Continuous Descent Operations

(CDO)

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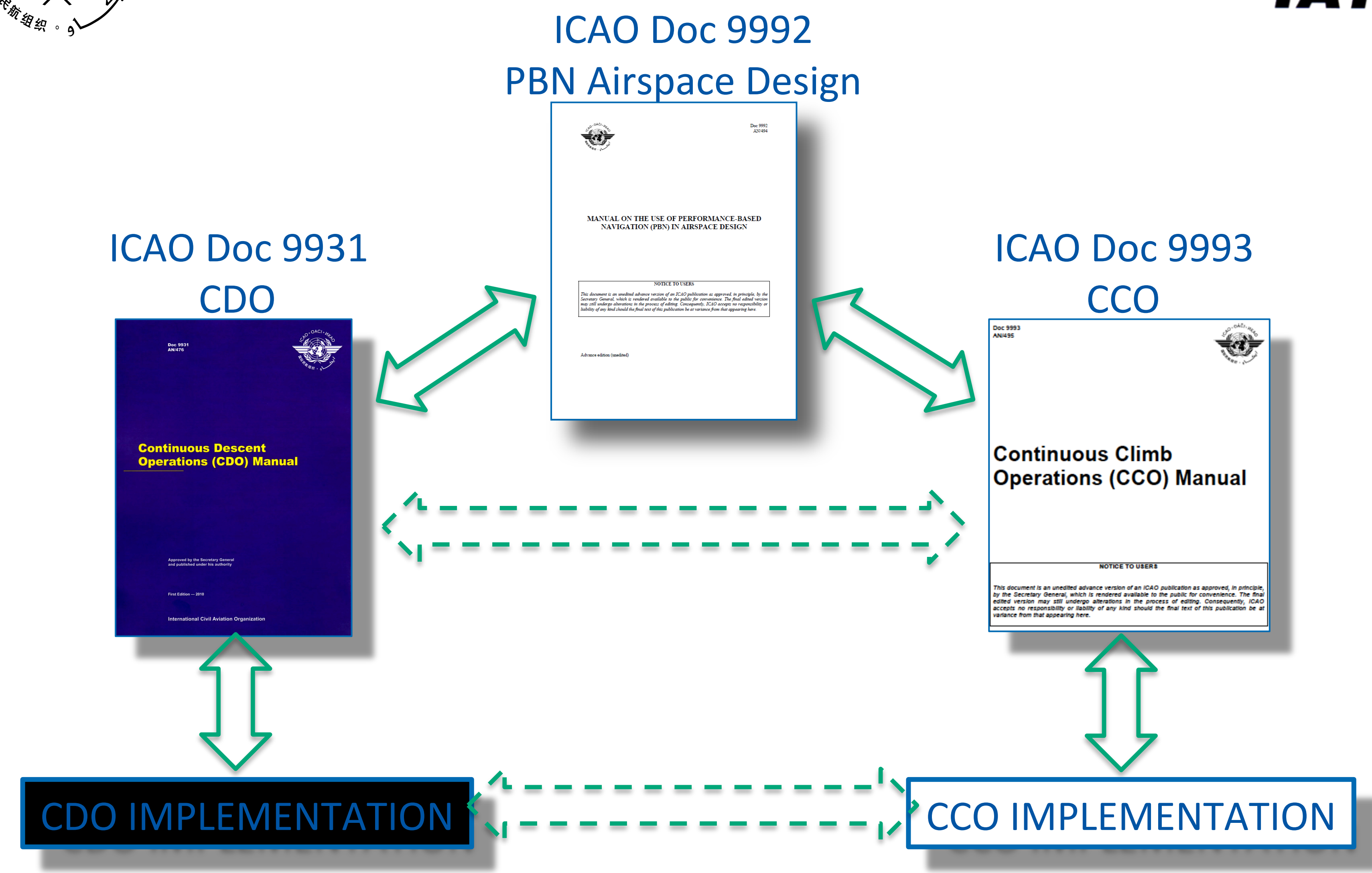
Learning Objectives

- By the end of this presentation you should understand:
  - What ICAO Manual covers CDO
  - What is a CDO
  - Differences between Closed and Open path CDO

CDO, CCO, and Airspace



Continuous Descent Operations

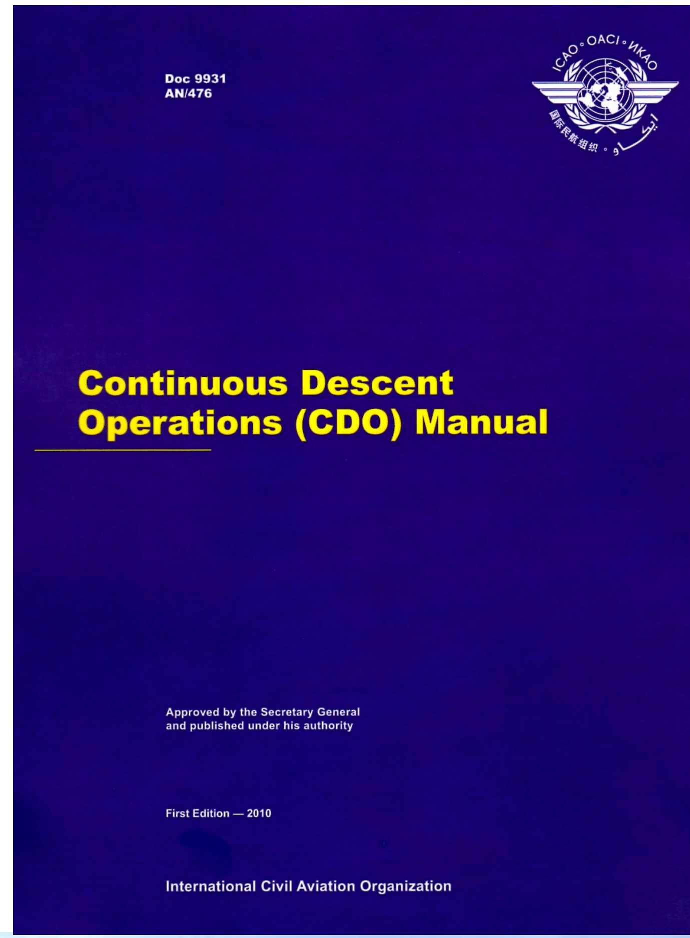
Continuous Descent Operations (CDO) Manual
ICAO Doc 9931
First Edition published 2010

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.

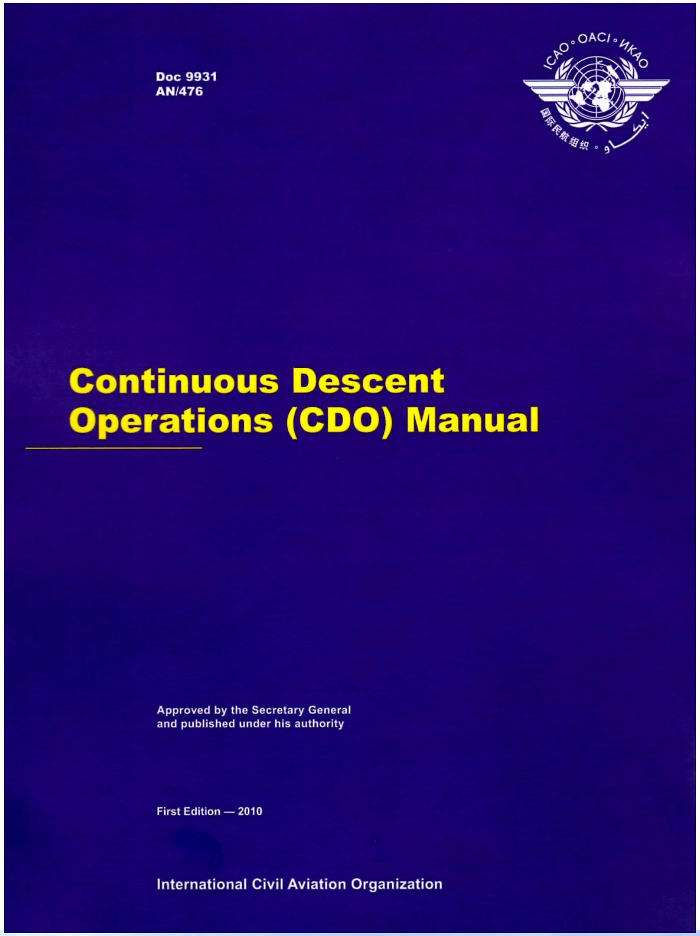


Continuous Descent Operations

Continuous Descent Operations (CDO) Manual ICAO Doc 9931

Provides background for:

- Air Navigation Service Providers
- Aircraft Operators
- Airport Operators
- Aviation Regulators



Continuous Descent Operations

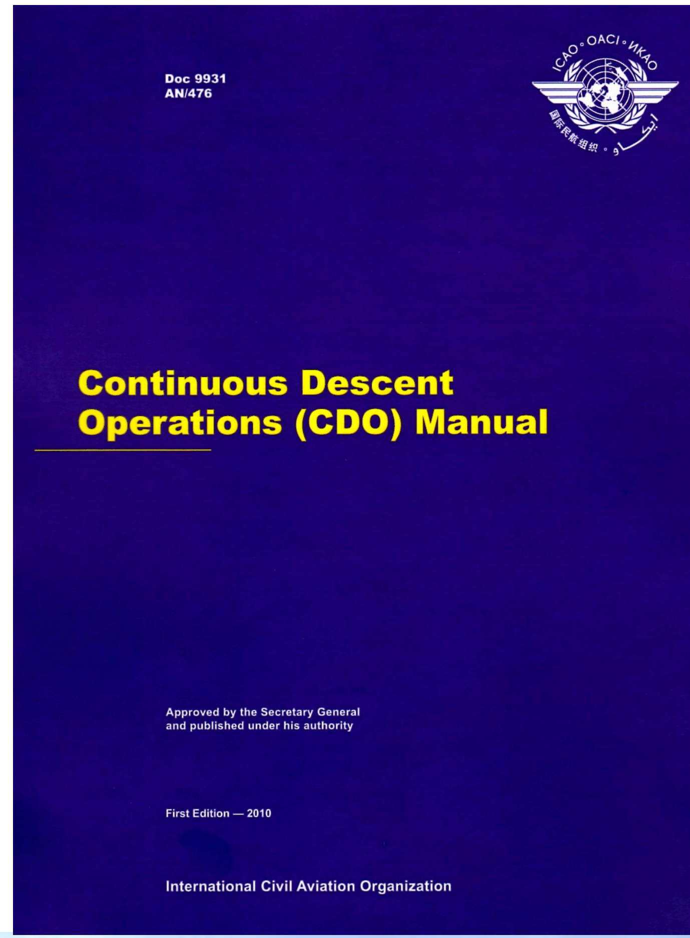
Continuous Descent Operations (CDO) Manual ICAO Doc 9931

Key objectives for the manual are to improve:

Overall management of traffic and airspace in order to enable uninterrupted continuous descents without disrupting departures.

Understanding of continuous descent profiles and:

Understanding and harmonization of associated terminology.



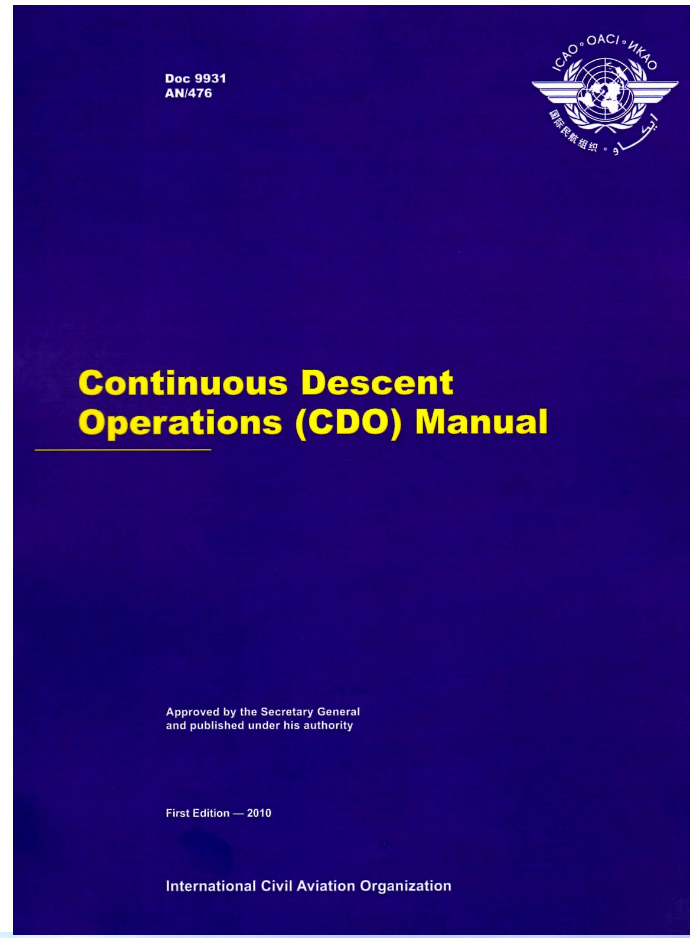
CDO Benefits

Increase:

- Flight predictability
- Airspace efficiency & capacity
- Safety

Reduce:

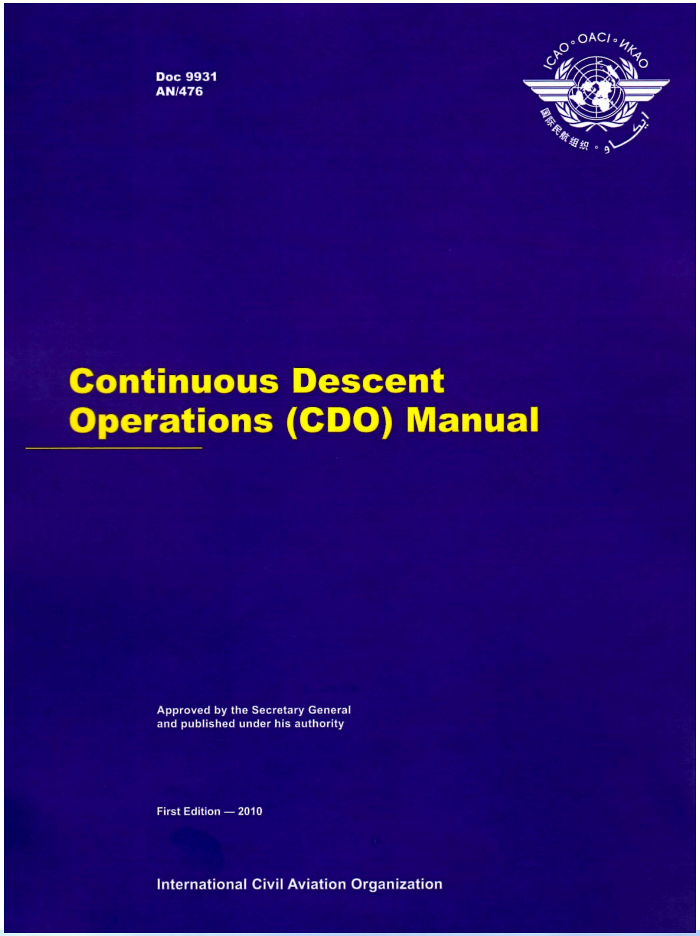
- Fuel burn
- Emissions
- Pilot & controller workload
- Radio communications
- CFIT



CDO

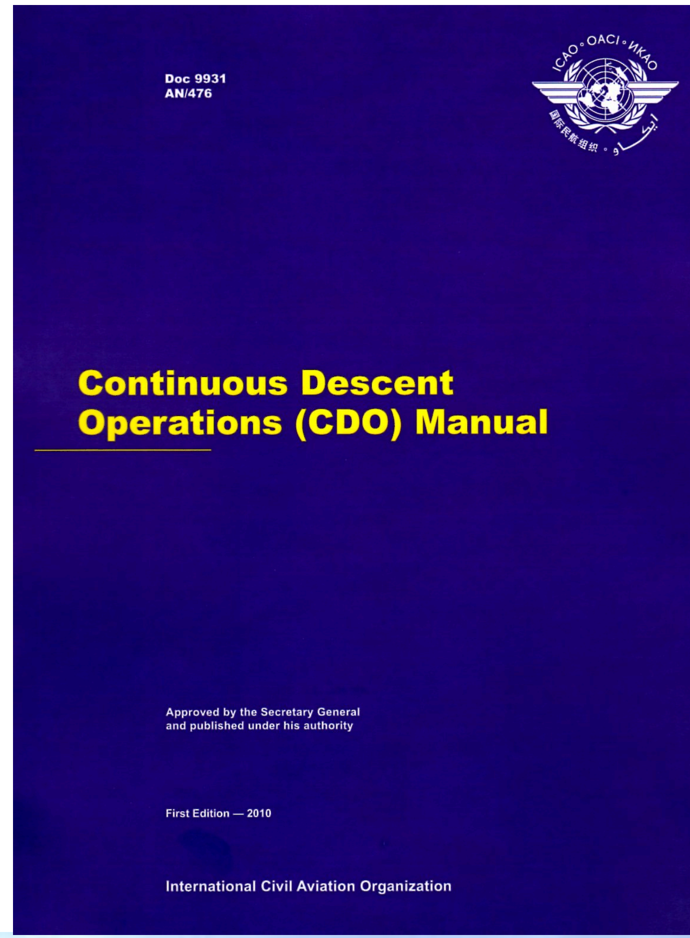
Accurate planning for an optimum descent path is facilitated by the pilot and/or the FMS knowing the flight distance to the runway and the level above the runway at which the CDO is to be initiated.

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

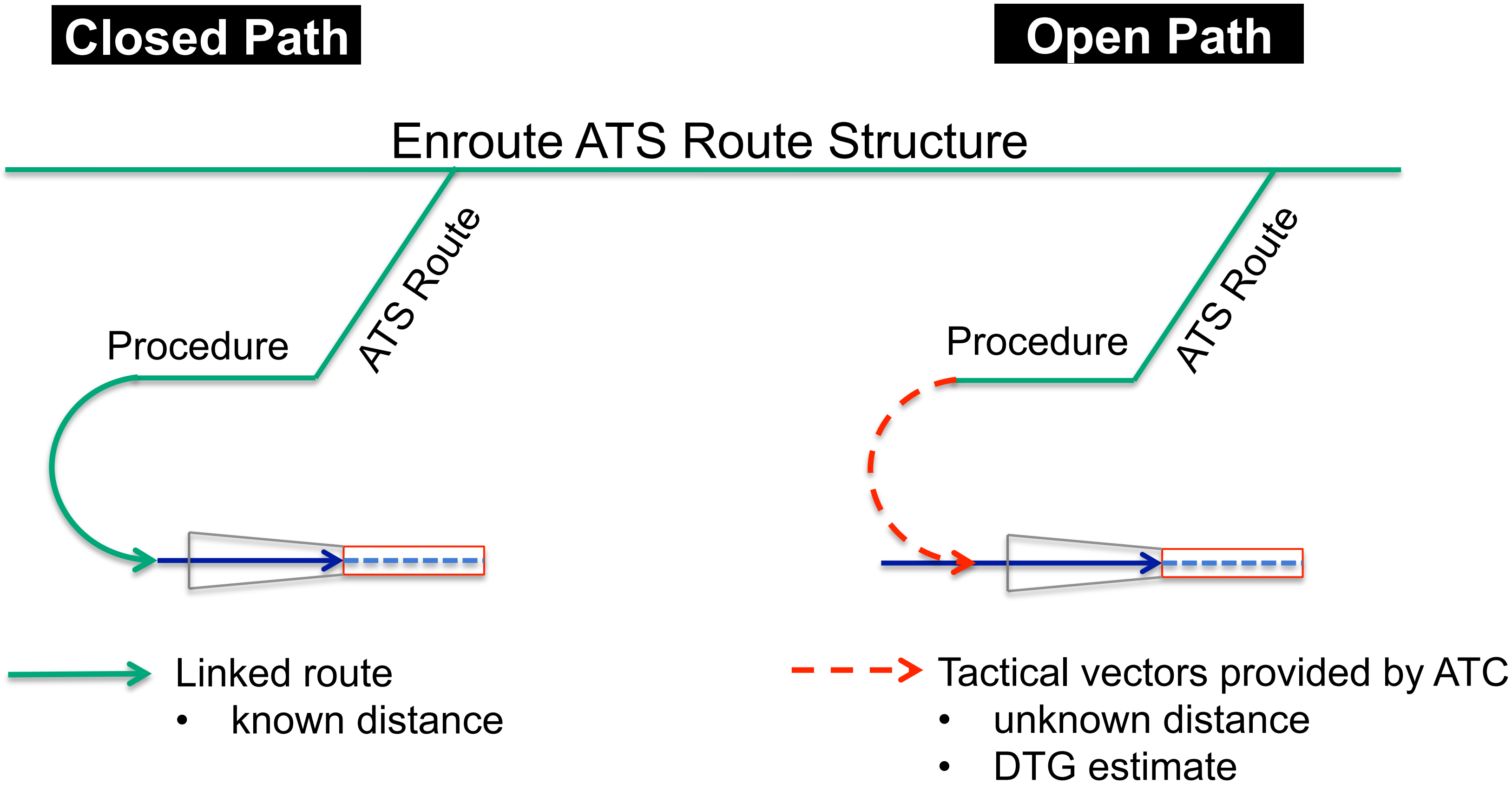


CDO

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



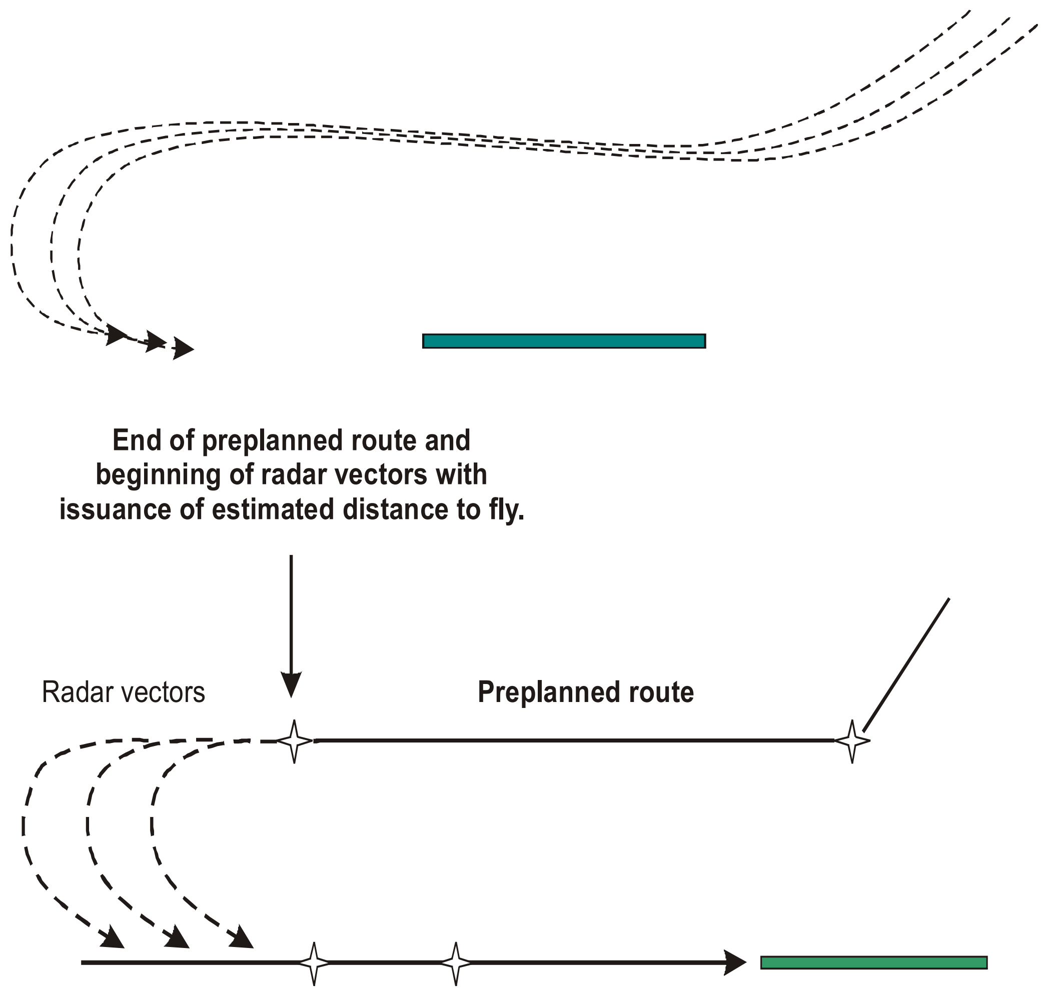
Different Types of Arrivals



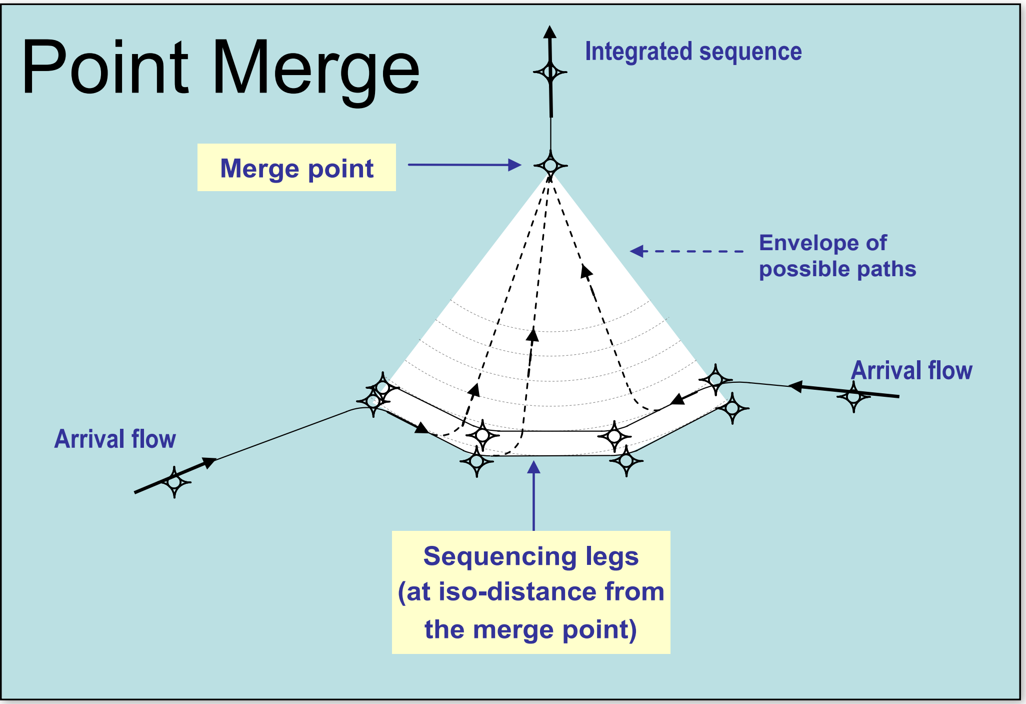
Open Path Arrival Designs

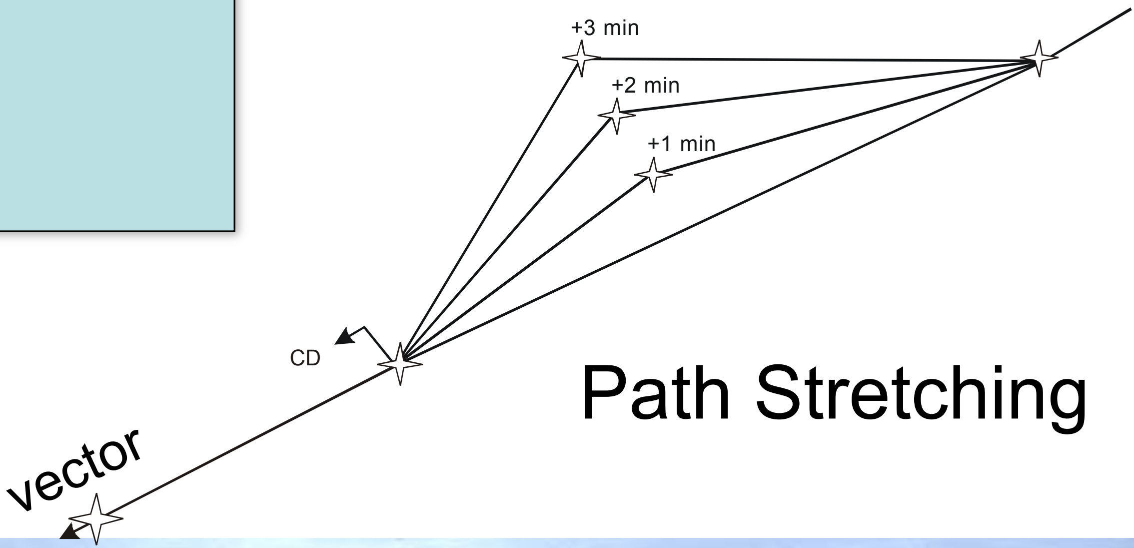
✈Vectored CDO

ATC issues pilot "Distance-To-Go" estimate

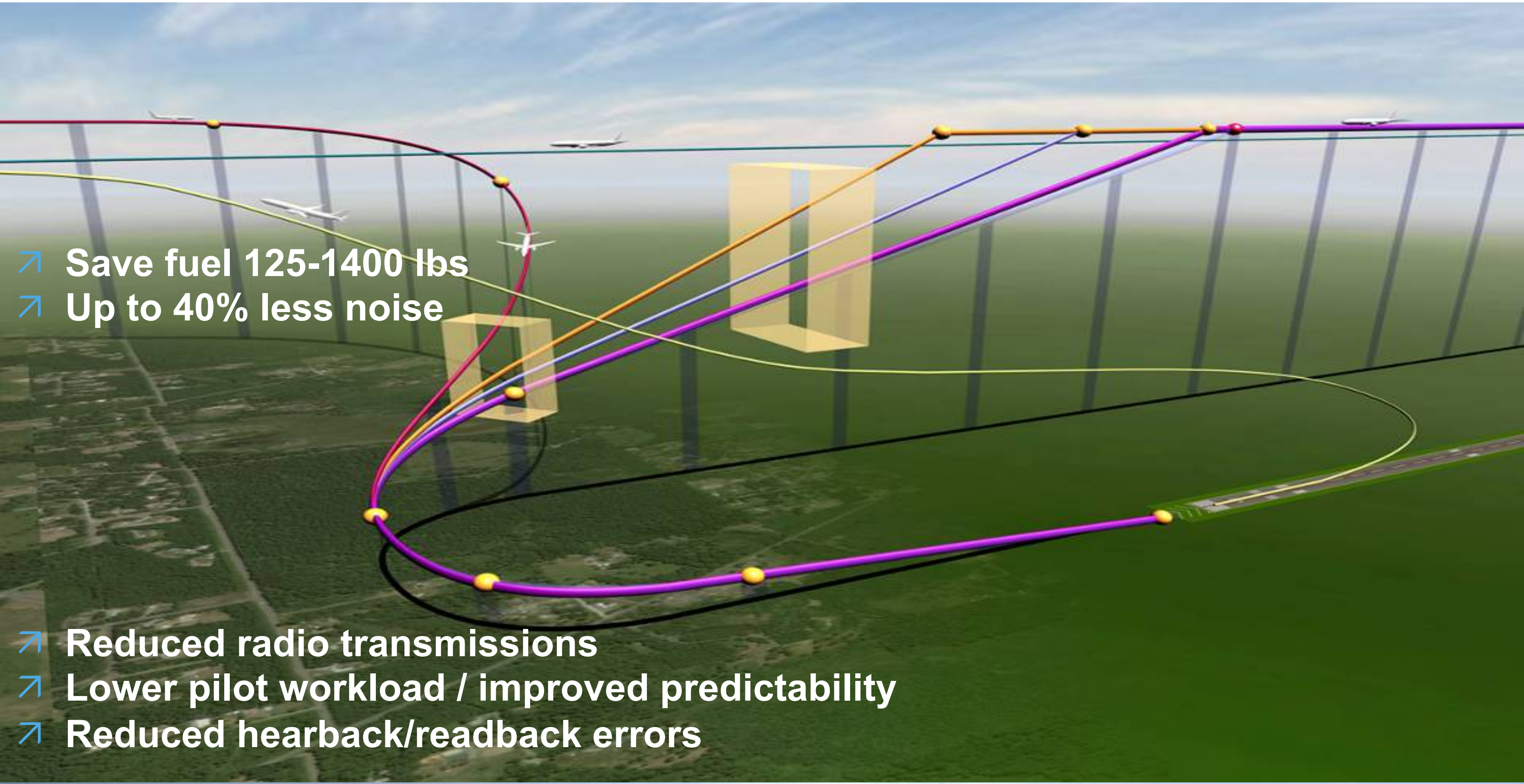


Open Path Arrival Designs





Closed Path CDO Design

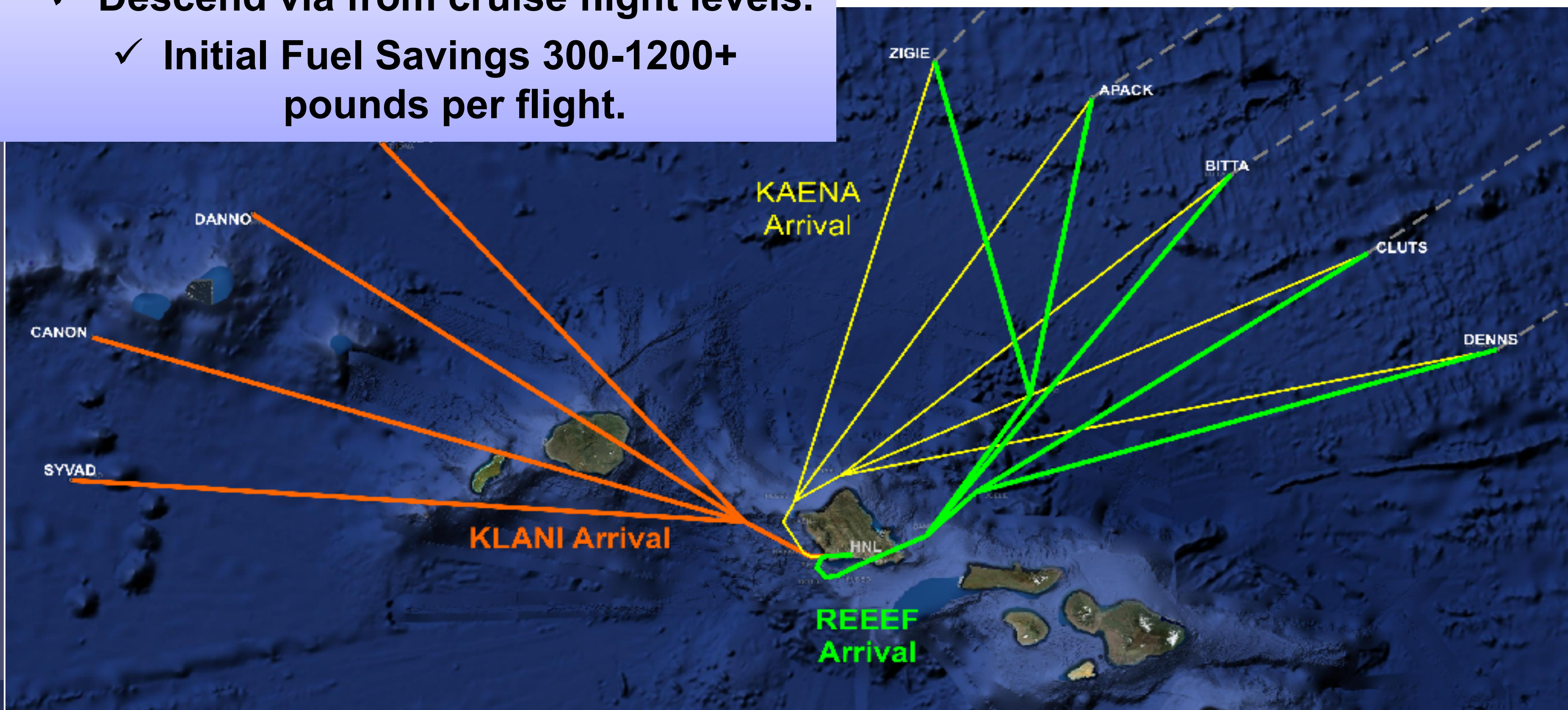


- Save fuel 125-1400 lbs
- Up to 40% less noise

- Reduced radio transmissions
- Lower pilot workload / improved predictability
- Reduced hearback/readback errors

HNL CDO Example

- **KAENA, KLANI, REEEF CDO**
  - ✓ Fully integrated/linked to approach.
  - ✓ Descend via from cruise flight levels.
  - ✓ Initial Fuel Savings 300-1200+ pounds per flight.



Continuous Descent Operations

(CDO)

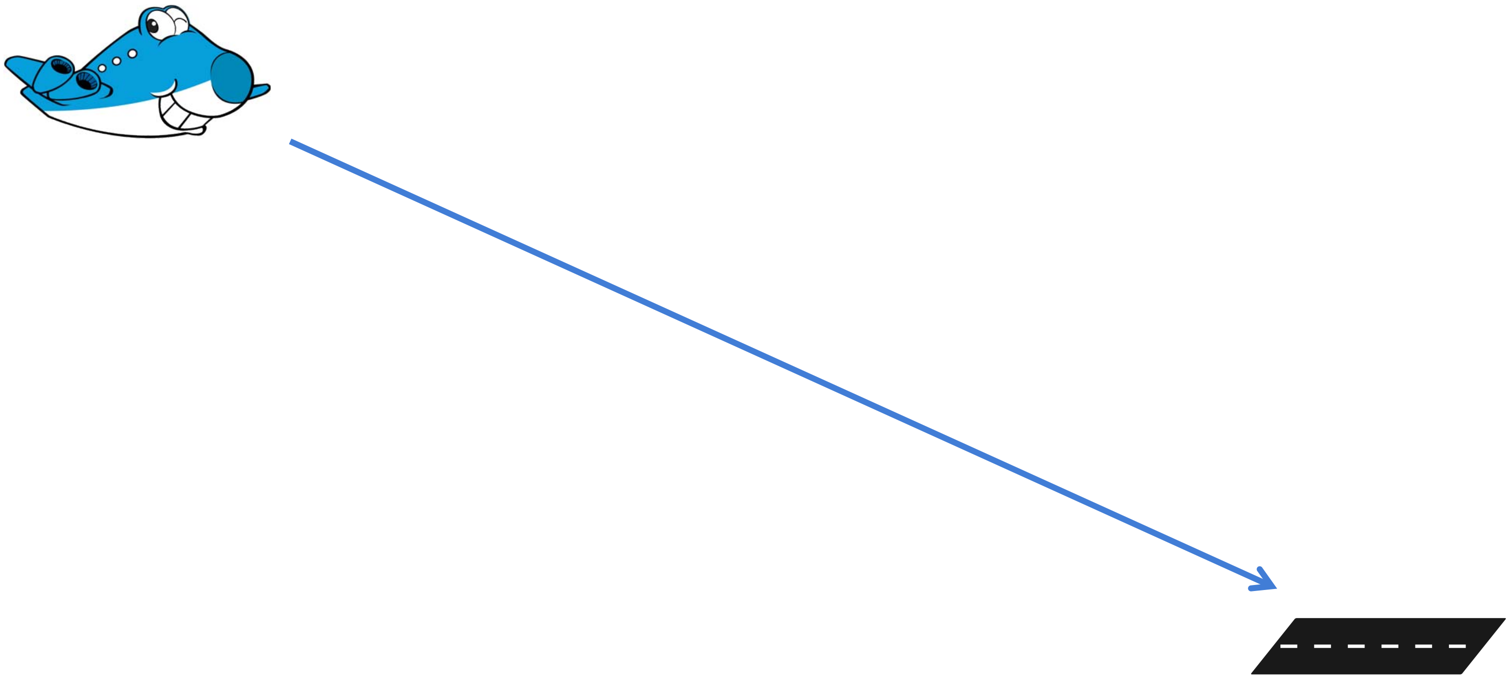
Design Methods

Learning Objectives

- By the end of this presentation you should understand:
  - CDO design methods and limitations
  - CDO Design considerations
  - Possible CDO sequencing methods
  - CDO Implementation Process

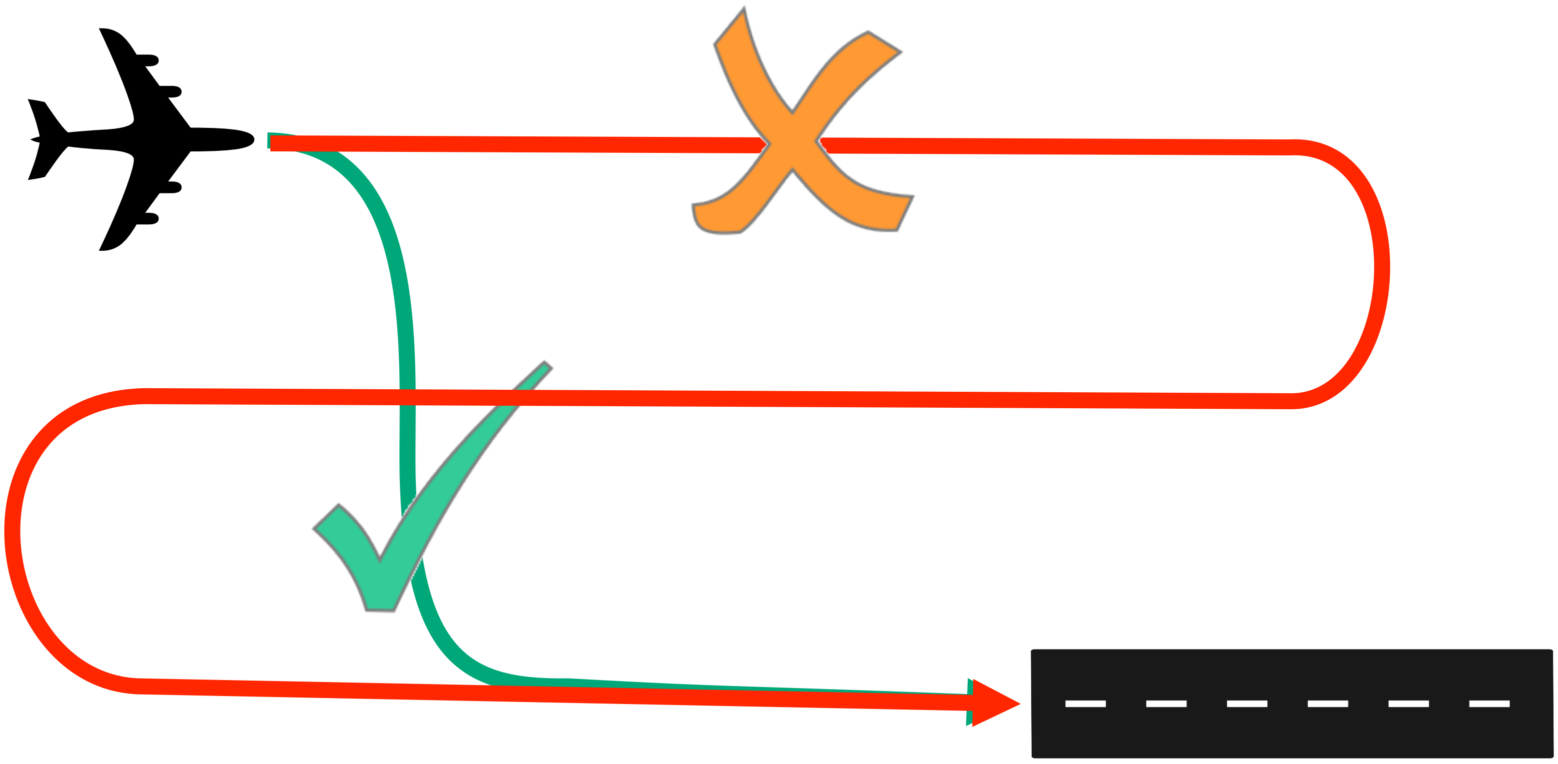
CDO Design Methods

- Design to select the shortest path



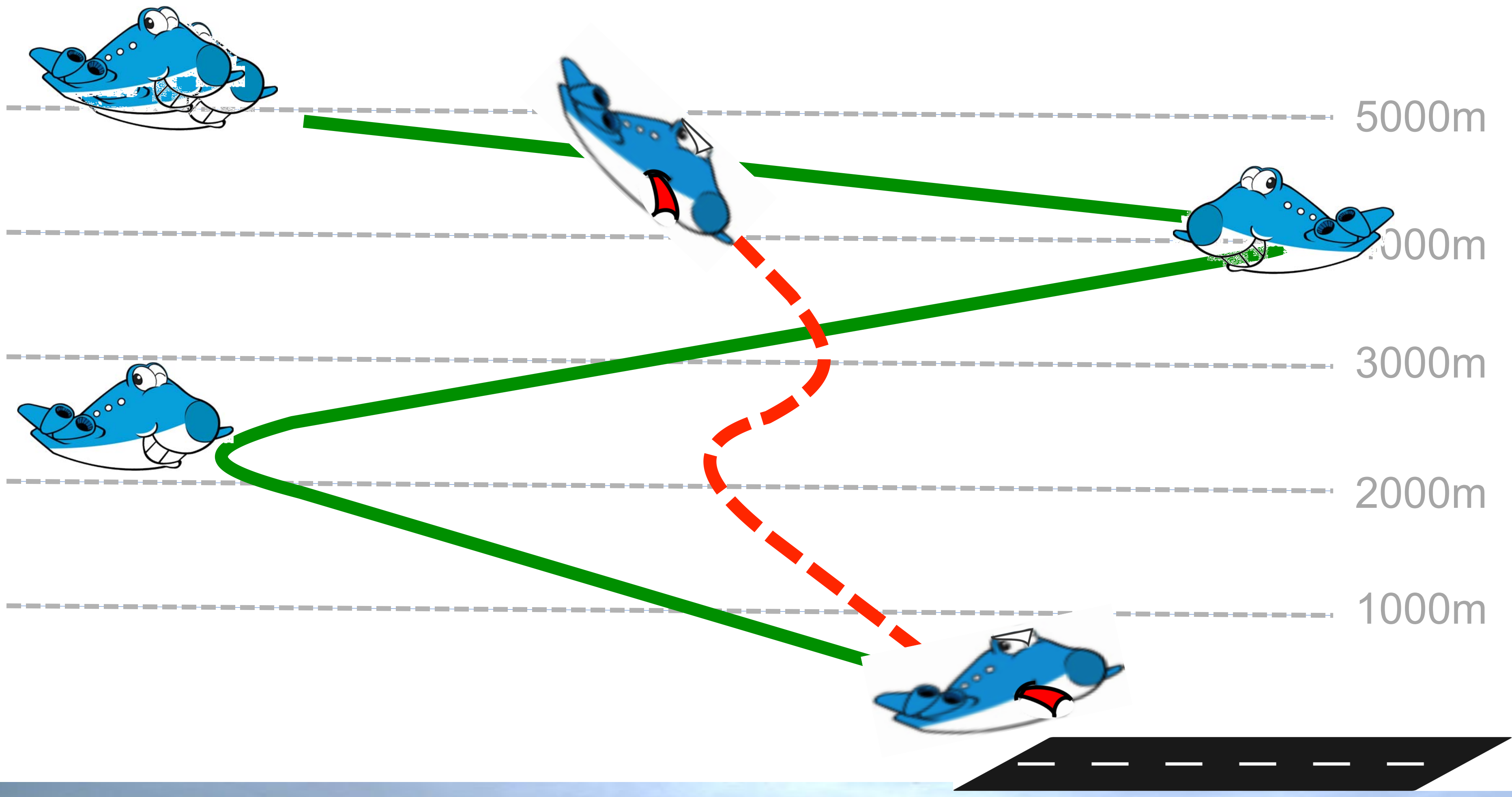
CDO Design Methods

- Design to select the shortest path

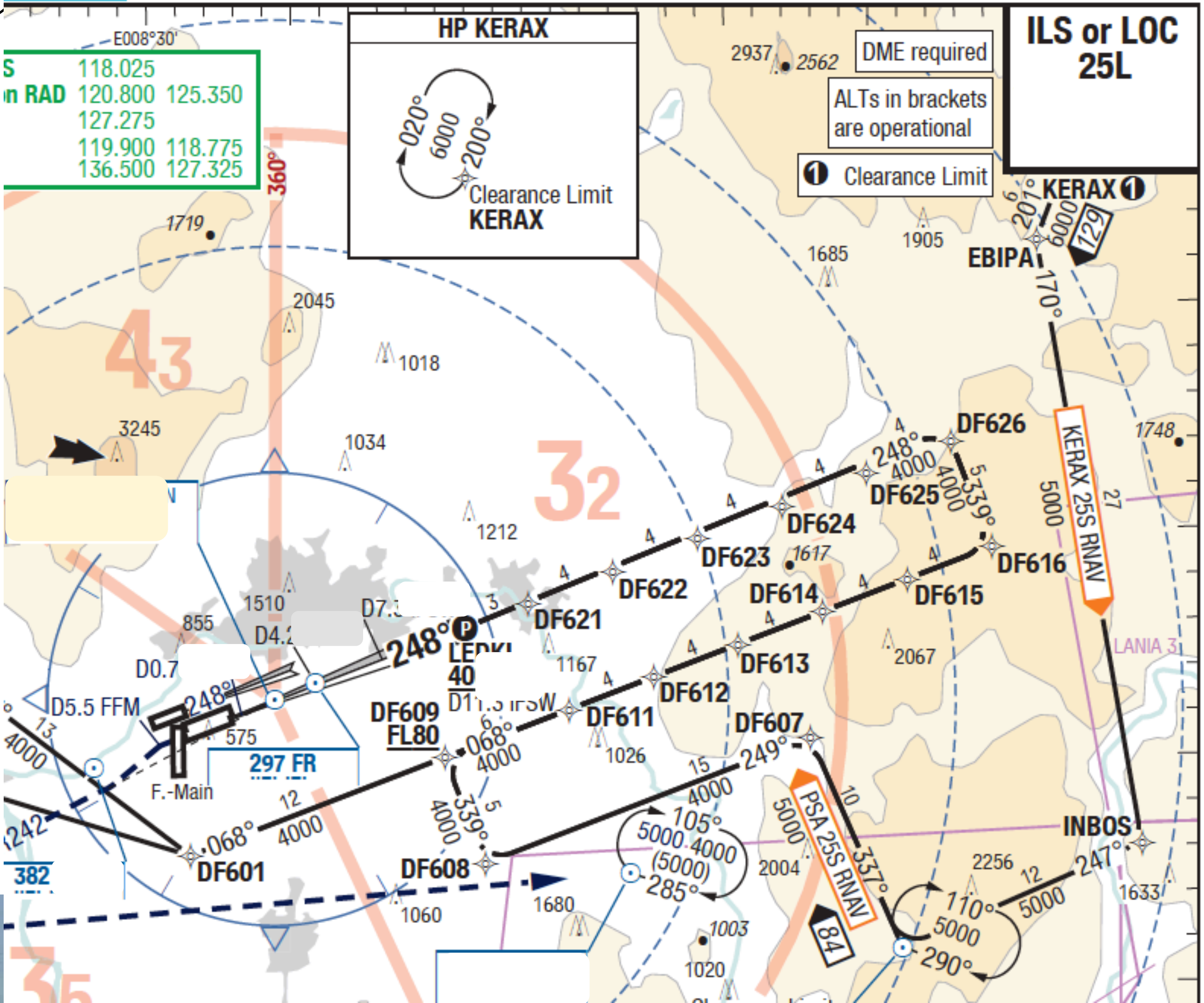


CDO Design Methods

- Long path plus "shortcuts" are inefficient



CDO Discussion



CDO Design Methods

1. Select the shortest path.
2. Modify path as necessary in response to:
   - airspace,
   - terrain,
   - departure paths,
   - other traffic.
3. Apply required speeds and or altitude profiles.
4. Review and modify as necessary.

CDO Design Methods

CDO STAR waypoints may contain:

1. Speed restrictions
2. Altitude restrictions

Altitudes restrictions may be

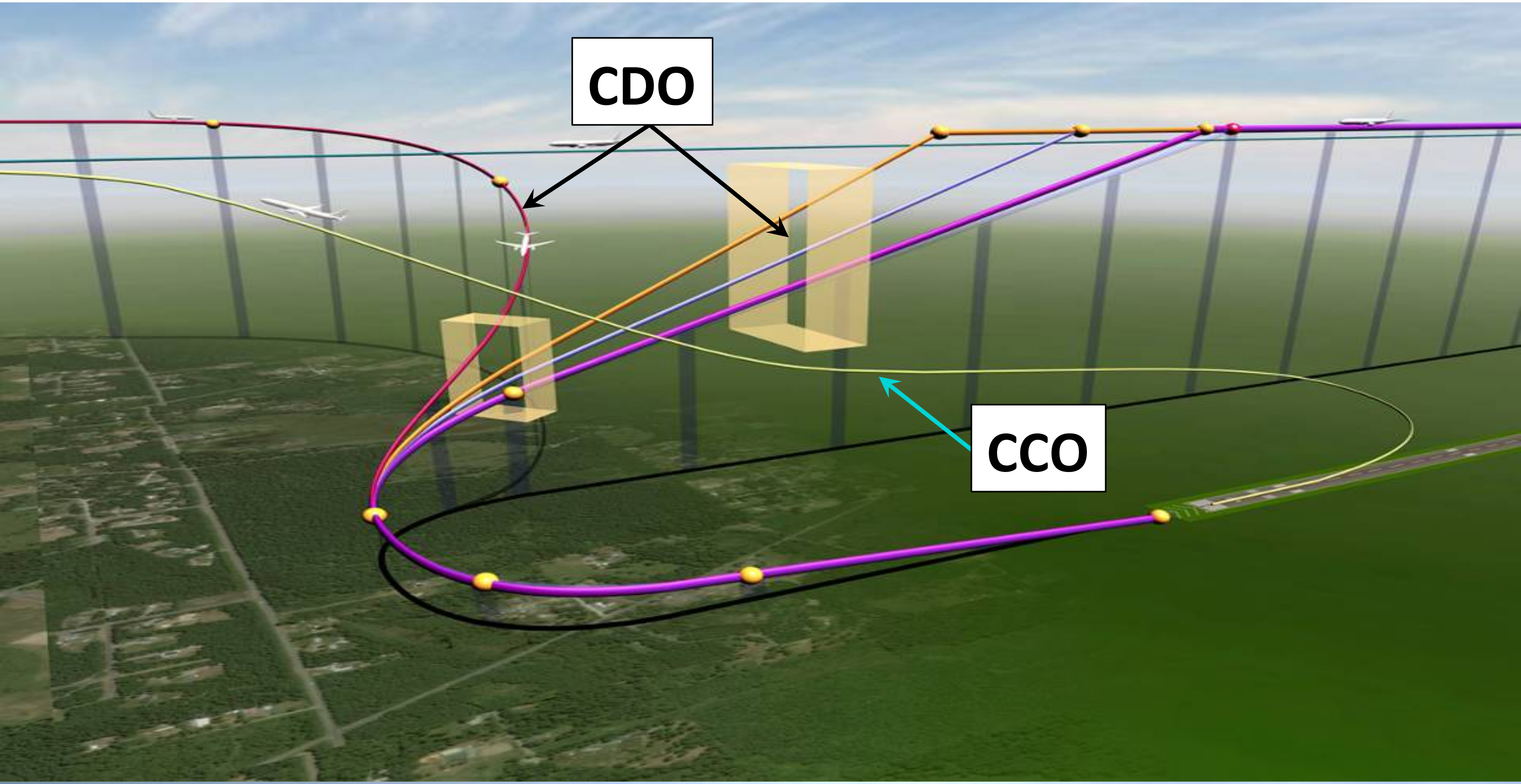
- "At",
- "At or above",
- "At or below",
- or a window of both "At or above and at or below"

Limit speed and altitude restrictions to the minimum necessary.

- In general speed restrictions should not be less than 280kt above 10,000 msl.
- Speed restrictions must have an associated altitude restriction (FMS requirement)

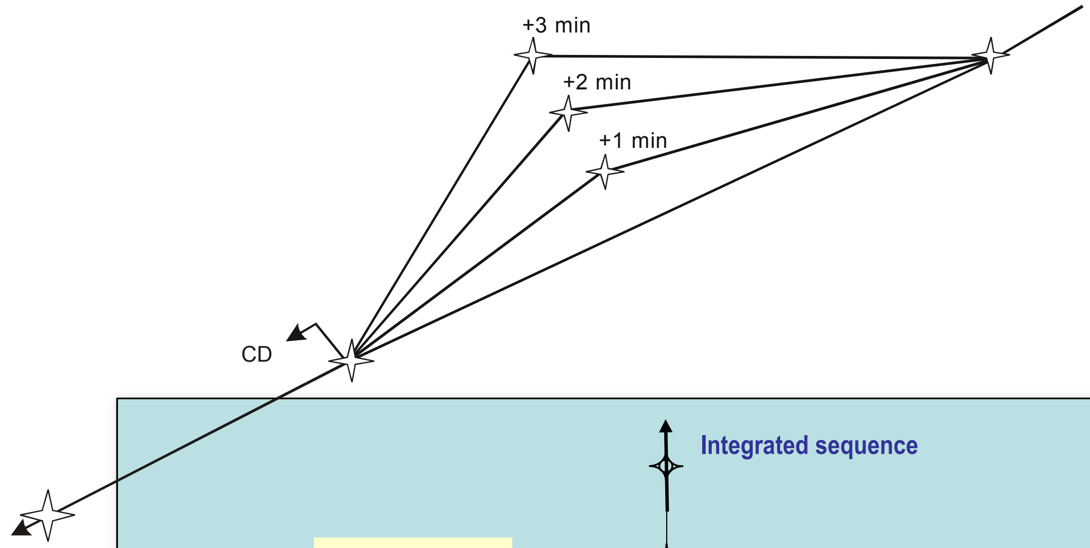
Integrating CCO and CDO Designs

Altitude windows safely separate aircraft and allow predictable flight performance

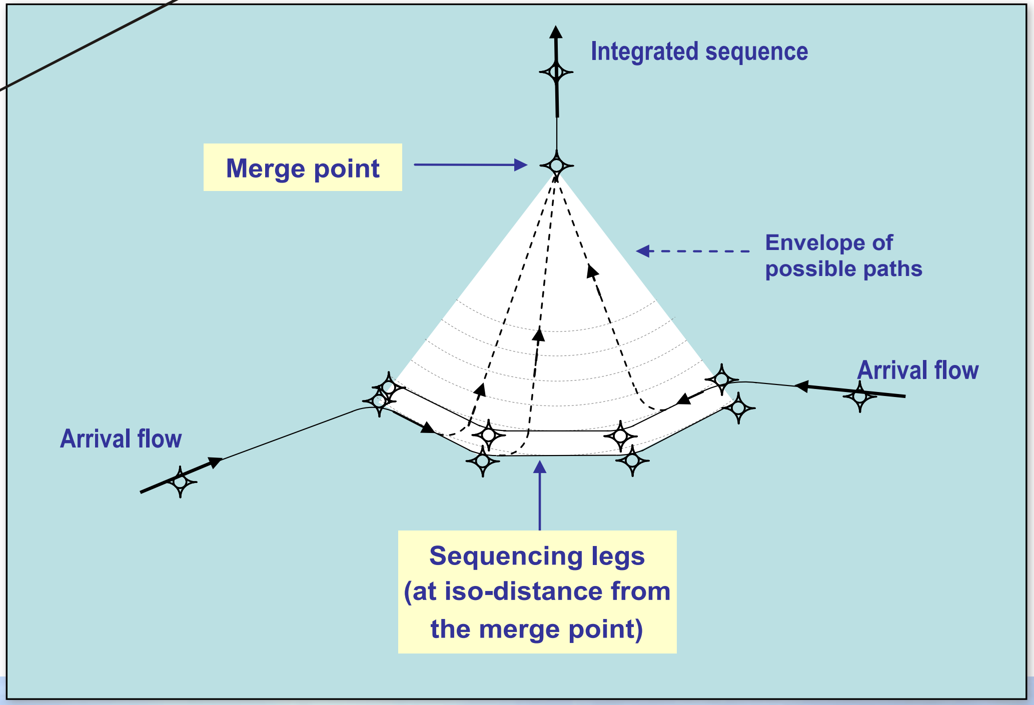


Open Path Arrival Designs

Path Stretching



Point Merge



Closed Path CDO Calculations

Starting formulas:

Upper level for "at or below" restrictions:

Lower level for "at or above" restrictions:

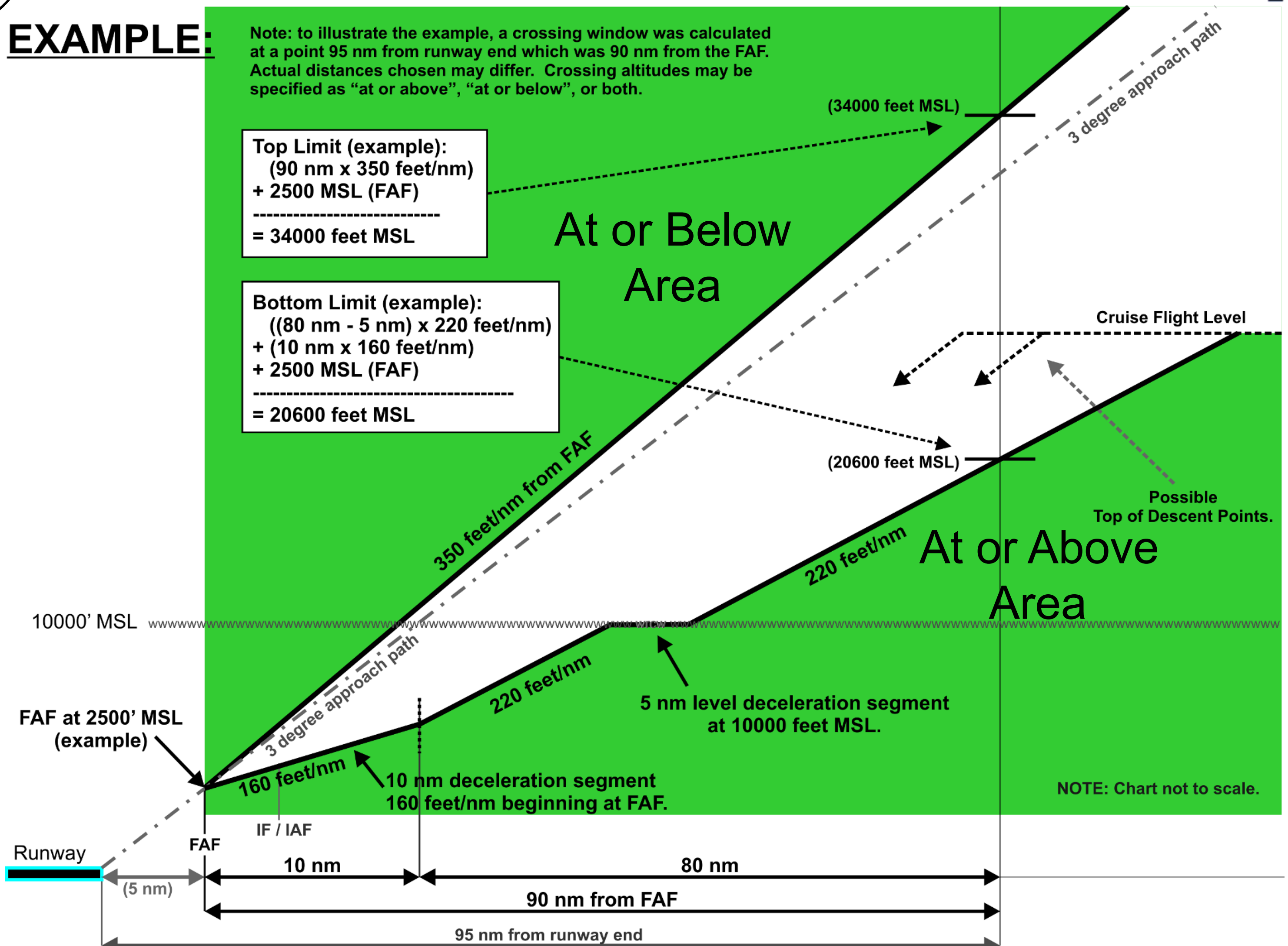
Upper level limit =
(distance from FAF/FAP x 350 ft/nm) + altitude of FAF/FAP

Lower level limit when starting at or below 10,000 MSL =
(FAF deceleration distance X 160 ft/nm) +
+ ((distance from FAF - FAF deceleration distance) x 220 ft/nm)
+ FAF altitude

Lower level limit when starting above10,000 MSL =
(FAF deceleration distance X 160 ft/nm) +
+ ((distance from FAF - FAF deceleration distance -5nm) x 220 ft/nm)
+ FAF altitude

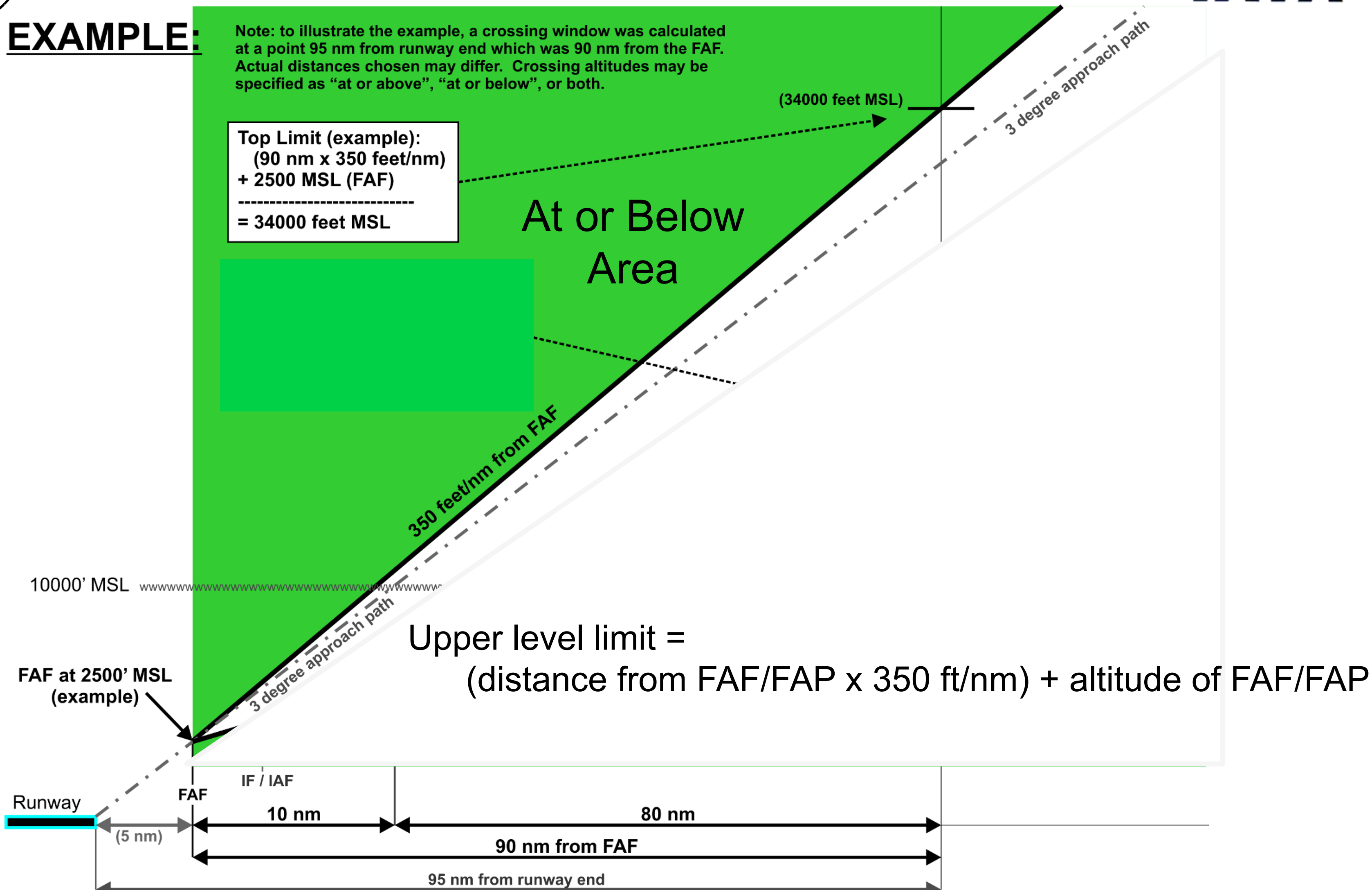
Note: FAF includes FAP in above formulas

Closed Path CDO Calculations



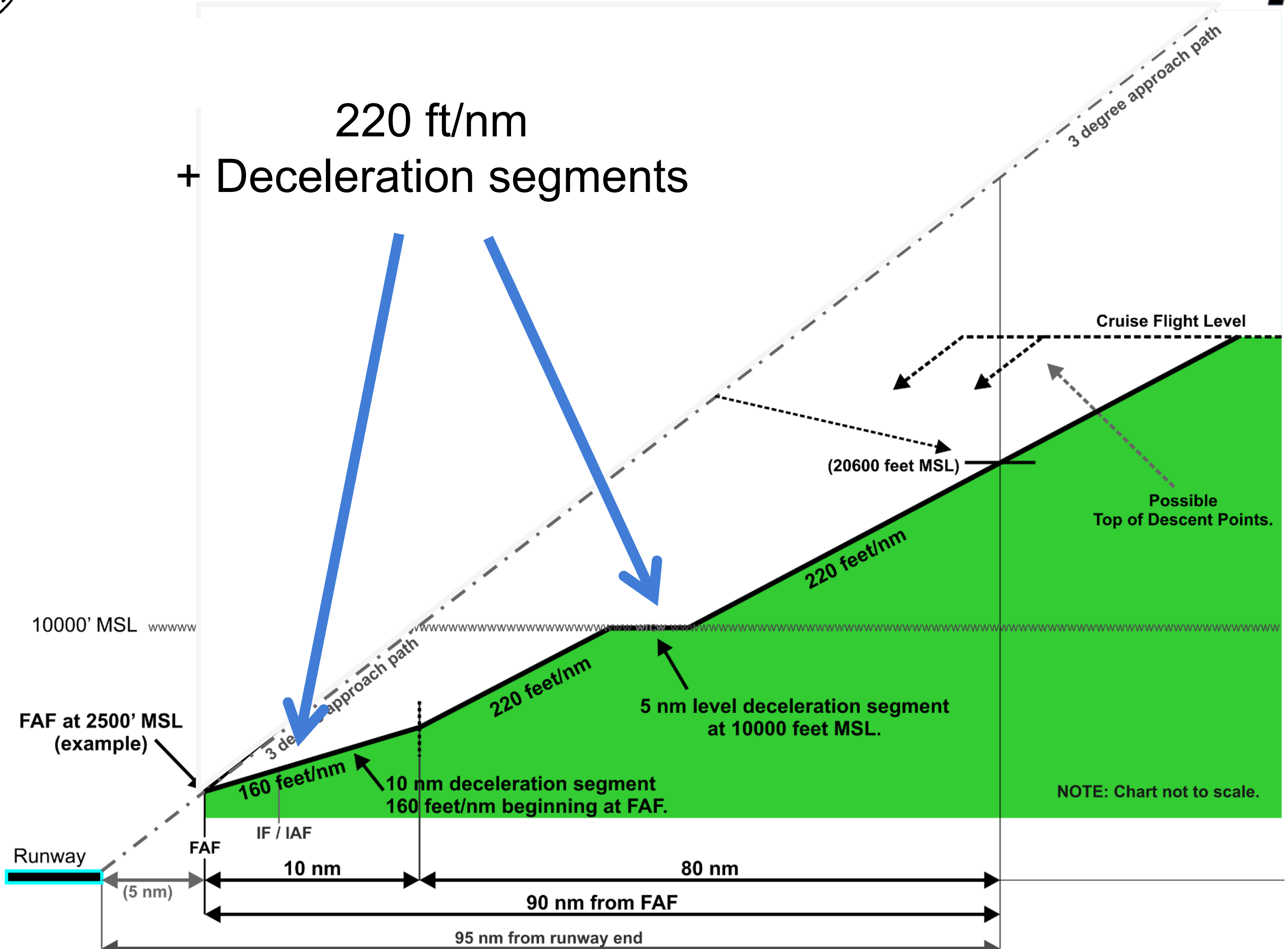
Closed Path CDO Calculations

EXAMPLE:

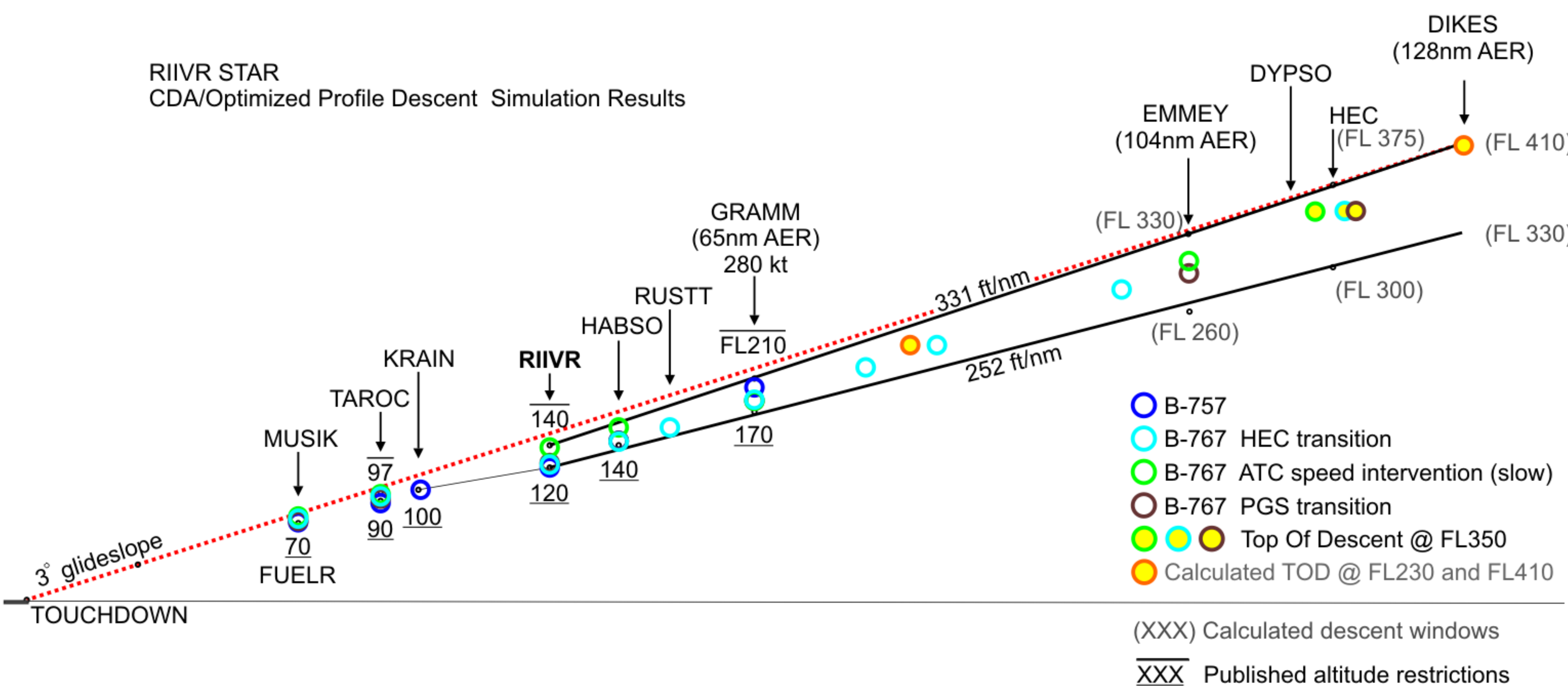


Closed Path CDO Calculations

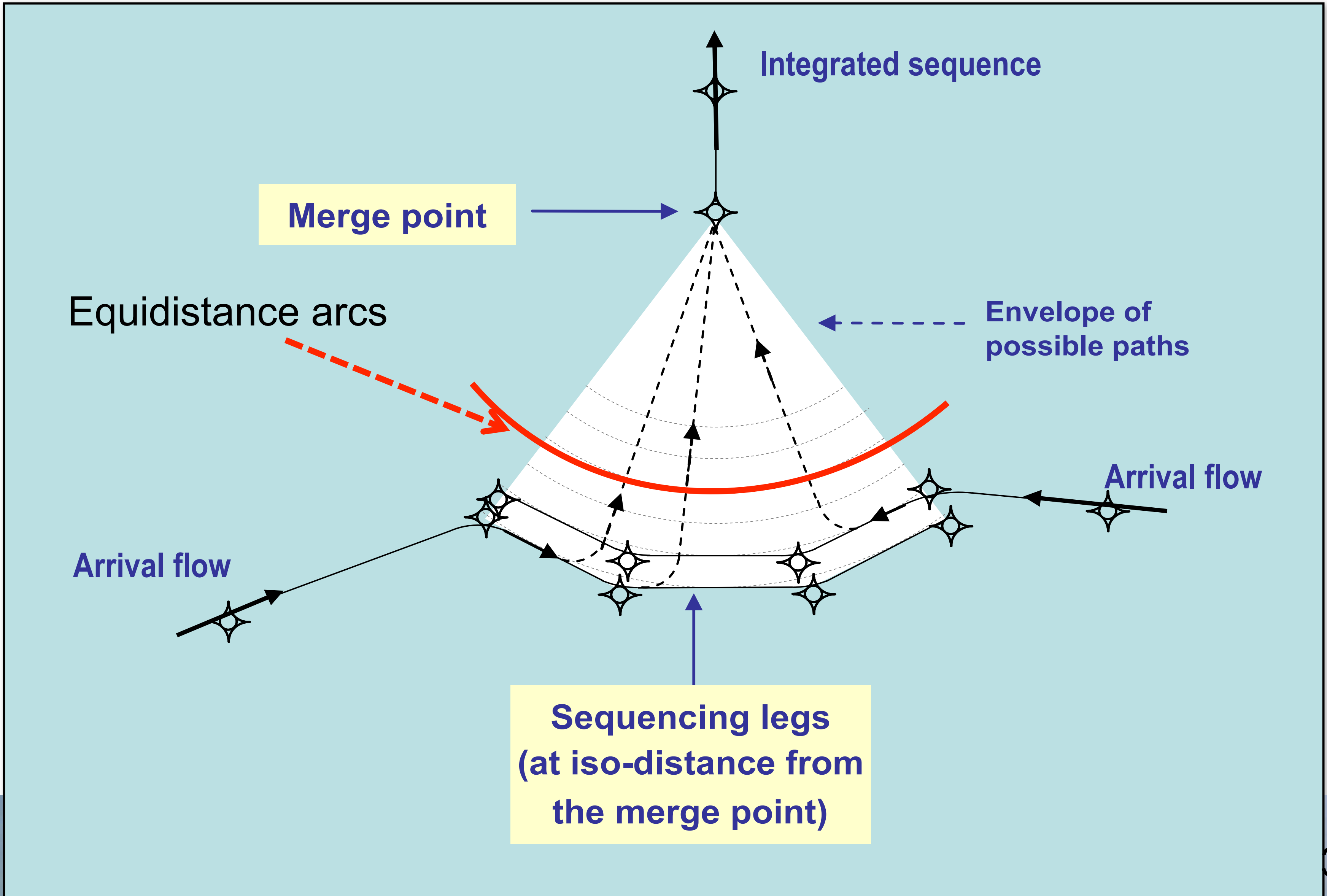
220 ft/nm
+ Deceleration segments



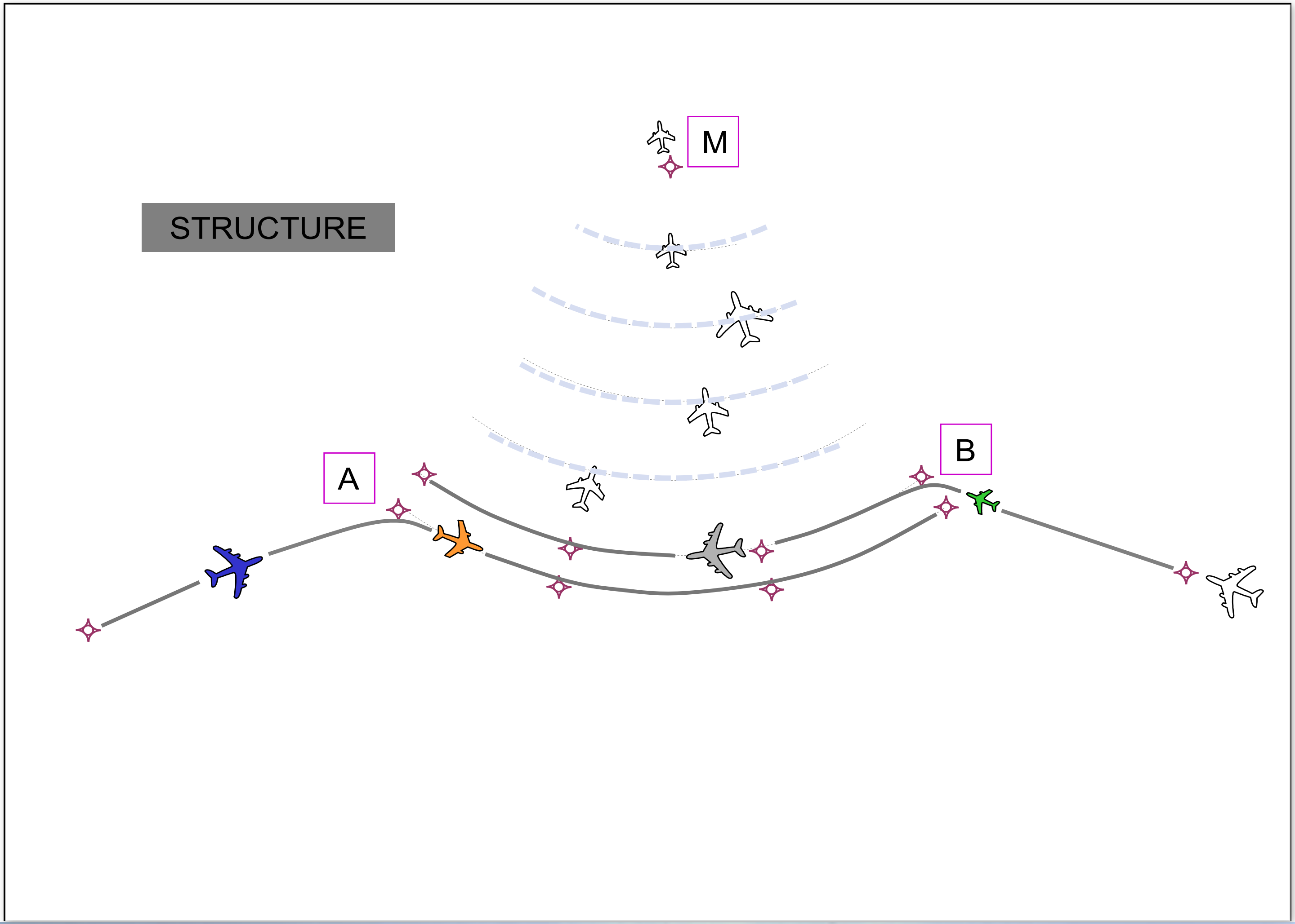
Closed Path CDO Calculations Example - refined with simulation



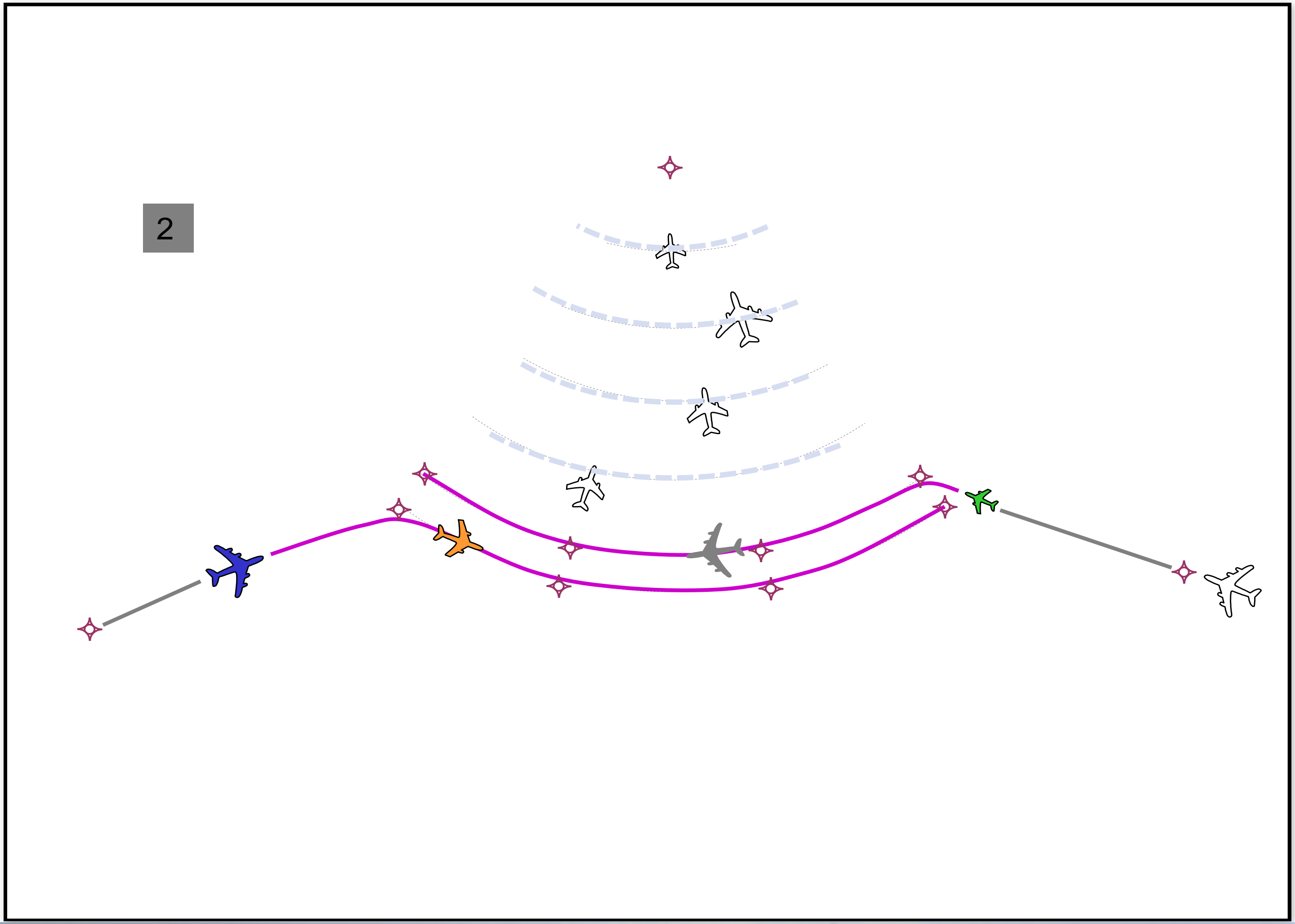
Open Path Arrival Point Merge



Point Merge “talk-through” (1/5)

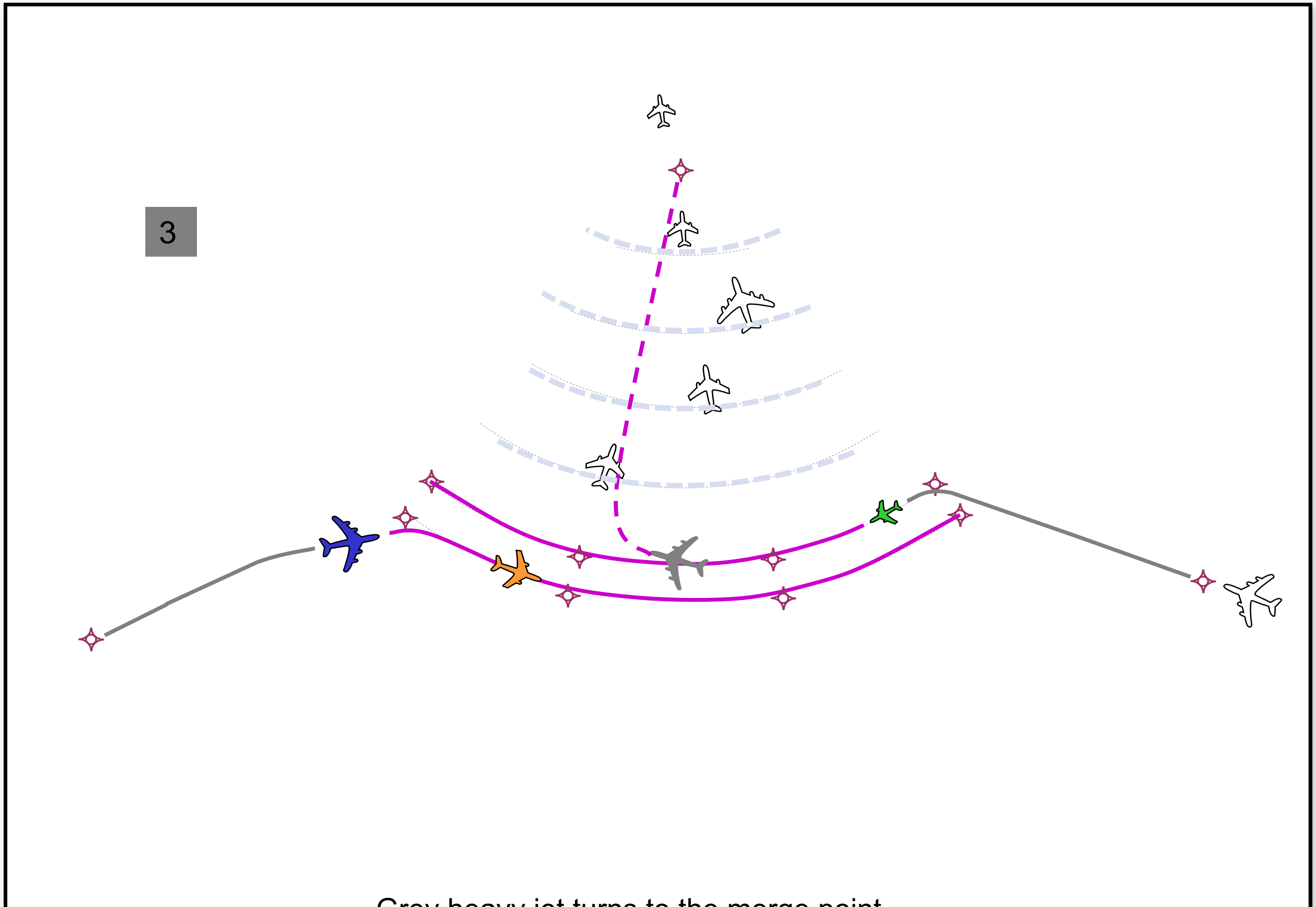


Point Merge "talk-through" (2/5)



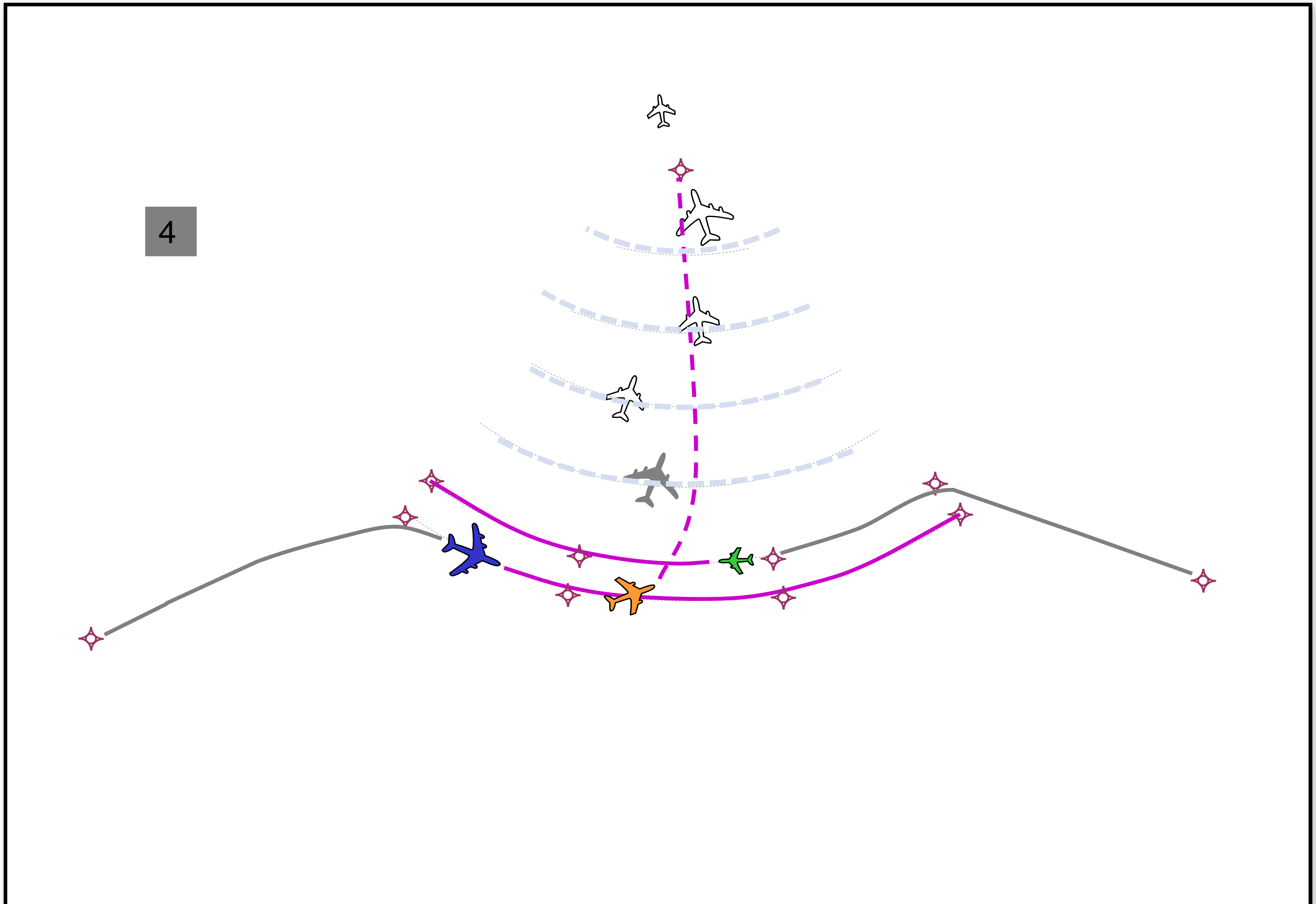
Initial situation with a busy flow of traffic to the merge point

Point Merge “talk-through” (3/5)



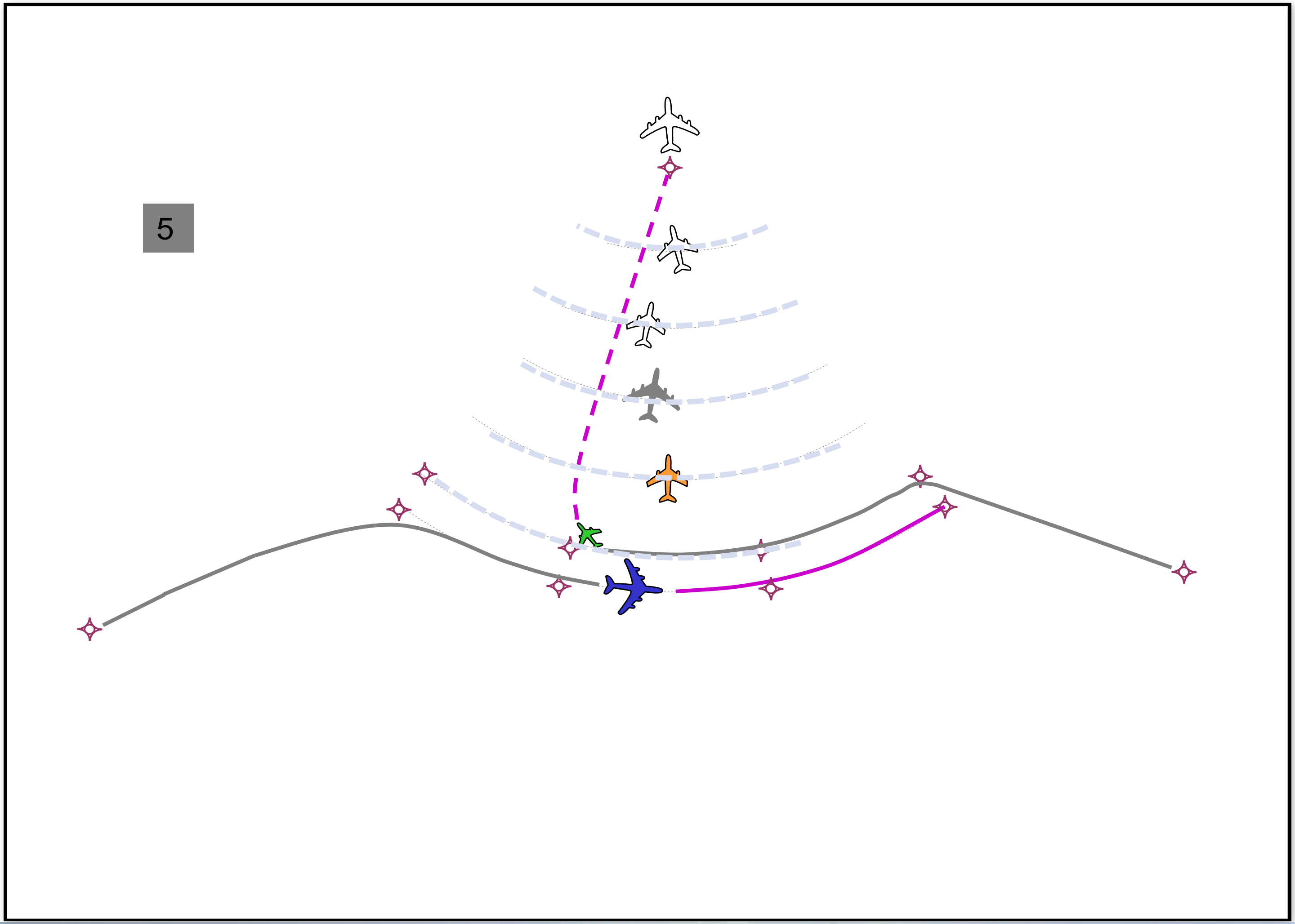
Grey heavy jet turns to the merge point.
Controller determines when to issue the “Direct to merge point” instruction to the Gold aircraft to ensure that the required spacing behind the preceding aircraft will be achieved.

Point Merge "talk-through" (4/5)



Controller issues the "Turn left direct to merge point" instruction
to the Gold aircraft using the range ring arcs to assess
the appropriate spacing from the Grey aircraft.

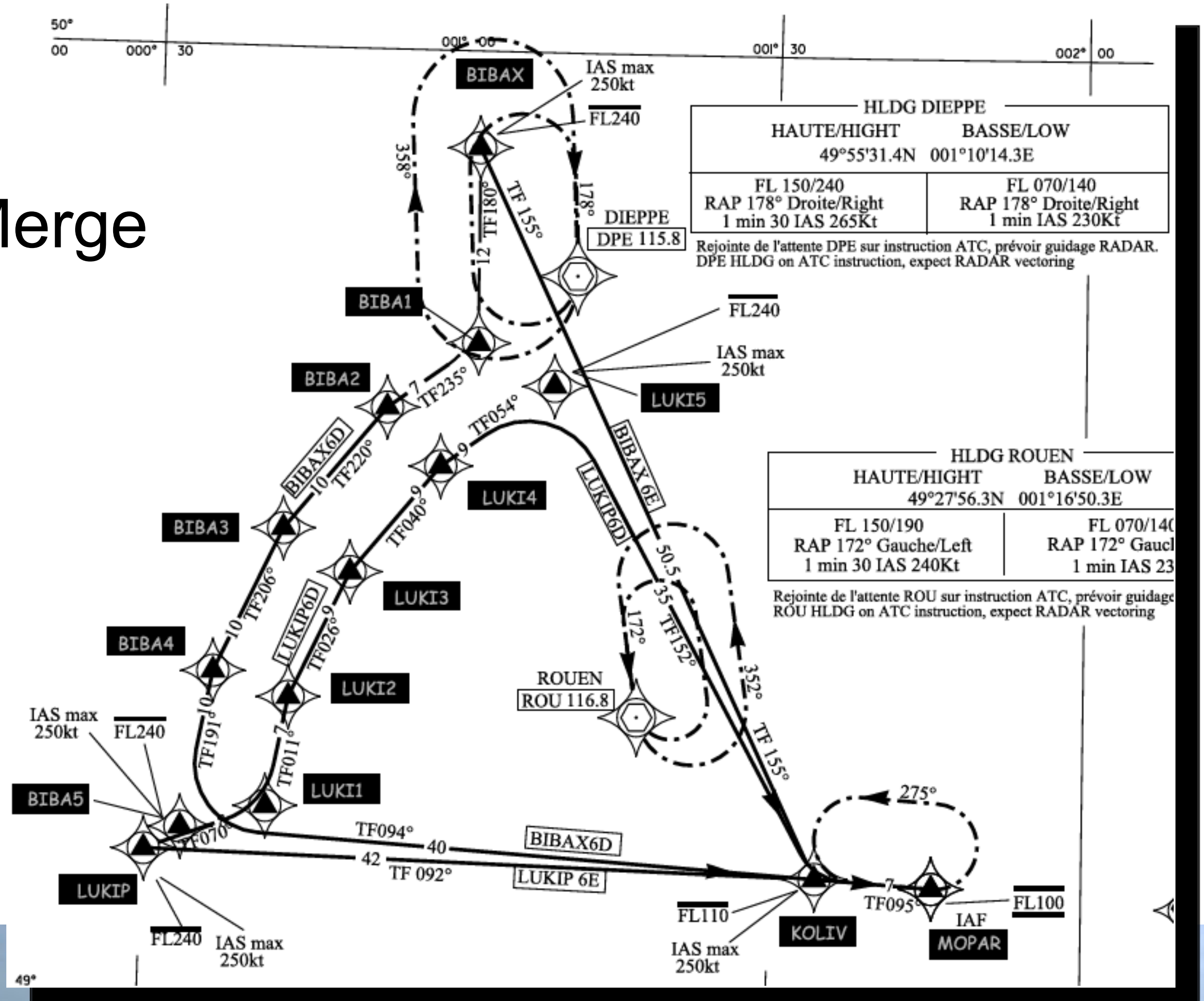
Point Merge "talk-through" (5/5)



The same technique is repeated for the Green aircraft

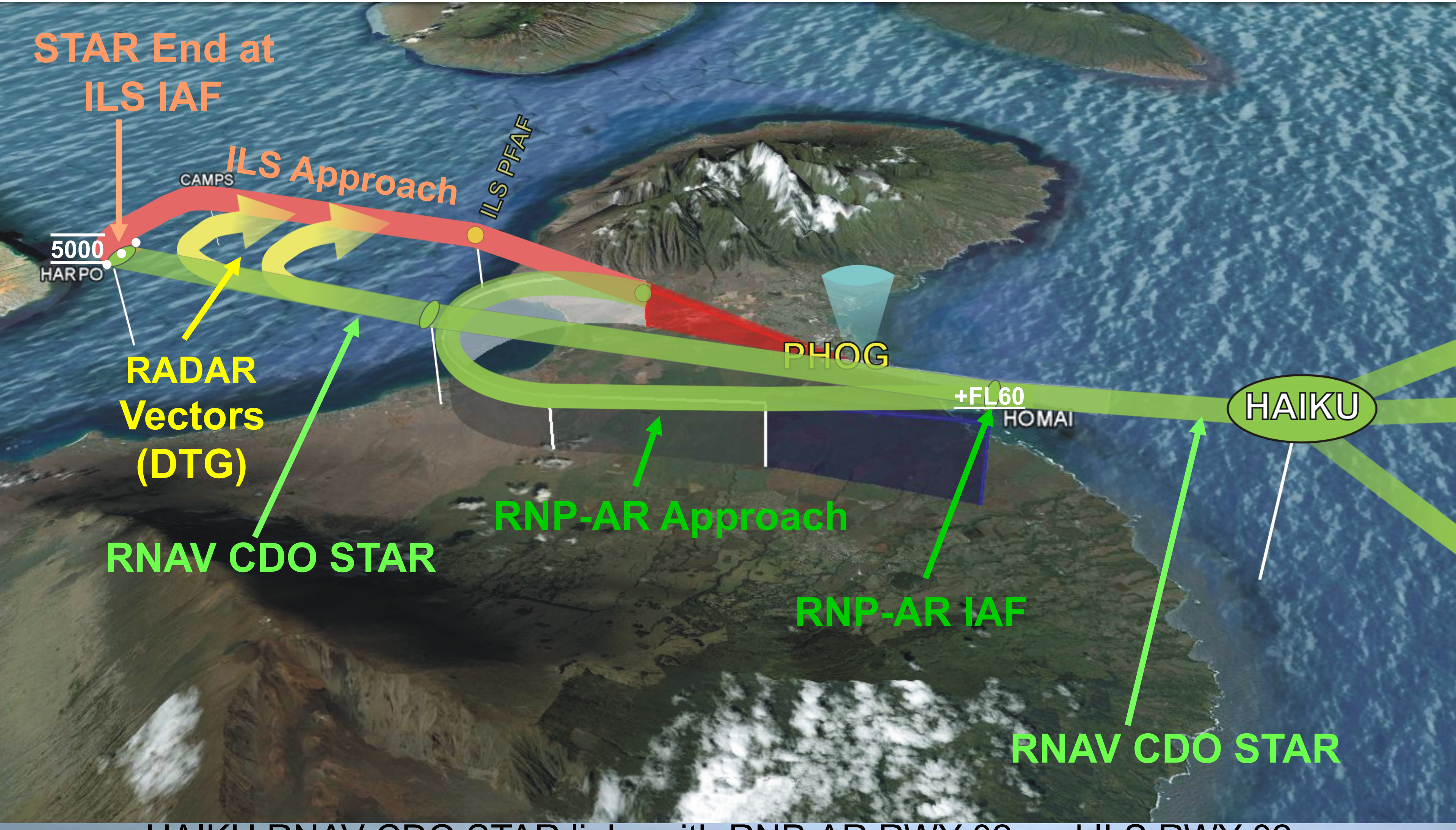
Point Merge Example

Point Merge



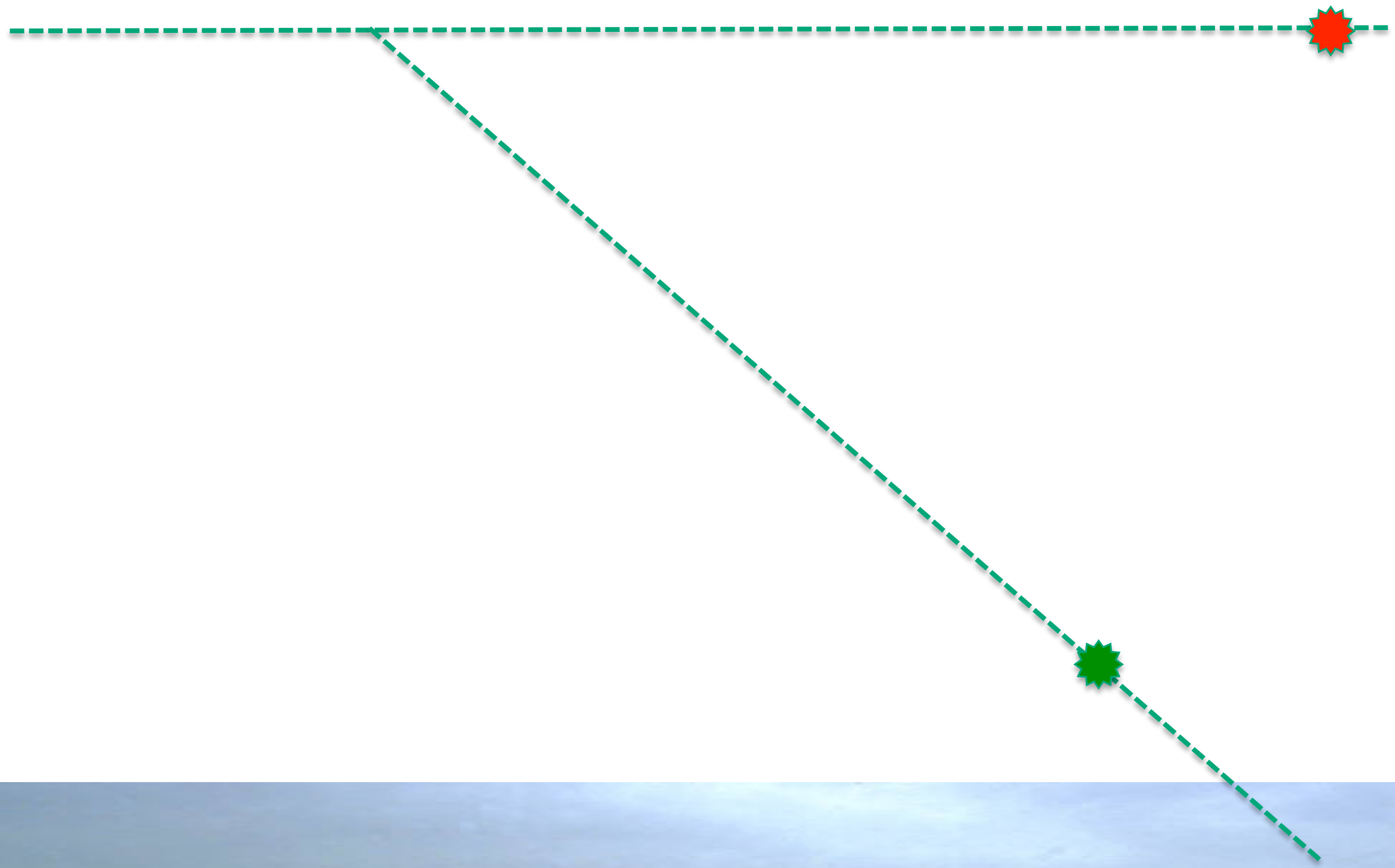
CDO Integration

Integrating RNAV, RNP, & Conventional Capabilities

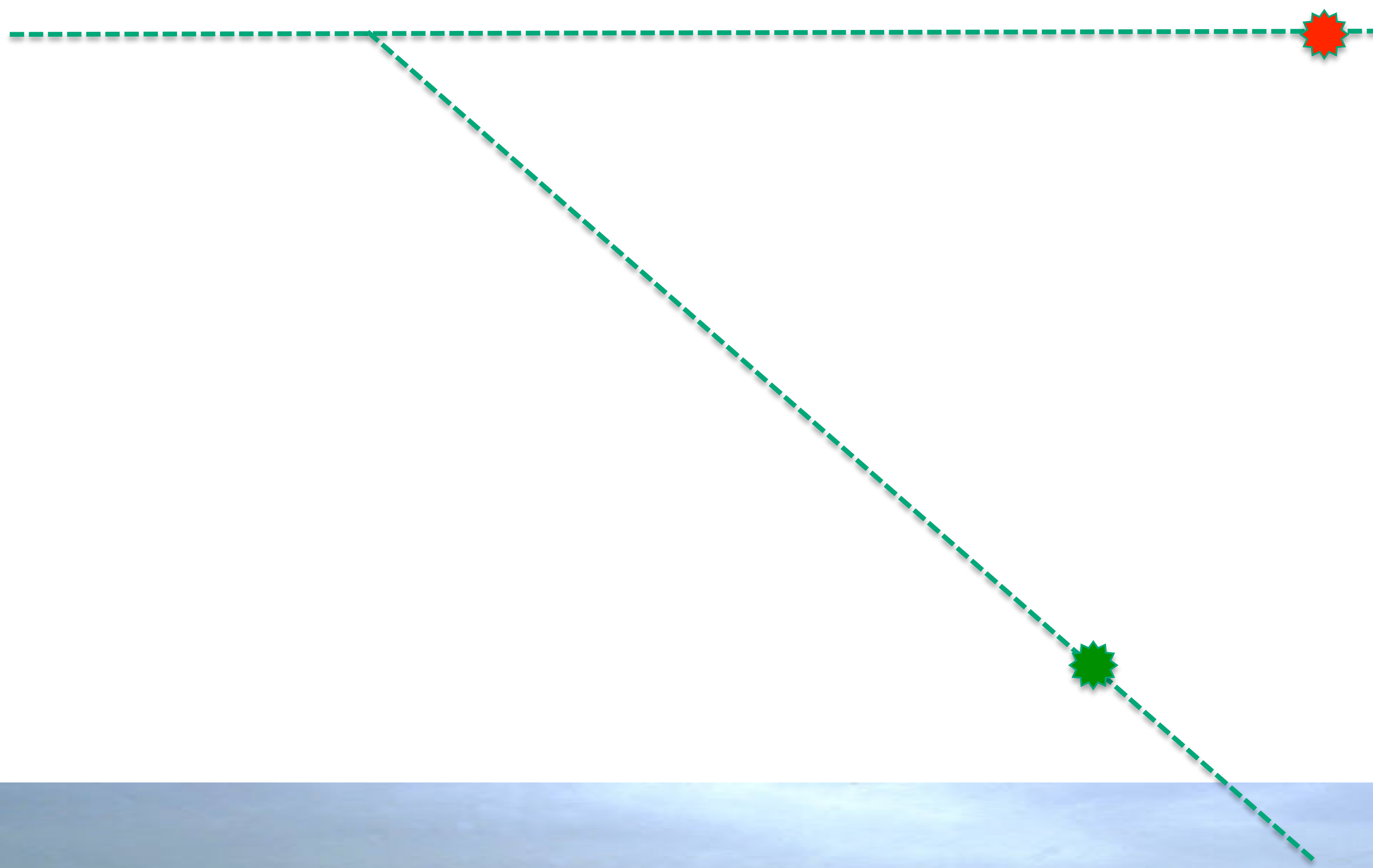


HAIKU RNAV CDO STAR links with RNP-AR RWY 02 and ILS RWY 02

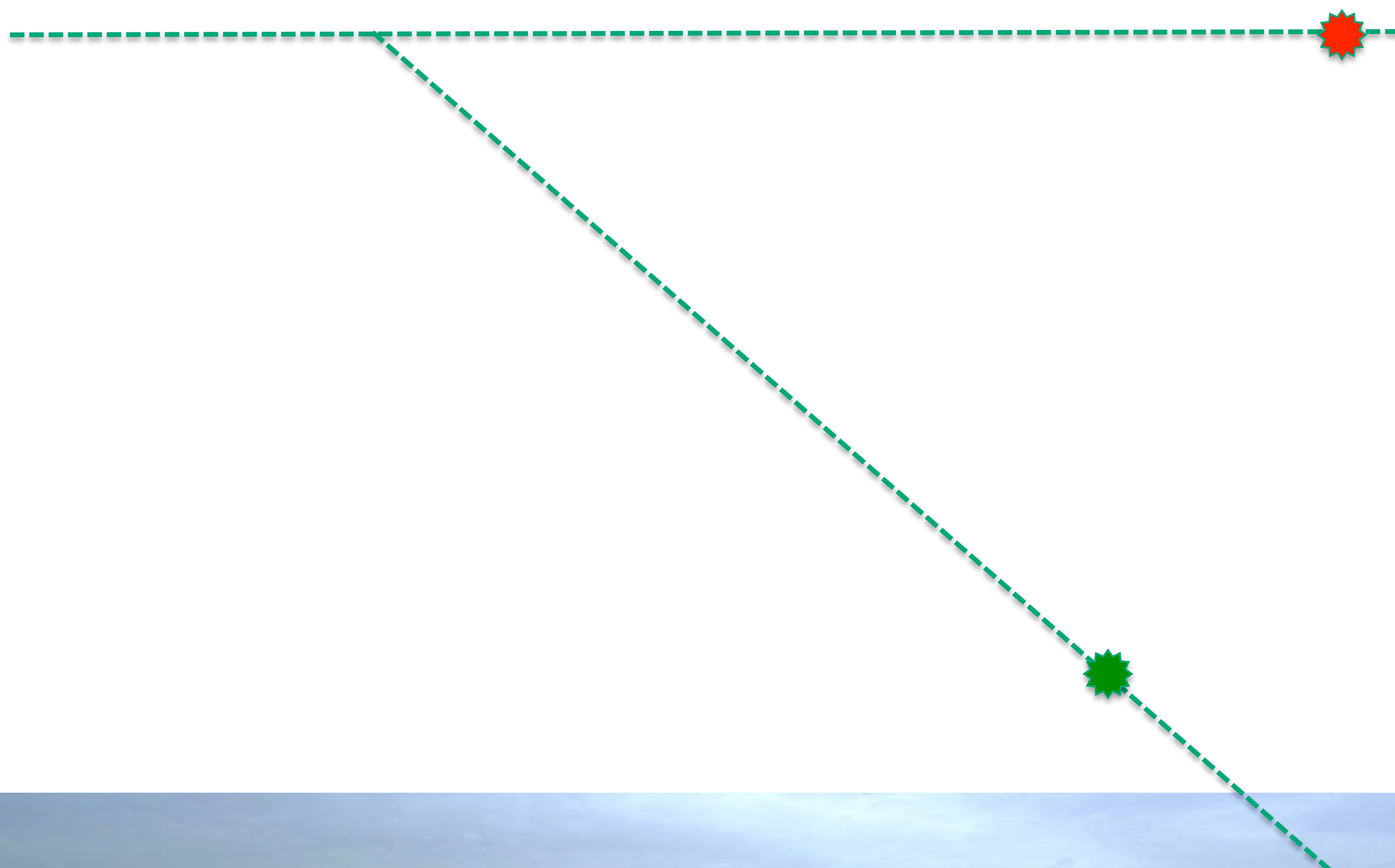
Decision Making



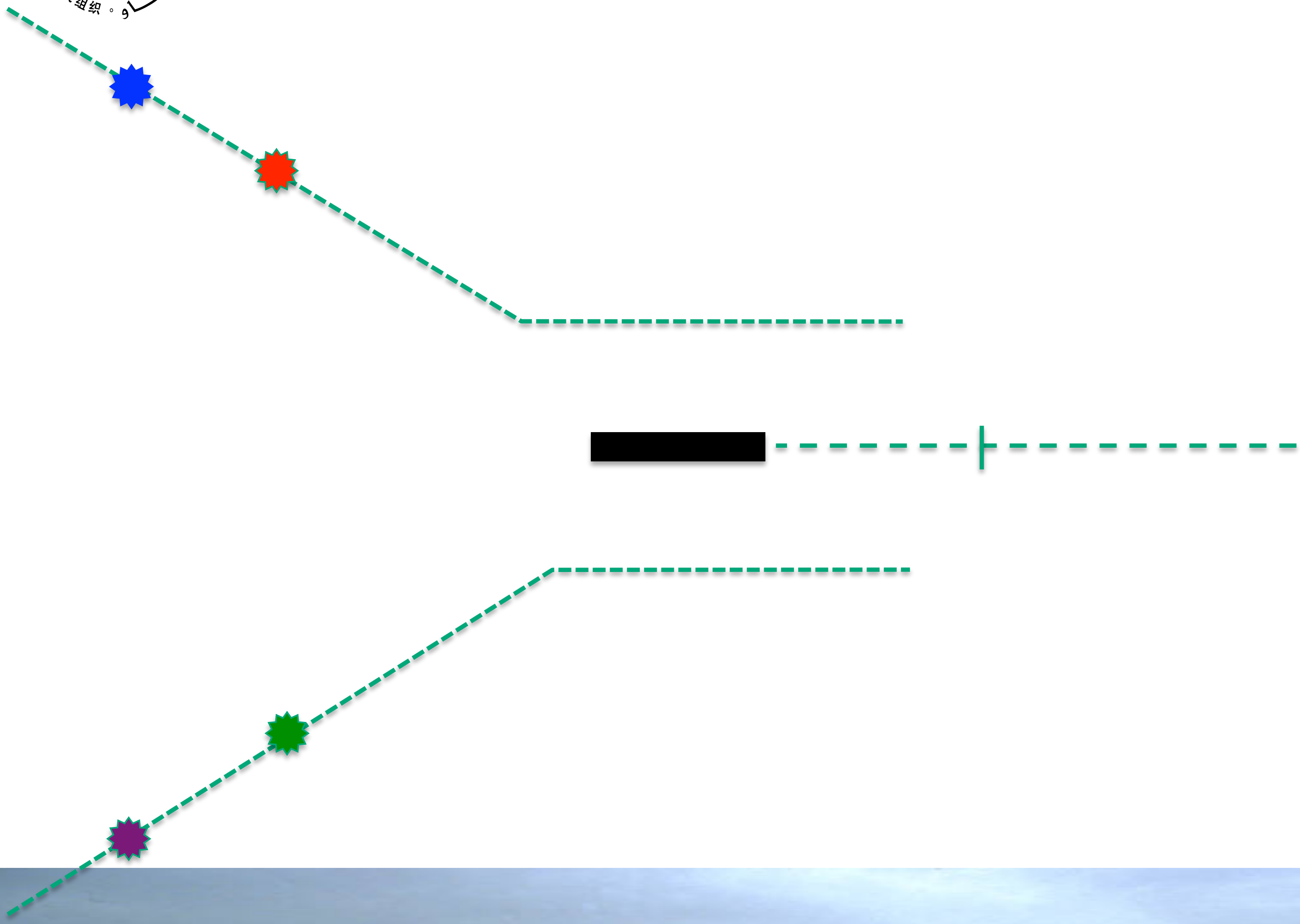
Decision Making



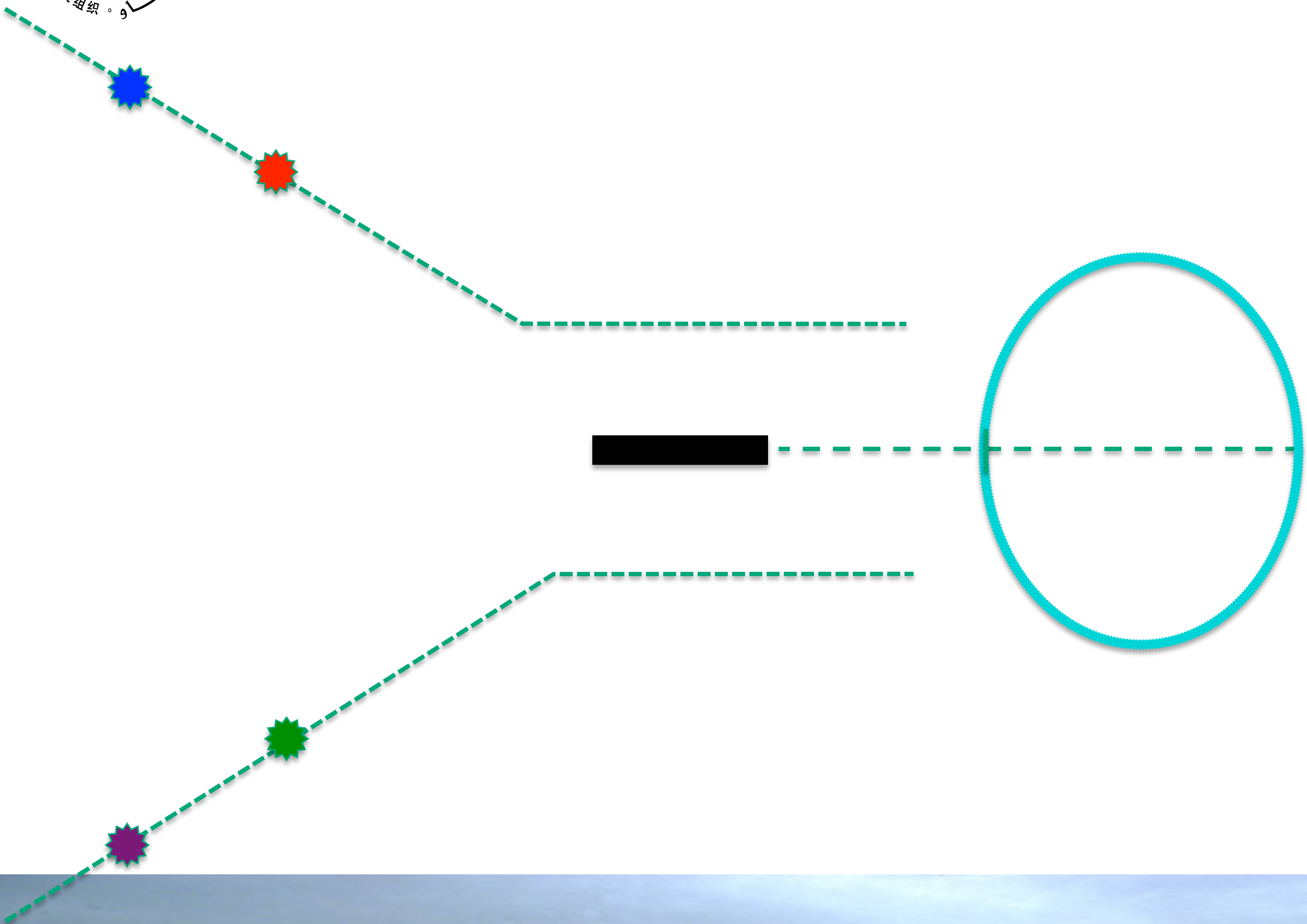
Decision Making



Decision Making



Decision Making



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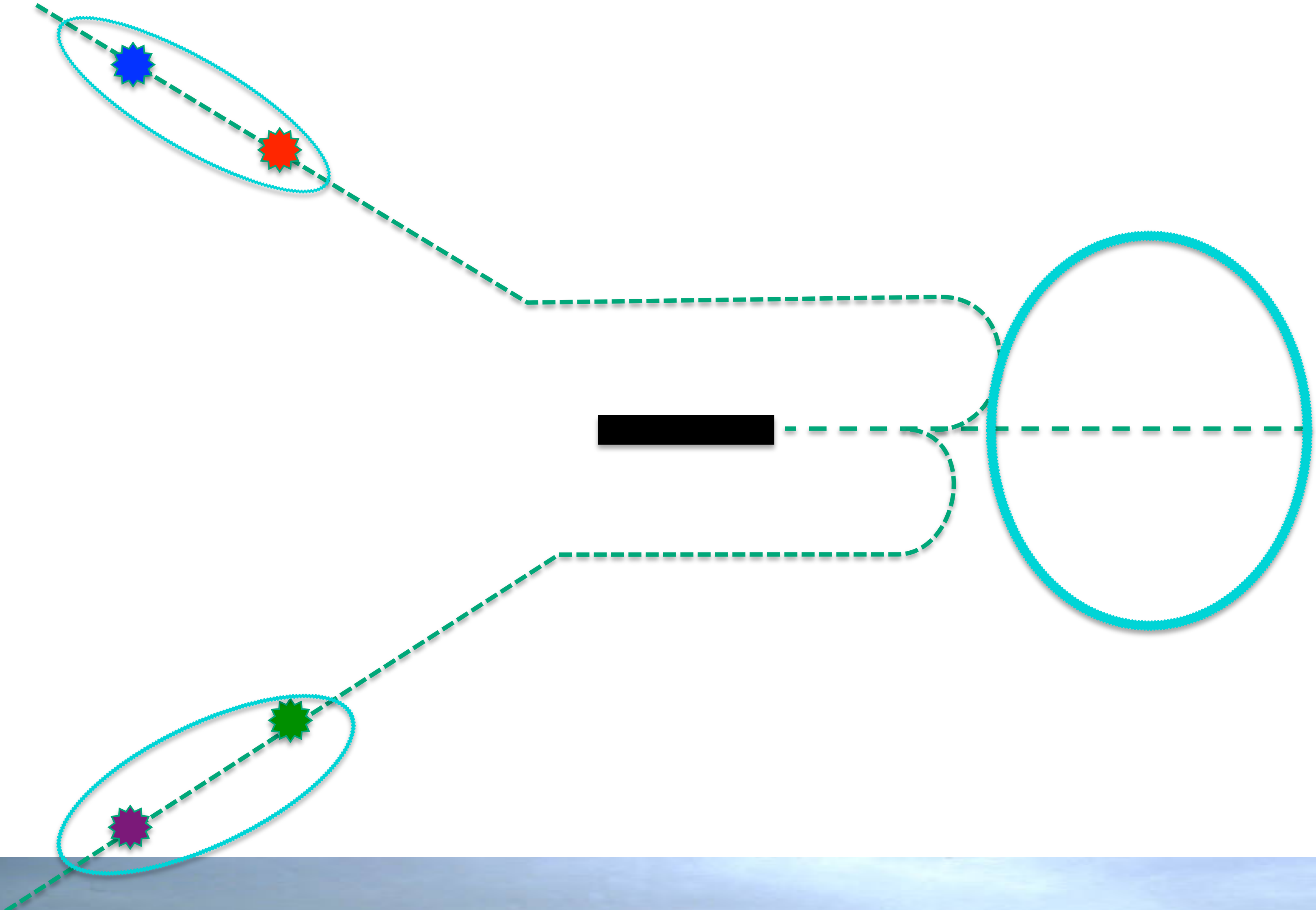
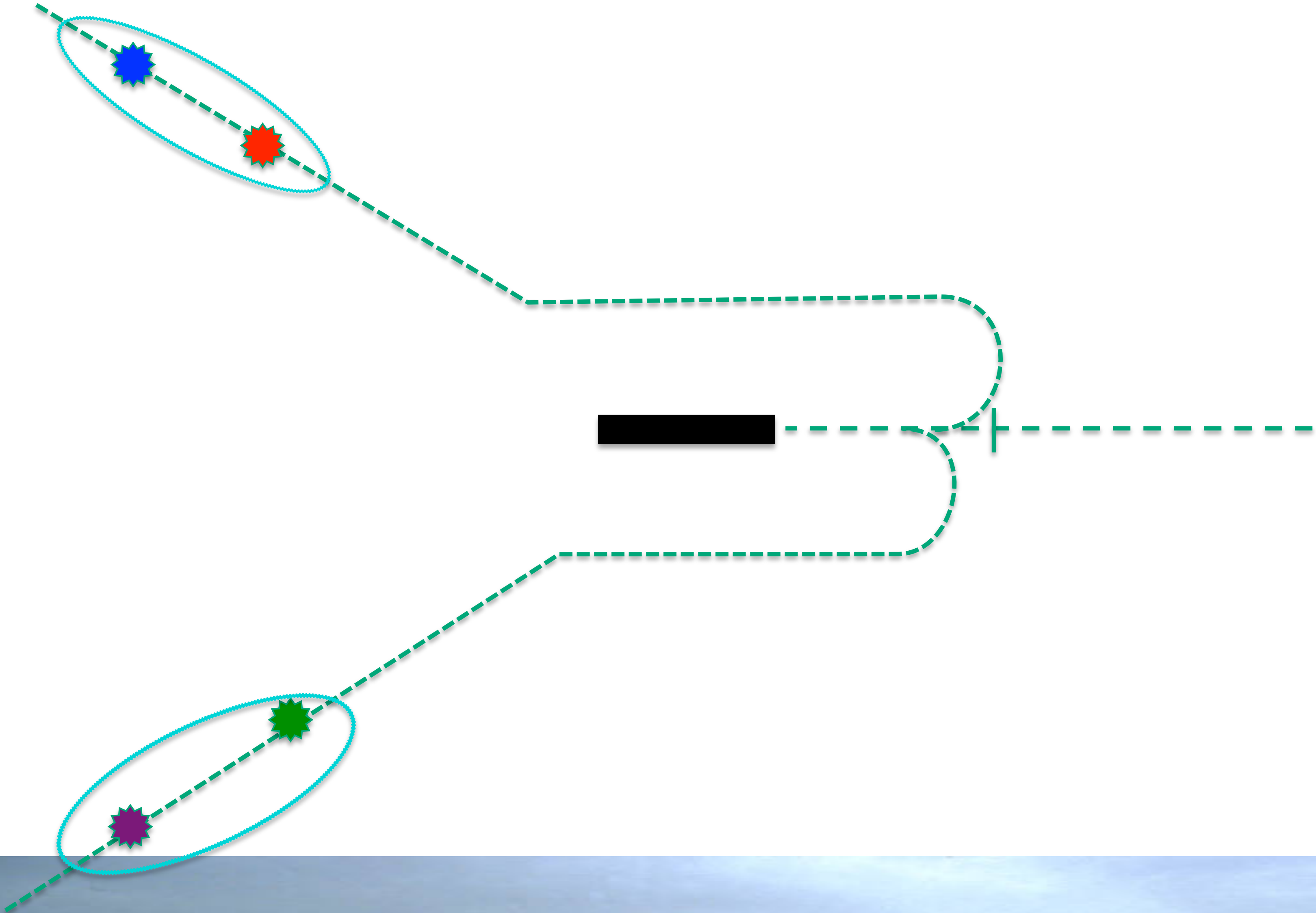
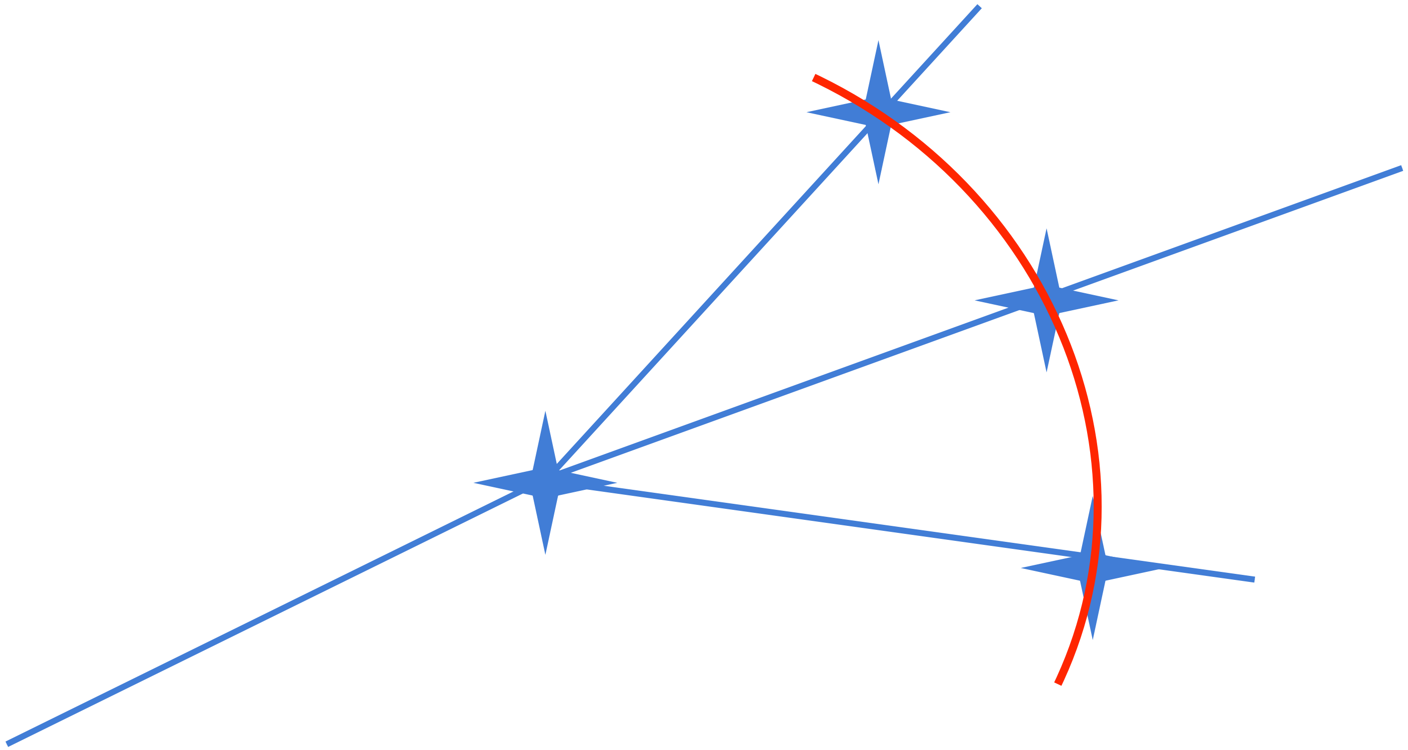


Decision Making



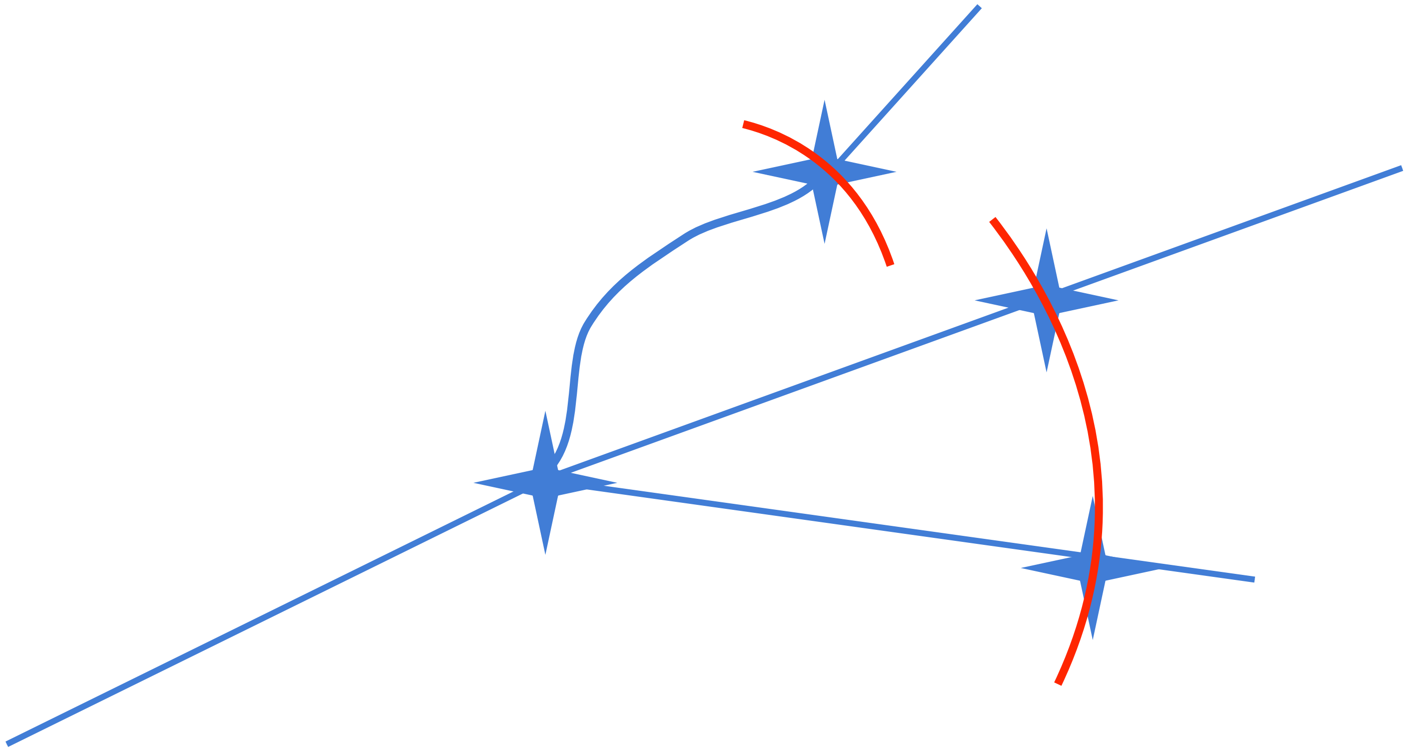
Sequencing Using Structured Decision Points

Use equidistant points to judge distance

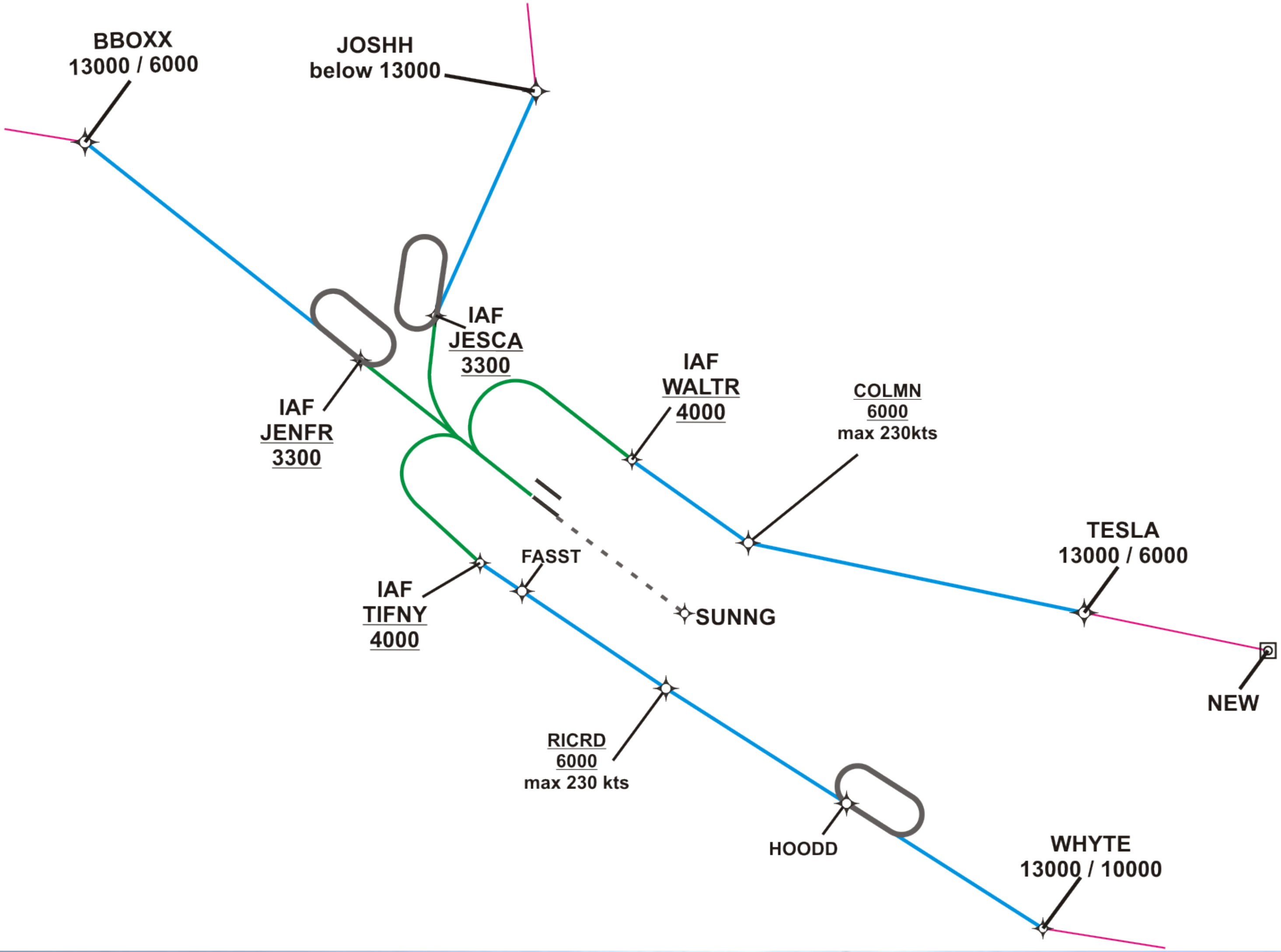


Sequencing Using Structured Decision Points

PBN consistency allows equidistance for non linear paths



CDO Design Using Structured Decision Points



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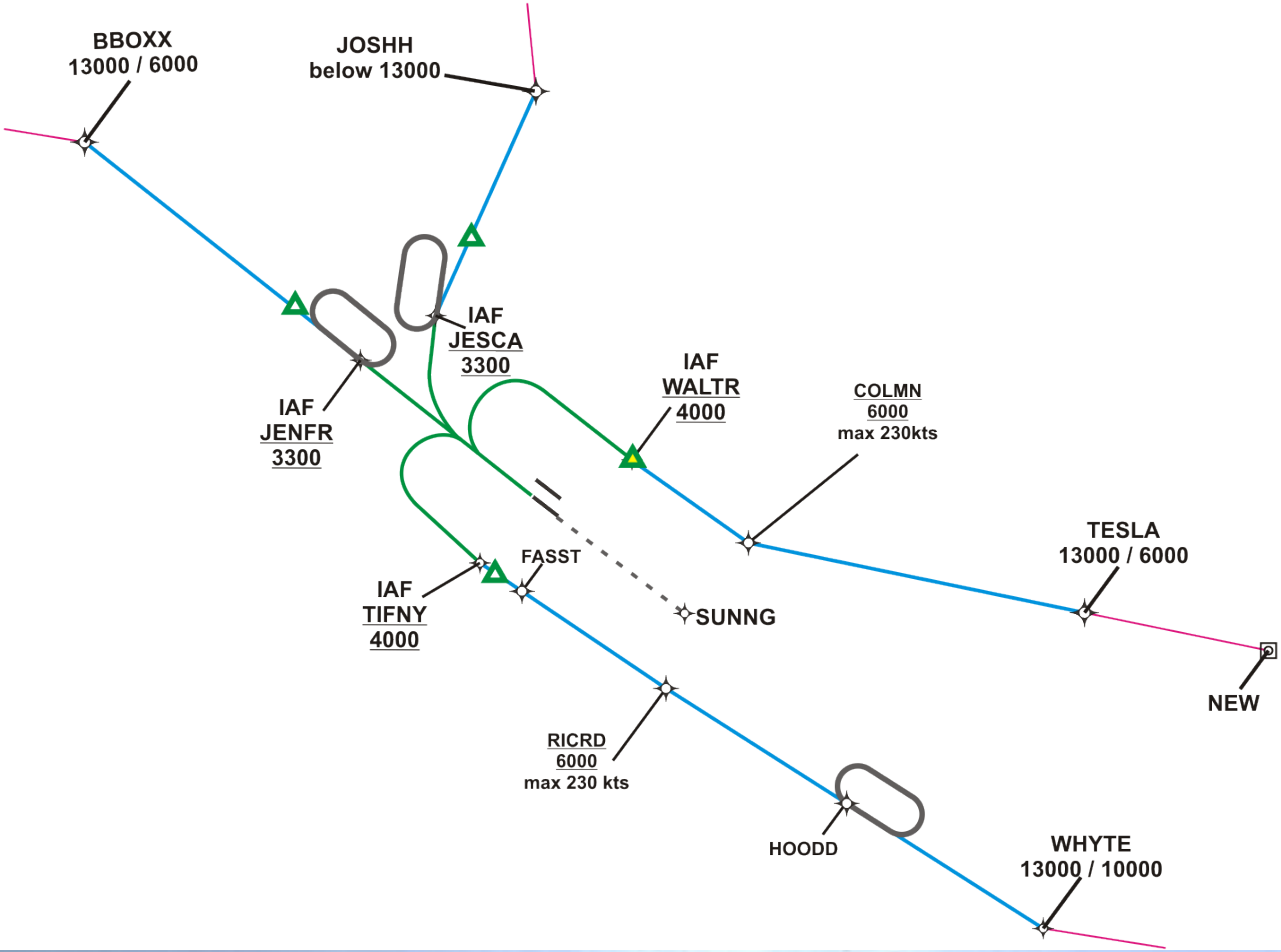

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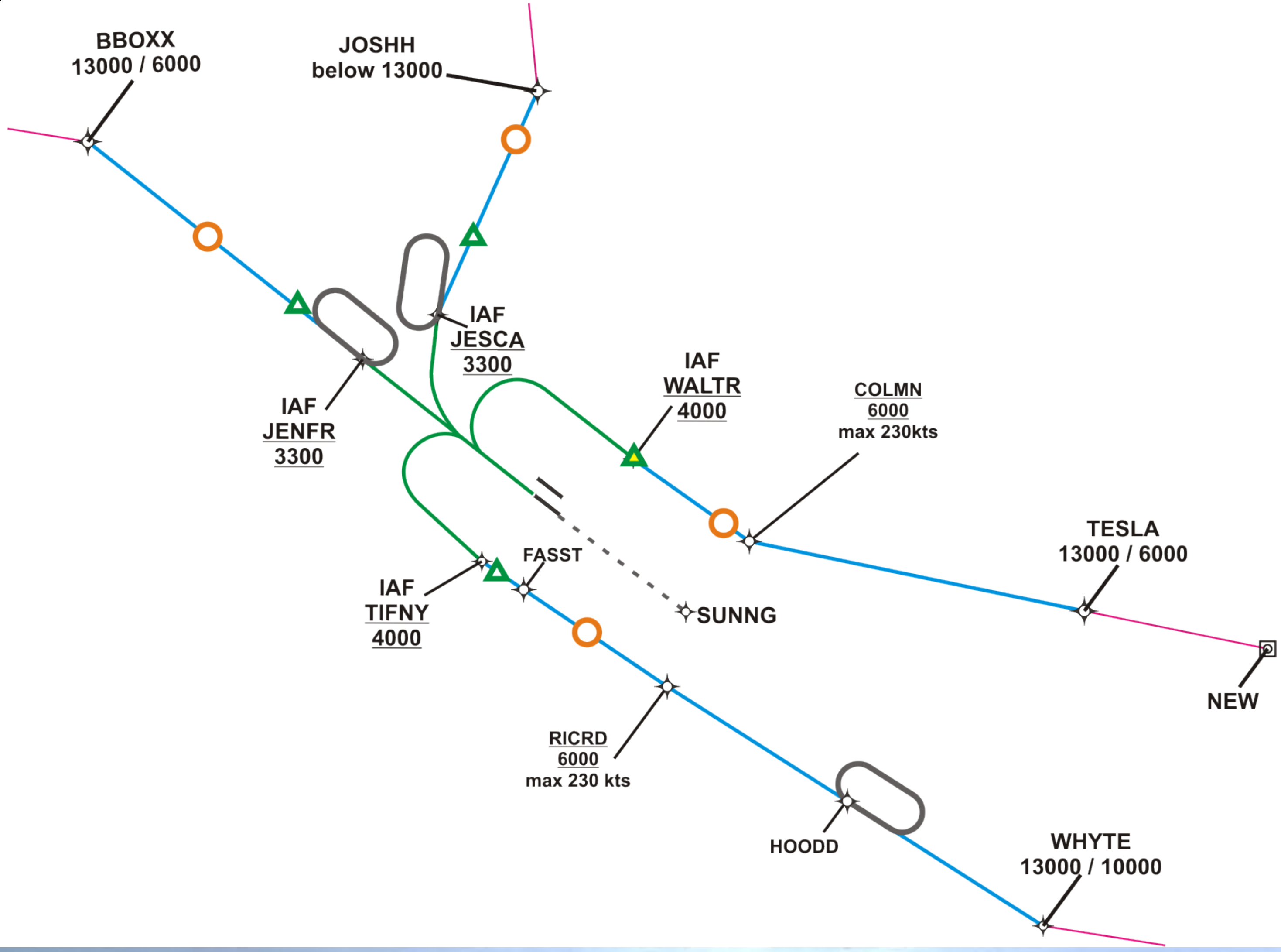

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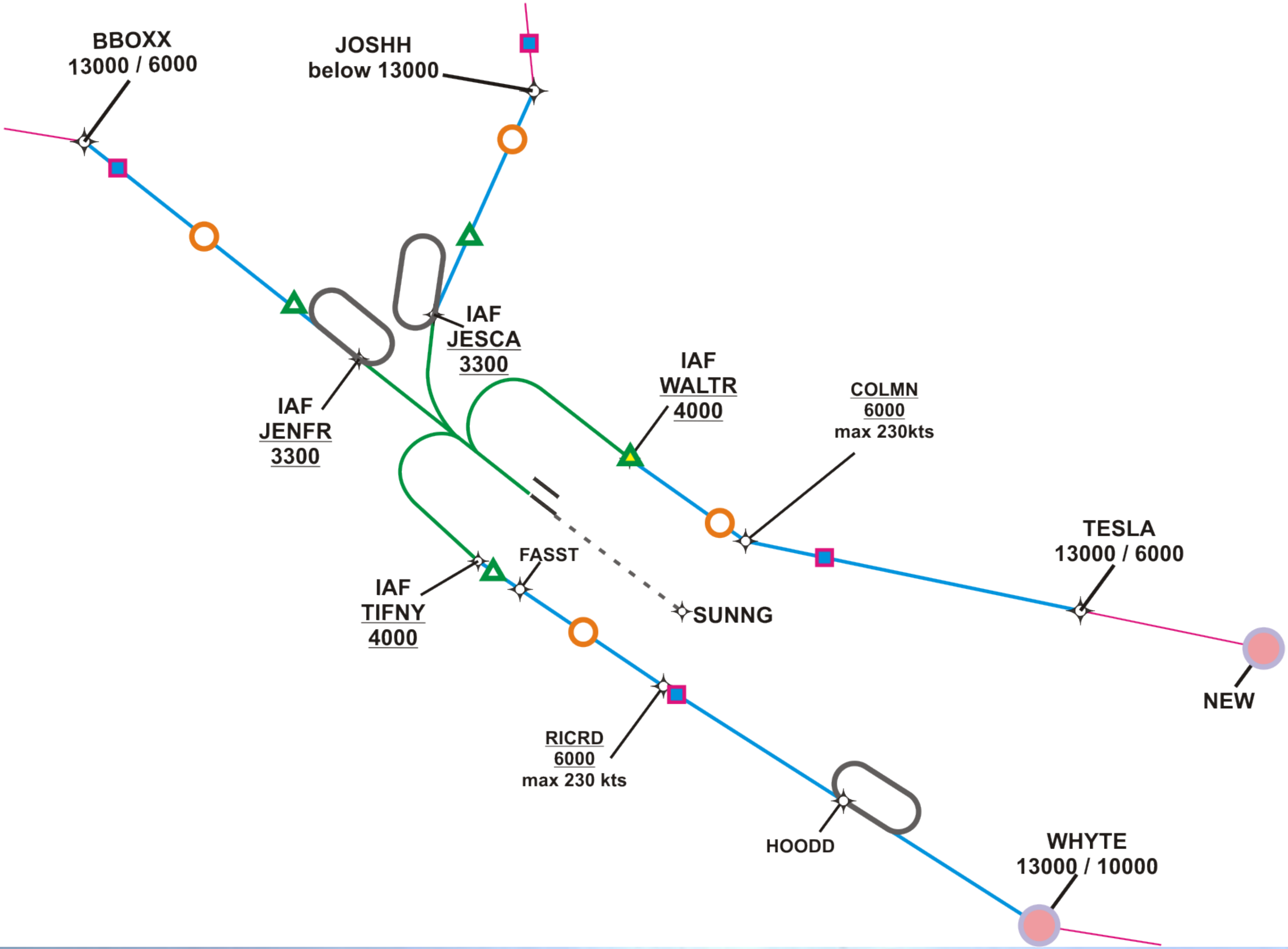
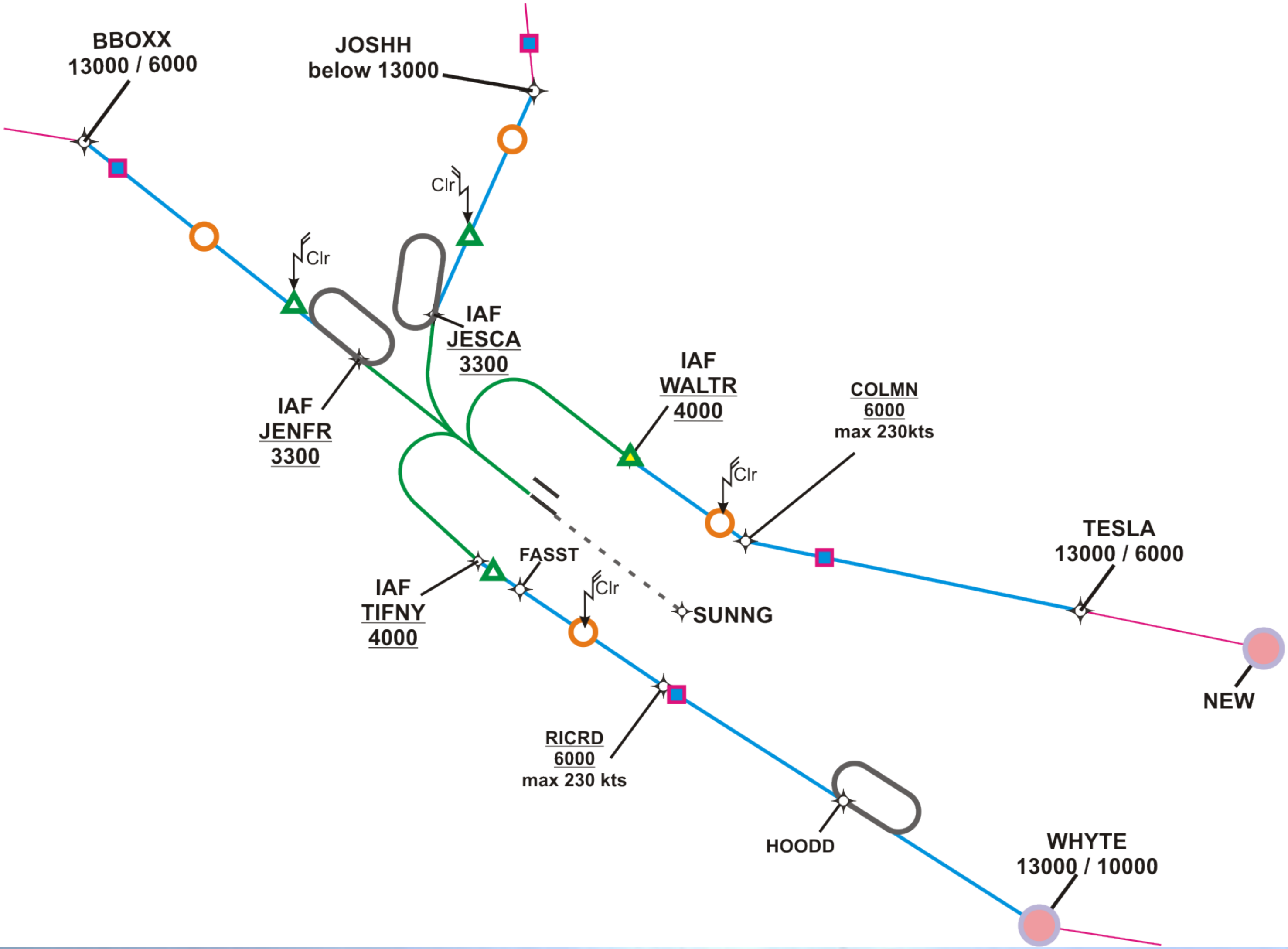
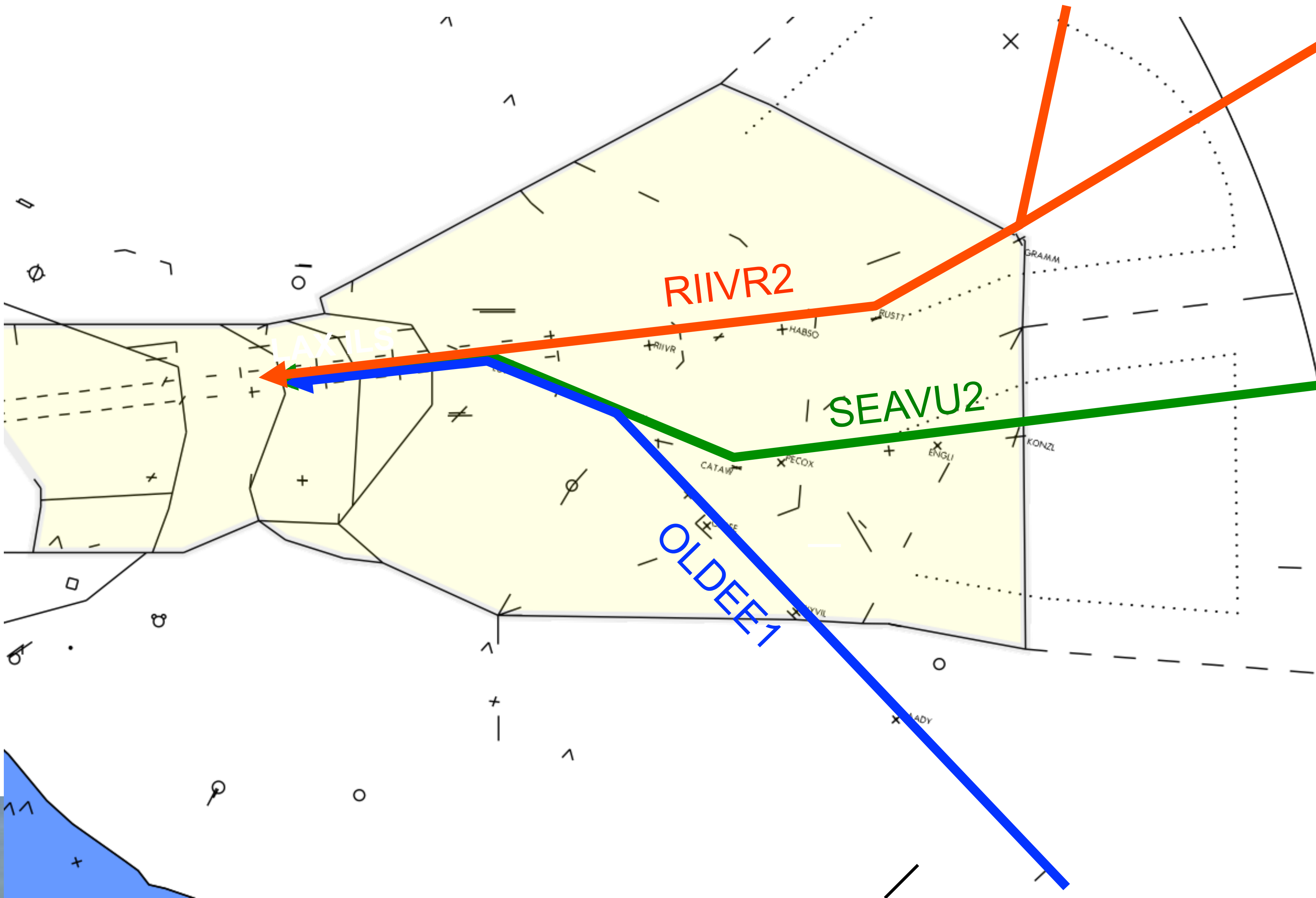


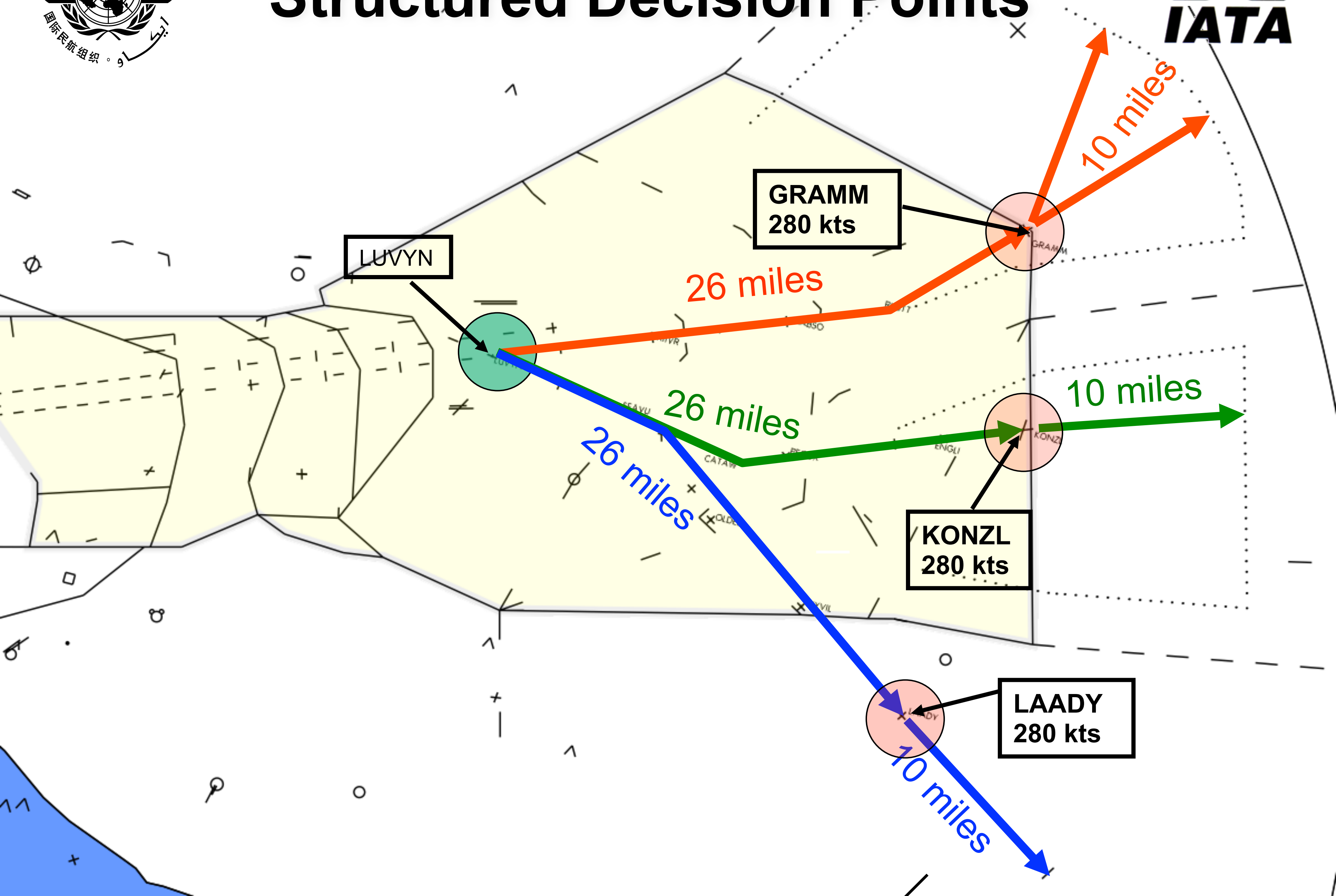
CDO Design Using Structured Decision Points



Closed Path Sequencing: LAX



Sequencing Using Structured Decision Points



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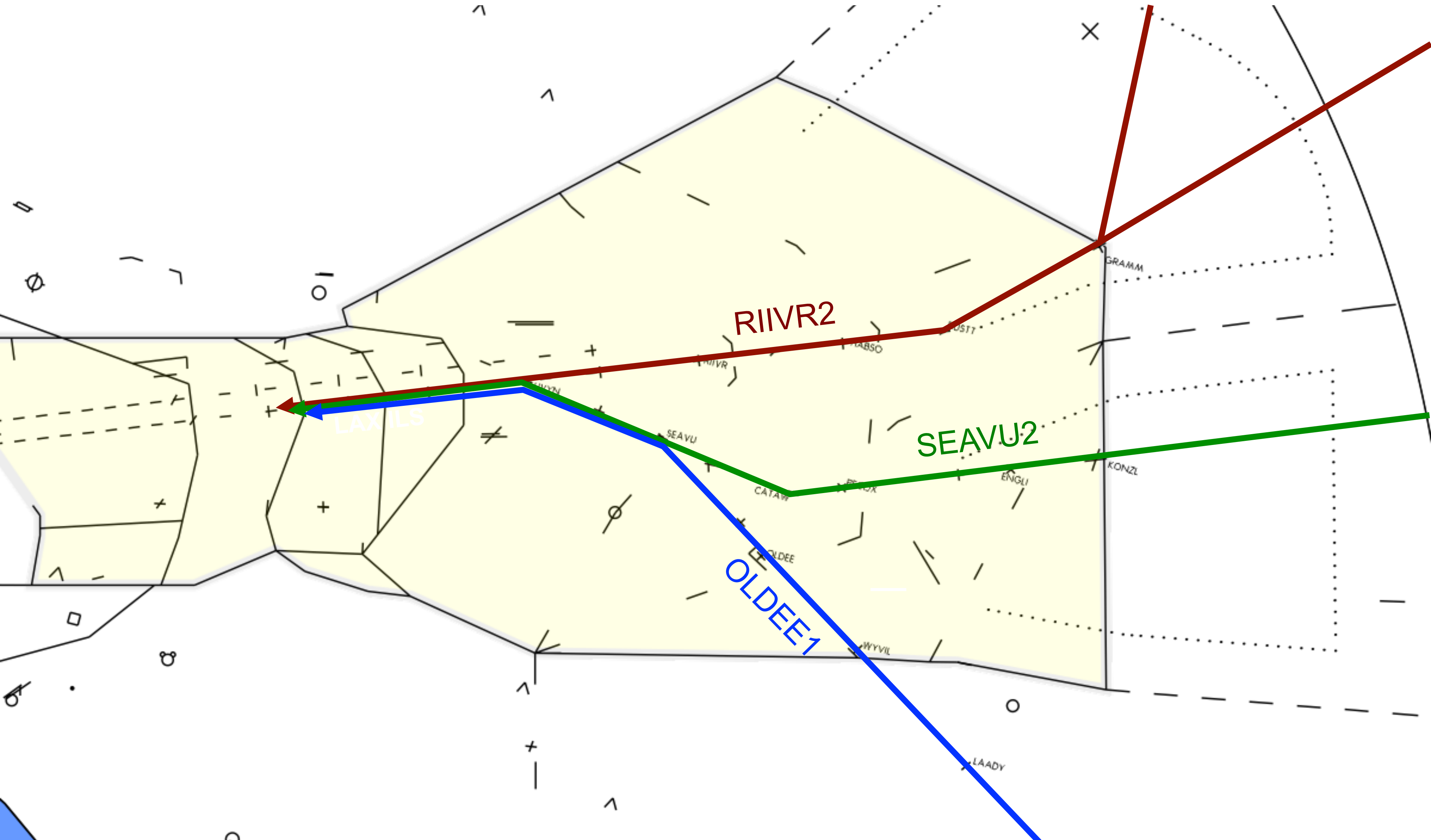

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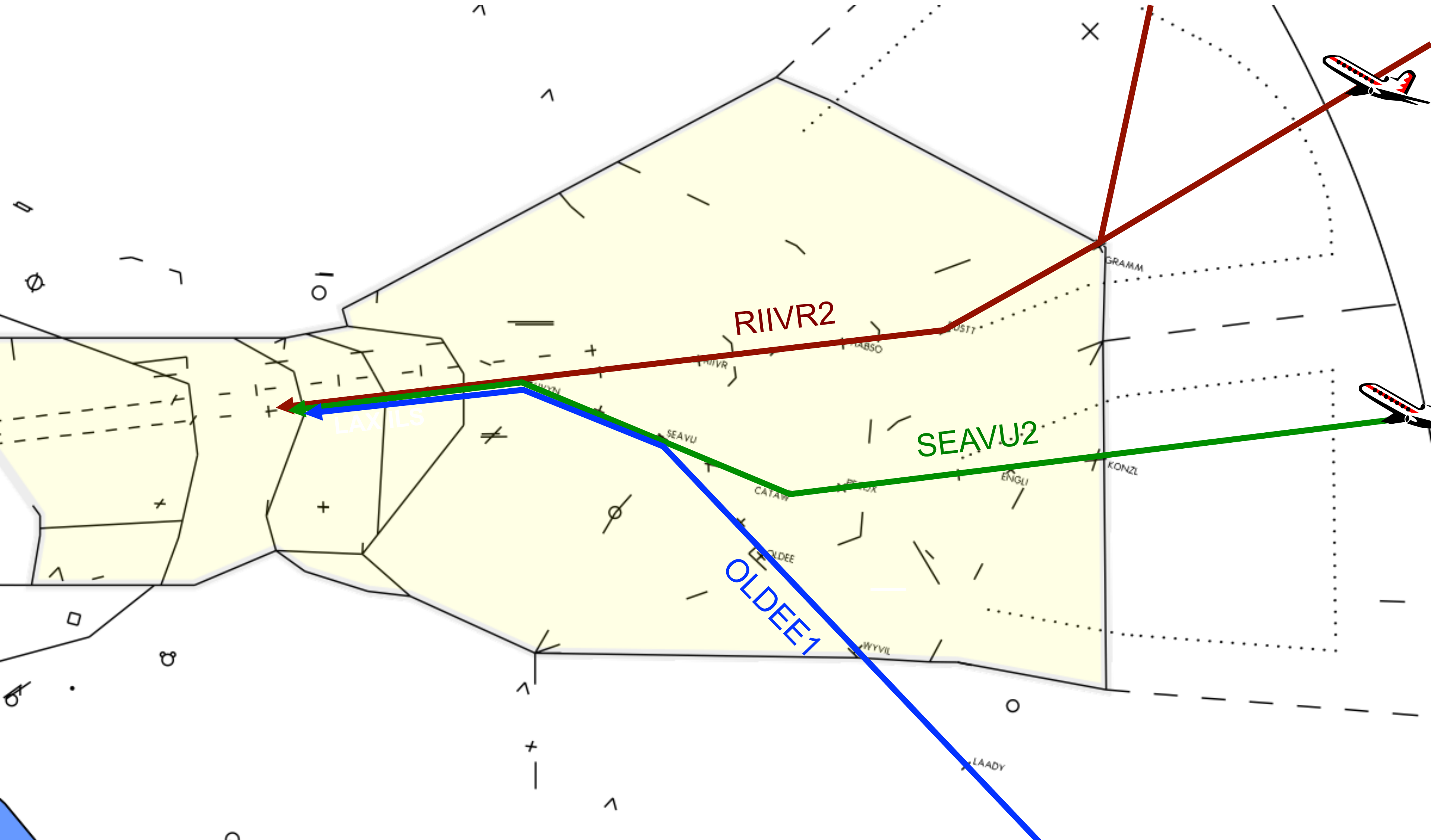
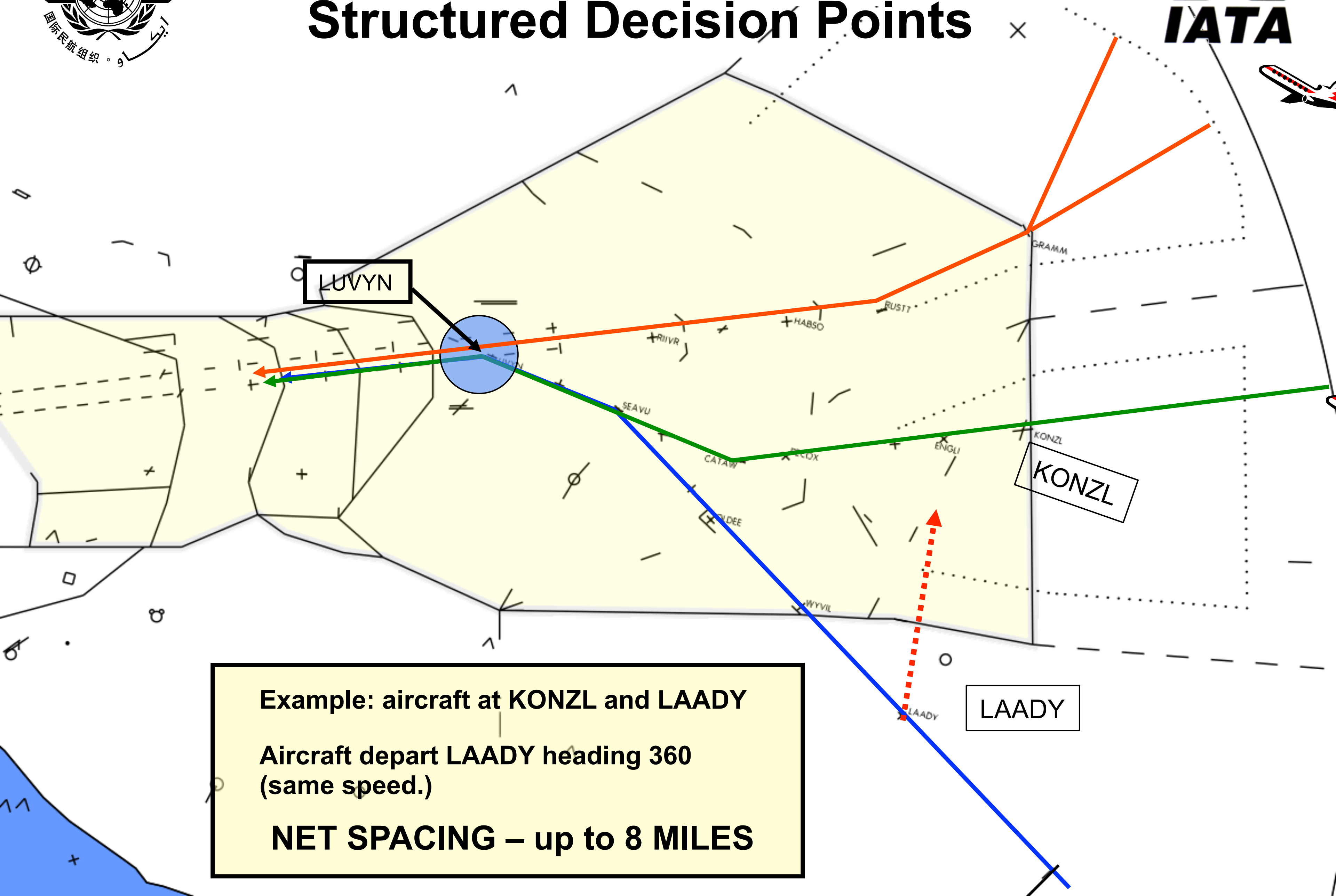


Sequencing Using Structured Decision Points

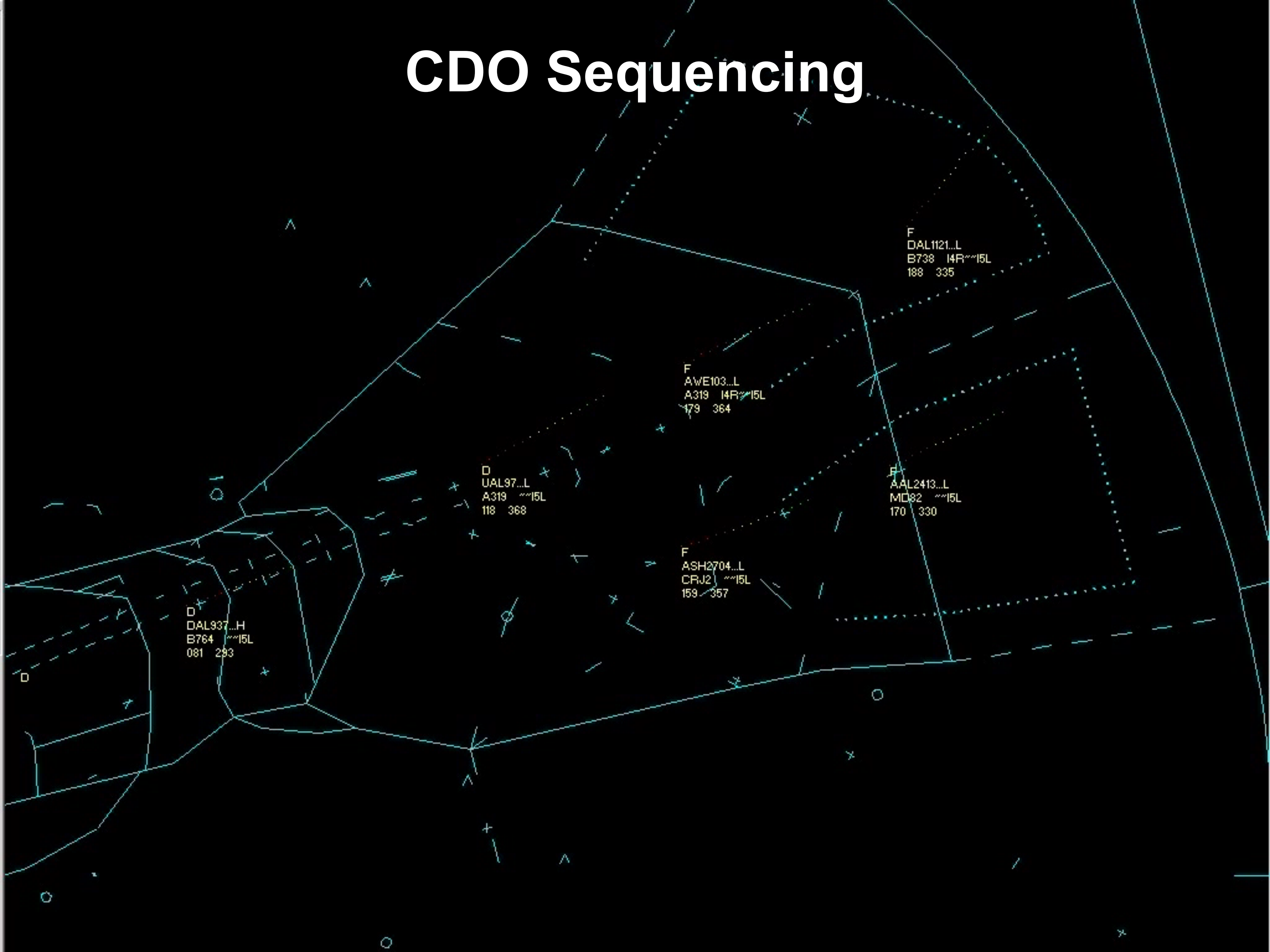


Example: aircraft at KONZL and LAADY

Aircraft depart LAADY heading 360 (same speed.)

NET SPACING – up to 8 MILES

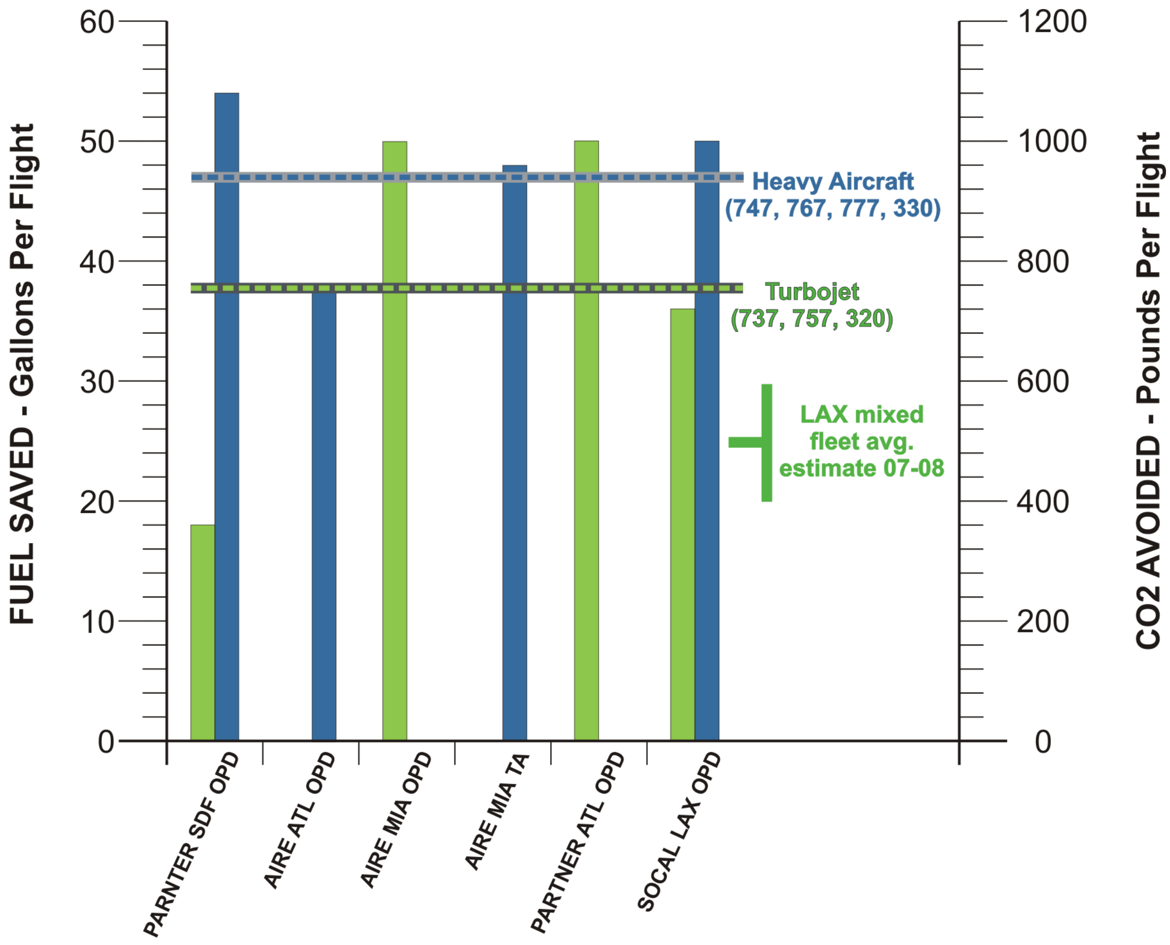
CDO Sequencing



LAX CDO Results

- Implemented 25/09/08 – in use full time at LAX.
- ATC Issues descent and approach clearance on initial contact.
- ½ of all jet arrivals into KLAX fly CDO (over 300,000 CDO's flown since inception).
- 50% reduction in radio transmissions.
- Average fuel savings.
  - ✓ 13.7 million pounds of fuel saved per year.
  - ✓ = CO_2 reduction of 41+ million pounds per year.

CDO Fuel Savings



CDO Design Considerations

- Closed Path design improves predictability and efficiency.
  - STARs join/terminate at IF/IAF, path continues to touchdown.
- Open path may increase flexibility.
- Use speed control in preference to vectors.
- 280kts provides opportunity for meaningful speed ATC adjustments.
- Minimize number of required windows.
- Avoid specifying hard altitudes, make windows as large as feasible.
  - ✓ "at or above 7000" is preferable to "at 7000".
  - ✓ "above 7000, below 11000" is preferable to "above 7000, below 7500".
- Structured Decision Points on radar scope gives ATC ability to judge control actions early.

QUESTIONS?