الإتحاد
ETIHAD

CONTINUOUS CLIMB AND DESCENT OPERATION (CCO & CDO)

ETIHAD SUSTAINABILITY VISION

- Around 2% of global CO_2 emission is produced by the aviation industry.
- Etihad Airways understands the impact of flying on the environment…..
- …..and is therefore adopting a bold leadership position in sustainable aviation technology and innovation.
- Committed to reducing its CO_2 emissions by:
  - 20% by 2025
  - 50% by 2035
  - Net Zero Emission by 2050 (Aligned with IATA Target)

EY'S SUSTAINABILITY JOURNEY SUPPORTS A WIDER UAE AMBITION

The National

The UAE's 2050 net-zero initiative marks a global turning point

Success will require supportive contributions from us all, as one team!

CURRENT SUSTAINABILITY INITIATIVES

- **Modern fleet:**
  - Etihad operates one of the youngest, most innovative and fuel-efficient fleets in the world. F Example - B787 Dreamliner & A350
  - **Contrail Avoidance:**
  - Etihad - in partnership with SATAVIA – is conducting pioneering trials on a weekly basis.
  - Reduces global warming through reduction in creation of contrails and their associated greenhouse impact, measured as 'equivalent – CO2 benefit'

CURRENT SUSTAINABILITY INITIATIVES

- **EcoDemonstrator programme:**
  - It used commercial aircraft as flying testbeds to improve the entire aviation ecosystem; from cabins and landing gears to CO_2 emissions and noise
- **Sustainable Flights:**
  - Many Eco Flights were operated by Etihad.
  - In October 2021, Etihad operated its most environmentally friendly flight to date.
    - Reduced emissions by 72%
    - Powered by 40% SAF.
    - And employing green technologies across all aspects of the flight; operational but also including onboard service and ground handling.

CURRENT SUSTAINABILITY INITIATIVES

- **Fuel efficiency programme:**
  - As part of the programme Etihad strives to continually improve its fuel efficiency performance through:
    - Traditional initiatives e.g. Weight Reduction, Continuous Climb and Continuous Descent Operations, Route Optimization, and
    - More innovative solutions e.g. Flight Deck Advisor, Optimized FMS Winds

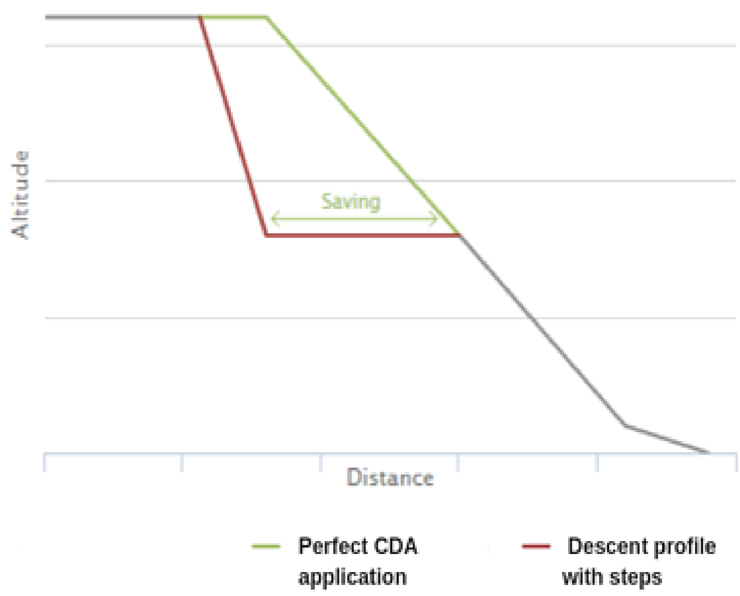
- **Sustainable Fuel:**
  - Etihad supports the development of sustainable fuel and SAF has been used on Etihad Eco Flights

CONTINUOUS CLIMB AND DESCENT OPERATION (CCO & CDO):

- It allows arriving and departing aircraft to descend and climb continually.
- Optimum Climb engine thrust and climb speed is used for CCO.
- Minimum engine thrust is used for CDO to allow low drag.

BENEFITS & CURRENT CONSTRAINTS:

- **Benefits:**
  - Flexible and Optimum Flight Path
  - Reduced Fuel Burn
  - Reduced CO_2 Emission
  - Reduced Noise



- **Constraints:**
  - Traffic Orientation Scheme (TOS): In some cases, aircraft may be required to maintain a particular level due to TOS requirement.
  - SID/STAR Level Requirement: Aircraft maybe required to maintain levels as part of arrival and departure procedures.

CURRENT IMPLEMENTATION

- Etihad has worked closely with Sheikh Zayed Air Navigation Center & ATCs team at Abu Dhabi Airport to obtain CCO/CDO during Eco-flight and normal flights when possible.

NEXT STEP

- Etihad appreciate regional ATCs support in this initiative
- Implementation of CCO/CDO is a good opportunity to reduce CO_2 and save the environment
- Possibility of starting a trial for CCO/CDO in different airports in the region

THANK YOU

Industry View

Global Aviation Industry Targets

2010

1.5% yearly fuel efficiency

Working towards Carbon-Neutral Growth

2020

Carbon-Neutral Growth from 2020

Implementation of global sectoral approach

2050

50% reduction in net CO_2 emissions over 2005 levels

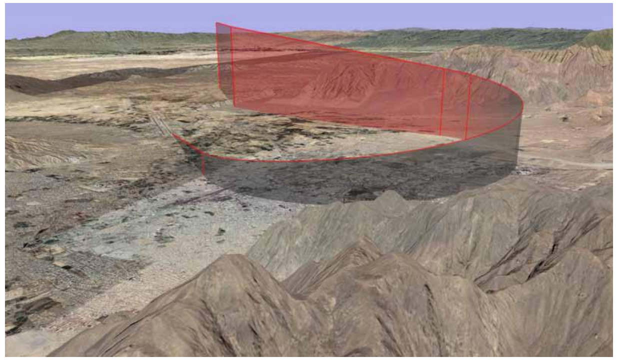
Block 0: Capabilities overview

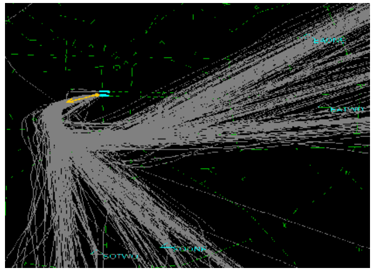
- Improved airport accessibility – using PBN
- Improved flexibility and efficiency in descent profiles – **Continuous Descent Operations (CDO)**
- Improved flexibility and efficiency in departure profiles – **Continuous Climb Operations (CCO)**

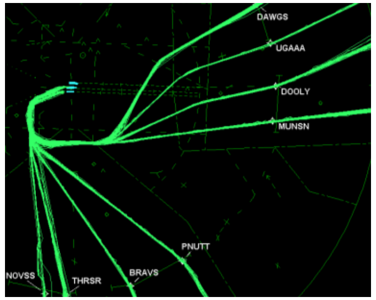
Block 0: Capabilities within our grasp PBN

PBN is **today** and we have to implement it **now**:

- Main enabler for runway safety
- Increase accessibility of airports
- Increase of airspace efficiency
- Environmental solutions (noise and emissions)

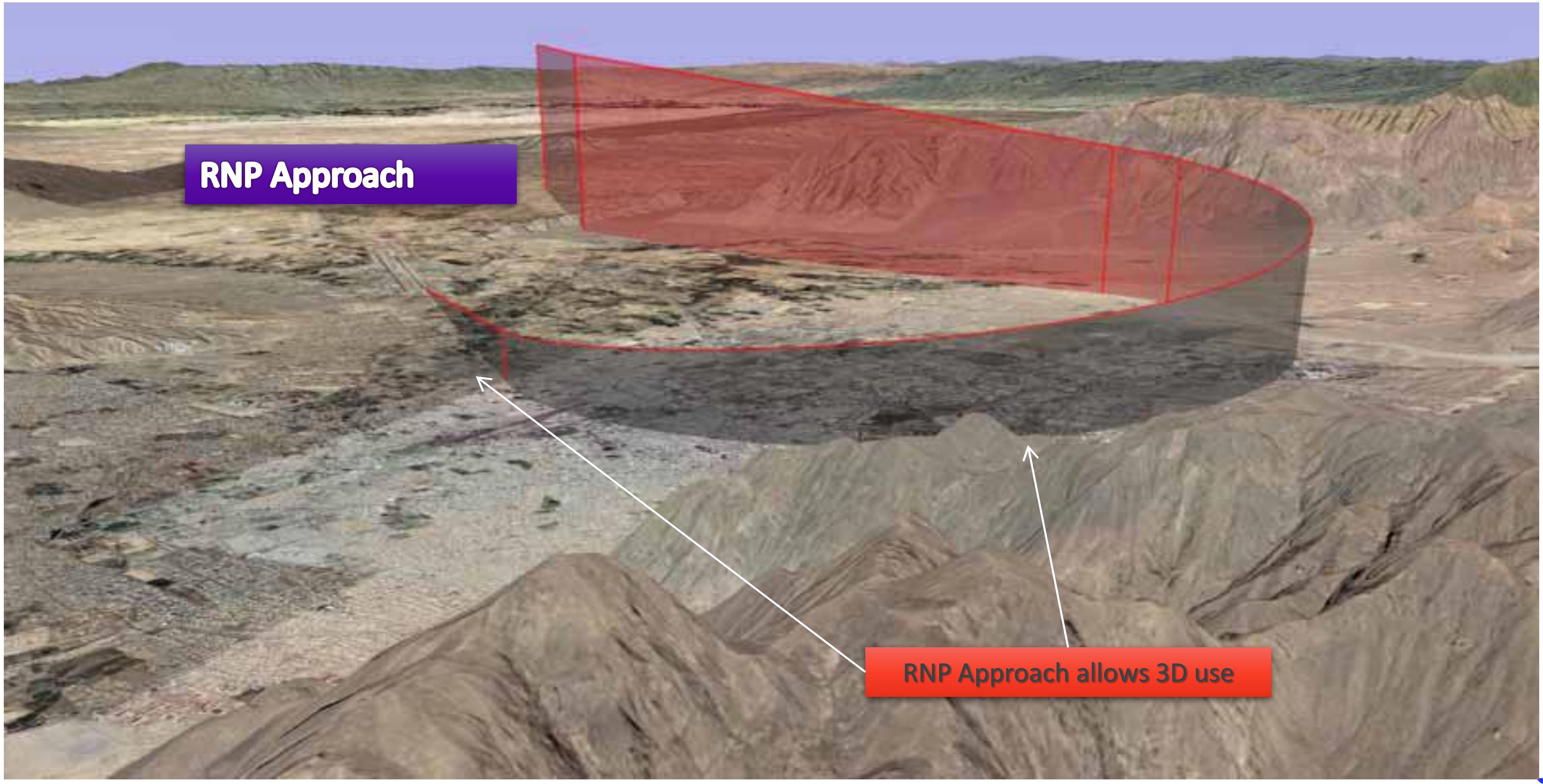






PBN is the key building block for next generation airspace concepts (SESAR, NextGen, etc.)

Safety - Accessibility



Status of PBN Implementation in the MID Region

- The global and MID region PBN implementation status at international airports .

Dec 2020	PBN Approach	LNAV/VNAV	LNAV	PBN SID	PBN STAR
Global (%)	76	59.4	71.4	49.4	44.8
MID (%)	72.1%	46.1	71.5	55.2	55.2

- Implementation of APV procedures are behind global achievement. However, implementation of LNAV and PBN SID/STAR are above the global implementation status.

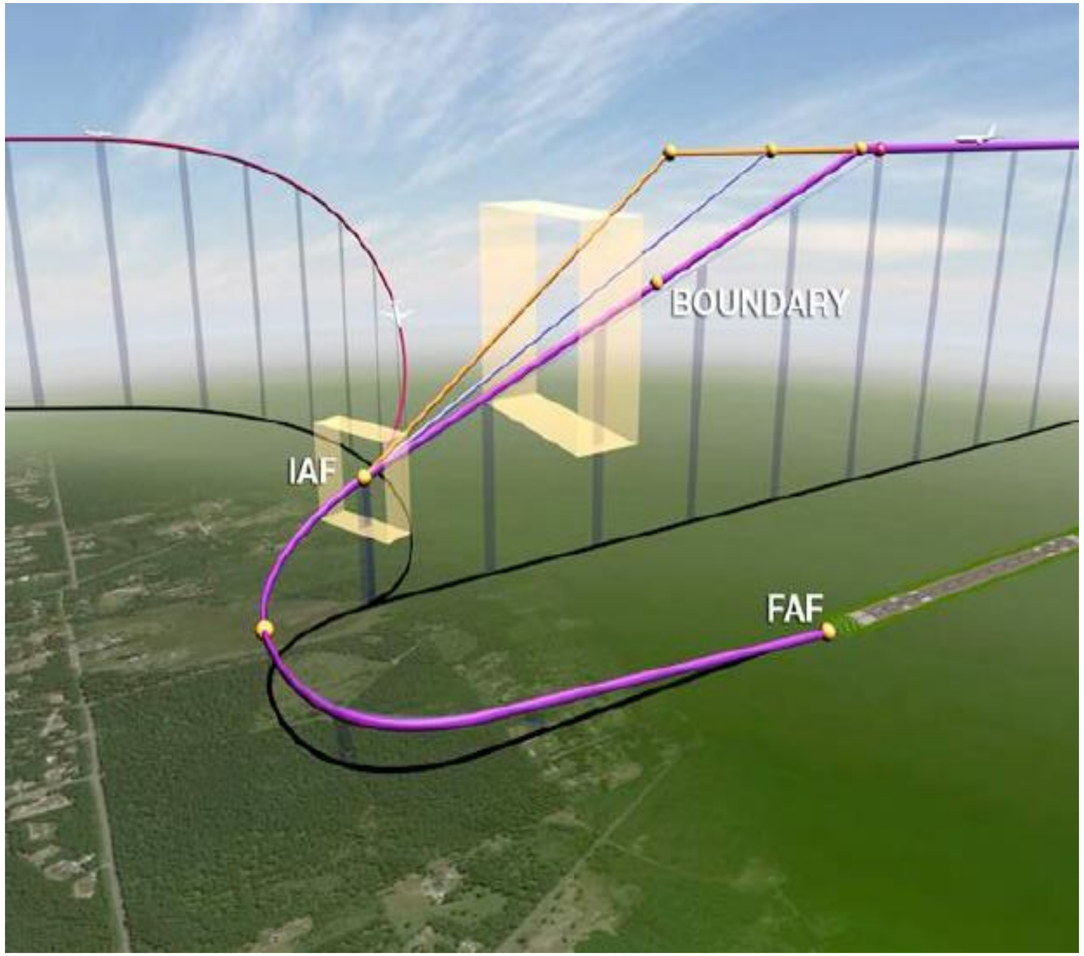
- **CDO/CCO Implementation** : 24 International Airports identified where CCO/CDO implementation would provide significant operational improvements. **71%** of International airports have implemented CDO and **67%** implemented CCO.

Capabilities within our grasp CDO and CCO

CDO and CCO provide significant benefits in terms of:

- Fuel burn reduction
- Gaseous emissions reduction
- Noise reduction

CDO and CCO enabled by **Performance-based Navigation** (PBN)



Challenges and potential constraints

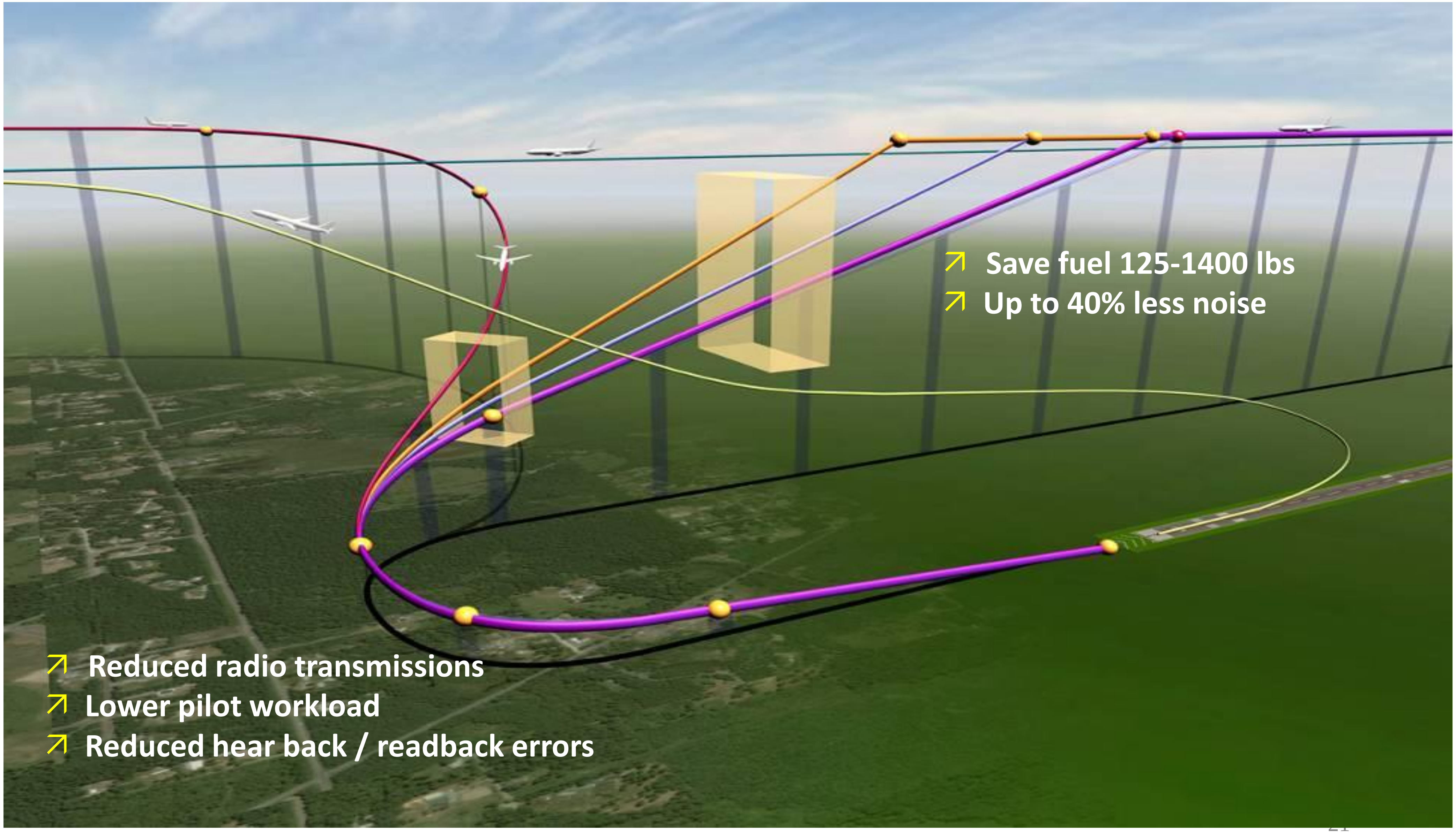
Capacity

- In an optimum airspace configuration, CDO should be **facilitated from the top of descent point to the final approach phase.** However, there is a balance to be struck between **capacity and efficiency**, and this can be due to state boundaries, sector boundaries or local working agreements for the transfer of traffic in a systemised air traffic network. Increased holding in order to carry out CDO may increase fuel burn and so such a scenario is to be avoided.

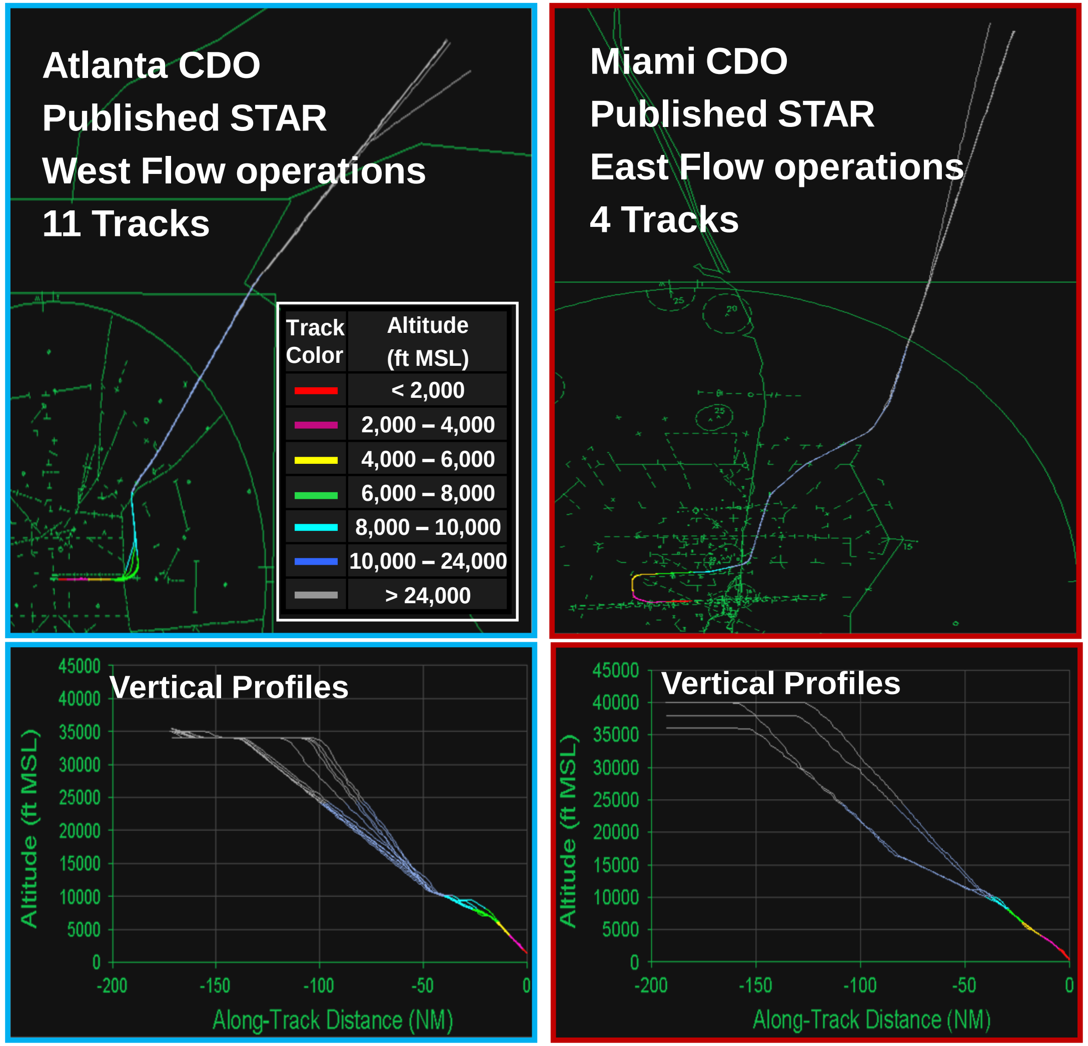
Design CCO and CDO

- Reduce crossing conflicts.
- Enhance capacity and efficiency
- Reduce radio transmissions.
- Reduce mileage flown and reduce sector occupancy times.
- Reduce radar vectoring.
- Improve runway throughput.
- Increase safety

Continuous Descent Operations (CDOs)



Fuel savings/emission reduction



Atlanta (ATL) :

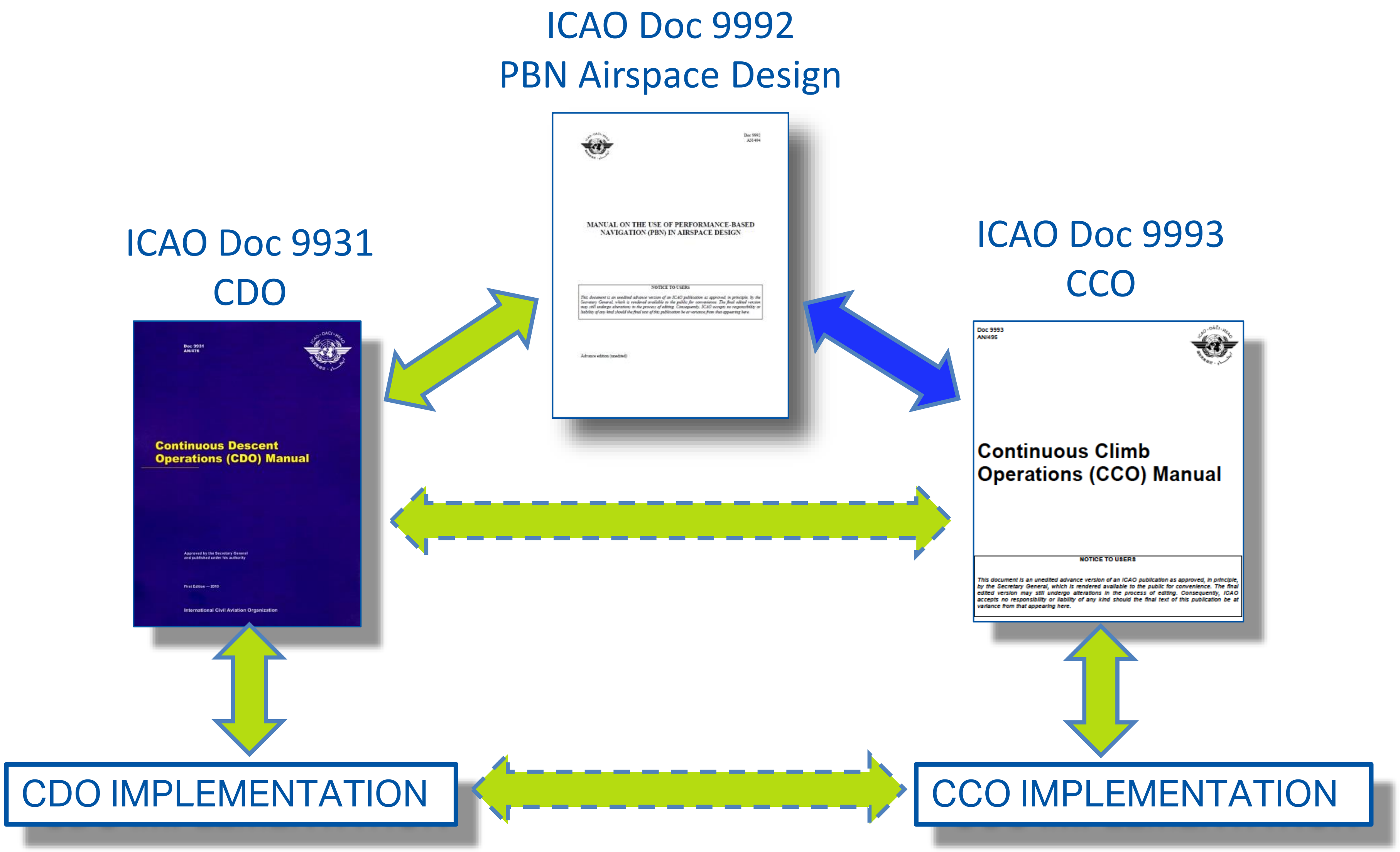
- North Arrival STAR at Atlanta (ATL)
  - 144 Liters of fuel savings and 360kg reduction in CO2 emissions per flight
- North Arrival STAR at Miami (MIA)
  - 182-197 liters of fuel savings and 460-500kg reduction in CO2 emissions per flight

Pilot and ATC Benefits of CCO and CDO

- **Fewer radio transmissions**
  - Less chance of readback/hearback errors
  - Safety improvement
  - Reduced pilot and controller workload
- **Greater predictability**
  - Flight path
  - Turn points
  - Reduced TAWS / CFIT exposure
- **Less transit occupancy time in airspace**
- Fuel and emissions savings

IATA

CDO & CCO Design Relationship

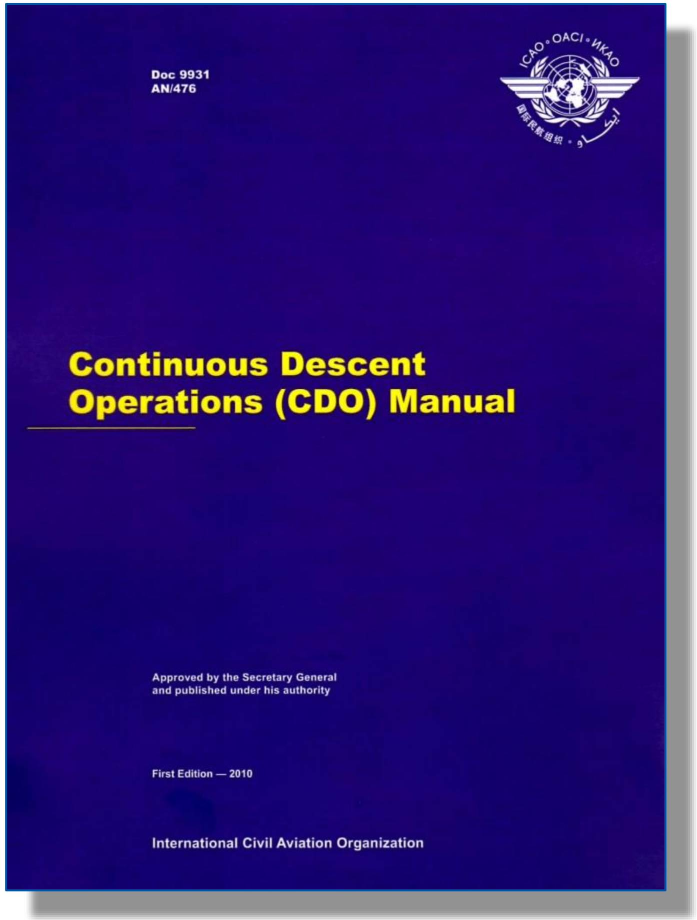


Continuous Descent Operations (CDO) Manual

ICAO Doc 9931

First Edition published 2010

- CDO is an aircraft operating technique
- enabled by airspace design, procedure design and
- facilitated by ATC
- in which an arriving aircraft descends continuously, to the greatest extent possible, using minimum engine thrust and low drag.

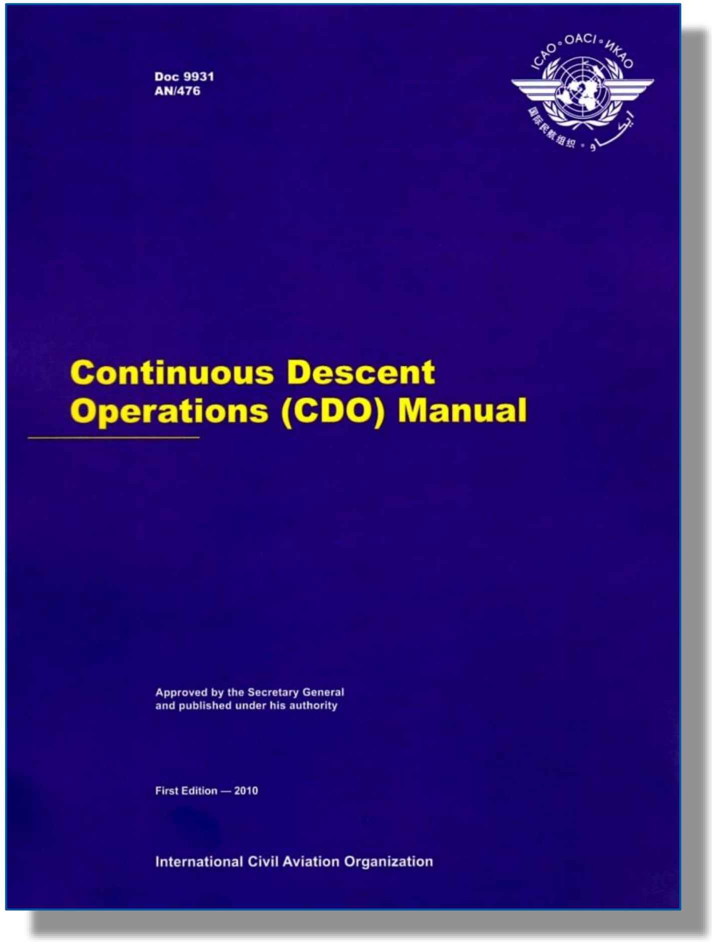


CDO Planning

- Accurate planning for an optimum descent path is facilitated by the **pilot and/or the FMS knowing the flight distance to the runway** and the **level above the runway** at which the CDO is to be initiated.

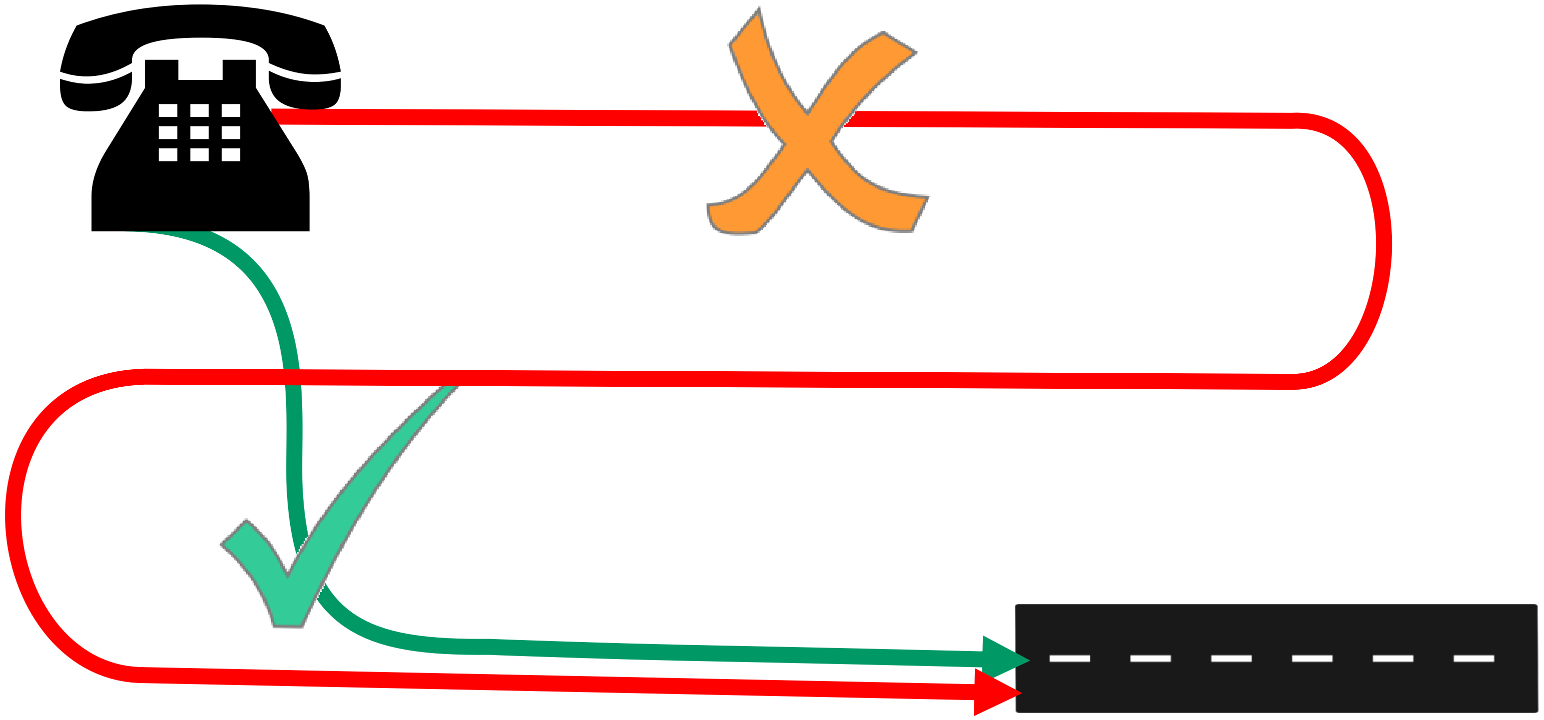
- Thus, a CDO requires **planning and communication between the pilot and the air traffic controller.**

- A CDO design is **integrated** within the **airspace concept** and must **balance** the needs of departing aircraft with the CDO arrival aircraft.



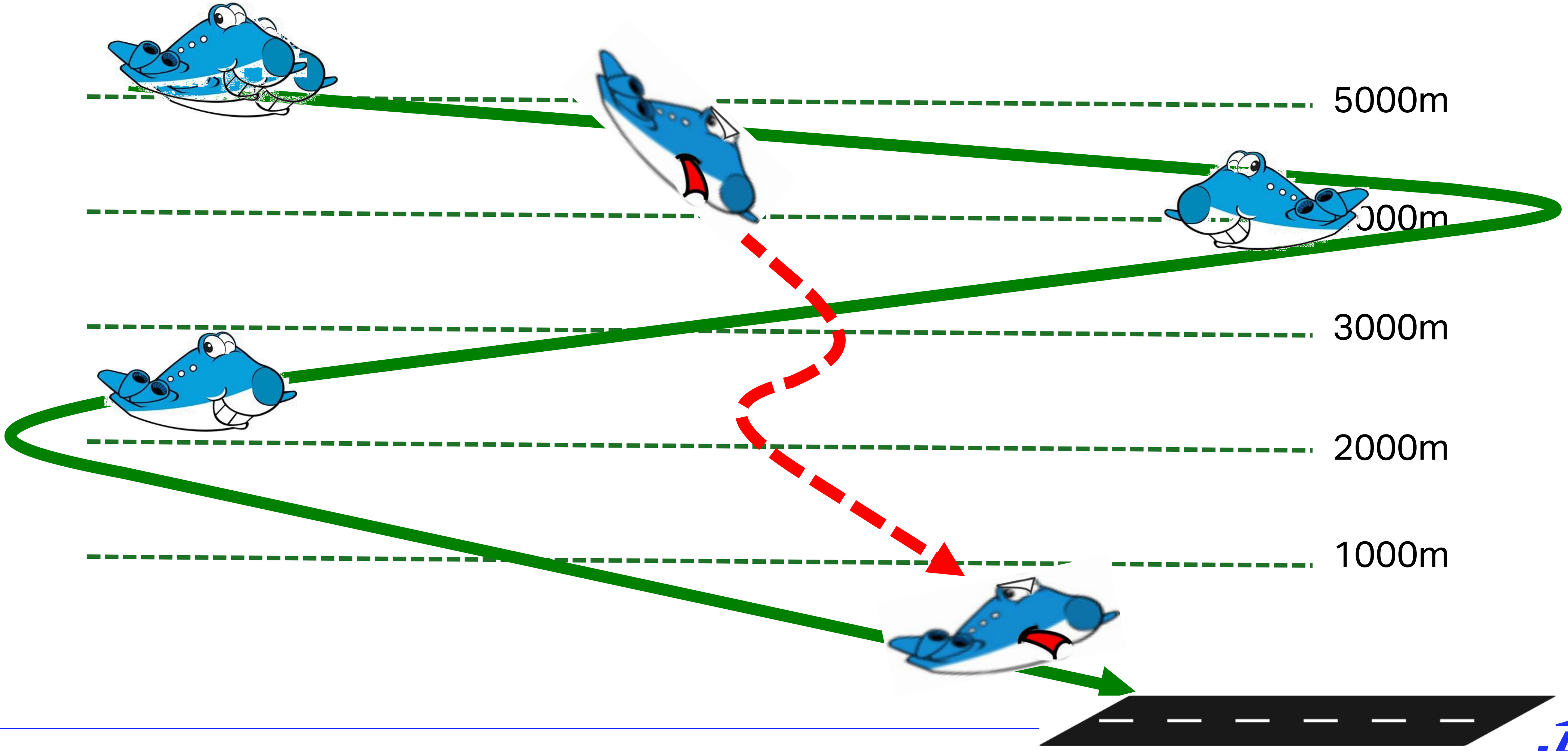
CDO

- Designs should select the shortest path



CDO

- **Long path plus "shortcuts" are inefficient**



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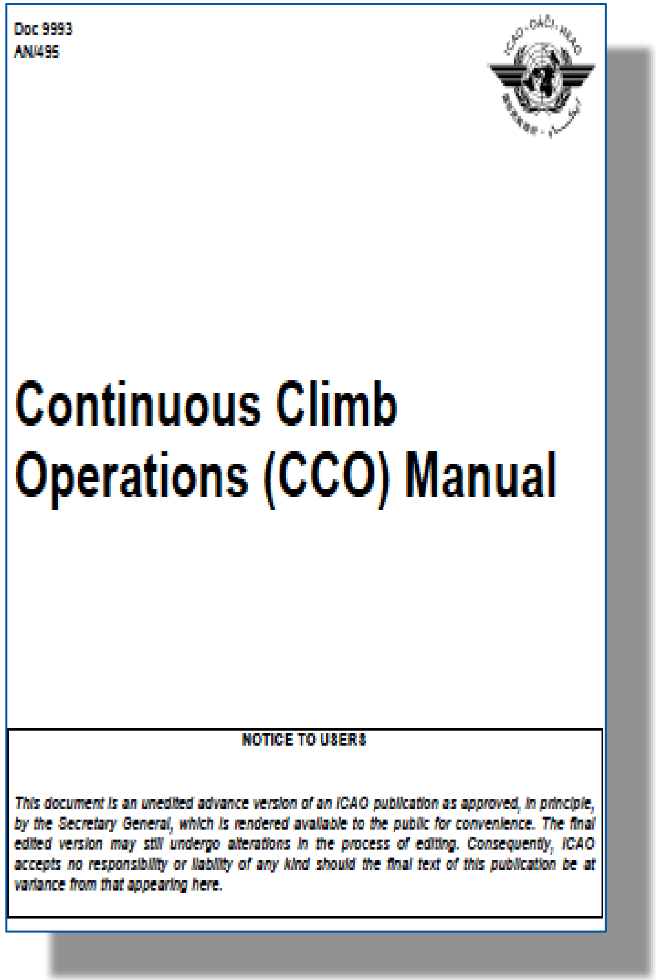
CCO Definition & Planning

ICAO Doc 9993

- CCO is an aircraft operating technique made possible by

  1. appropriate airspace and procedure design
  2. appropriate ATC clearances

- enabling the execution of a flight profile optimized to the performance of the aircraft, allowing the aircraft to **attain initial cruise** flight level **at optimum air speed** with climb engine thrust setting set throughout the climb, thereby **reducing total fuel burn and emissions** during the whole flight.


Doc 9993
AN/495

Continuous Climb Operations (CCO) Manual

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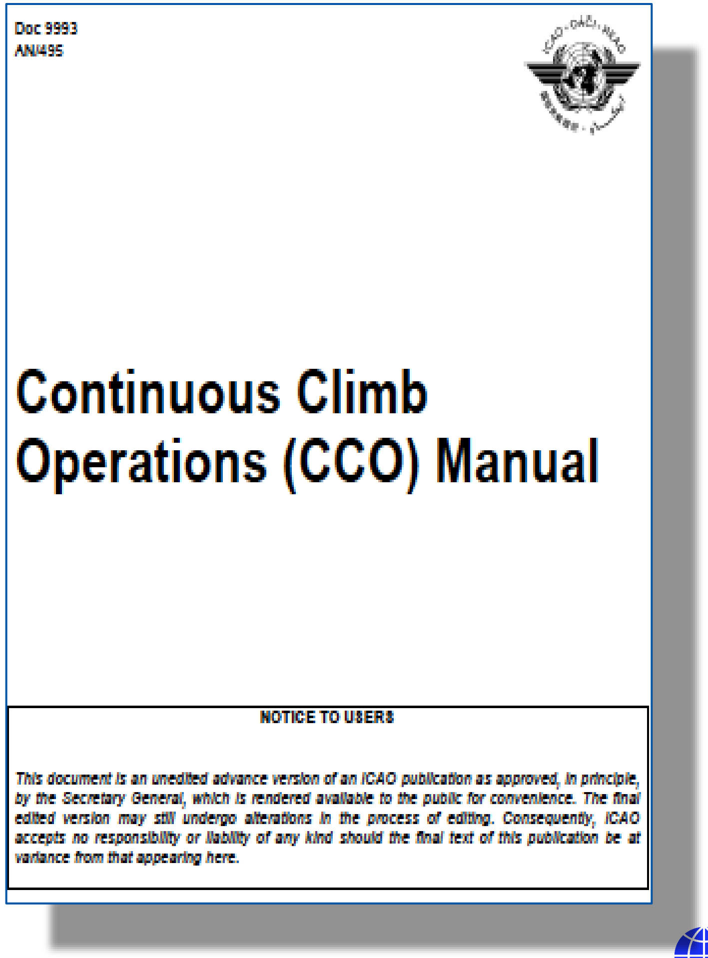
CCO & CDO Design Methods

BALANCE:

•Where a trade-off between CCO and CDO is unavoidable, the local analysis and decision making should **take into account** that a level segment for an aircraft in **descent** would normally **burn less fuel** than for the same duration of level segment for an **equivalent aircraft in climb**.

•The balance will depend on local characteristics such as the **extent of level flight in both phases**, the **significance of noise** in the areas affected etc.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Challenges and potential constraints

Military airspace

- A significant contributory factors to CCO / CDO and vertical flight inefficiency is the sharing of airspace between civil and military airspace users, the activation of a military reserved area may restrict aircraft from flying their optimal climb or descent profile in the activation time window because they have to level-off below or above it.

- **GNSS/GPS Vulnerability /Jamming**

GPS Interference

Reported in MID Region Jan-Dec. 2021

GADM members

- **Flight Data Exchange (FDx)**

5800 + Total number of aircraft

166 Airline members

15 Airlines from MENA

- **Incident Data base (IDx)**

212 Airline /GSP members

27 from MENA

Background – GNSS/GPS Vulnerability

- GNSS is a key technology of the Communications, Navigation, and Surveillance (CNS) infrastructure. GNSS can **support** navigation applications in all phases of flight as well as surveillance application like ADS-B. GNSS is also used in safety nets like the EGPWS (Enhanced Ground Proximity Warning Systems) and provides **the time reference** that is used to synchronize systems and operations in ATM.
- GNSS/GPS vulnerability, including **intentional and unintentional signal** interference, has been identified as a major safety issue in MID Region as GNSS is embedded into numerous critical infrastructures. Especially the intentional interference presents significant threat to aircraft and passengers. Therefore, such interference needs to be **monitored and its operational risk needs to be assessed.**
- GADM IDX program enables identifying **hot spots and trends** of reported GNSS/GPS interference reports. Furthermore, GADM NOTAM repository enables tracking of any NOTAMs issued by States to inform potential GNSS/GPS Interferences to Airspace Users.
- To monitor the potential GNSS/GPS interference risk, IATA FDX program introduced **new event of GPS outage from August 2021.**

Background – GNSS/GPS Vulnerability

In April 2019, the RASG-MID released the guidance material to GNSS vulnerabilities to mitigate the safety and operational impact of GNSS service disruption. The guidance recommends **pilots to report GNSS interference** and **ANSP to issue appropriate advisories and NOTAMs**.

To support the joint-effort monitoring the GNSS/GPS Interference in the region, IATA GADM presented the first version of GNSS/GPS interference analysis in **November 2020** and second version in **July 2021**. The GNSS/GPS Interference was published in 10th MID Annual Safety Report (2021) as one of the **emerging safety risks** in ICAO MID region.

In February 2022, the MIDANPIRG/19 & RASG/9-WP/16 was presented by IATA to provide the status of the GNSS and Radio Altimeter Interferences and proposed development of **standard NOTAM text template** to be used for GNSS Interference, to facilitate operators in filtering and searching through the NOTAMs.

In a continuous monitoring the regional safety risk of GNSS/GPS Interference, this analysis is presented to provide updated **figure until 2021 December** of GNSS/GPS Interference in MENA and adjacent countries.

IATA

Analysis Scope – Data Coverage

This GNSS/GPS Interference analysis has completed using two dataset in GADM: **IDX (Incident Data Exchange)**, **FDX (Flight Data Exchange)** data and **NOTAM** information also held in IATA.

Incident Data Exchange (IDX)

IDX Incidents

Total **586** GNSS/GPS jamming or suspected interference reports from MENA and adjacent States have been reported by **15** operators in Incident Data Exchange (IDX).

- 2021 January ~ 2021 December (1 year)

Flight Data Exchange (FDX)

FDX Flight Data

Total **46,936** GPS signal lost events from **38 operators** from MENA and adjacent States have been extracted from Flight Data Exchange (FDX) dataset.

- 2021 August ~ 2021 December (5 months)

NOTAM

105 GNSS/GPS interference NOTAMs were extracted from NOTAM archive issued over MENA States.

- 2021 January ~ 2021 December (1 year)
- Source: FAA SWIFT Portal

2021 Monthly Data Coverage

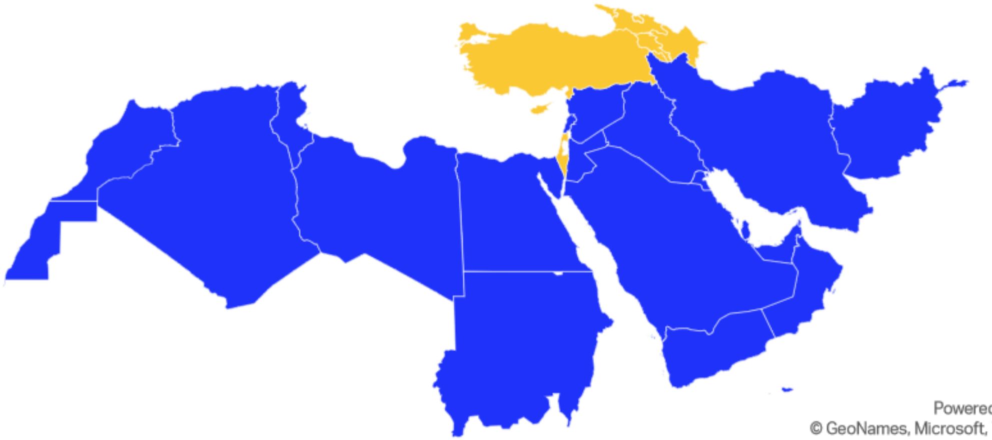
Both IDX and NOTAM data have full coverage of the year 2021.

However, the FDX event "GPS signal lost" was introduced in August 2021, and therefore, only flight data submitted after August 2021 contain "GPS signal lost" event. For consistent rate monitoring, the FDX event "GPS signal lost" was extracted for flights conducted only from August 2021.

	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
IDX	covered	covered	covered	covered	covered	covered	covered	covered	covered	covered	covered	covered
FDX*	not covered	not covered	not covered	not covered	not covered	not covered	not covered	covered	covered	covered	covered	covered
NOTAM	covered	covered	covered	covered	covered	covered	covered	covered	covered	covered	covered	covered

Analysis Scope – Geographic Scope

In previous analyses, it was that a considerate amount of the GNSS/GPS interferences were reported across the international borders. Therefore, the analysis is based on airports and airspaces in the expanded geographic coverage of MENA and adjacent States as below.



IATA MENA States:

- Afghanistan, Algeria, Bahrain, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Sudan, Syria, Tunisia, UAE, Yemen

Adjacent States included in this analysis:

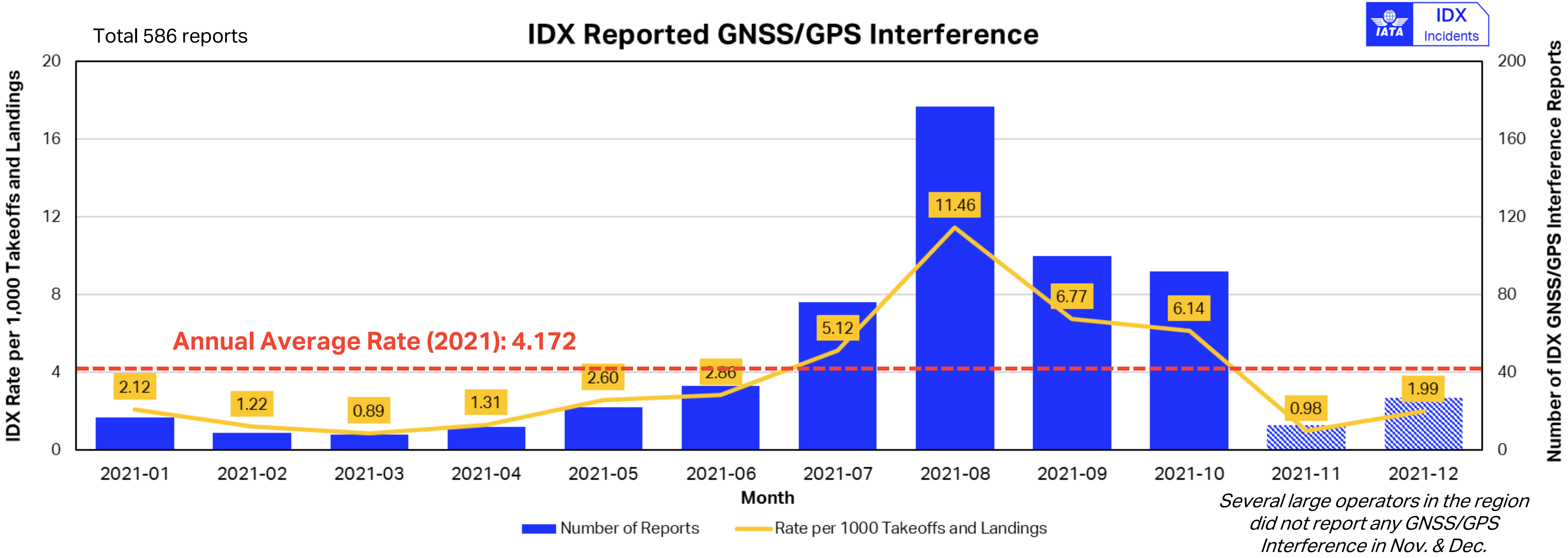
- Armenia, Azerbaijan, Cyprus, Georgia, Israel, Turkey

List of FIRs (Flight Information Regions)

In alphabetical order of FIR Code (as per 2021 December)

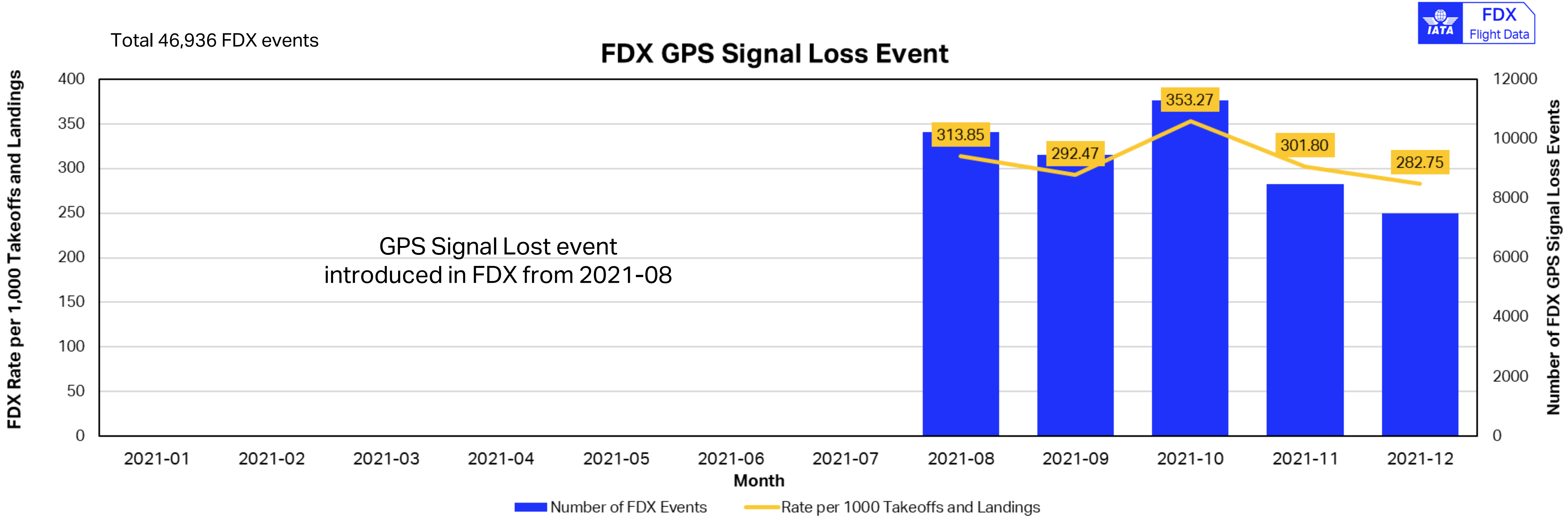
FIR Code	FIR Name	Country Code	Country
DAAA	Algiers	DZA	Algeria
DTTC	Tunis	TUN	Tunisia
GMMM	Casablanca	MAR	Morocco
HECC	Cairo	EGY	Egypt
HLLL	Tripoli	LBY	Libya
HSSS	Khartoum	SDN	Sudan
LCCC	Nicosia	CYP	Cyprus
LLLL	Tel-Aviv	ISR	Israel
LTAA	Ankara	TUR	Turkey
LTBB	Istanbul	TUR	Turkey
OAKX	Kabul	AFG	Afghanistan
OBBB	Bahrain	BHR	Bahrain
OEJD	Jeddah	SAU	Saudi Arabia
OIIX	Tehran	IRN	Iran
OJAC	Amman	JOR	Jordan
OKAC	Kuwait	KWT	Kuwait
OLBB	Beirut	LBN	Lebanon
OMAE	Emirates	ARE	UAE
OOMM	Muscat	OMN	Oman
ORBB	Baghdad	IRQ	Iraq
OSTT	Damascus	SYR	Syria
OYSC	Sanaa	YEM	Yemen
UBBA	Baku	AZE	Azerbaijan
UDDD	Yerevan	ARM	Armenia
UGGG	Tbilisi	GEO	Georgia

GNSS/GPS Interference Trend



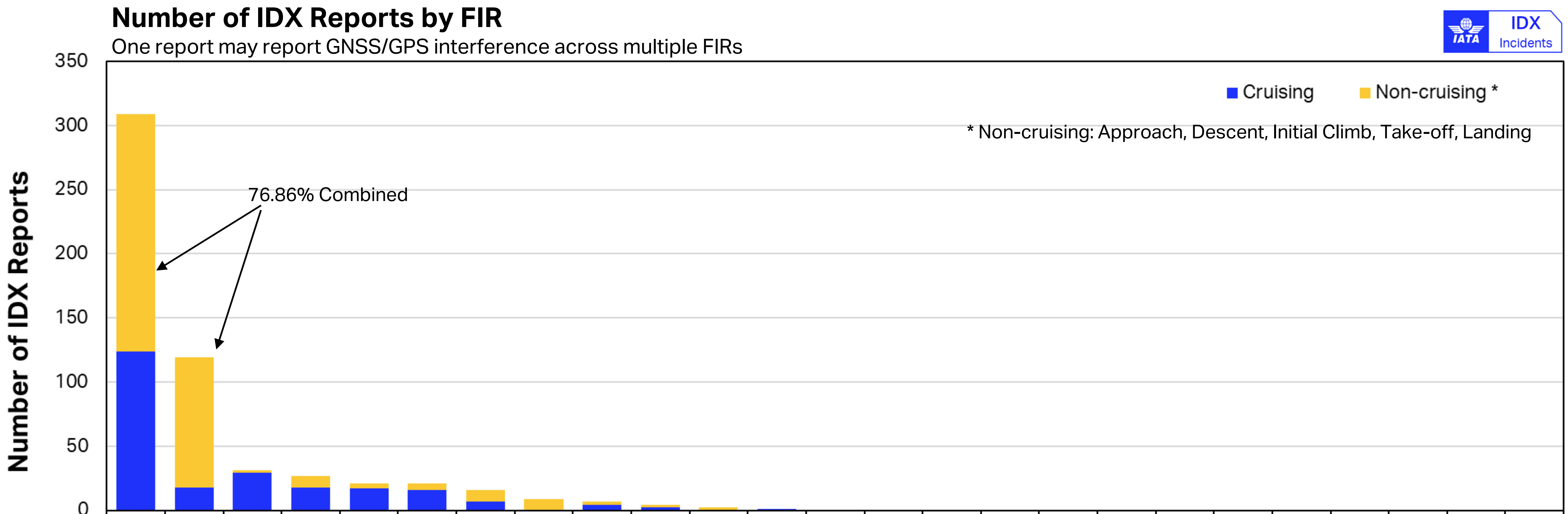
The number of GNSS/GPS interference reports has increased significantly during June ~ August 2021, peaked in August with the rate of 11.46 per 1,000 takeoffs and landings. Afterwards, the rate of GNSS/GPS Interference has been decreased to 6.77 and 6.14 in September and October, then dropped below than the annual average of 4.17 in November and December.

GNSS/GPS Interference Trend



However, the FDX rate shows relevantly consistent event rate from August to December 2021. Considering (1) the number of FDX events (46,936 events) was larger than IDX reports (586 reports), (2) the number of FDX operators with at least one event (38 operators) was higher than the ones from IDX (15 operators) and (3) the difference of data collection methods, where IDX event relies on voluntary reporting from crew, while FDX event is captured automatically from the flight data recorder, it is likely that the GNSS/GPS interference in the region may not have decreased during August ~ December 2021, as shown in FDX rate.

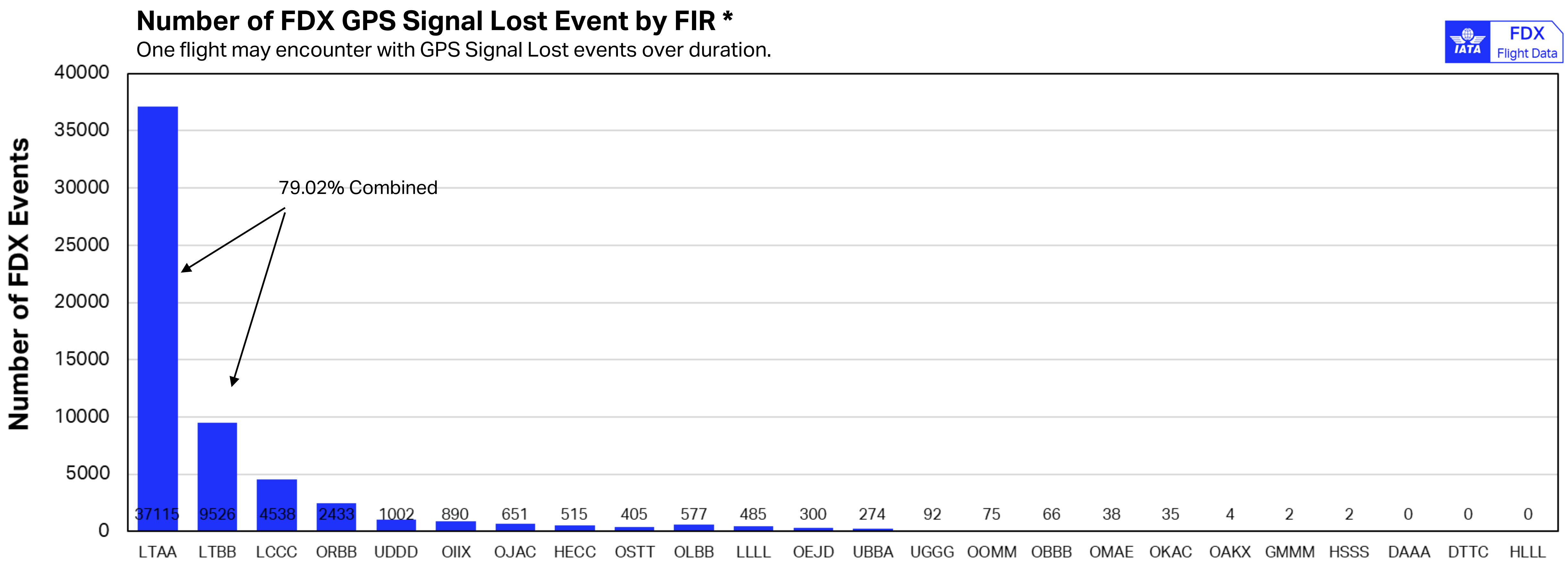
Distribution of GNSS/GPS Interference by FIR



	LTAA	LTBB	OIIX	LCCC	HECC	ORBB	LLLL	OLBB	OJAC	UBBA	OBBB	OMAE	DAAA	DTTC	GMMM	HLLL	HSSS	OAKX	OEJD	OKAC	OOMM	OYSC	UDDD	UGGG	OSTT
Non-cruising *	185	101	2	9	4	5	9	9	3	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cruising	124	18	29	18	17	16	7	0	4	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0

In IDX, the FIR with highest number of reported GNSS/GPS Interferences was **LTAA (Ankara FIR)**, followed by **LTBB (Istanbul FIR)**, **OIIX (Tehran FIR)**, **LCCC (Nicosia FIR)**, **HECC (Cairo FIR)**, **ORBB (Baghdad FIR), LLLL (Tel-Aviv FIR), OLBB (Beirut FIR)** and **OJAC (Amman FIR)**. The rest of the FIRs had less than 10 reported GNSS/GPS Interference. 76.86% of all GNSS/GPS Interference reports was collected in Turkish FIRs. Notably, the number of reports in **LTBB (Istanbul FIR)** has significantly increased compared to previous analysis.

Distribution of GPS Signal Lost by FIR



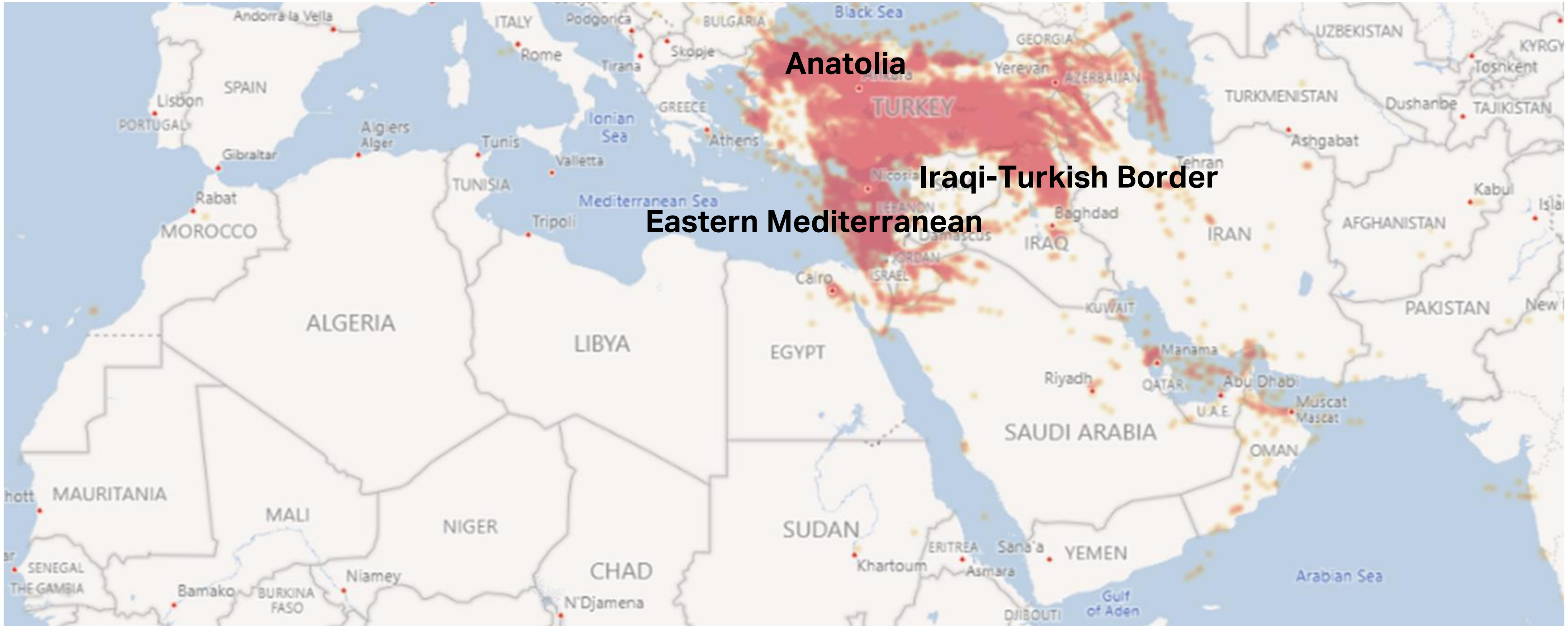
Similarly, the FIR with highest number of FDX GPS Signal Lost events was **LTAA (Ankara FIR)**, followed by **LTBB (Istanbul FIR)**, **LCCC (Nicosia FIR)**, **ORBB (Baghdad FIR), UDDD (Yerevan FIR), OIIX (Tehran FIR), OJAC (Amman FIR), HECC (Cairo FIR)**, **OSTT (Damascus FIR), OLBB (Beirut FIR), LLLL (Tel-Aviv FIR), OEJD (Jeddah FIR) and UBBA (Azerbaijan).** The distribution of GPS Signal Lost event from FDX follows similar pattern of that from IDX. The rest of the FIRs had less than 100 GPS Signal Lost Events.

GPS Signal Lost Hot-Spots

Reported coordinates of FDX GPS Signal Lost Event

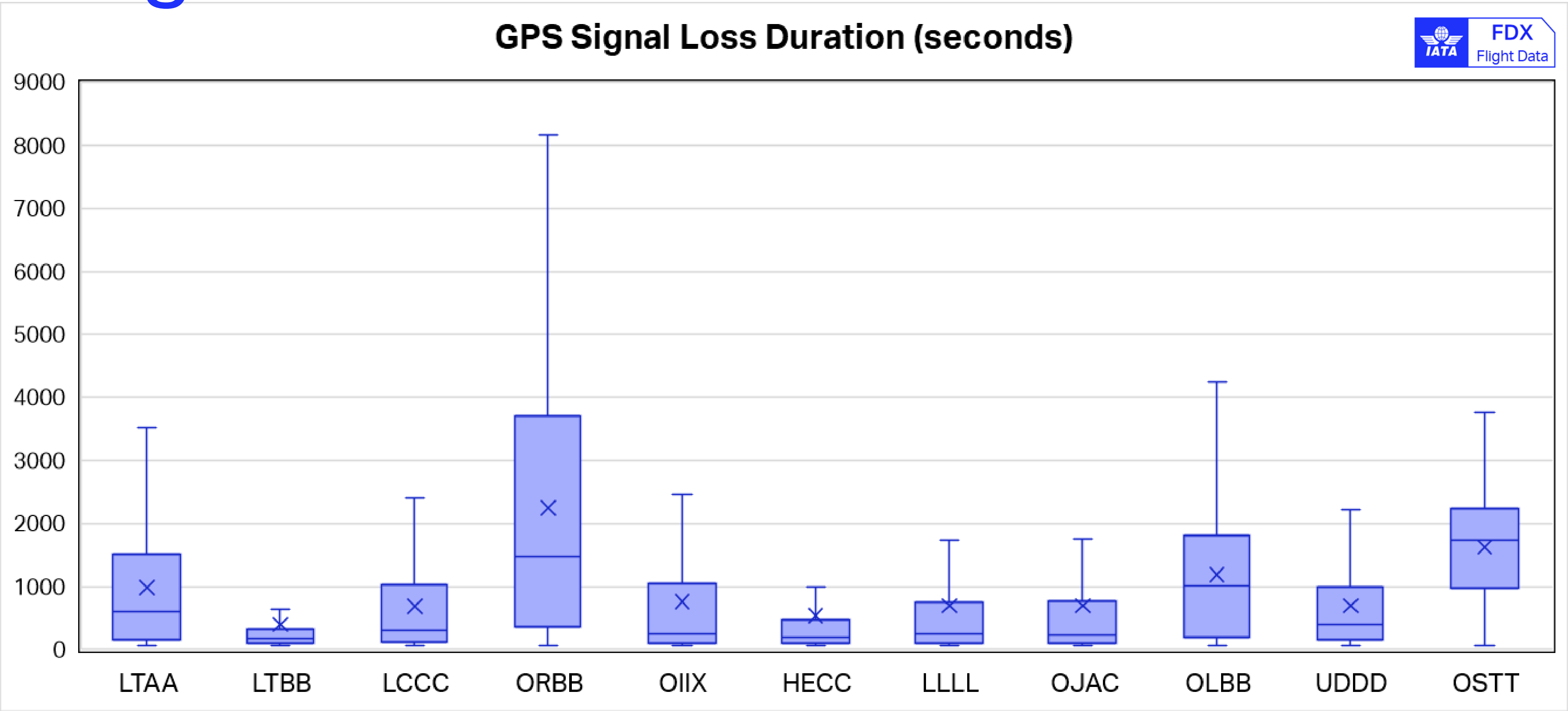
One flight may encounter with GPS Signal Lost events over duration.

FDX Flight Data



Majority of GPS Signal Lost was detected within or in vicinity of Turkish airspace (Ankara FIR and Istanbul FIR), and in Eastern Mediterranean area. Compared to previous analysis, the identified hot-spots have been expanded into entire Anatolian peninsula, including Istanbul FIR (LTBB).

GPS Signal Lost Duration



Sorting by average seconds of GPS Signal Lost duration in descending order, **ORBB (Baghdad FIR)** had the longest duration, in average of 2,251 seconds, followed by **OLBB (Beirut FIR)** with 1,184 seconds, **LTAA (Ankara FIR)** with 984 seconds, **OIIX (Tehran FIR)** with 760 seconds, **OJAC (Amman FIR)** with 699 seconds, **LLLL (Tel-Aviv FIR)** with 697 seconds, **UDDD (Yerevan FIR)** with 691 seconds, **LCCC (Nicosia FIR)** with 687 seconds, **HECC (Cairo FIR)** with 536 seconds and **LTBB (Istanbul FIR)** with 402 seconds.

GNSS/GPS Interference NOTAM Issued

Active GNSS/GPS Interference NOTAM Coverage from 2021-01 to 2021-12

Yellow Cell: One or more than one NOTAMs warning about potential GNSS/GPS Interference were active during the month.
Red Cell: More than 3 GNSS/GPS Interferences were reported in IDX but no warning NOTAM was active during the month.

IDX Incidents

FIR		2021-01	2021-02	2021-03	2021-04	2021-05	2021-06	2021-07	2021-08	2021-09	2021-10	2021-11	2021-12	# of NOTAM Issued
Ankara FIR	LTAA	10	5	4	5	17	23	40	88	77	57	8	7	3
Istanbul FIR	LTBB	0	1	1	2	2	7	11	70	12	28	0	0	1
Nicosia FIR	LCCC	4	2	1	1	1	0	7	4	1	1	0	7	2
Baghdad FIR	ORBB	0	0	2	0	1	3	7	6	1	1	0	0	3
Teheran FIR	OIIX	0	0	0	0	0	1	1	0	0	9	10	10	25
Cairo FIR	HECC	1	1	0	3	0	0	3	0	1	2	0	10	1
Tel-Aviv FIR	LLLL	1	1	0	1	0	0	8	3	1	0	0	2	49
Amman FIR	OJAC	0	0	1	0	0	0	2	1	0	1	0	2	2
Beirut FIR	OLBB	0	0	0	0	2	0	2	1	3	2	0	0	2

In most of the FIRs with reported GNSS/GPS Interferences, there were active NOTAMs warning the operators about potential GNSS/GPS Interference risk. However, In Istanbul FIR on 2021 June, Baghdad FIR on 2021 July ~ August and Cairo FIR on 2021 December, there were no NOTAM warning operators about the GNSS/GPS Interference risk.

Some FIRs such as OIIX (Teheran FIR) and LLLL (Tel-Aviv FIR), had issued high number of NOTAMs with short durations (e.g. several days or hours), while other part of the area issued NOTAMs with longer duration.

- Data Source: Federal NOTAM Service (FNS), Distributed from SWIFT Portal: https://portal.swim.faa.gov/

Acronyms List

- **ADS-B**: Automatic Dependent Surveillance - Broadcast
- **ANSP**: Air Navigation Service Provider
- **ASR:** Air Safety Report
- **ATM**: Air Traffic Management
- **ECAM**: Electronic Centralized Aircraft Monitor
- **EGPWS/GPWS**: (Enhanced) Ground Proximity Warning System
- **EICAS**: Engine-Indicating and Crew Alerting System
- **FIR**: Flight Information Regions
- **FMS**: Flight Management System
- **GADM:** Global Aviation Data Management
- **GNSS**: Global Navigation Satellite System
- **GPS**: Global Positioning System
- **IDX**: Incident Data Exchange
- **MENA**: Middle East and North Africa
- **ND**: Navigation Display
- **NOTAM**: Notice-to-Airmen
- **PBN**: Performance Based Navigation
- **RAIM**: Receiver Autonomous Integrity Monitoring
- **RASG-MID**: Regional Aviation Safety Group – Middle East
- **RNP**: Required Navigation Performance
- **TAWS**: Terrain Awareness and Warning System

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Beyond Planning…

ICAO and its partners are already addressing roll-out of PBN and associated airspace design features such as CDO and CCO.

But assistance and full support from all our aviation stakeholders is needed.

Thank you!