Agenda Item 5 – CDO/CCO Implementation

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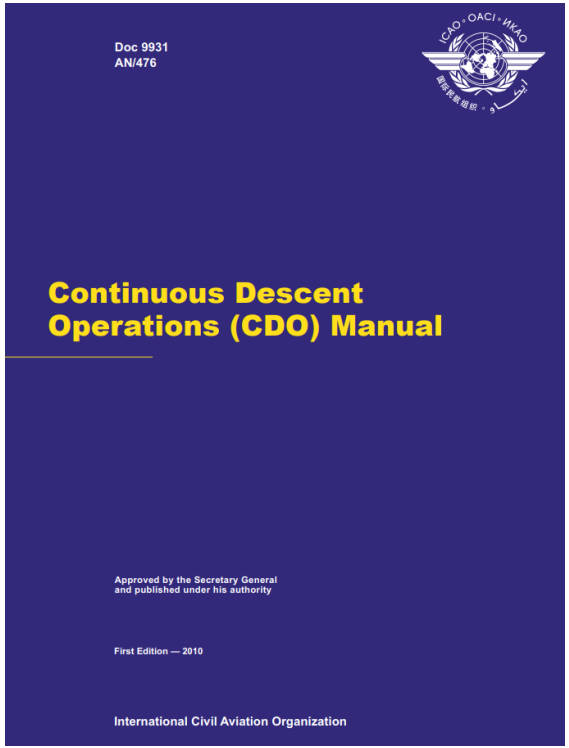
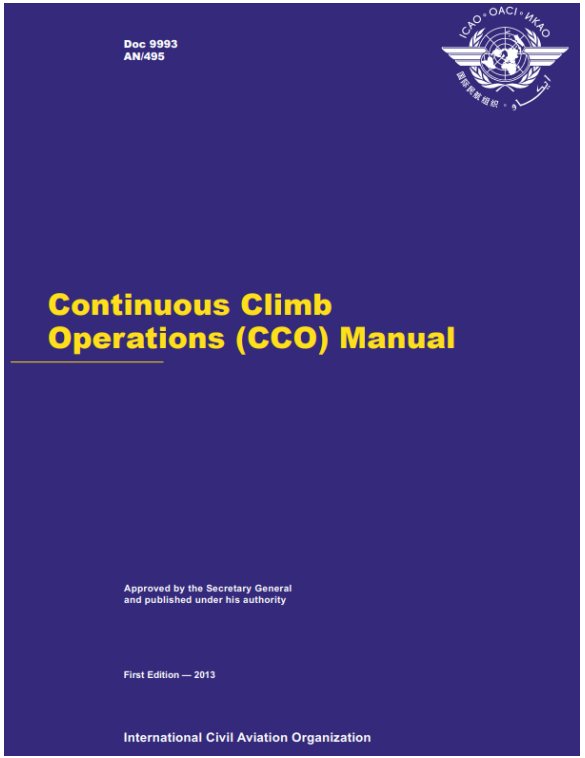

Doc 9931
AN/476
Continuous Descent Operations (CDO) Manual
Approved by the Secretary General and published under his authority
First Edition — 2010
International Civil Aviation Organization


Doc 9993
AN/495
Continuous Climb Operations (CCO) Manual
Approved by the Secretary General and published under his authority
First Edition — 2013
International Civil Aviation Organization

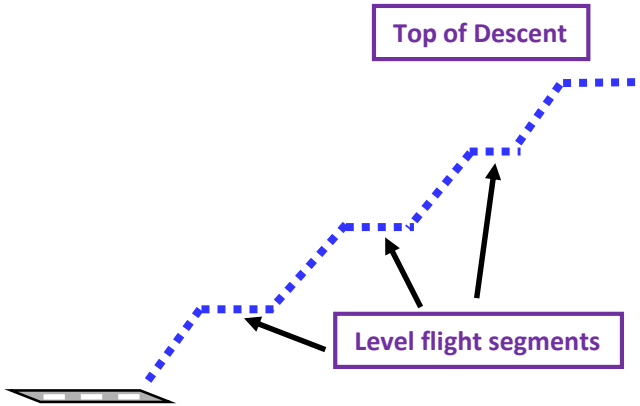
GENERAL OVERVIEW

APAC Seamless ANS Plan - APTA-B0/4 – 5, 7 – 8: CDO (Basic) and CCO (Basic)

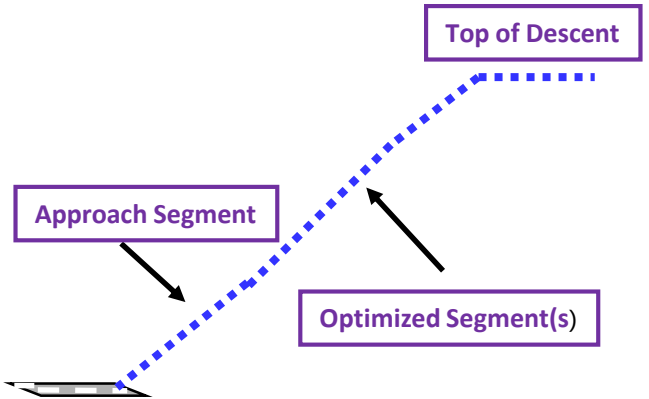
- CDO is an aircraft operating technique
  - Aided by appropriate airspace design, procedure design, and appropriate ATC clearance
  - Enabling the execution of a flight profile optimized to the operating capability of the aircraft
  - With low engine trust setting and a low drag configuration
  - Thereby reducing fuel burn and emissions during descent
- CDO should always be considered by
  - airspace designers and procedure designers
  - especially when implementing new Arrivals (STAR) and Approaches
- Usable by 85% of the aircraft, 85% of the time

GENERAL OVERVIEW

Conventional Step-down



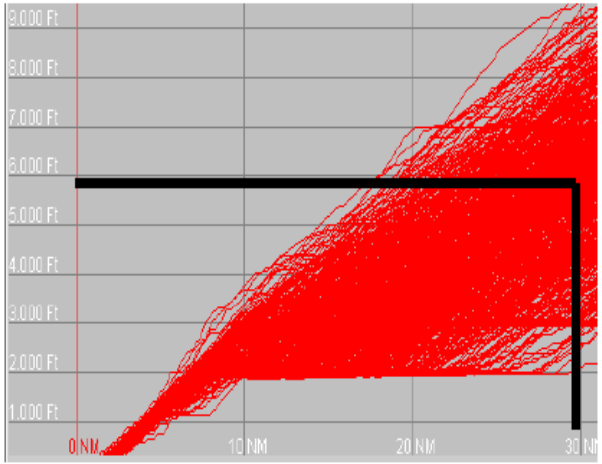
Continuous Descent Operations



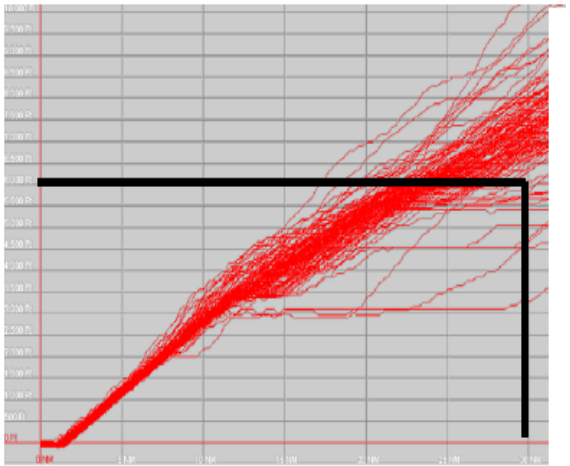
OPTIMUM VERTICAL PATH

- The optimum vertical path angle will vary depending on:
  - Type of aircraft and its actual weight
  - Weather (wind, temperature, atmospheric pressure, icing conditions)
  - Other dynamic considerations
- The maximum benefit is achieved by keeping the aircraft as high as possible until it reaches the optimum descent point.

OPTIMUM VERTICAL PATH



Flight tracks before CDO



Flight tracks after CDO

FACILITATING CDO

- Should start from the TOD to FAF/FAP
- Sequencing could be achieved during cruise or early phase of descent.
- Must consider aircraft performance limits and known wind data, when assigning altitude and speed restrictions.
- Distance to go (DTG) should be provided while being radar vectored.
- Supporting tools (e.g. AMAN) may increase airspace capacity.

BENEFITS OF CDO

- **CDO increases**
  - Flight predictability (predefined routes)
  - Airspace efficiency & Capacity (segregated Dep. & Arr. routes)
  - Safety (consistent and stabilized flight path, CFIT)
- **CDO reduces**
  - Fuel burn (cost savings)
  - Emissions and noise level (environmental benefits)
  - Pilot & controller workload
  - Radio transmission
  - CFIT
- However, if either CDO is not properly designed or ATC lose the flexibility, there could be a risk of reduced capacity and efficiency.

CDO DESIGN

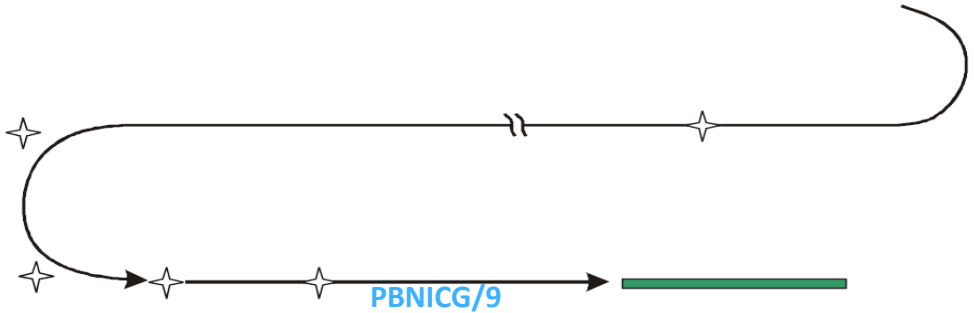
- **A CDO design**
  - is integrated with the airspace concept
  - must balance the needs of departing aircraft with the CDO arrival aircraft.
  - needs to consider populated areas, adherence to noise abatement routes, any dedicated take-off techniques, implementation time, etc.
- Fully optimized CDO may not always be possible
- Laterally and/or vertically fixed CDO routes could be applied to dense traffic environment.
- Vector based CDO could offer worthwhile efficiency and improvements

CDO DESIGN

- **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 from where the CDO is to be initiated
- Wind and weather information helps to improve the accuracy of the flight descent path.
- However, exact distance or flying time may not always be precisely known.
- Thus planning and communication between the pilot and the ATC are required for a CDO.

CDO DESIGN

- **Two methods of CDO design : “closed path” and “open path”**
- **Closed path design**
  - Lateral flight track is predefined up to/including FAF/FAP, e.g. STAR.
  - Exact distance to runway is precisely known.
  - FMS can accurately implement automated optimized descents.
  - The procedure may be published with crossing levels, level windows and speed constraints.



CDO DESIGN

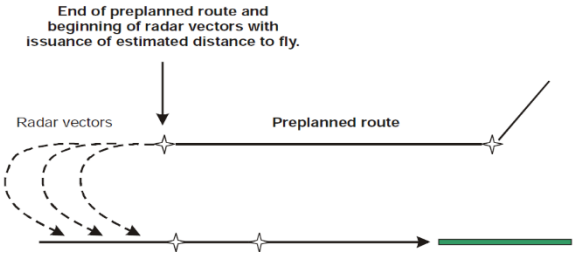
❖ Open path design

1) Vectored CDO

- ATC gives “Distance-To-GO” estimate
- Descent is at the pilot discretion.

2) Open CDO to downwind

- Ends in a downwind leg leaving the controller to clear the aircraft to final
- ATC gives “Distance-To-GO” estimate
- Combination of a fixed route and radar vector to FAF/FAP



CDO APPLICATION

❖ **Sequencing method for CDO**

- **Automated Sequencing methods**
  - RTA, traffic management advisory display, relative position indicators
  - Provide for efficient planning adjustment
- **Speed control**
  - Most effective when a small correction is made in early stage
  - Predictable and consistent performance, maintain separation
  - Large speed adjustments may be counter-productive
- **Vectoring**
  - Most flexible way to sequence arriving traffic and maintain capacity
  - Least advanced predictability to pilots in terms of flight path distances
  - Can be applied both method of CDO design

CDO IMPLEMENTATION

❖ CDO implementation principles

- Safety of operations shall not be compromised in any way;
- Collaboration between ANSP, aircraft operator and airport is essential;
- The effectiveness of a CDO procedures relies on unambiguous and timely clearances;
- An optimum CDO procedures require unimpeded descent of aircraft with a fixed lateral path and a preplanned vertical path;
- Energy management is critical to a successful CDO;
- Improved fuel efficiency and emission reduction can be achieved if CDO is initiated at higher levels, if possible, from TOD;
- CDO should not adversely affect capacity, other operations, etc.;
- The CDO procedure should be published in AIP so that ATC and pilot both are aware of CDO implementation.

CCO

- **CCO is an aircraft operating technique made possible by**
  - Appropriate airspace and procedure design
  - 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 settings set throughout the climb,
- Thereby reducing total fuel burn and emissions during the whole flight.

CCO

- Arriving and departing traffic are usually interdependent.
- The airspace design supporting CCO should ensure that both arriving and departing flights can achieve fuel efficient profiles.
- Balancing the demands of capacity, efficiency, access and the environment within the overall requirement for safe operations is the most demanding task when developing an airspace design.

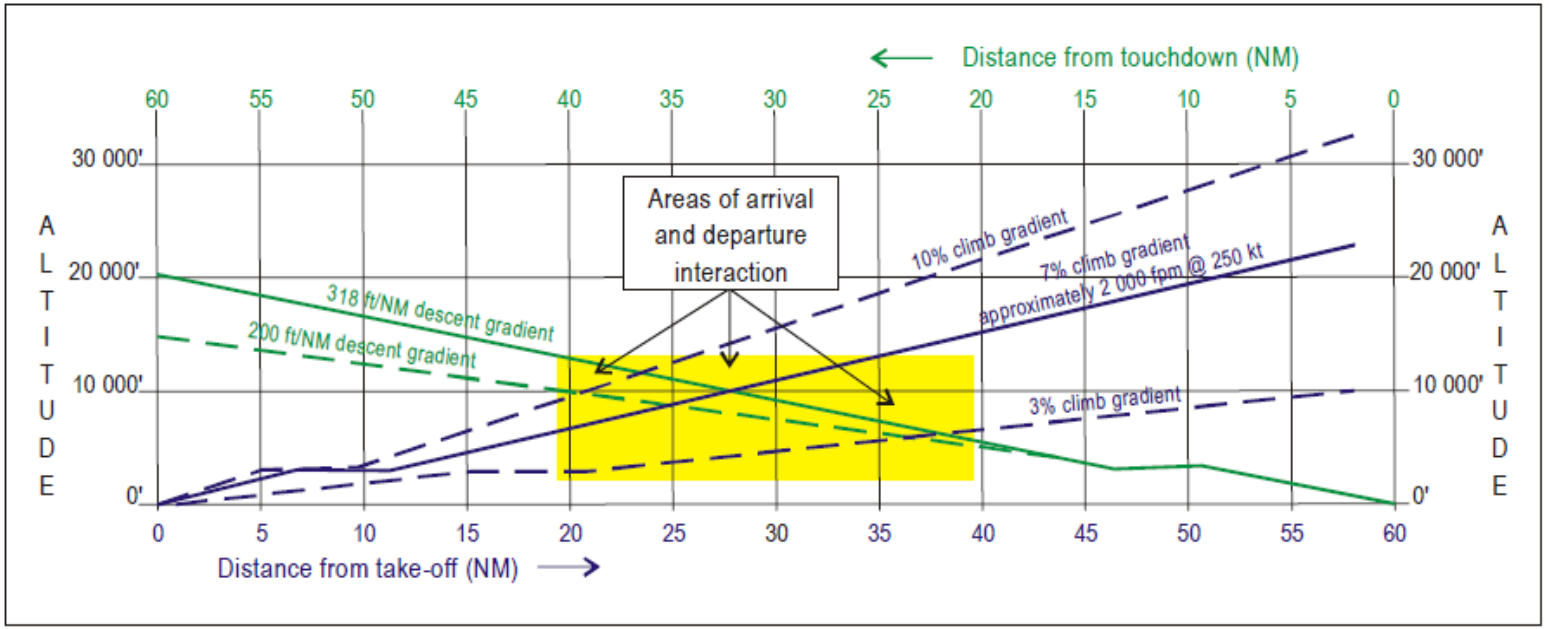
CCO

❖ How to make balance between CDO and CCO?

- 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.
- Often there is far more unnecessary level flight in the descent phase than in the climb phase.
- 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.

CCO

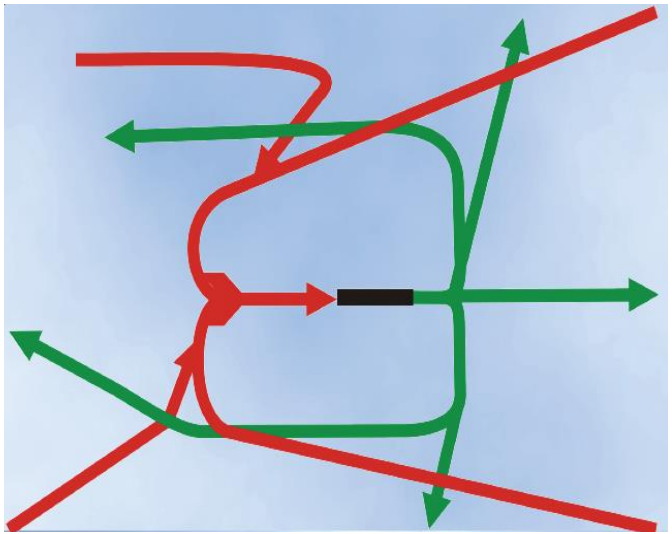
❖ Conflict Zones

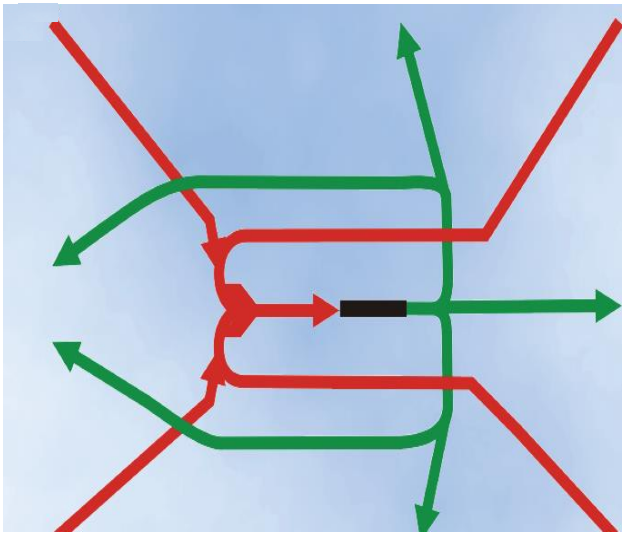


SAMPLE CHART ONLY: Similar graphs should be developed for each implementation depending on fleet

CCO

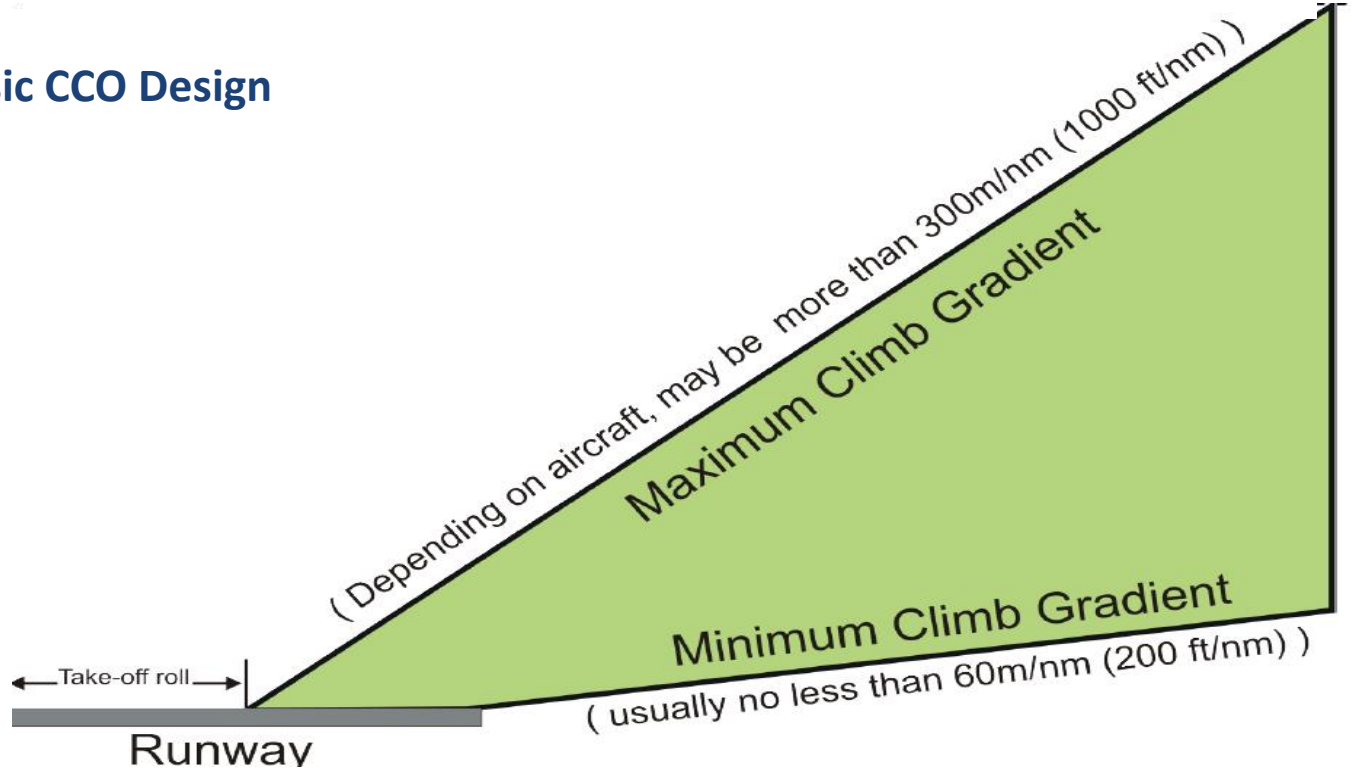
- **Profile interaction**





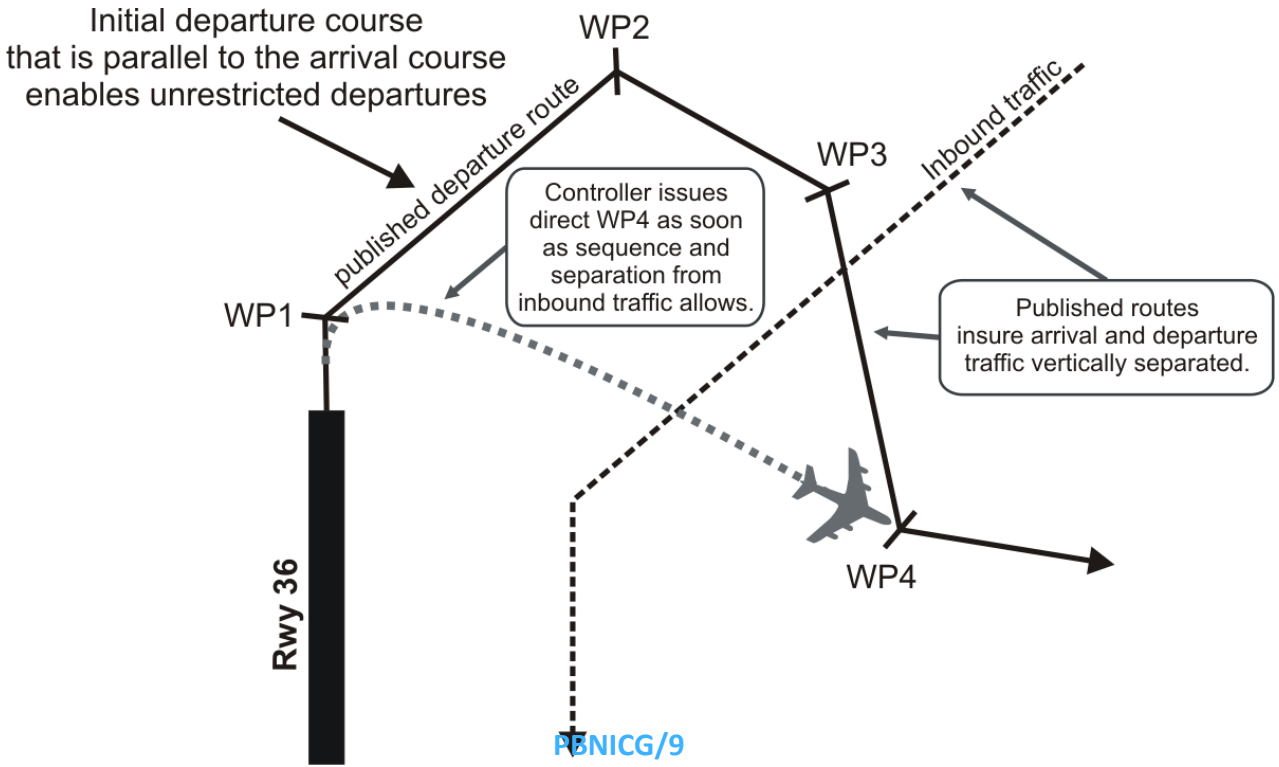
CCO

- **Basic CCO Design**



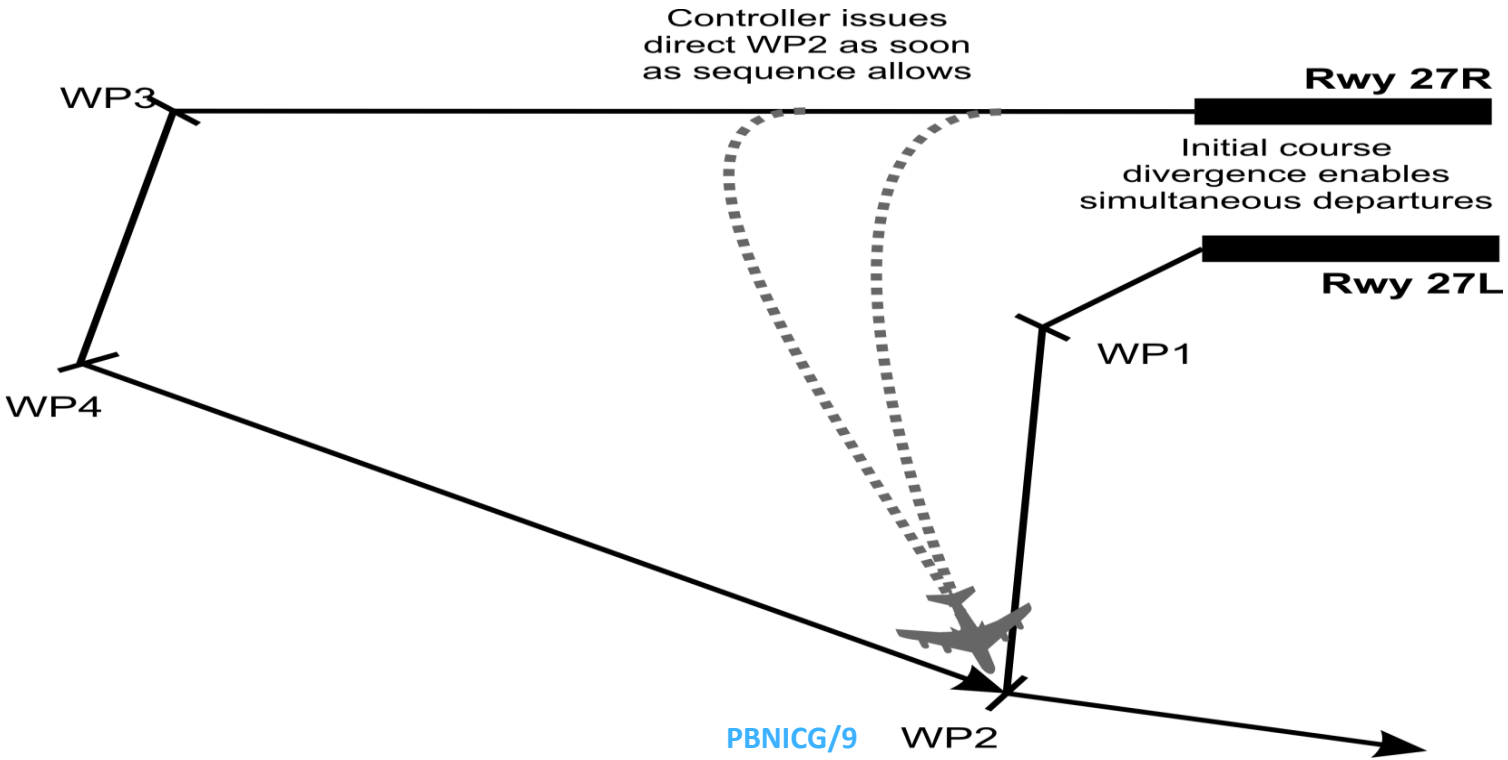
CCO

❖ CCO vs. Inbound Traffic



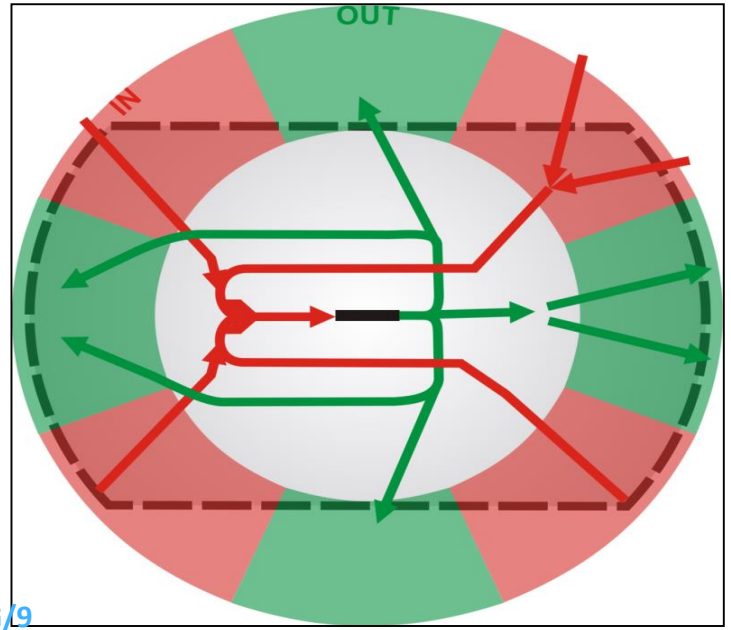
CCO

❖ Multi-runway CCO Departures



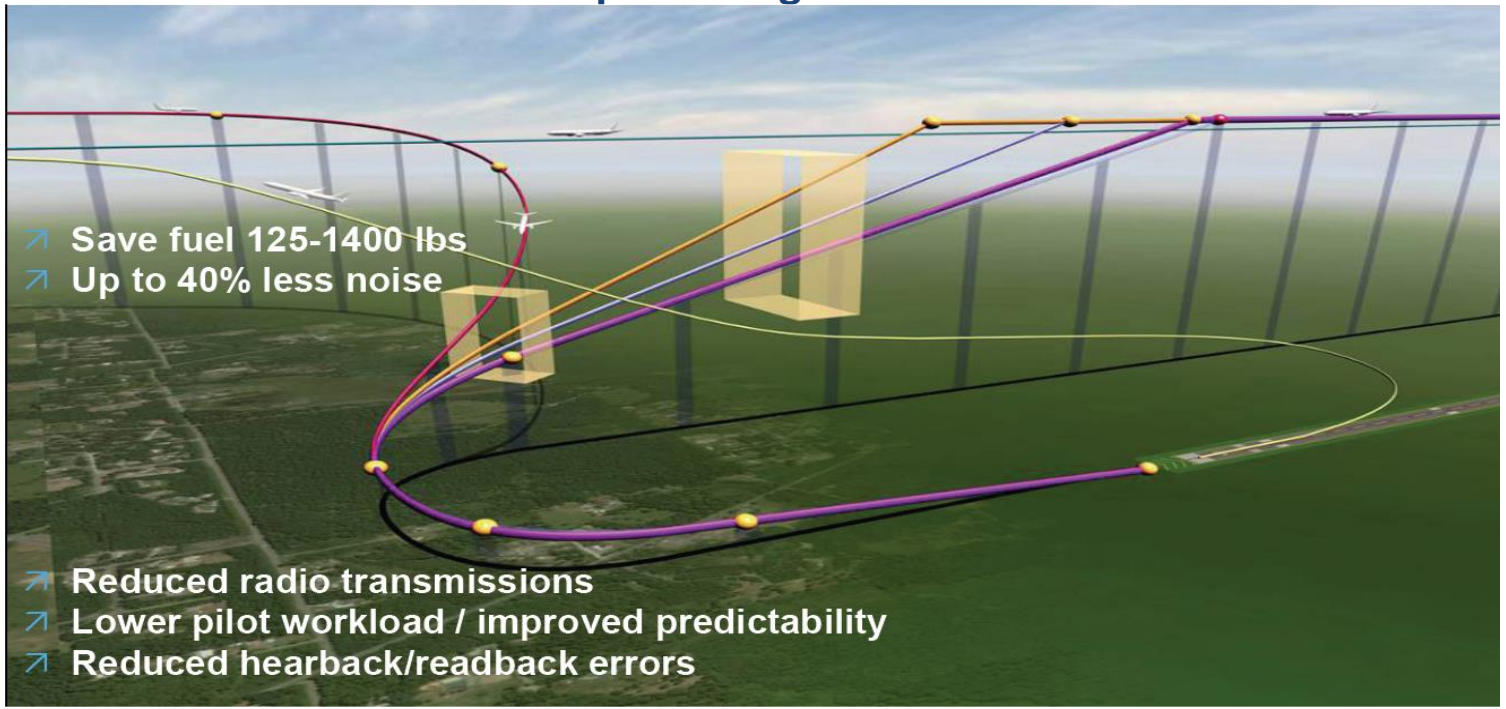
CCO

- **Good Design Practice**
  - Flows by quadrant (Corner Post), segregate Arrivals laterally and vertically from Departures
- **Rules of Thumb**
  - **CDO descent rate**
    - 1000ft/3NM plus 1NM/10knots or
    - 1000ft/4NM (4.1%)
  - **CCO climb rate**
    - Slow : 1000ft/5NM (3.3%)
    - Medium : 1000ft/3~4NM (4.1~5.5%)
    - Fast : 1000ft/2NM (8.2%)



CCO/CDO Interaction

- **Benefits of closed path design**




MONTRÉAL
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(EUROPEAN AND
NORTH ATLANTIC)
ICAO
BEIJING
(ASIA-PACIFIC
SUB-OFFICE)
ICAO
ICAO
CAIRO
(MIDDLE EAST)
MEXICO CITY
(NORTH AMERICA AND CARIBBEAN)
ICAO
ICAO
DAKAR
(WESTERN AFRICA)
ICAO
BANGKOK
(ASIA-PACIFIC)
NAIROBI
(EASTERN AFRICA)
ICAO
LIMA
(SOUTH AMERICA)

THANK YOU!