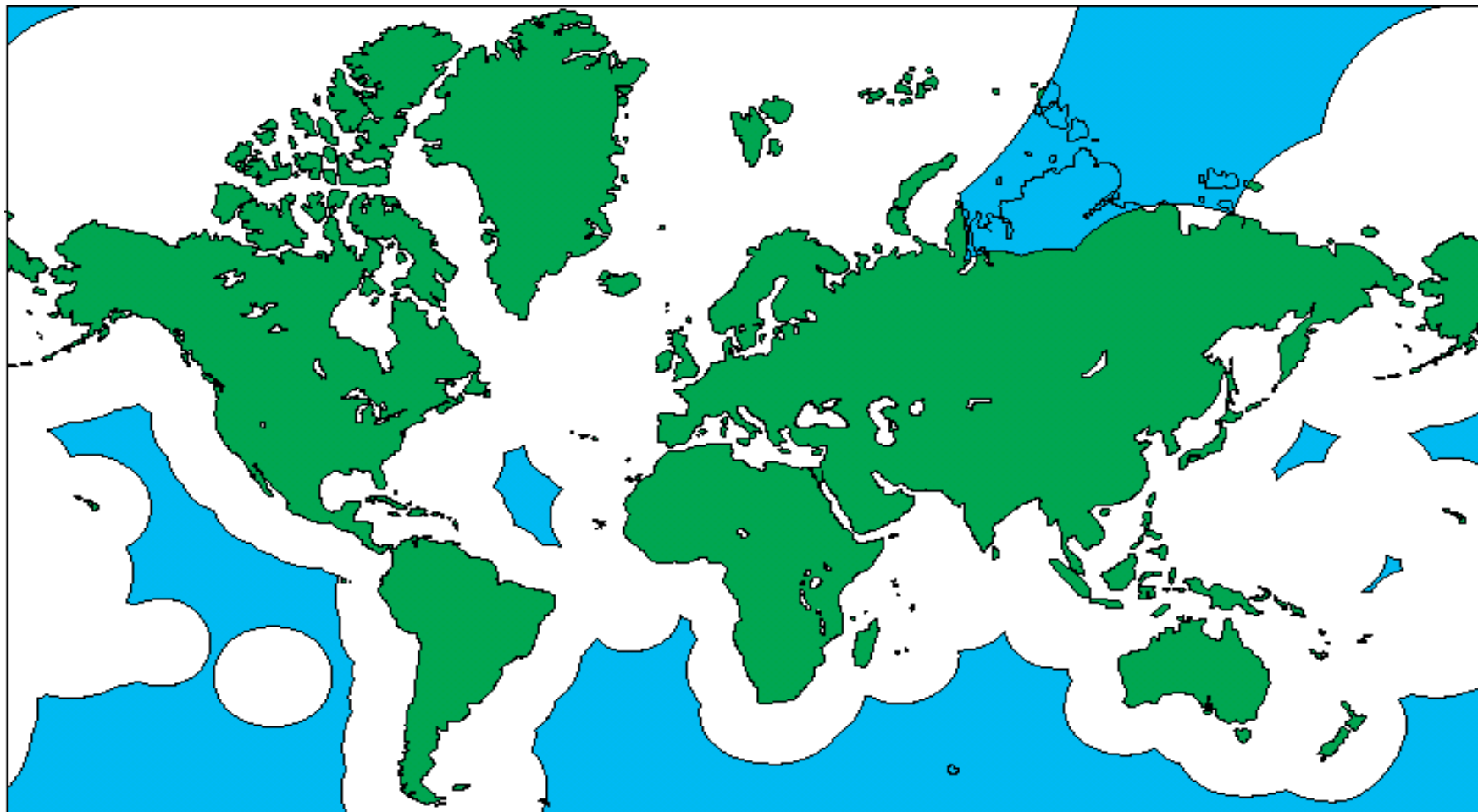
**Establishes** the Threshold Time; and  
**Approves** the Maximum Diversion Time

## *60 minute restriction limits route opportunities*



 Regions beyond 60 minute threshold (400 nm typical operational range)

## *120 minute MDT expands route opportunities*



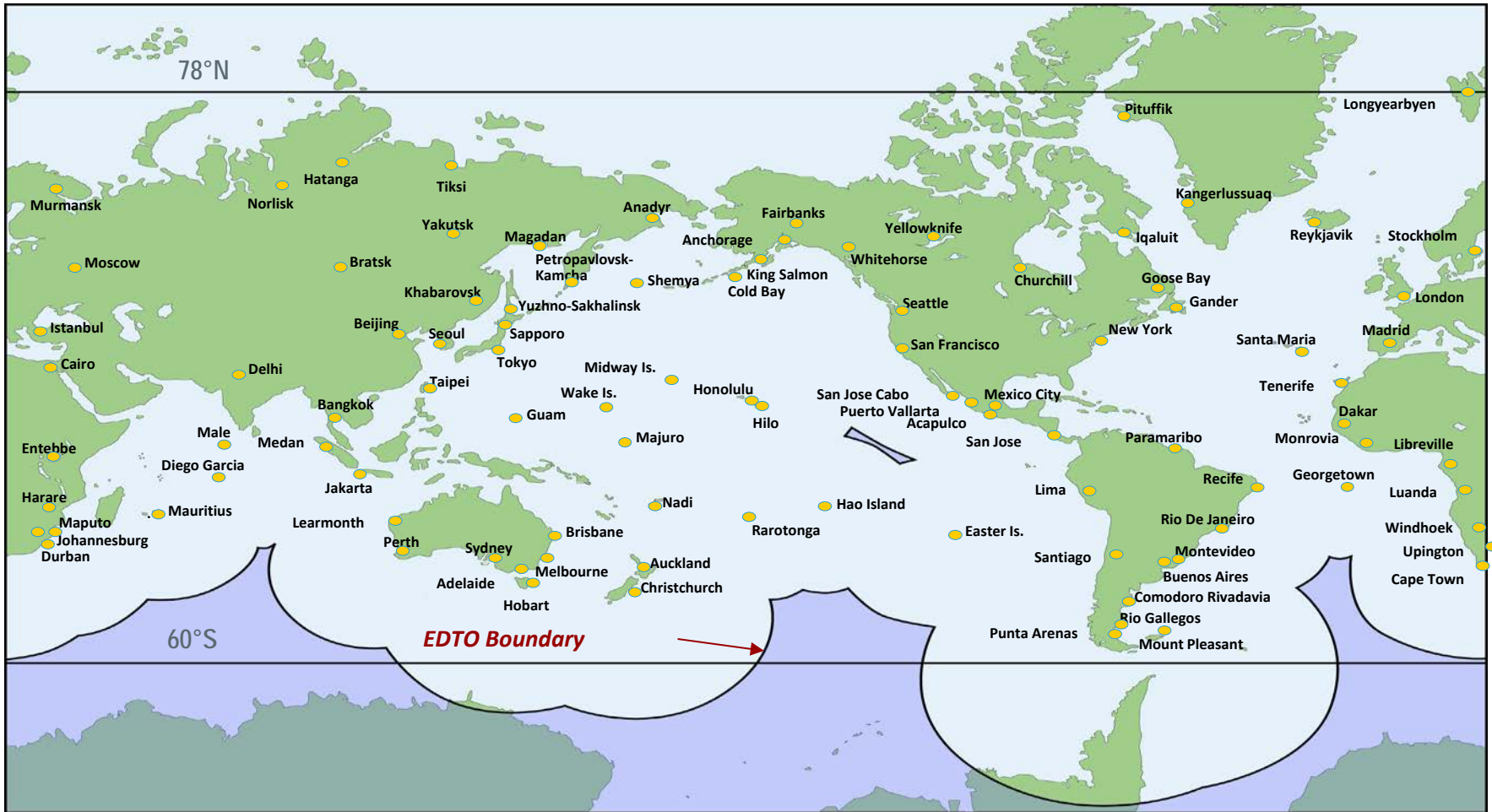
 Regions beyond 120 minute ETOPS area (800 nm typical operational range)

## *180 minute MDT further expands route opportunities*



 Regions beyond 180 minute ETOPS area (1200 nm typical operational range)

## Very few areas impacted by EDTO



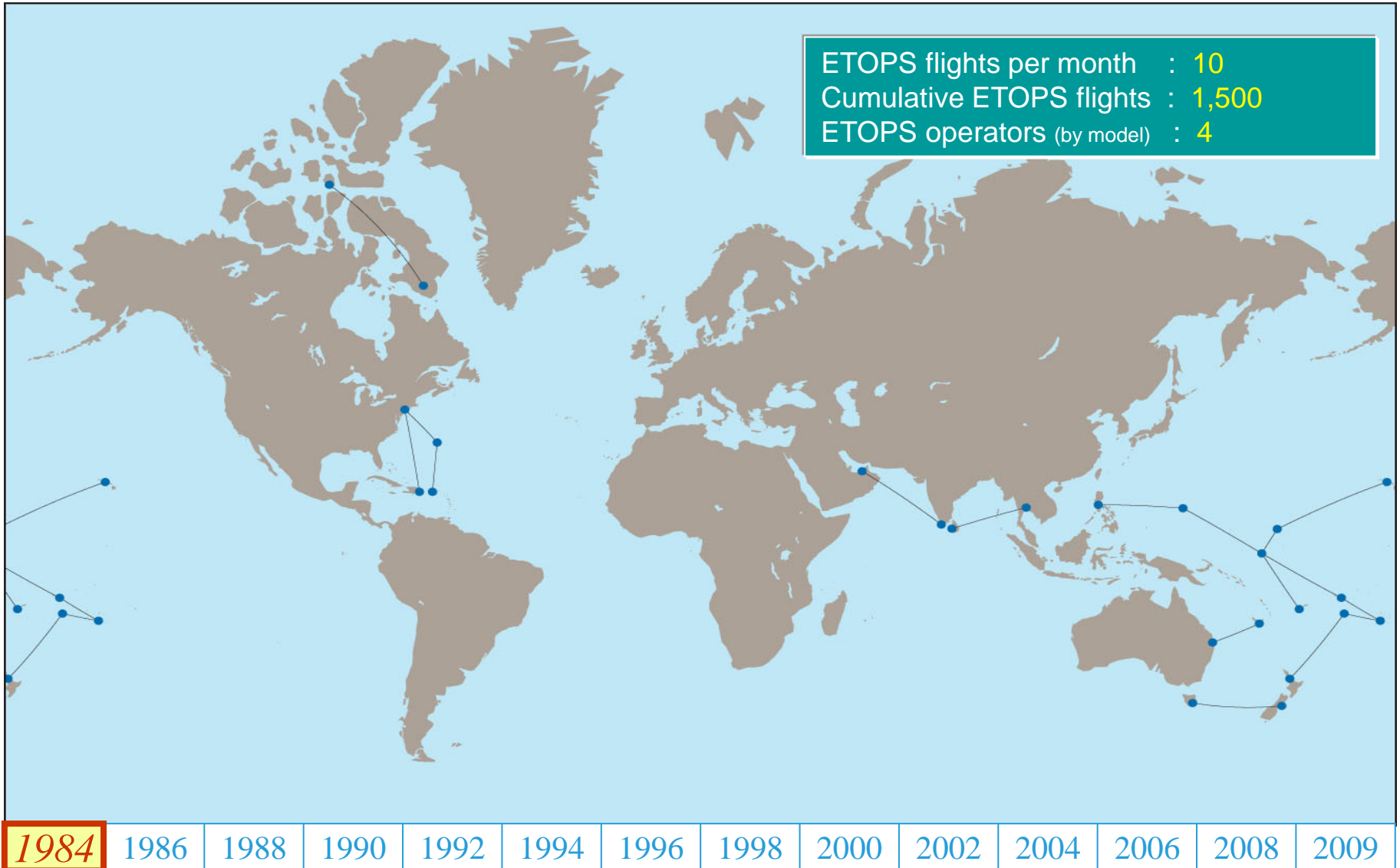
Regions beyond 180 minute threshold (1500 nm typical operational range)

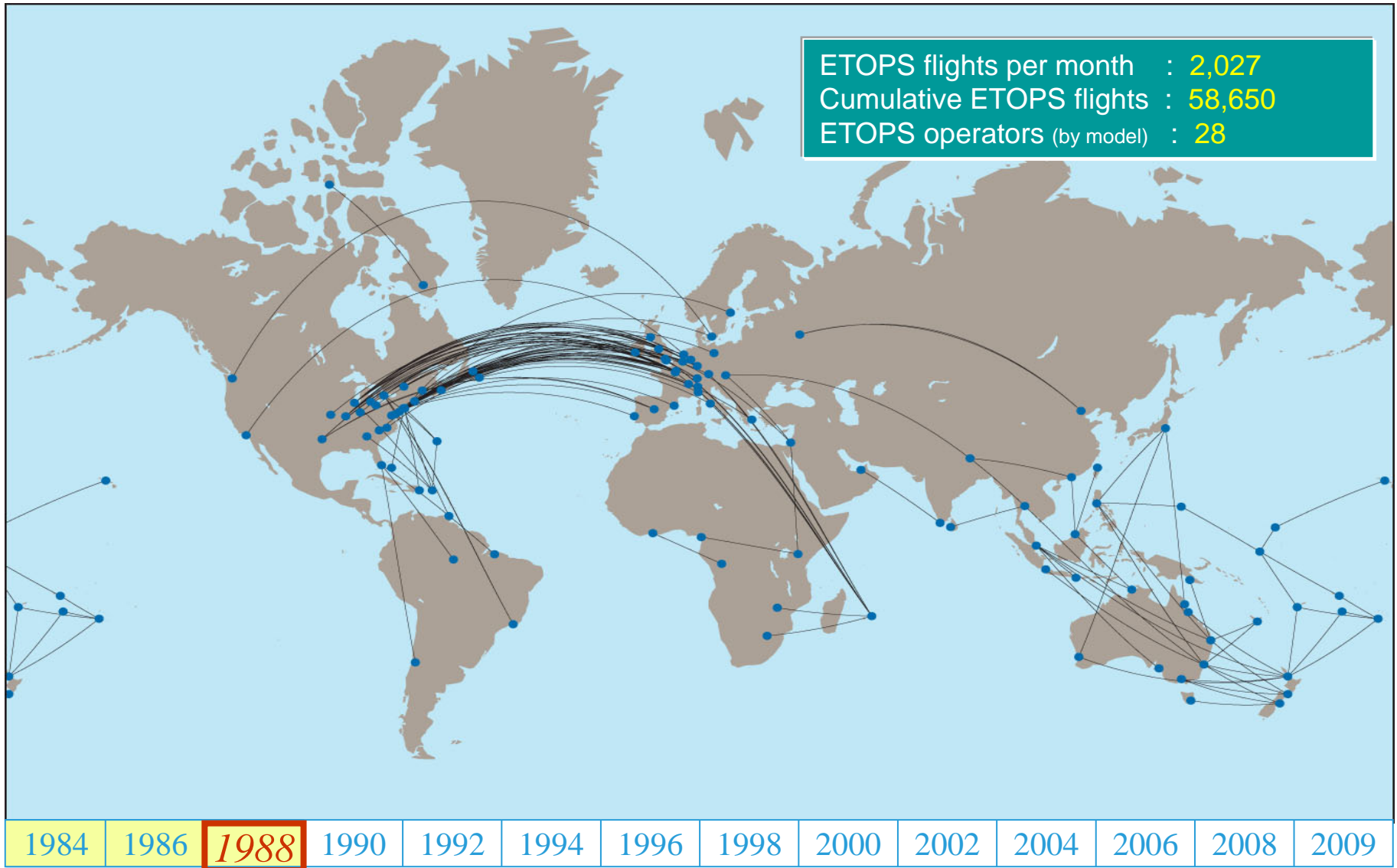
## *AC 120-42 (June, 1985)\**

- Two engine airplane capabilities re-evaluated
- Credit given for improved reliability of jet engines
- AC extended maximum diversion time to 120 minutes
  - 138 minutes (15 % extension) on a case by case basis
- Provided both type design and operational guidance for ETOPS
- First FAA approved ETOPS Flight: TWA 767-200, Boston to Paris



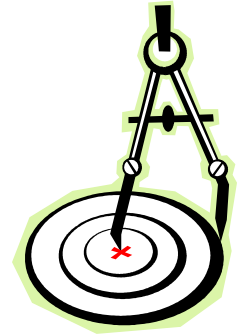
*\* No prior ETOPS standards but 60 minute exceptions granted on case by case basis*

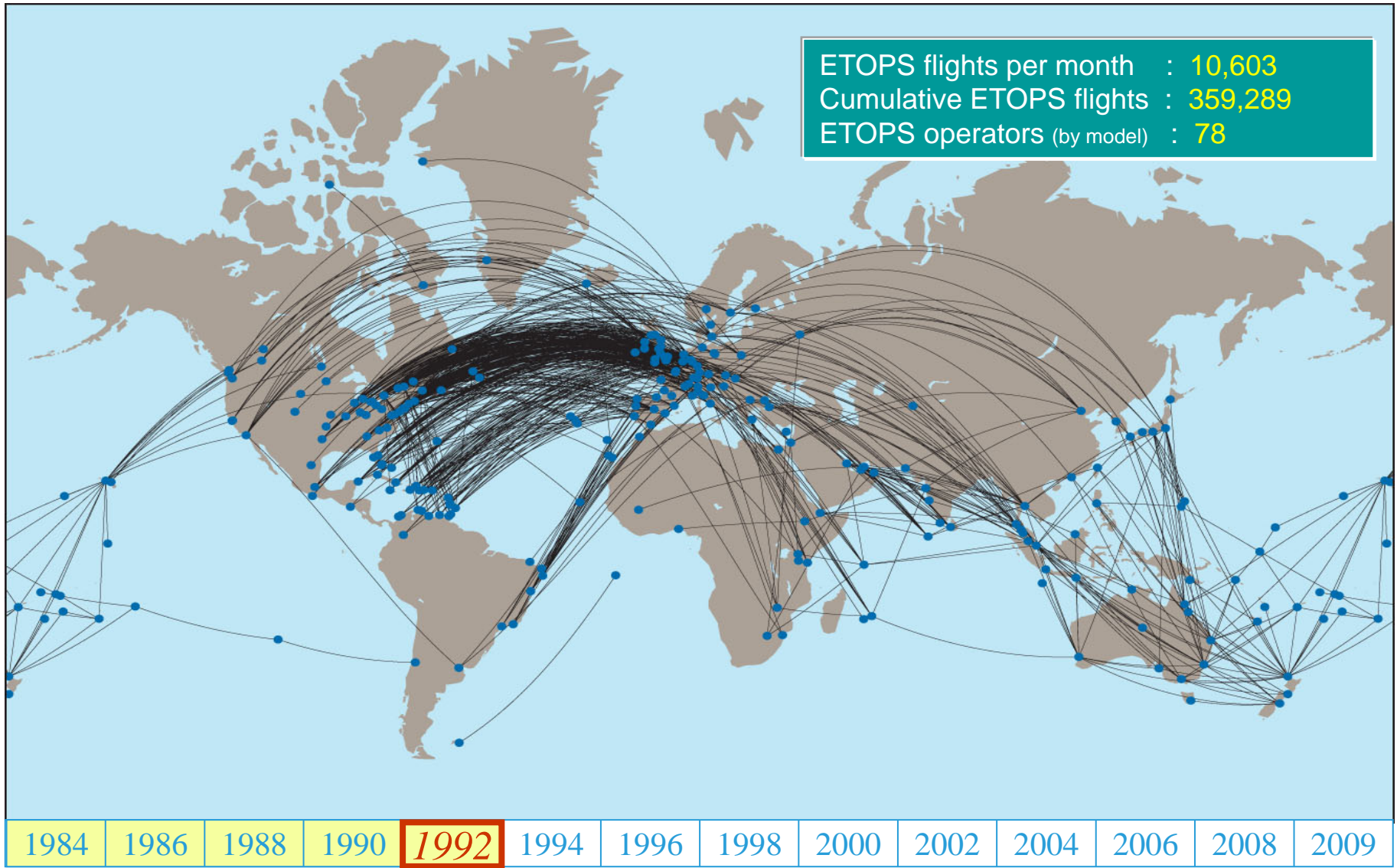


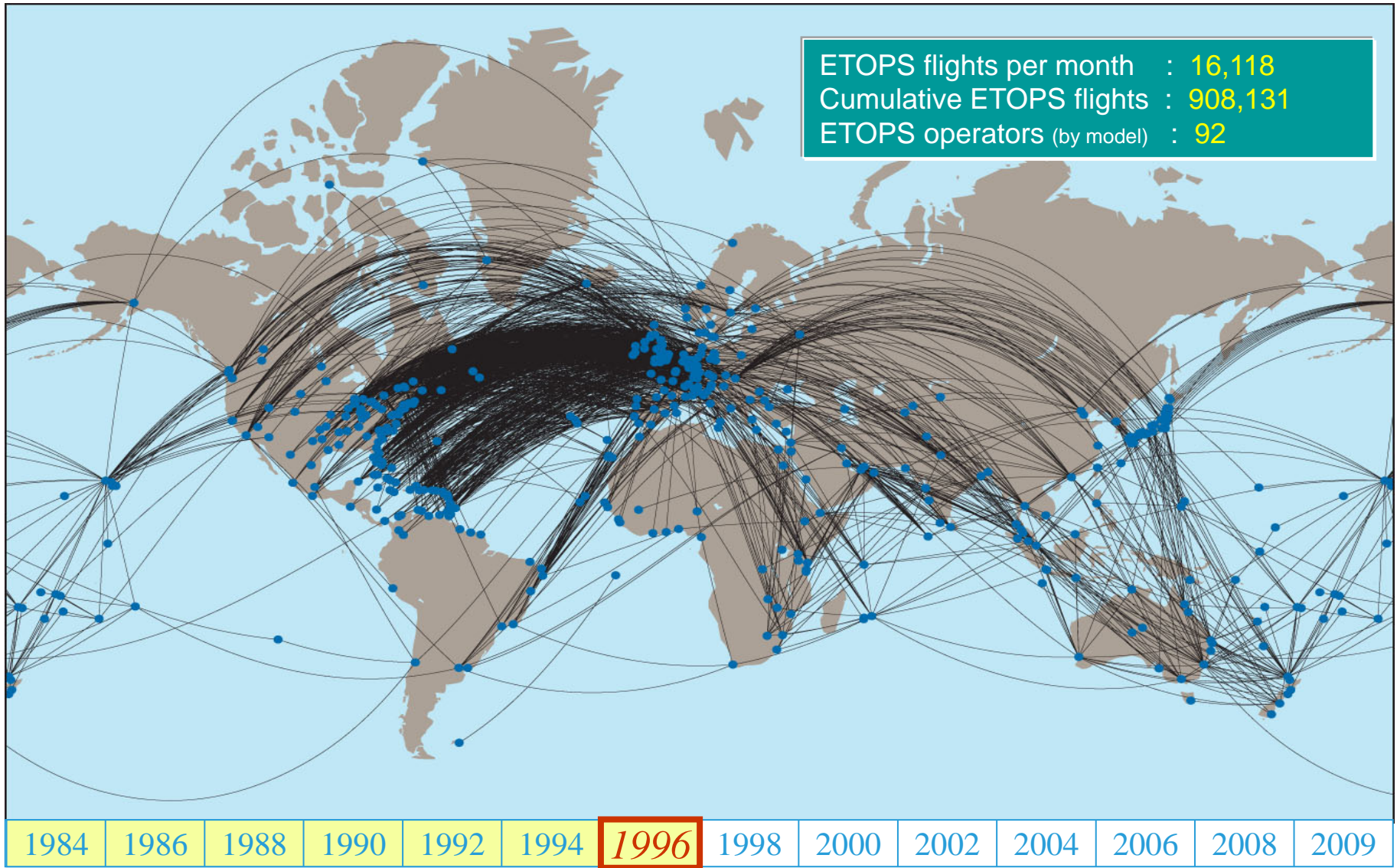


## AC 120-42A (December, 1988)

- Experience and success with 120-minute ETOPS evaluated
- Revision “A” of Advisory Circular increased maximum diversion time to 180 minutes from an alternate airport
- Requirements for 75-minute regional ETOPS also added:
  - Benign area of operation (*Caribbean*)
  - Challenging area of operation (*e.g. North Atlantic*)

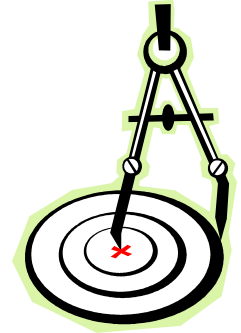




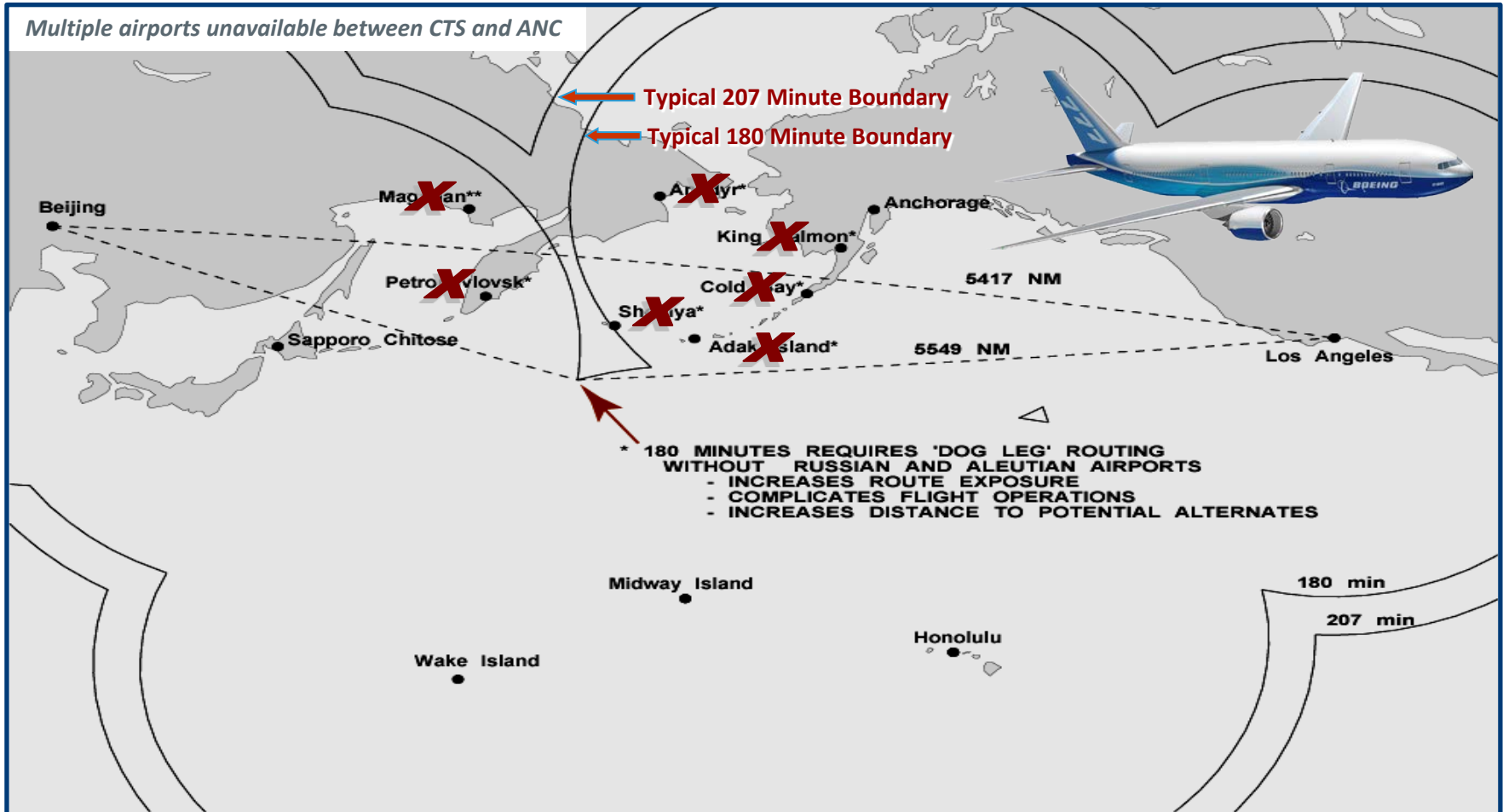


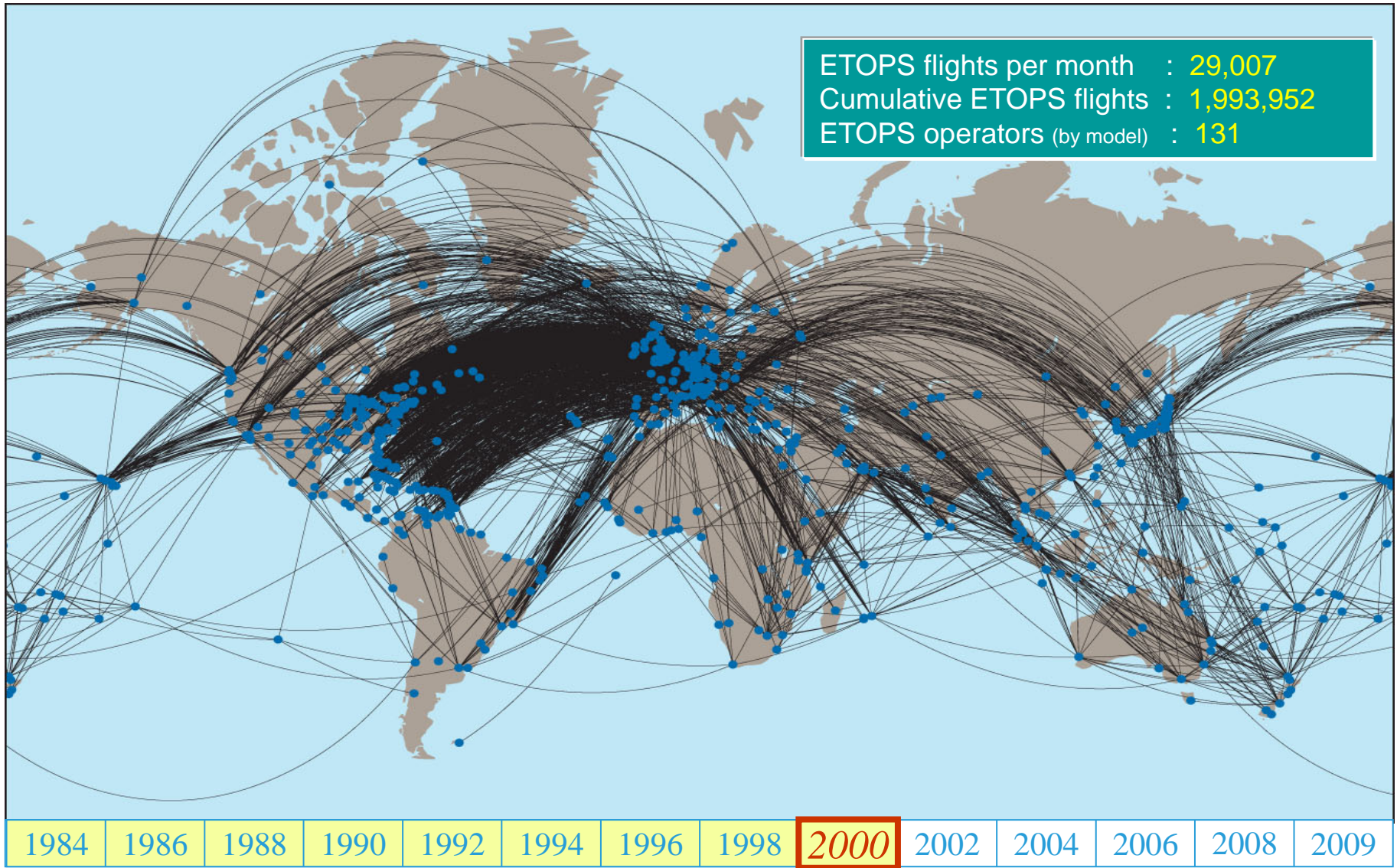
## *EPL 20-1 (March, 2000)*

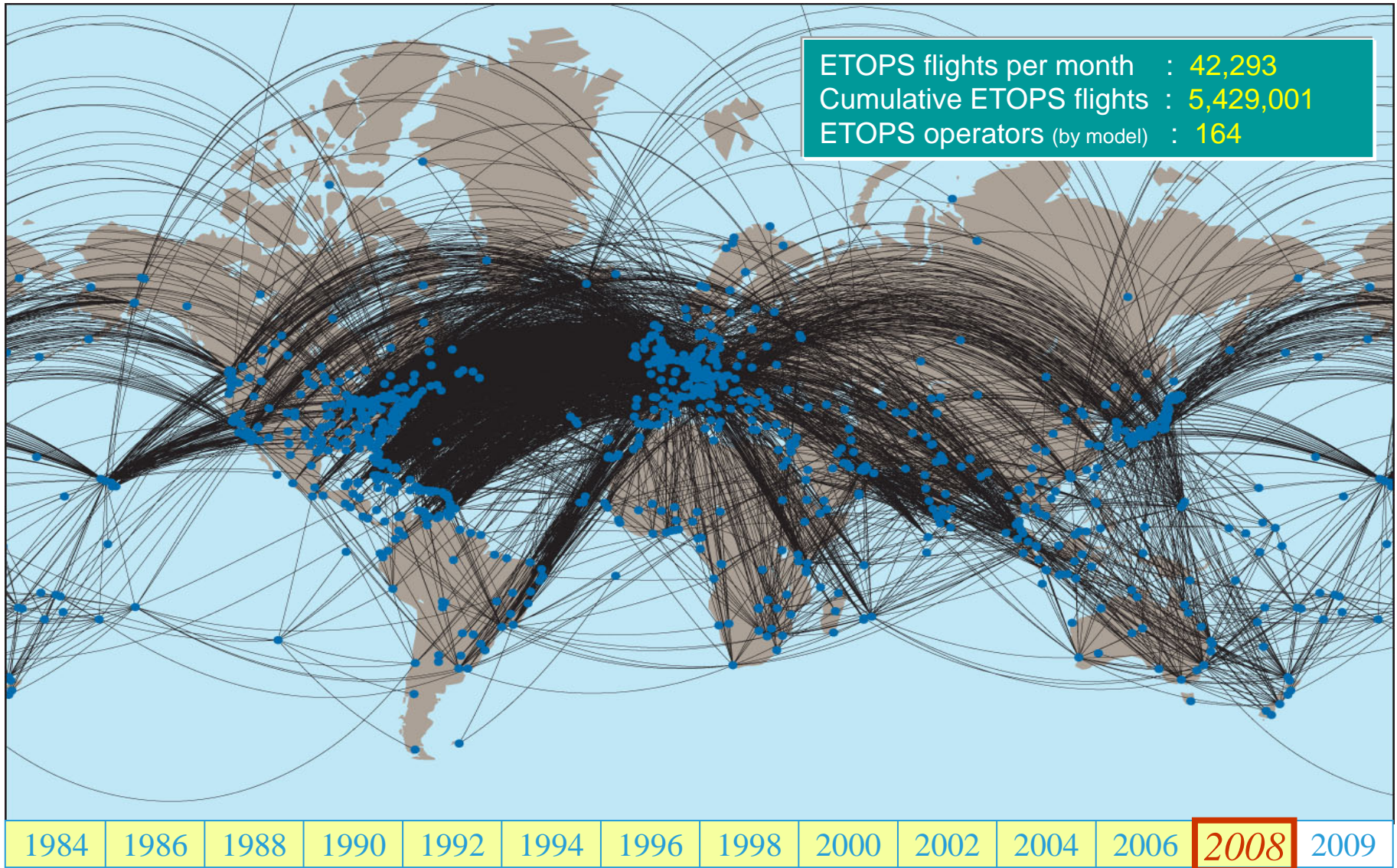
- FAA Policy Letter authorizes 15% extension from 180-minute ETOPS
- Applied on a 'flight by flight exception basis by approved operators in the North Pacific area
  - Pacific Ocean areas north of 40°N Latitude including NOPAC ATS routes, and published PACOTS tracks between Japan and North America
- EPL 20-1 established additional type design and operational requirements for 207-minute ETOPS



## 15% extension improves dispatch flexibility

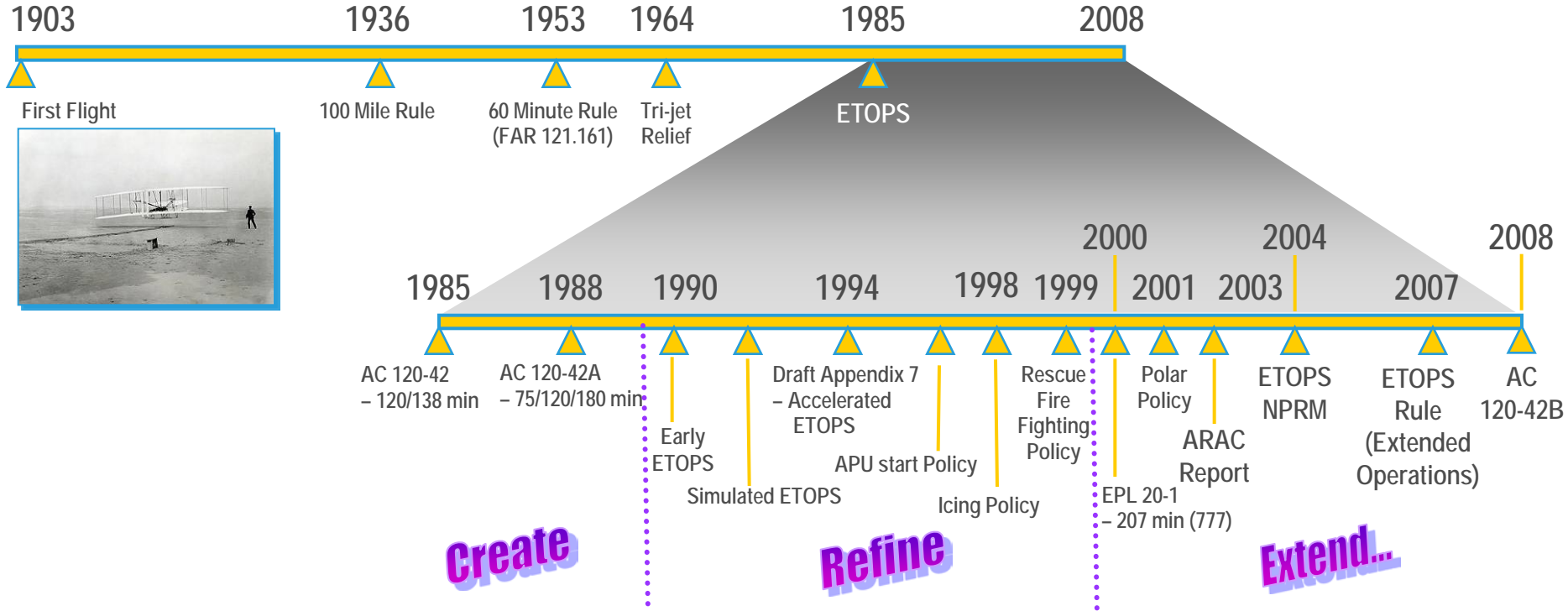






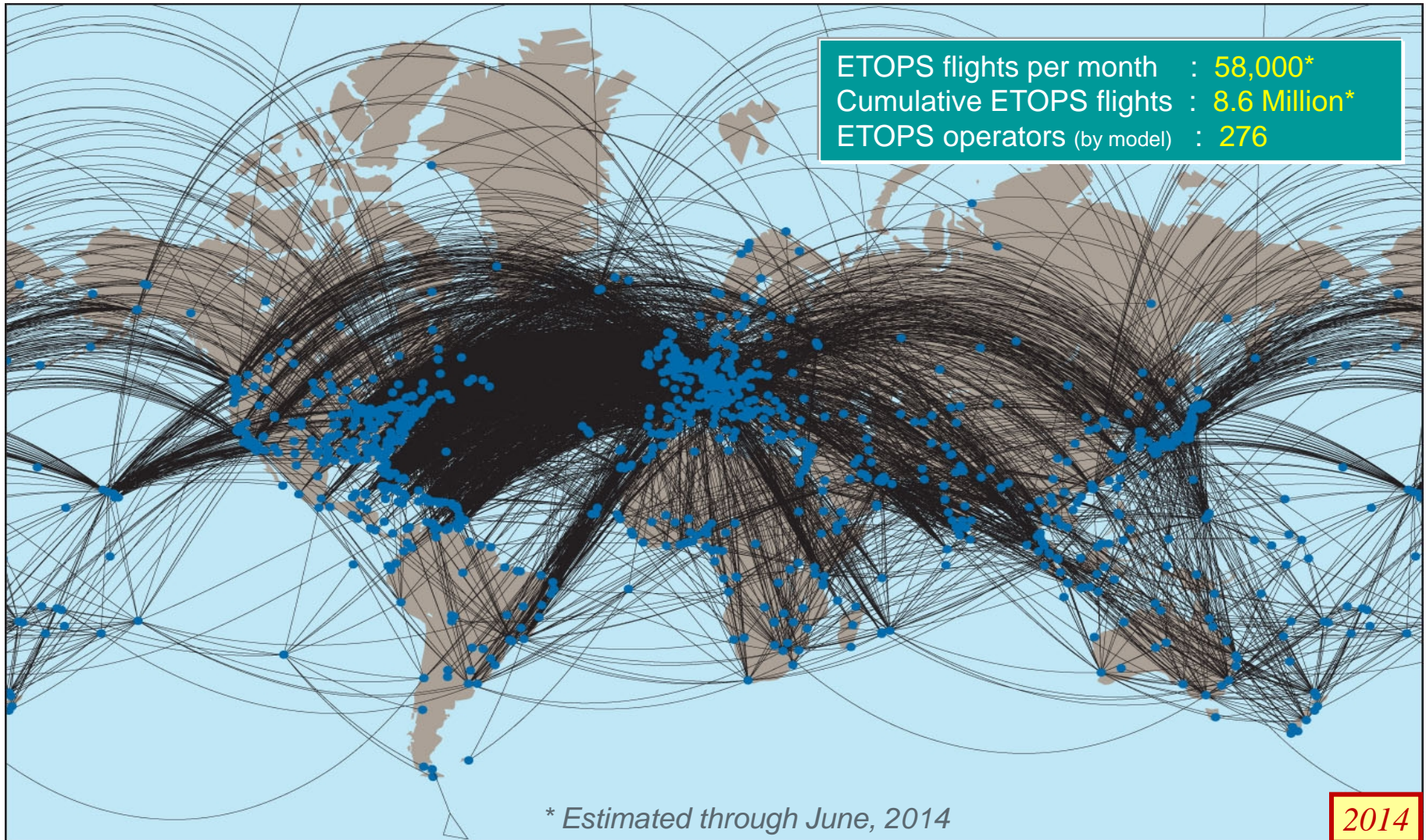


## Preclude and Protect

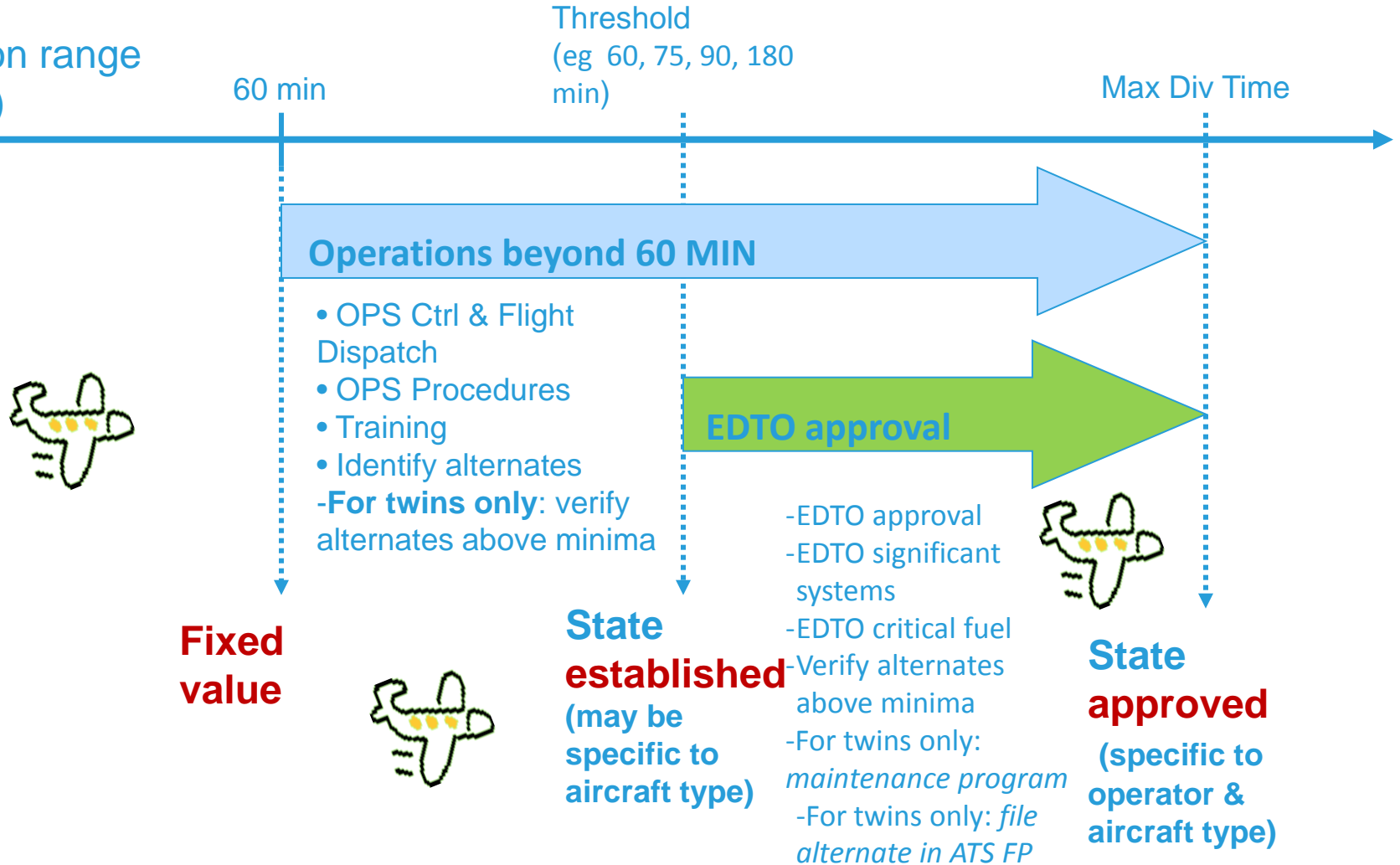




- **EASA ETOPS rules status vs ICAO EDTO criteria:**
  - For twins: requirements of AMC 20-6 Rev 2 are in line with ICAO EDTO criteria
  - For tris/quads: minor adjustments to existing operational regulations may be necessary to match the ICAO EDTO criteria
  - As a consequence, it is likely that the LROPS (Long Range Operations) criteria, which have initially been drafted to assess the need for ETOPS requirements for tris/quads, will not be published as such.
- **FAA ETOPS rules status vs ICAO EDTO criteria:**
  - For twins: requirements of Part 25 and 121 are in line with ICAO EDTO criteria
  - For tris/quads: FAA operational regulation is in line with ICAO EDTO criteria but:
    - FAA ETOPS certification is required for aircraft manufactured from Feb 2015. This is not required by ICAO EDTO criteria
    - FAA ETOPS rule do not apply to cargo airplanes. They are not exempted from ICAO EDTO criteria.
    - The 180 min threshold is based on OEI speed (AEO speed in ICAO criteria)
- **The ETOPS / EDTO rules status in other countries:**
  - For twins: most countries have an ETOPS/EDTO criteria very similar to the FAA or EASA criteria (no major difference between them)
  - For tris/quads: most countries are adopting the ICAO EDTO criteria
    - As of today, only the FAA is requiring an ETOPS certification for tris/quads



## Diversion range (in time)



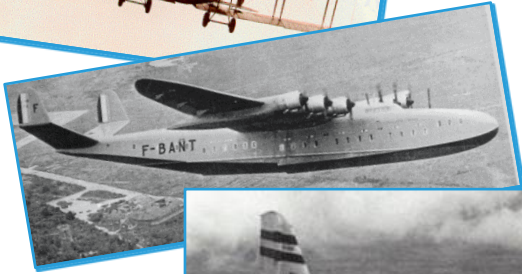
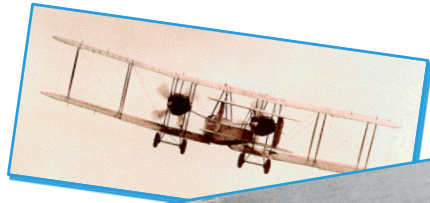


- **EDTO certification & operational requirements apply** whenever a commercial transport aircraft is operated beyond a defined threshold.
  - These requirements also introduce the concept of Maximum Diversion Time, thus defining an approved/authorized area of operations
  
- **The basic concept of ETOPS / EDTO is to:**
  - preclude the diversion (i.e. minimize occurrences); and
  - to protect the diversion should it occur.
  
- These objectives are achieved through
  - **Review of EDTO capability of the aircraft**
  - **EDTO operational approval of the airline**
  
- **ETOPS / EDTO rules have evolved mainly to allow “non-limited” EDTO operations** of latest generation of twin engine aircraft (A330 / A350 / B777 / B787)
  - Some of the ETOPS requirements for twins, based on “Industry Best Practices”, are now applicable to operations beyond applicable threshold (e.g. 180 min) of airplane with more than two engines
    - No change for the vast majority of current long-range operators

# Module 2

## EDTO Basic Concepts





Thank You !!