ICAO UNITING AVIATION

CELEBRATING 70 YEARS OF THE CHICAGO CONVENTION

Workshop on PBN airspace Design

31 May - 04 June 2021

Airspace Design Summary

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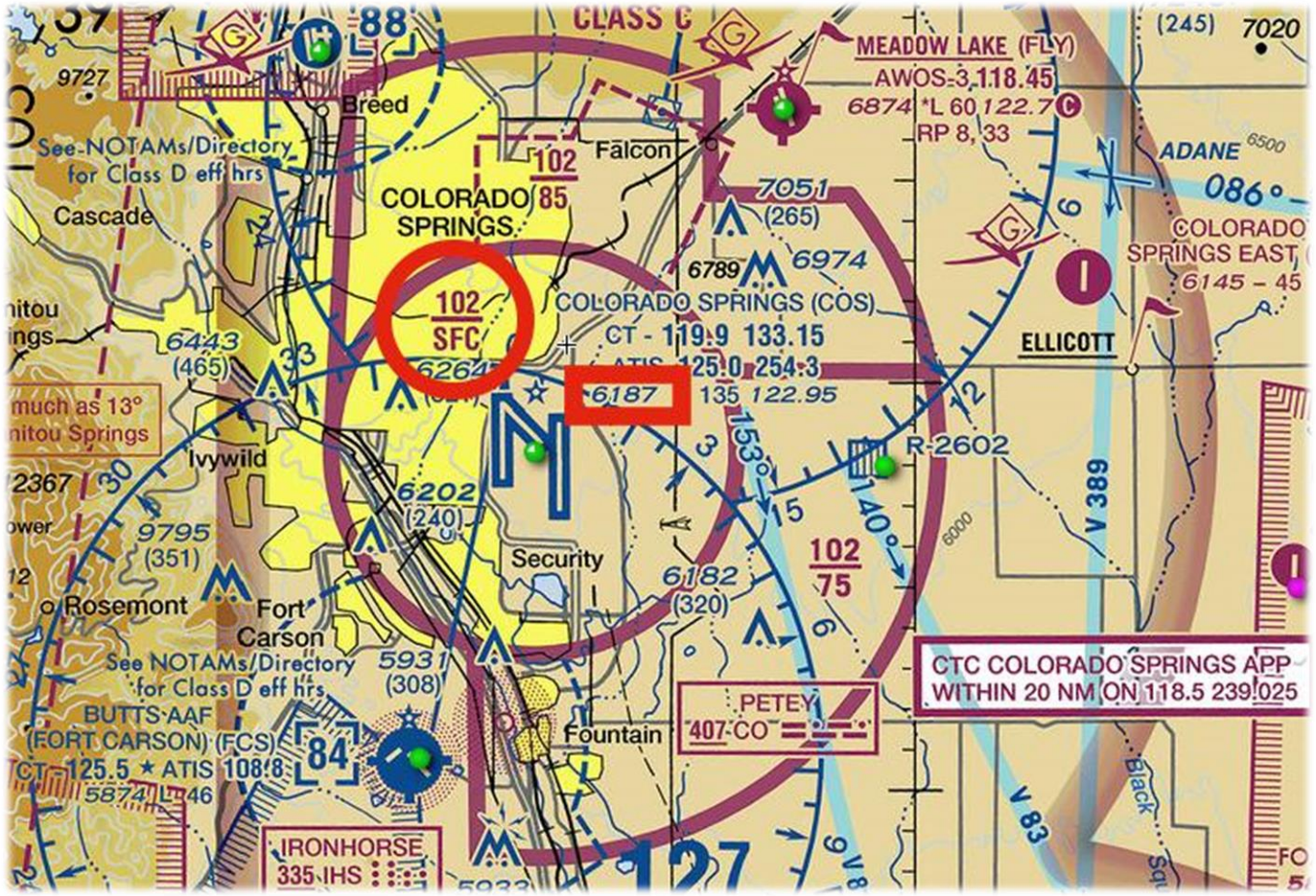
- ❑ STAR terminating levels
- ❑ TMA boundary and entry points
- ❑ Open and Closed Path STARs
- ❑ Planning STARs
- ❑ Strategic Delaying Techniques – Path Stretching, Merge Point
- ❑ Sequencing with Structured Decision Points
- ❑ Planning SIDs
- ❑ Lateral separation between STARs/SIDs
- ❑ Two CCO design examples
- ❑ STAR and SID Naming Convention
- ❑ Holding airspace, Sectorization

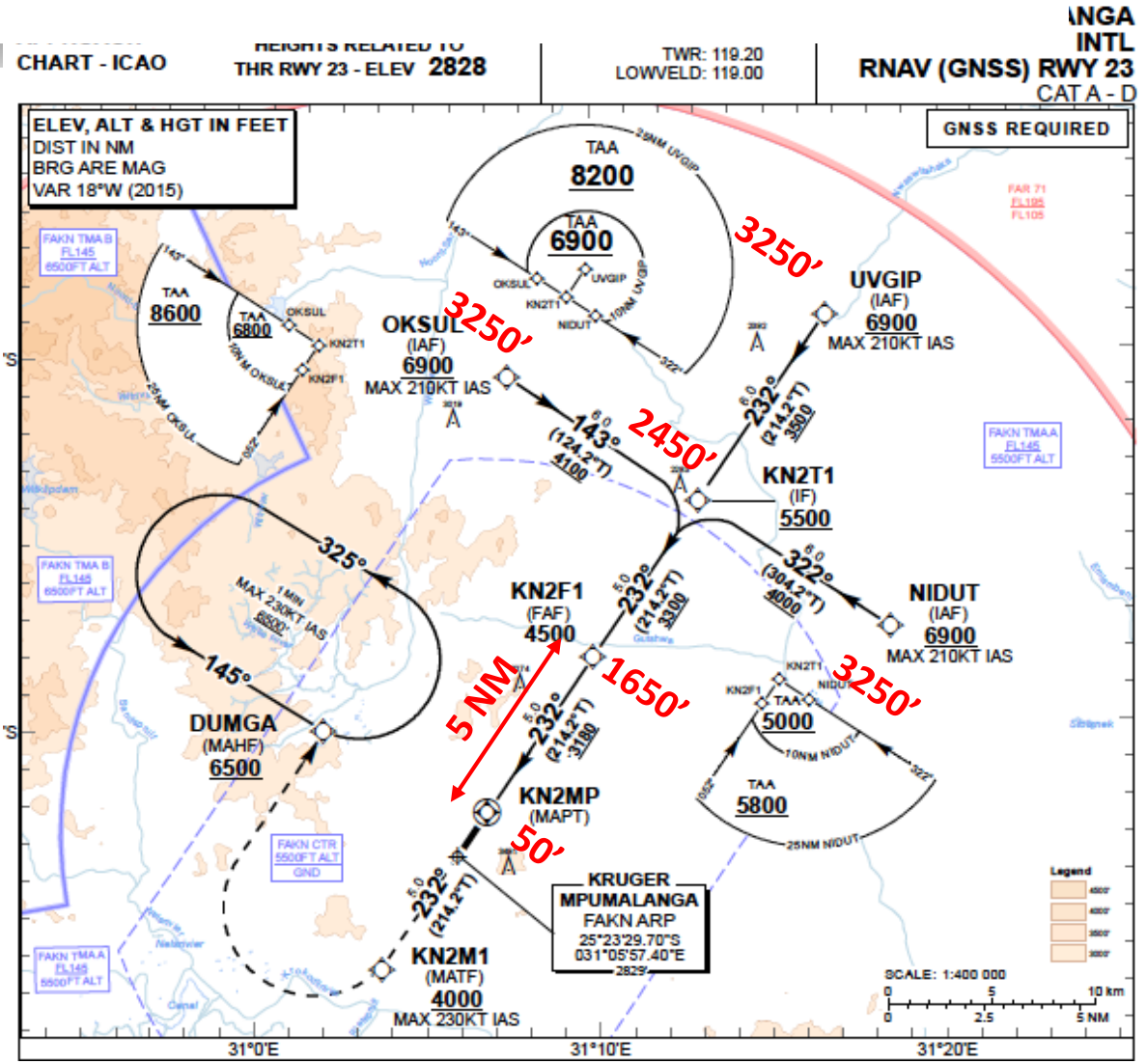
Airspace Design

PUTTING IT ALL TOGETHER

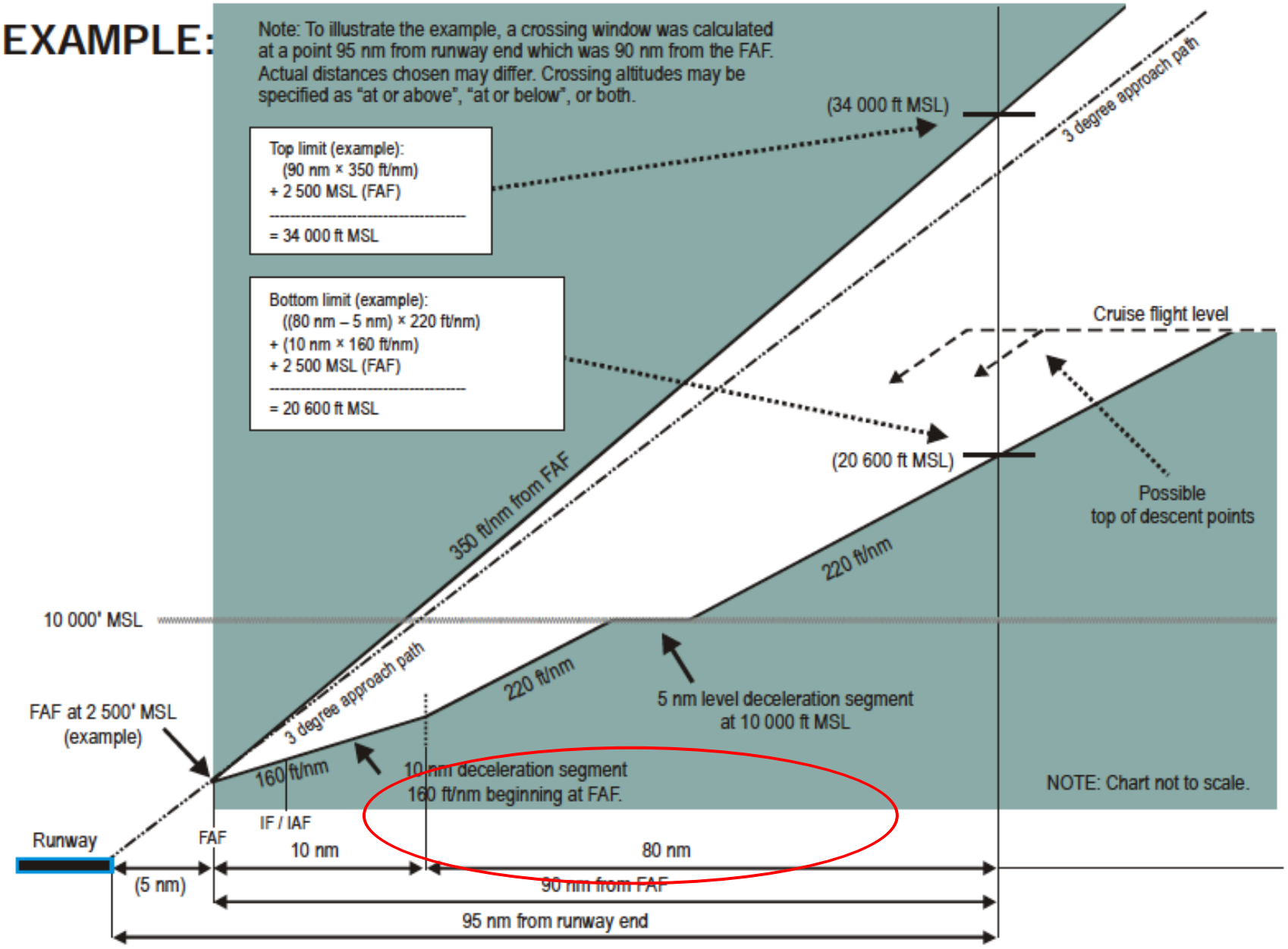


STAR Terminating Level

- We start with plotting the approach:
  - **5-NM** segments
  - Threshold crossing altitude (TCH) = **50’**
  - FAF altitude… 5 x 320’ = 1600’ add 50’ for a total of **1650’**
  - IF altitude… 5 x 160’ = 800’ add 1650’ for a total of **2450’**
  - IAF altitude… 5 x 160’ = 800’ add 2450’ for a total of **3250’**
  - Finally add the airport elevation… for Dakar this would be 85’ then round up
  - At Dakar the STAR termination altitude would be around **3350’**

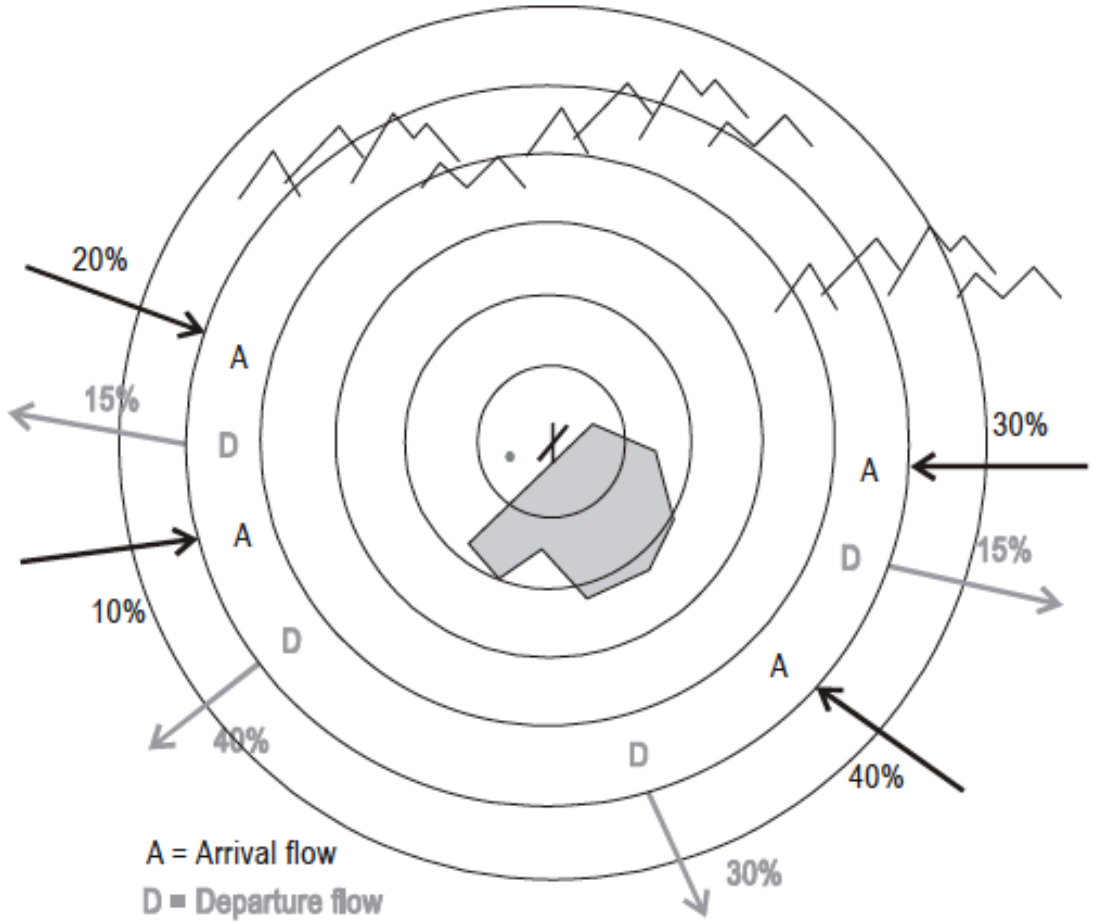


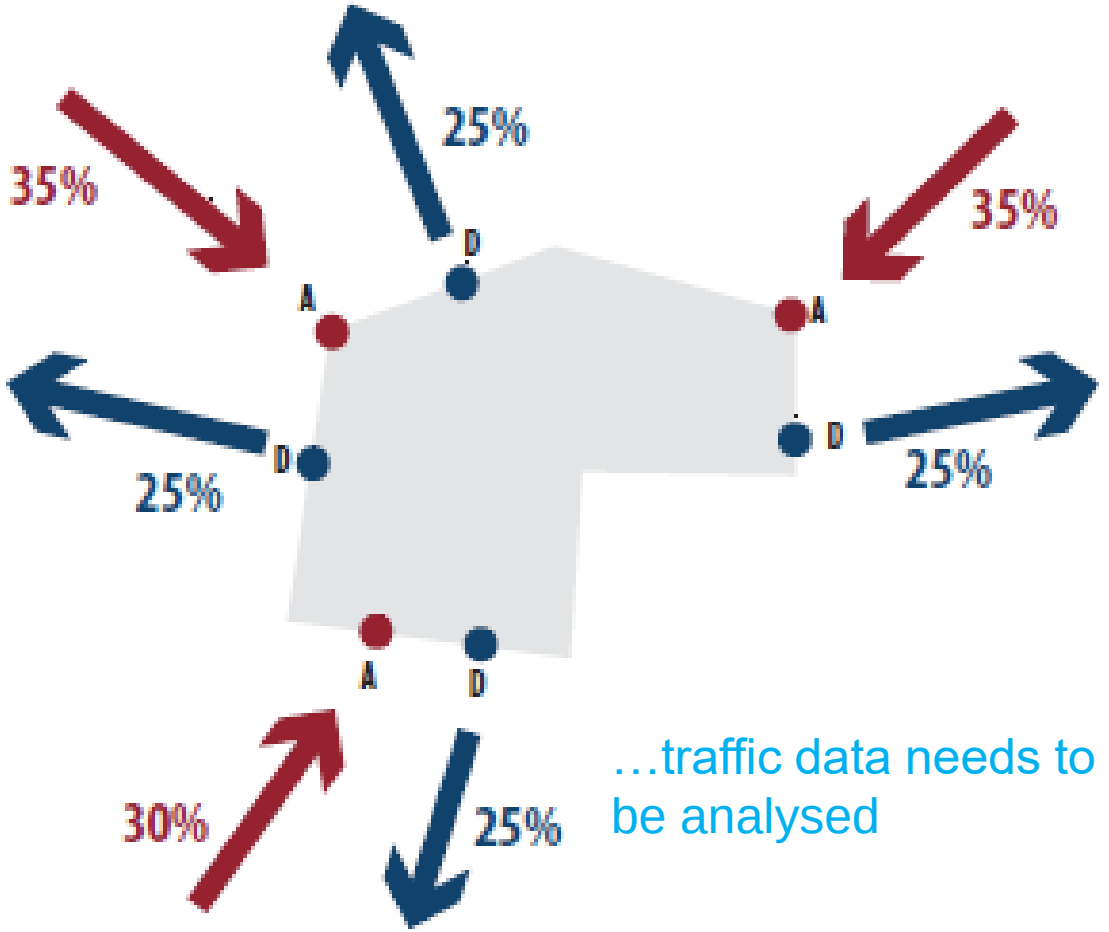
EXAMPLE:



This is why procedures need to be validated. 3° is a good average starting point, but…

Analysis of Traffic Flows

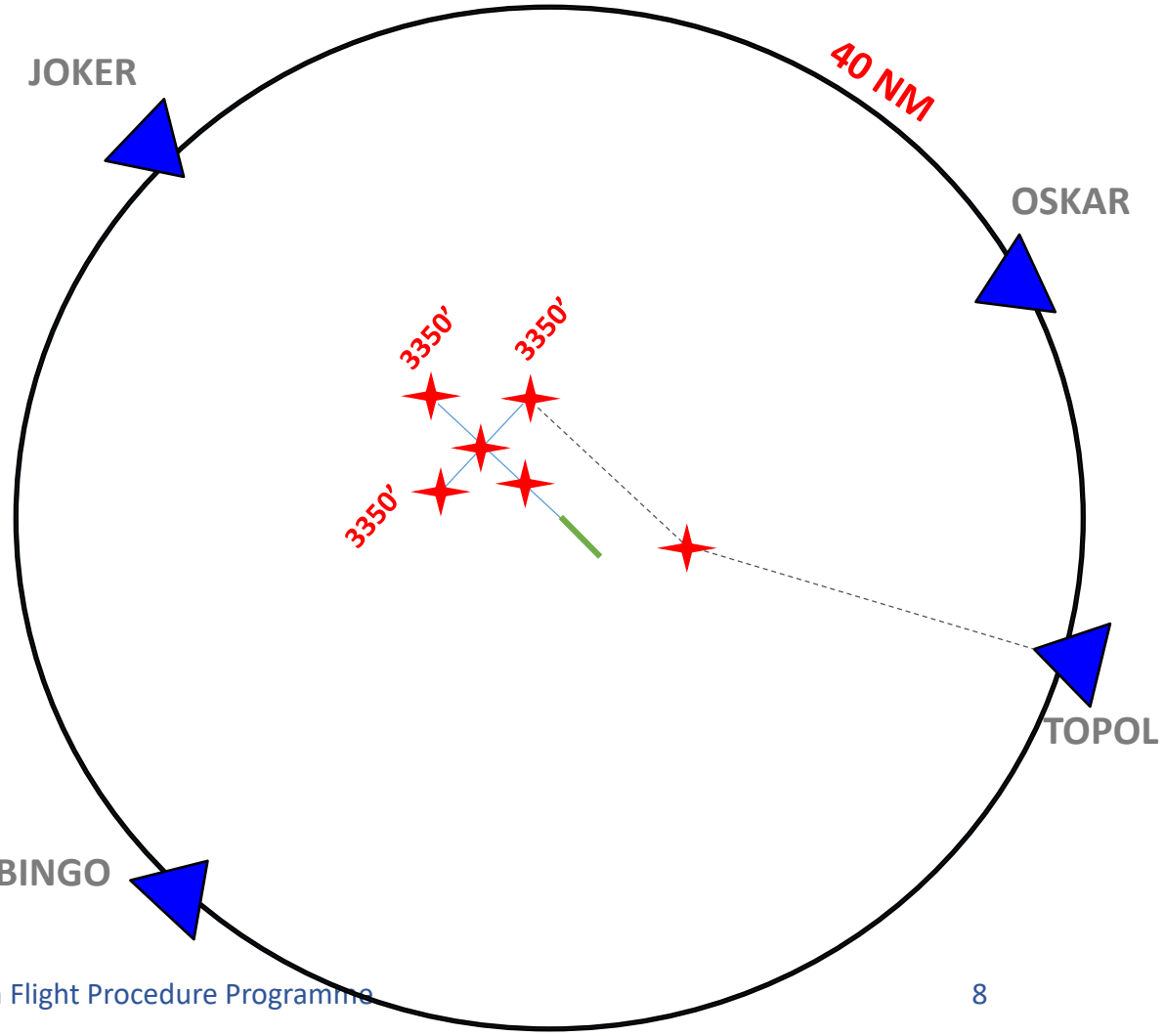




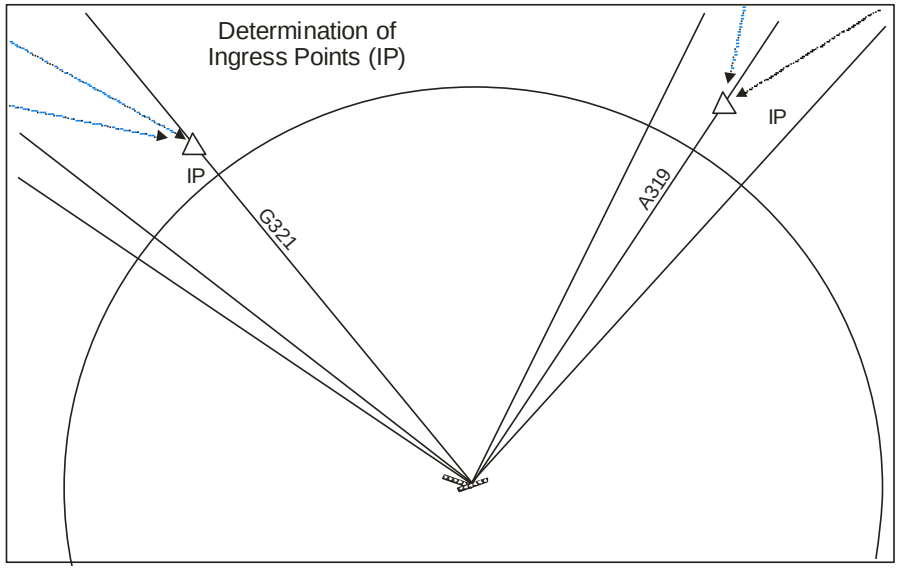
…traffic data needs to be analysed

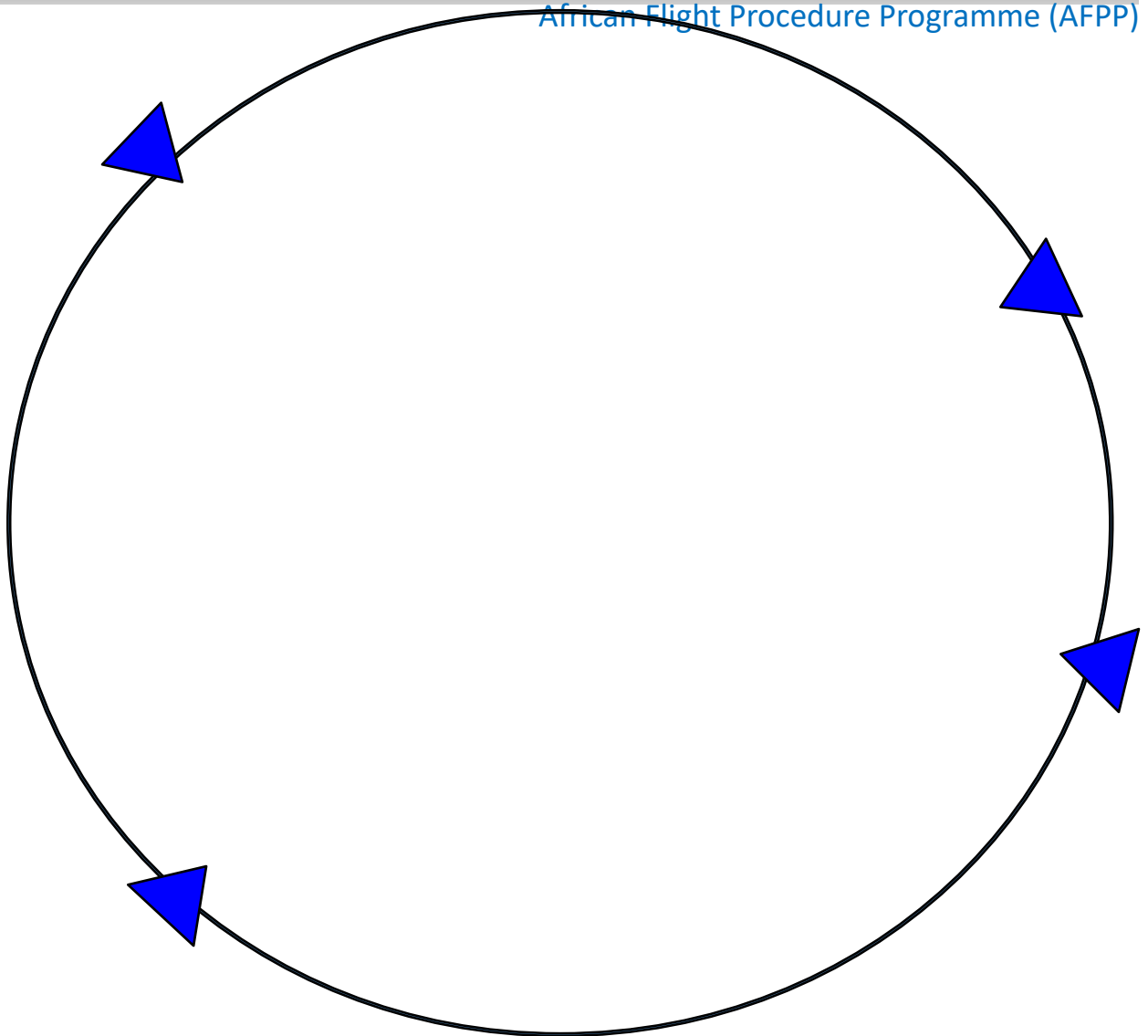
Boundary & Entry Points

- TMA boundary ideally no more than **30** to **40 NM.**
- Start with Entry Points:
  - No more than four (4);
  - Placement of entry points based on analysis of traffic flows:
    - For example ENE, ESE, SW and NW sectors.
- Then, join the Entry Points to the IAFs of the approach by STARs;
- From the base-sector, an Open Path STAR will typically join abeam the airport.



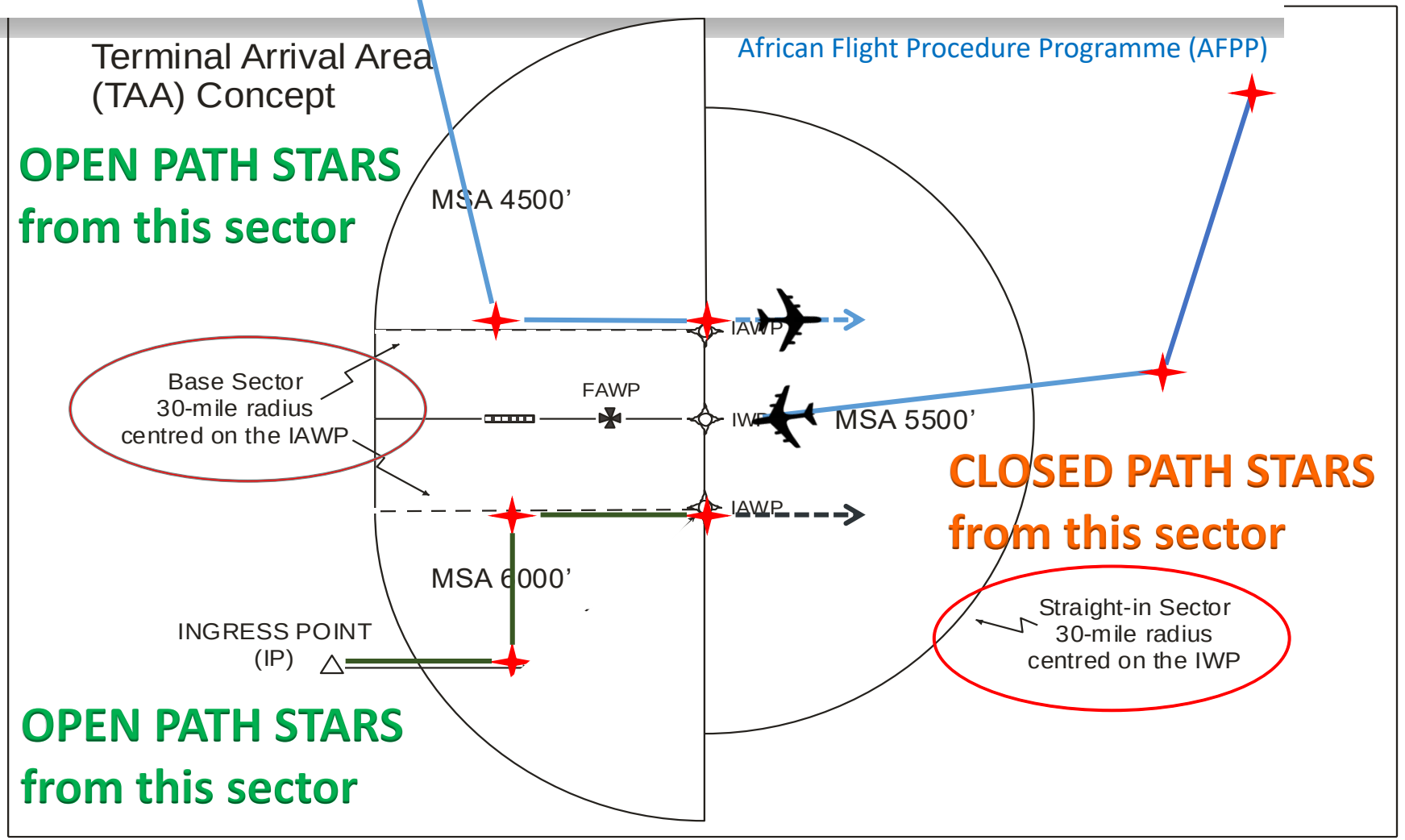
Placement of Ingress Points





Open and Closed Path STARs

- STARs from the Straight-In sector are of the CLOSED PATH design terminating at the FAF… no vectors.
- STARs from the Base Sector are of the **OPEN PATH** design terminating at the IAF followed by vectors, and turn to base leg followed by clearance for RNP APCH.

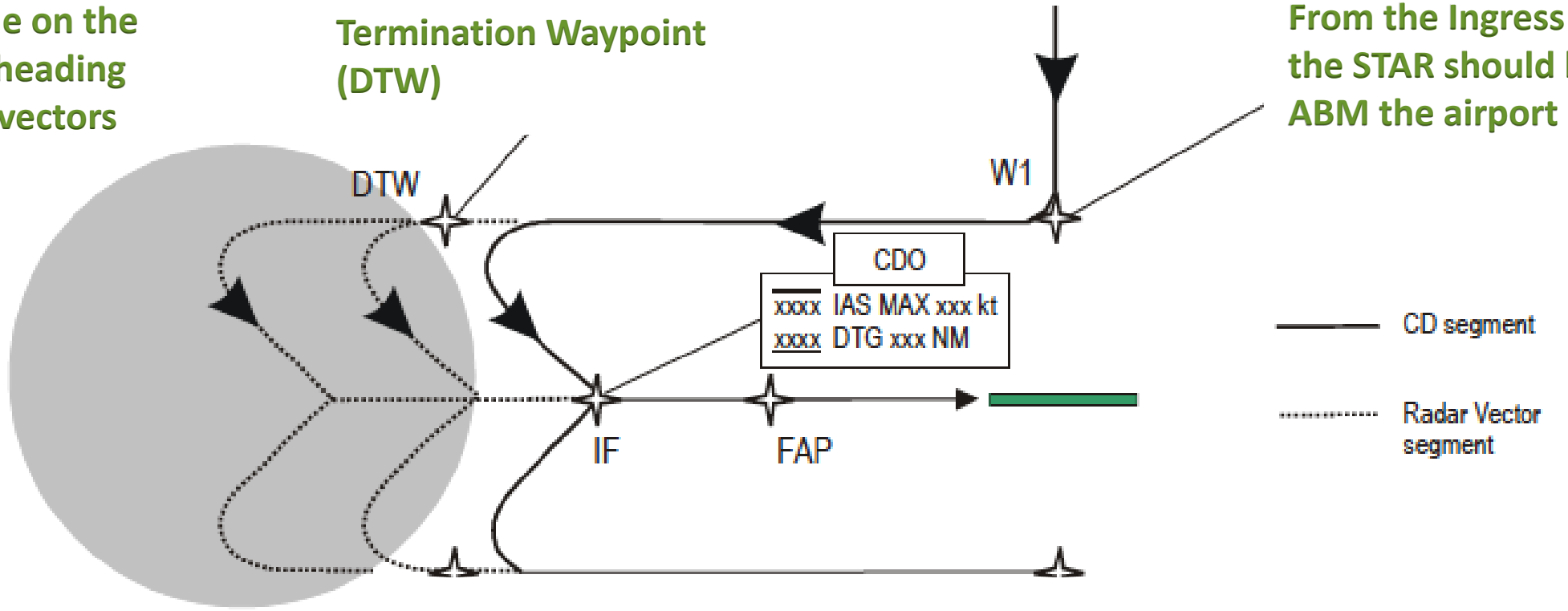


Lateral Profile

From here the aircraft will continue on the downwind heading waiting for vectors From ATC

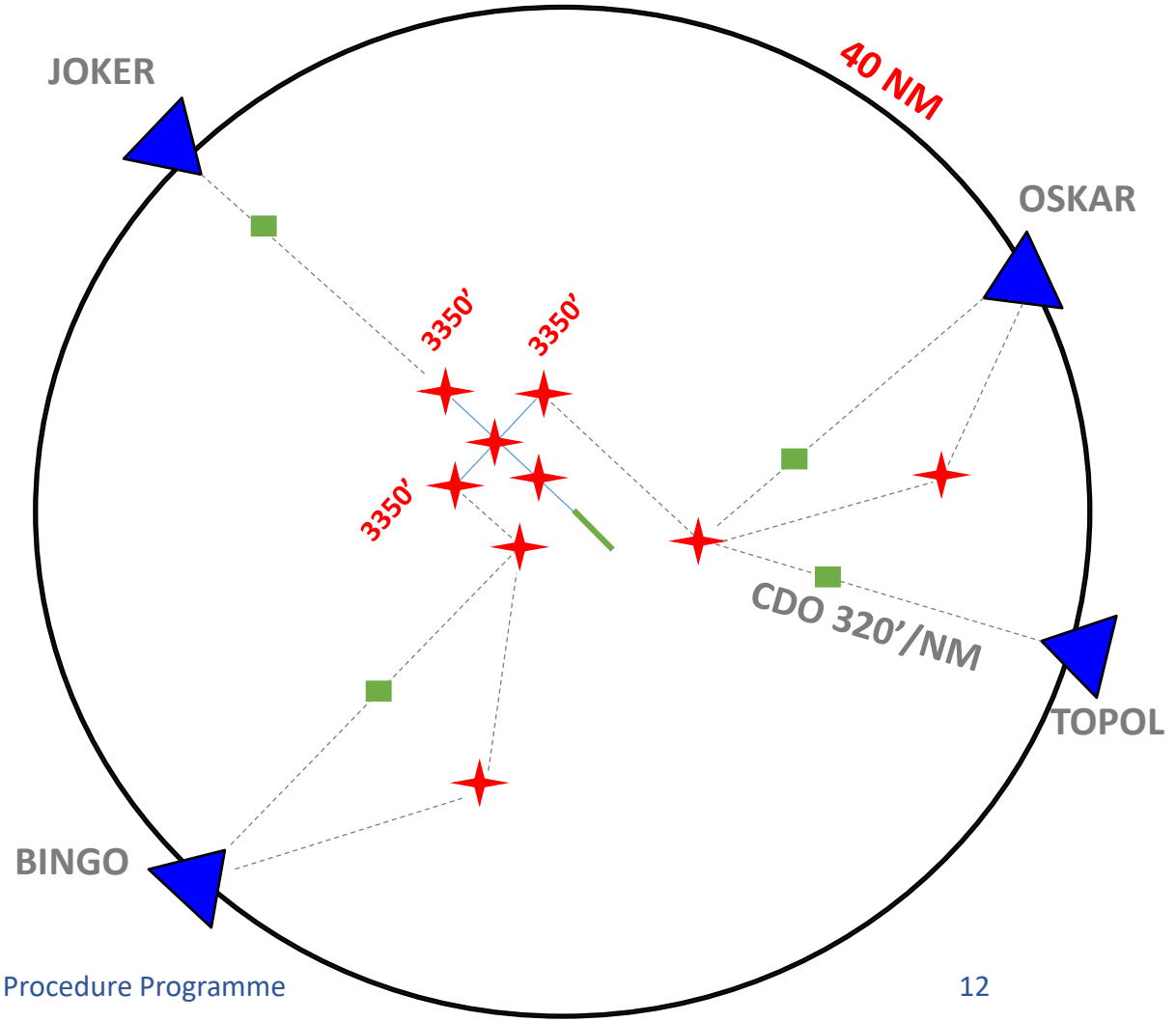
Then to the Downwind Termination Waypoint (DTW)

From the Ingress Point the STAR should lead ABM the airport

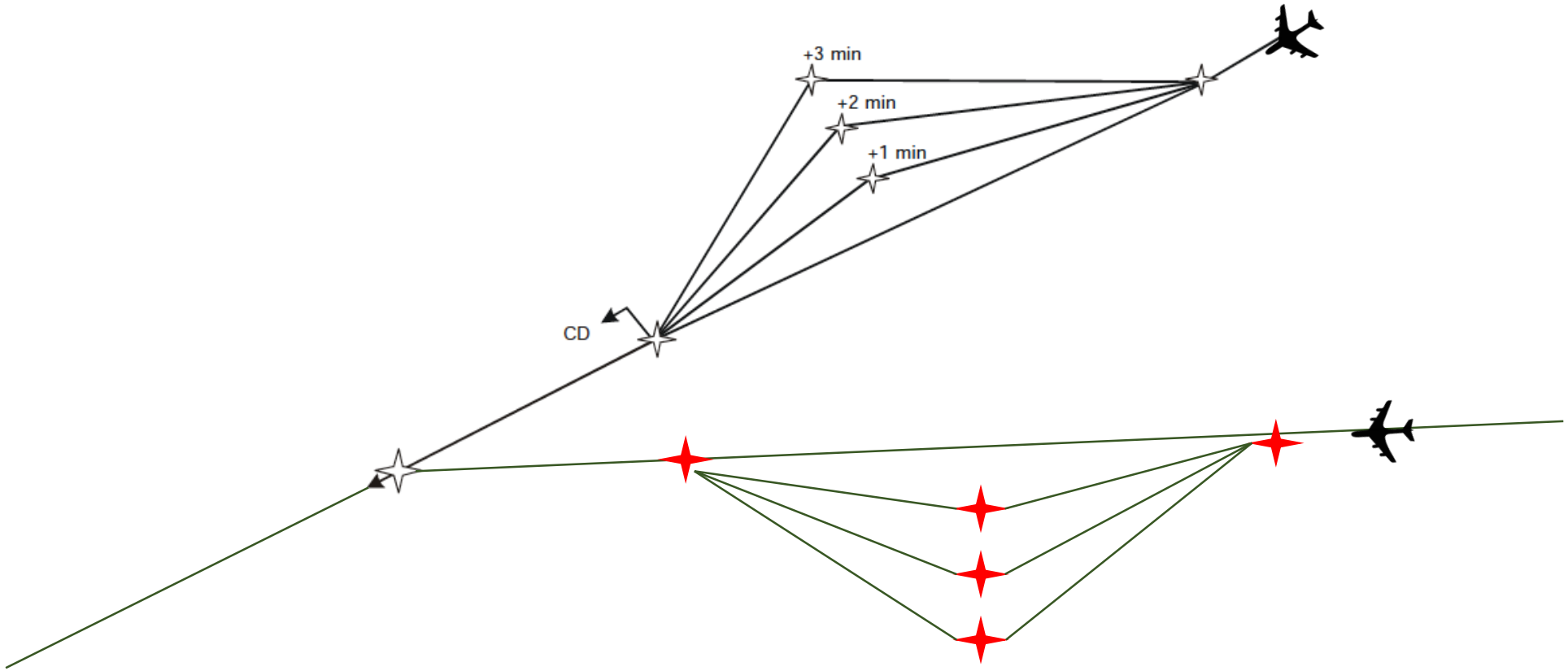


Planning STARs

- STAR CDO is based on 320'/NM average (minimum 250'/NM, maximum 350'/NM);
- Merge only two STARs at a time, as far away from the IAF as possible to allow for delaying techniques:
  - ☞ Always think about how to strategically deconflict any two aircraft merging together… if they were to enter the airspace at the same time:
    - Include strategic delaying techniques in the airspace design:
      - Remember, CDOs and speed control do not mix;
      - Path stretching, Merge Point, and Mini-Merge Point;
      - Include Equidistant Structured Decision Points on STARs.

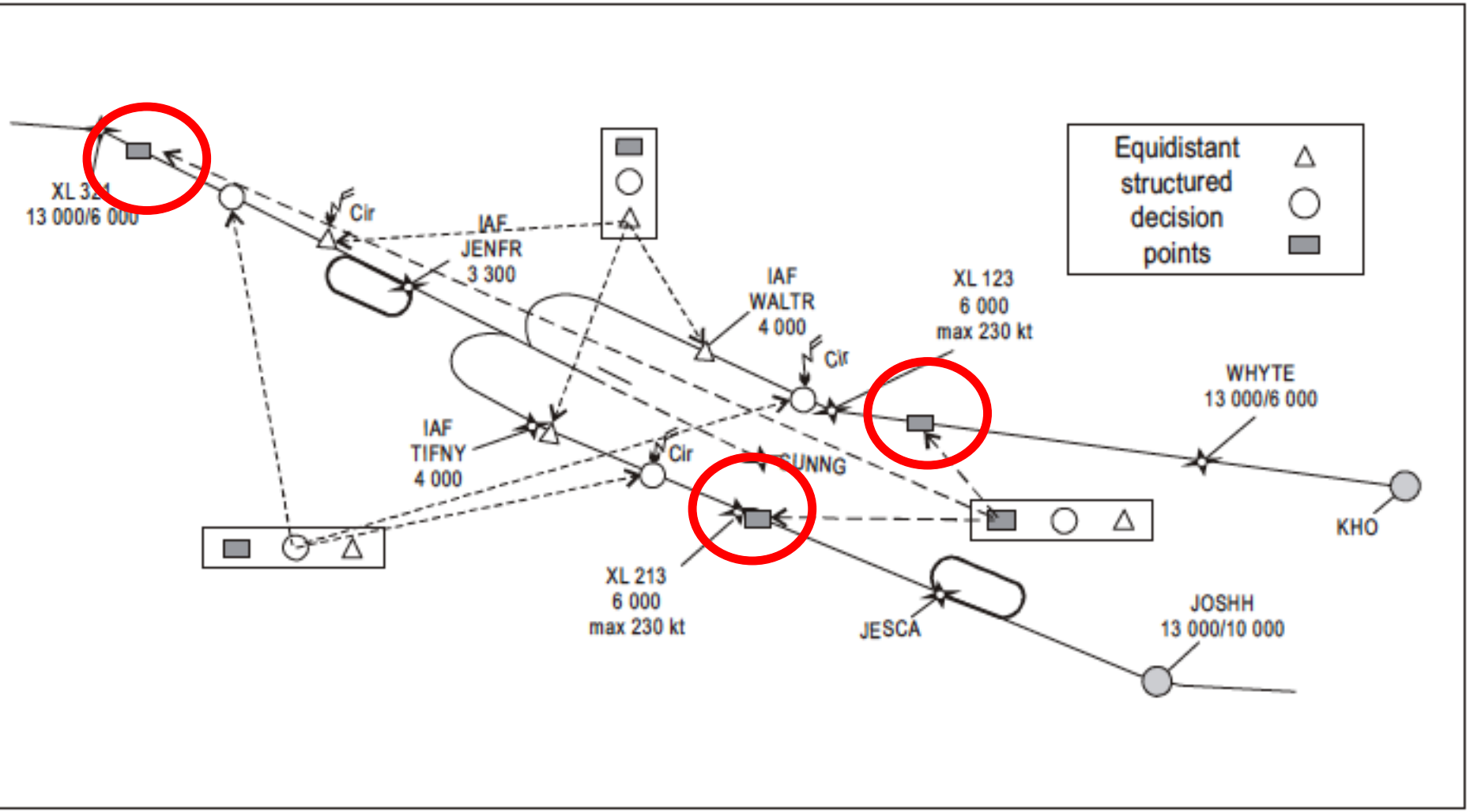


Path Stretching



Sequencing Techniques

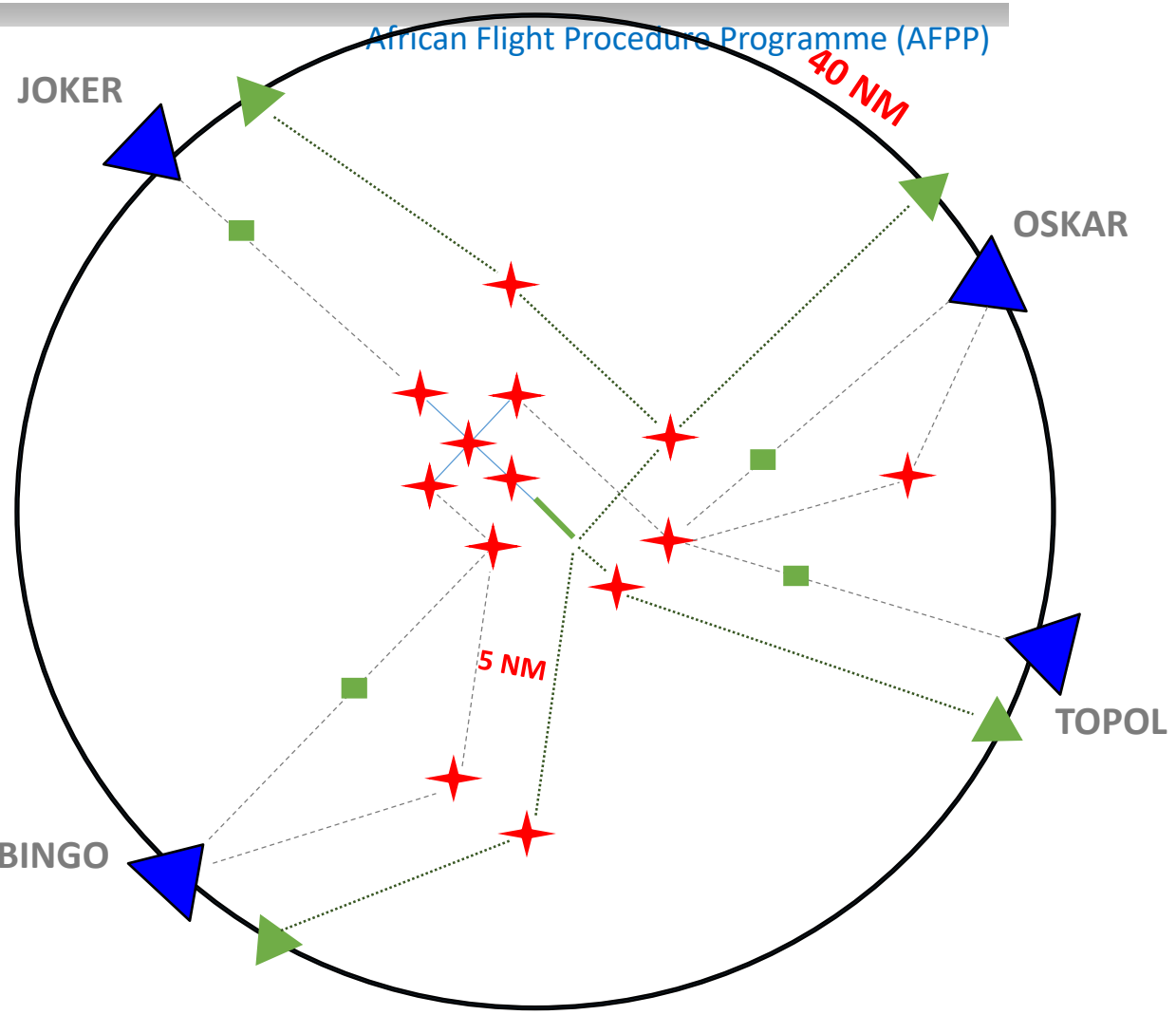
Procedure Programme (AFPP)



Structured Decision Points help with sequencing of traffic for tactical control of aircraft

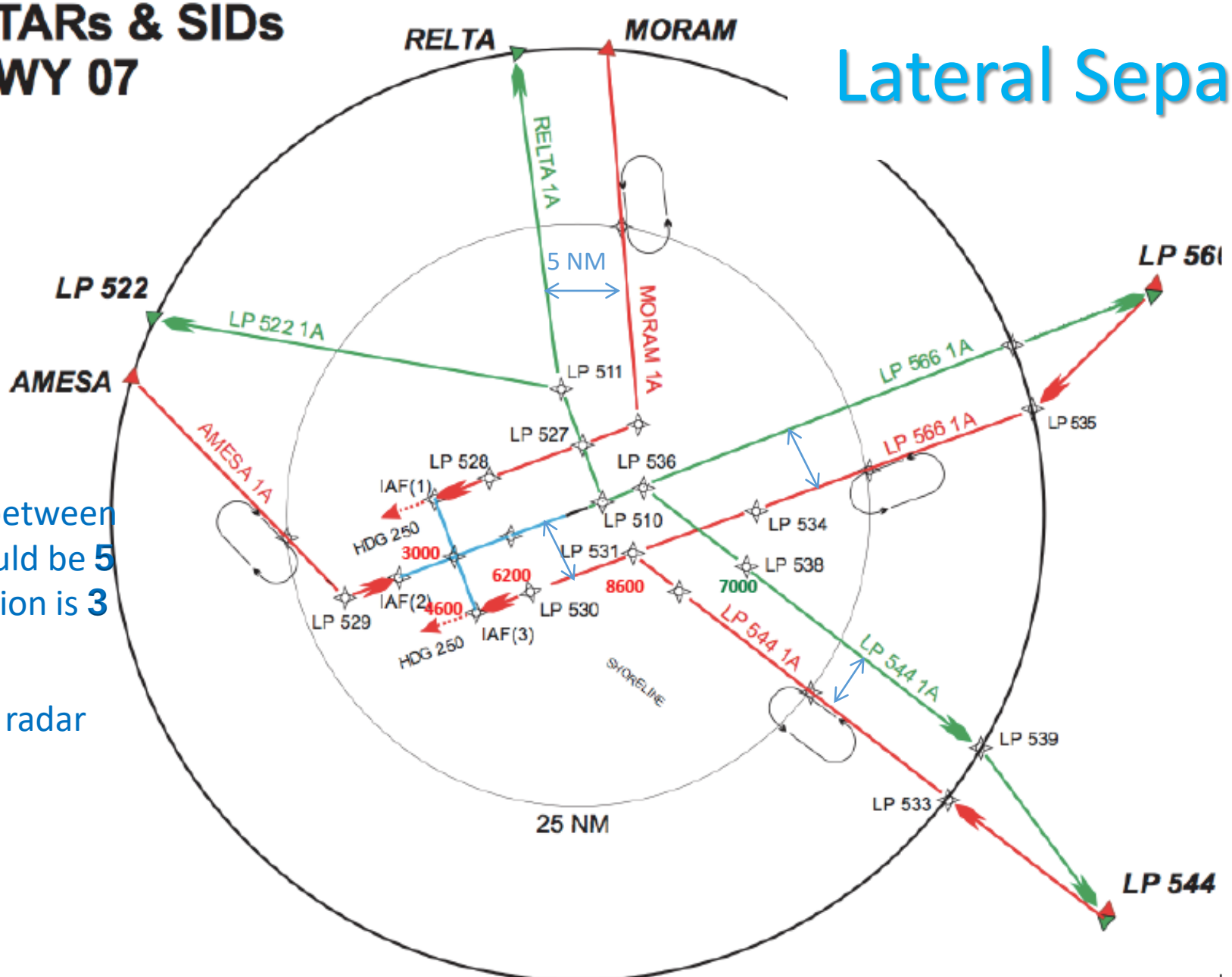
Planning SIDs

- Deconflict SIDs from STARs:
  - STARs have priority over SIDs during lateral profile planning:
    - Remember, ATC will keep aircraft on STARs as much as possible, shortcuts would disable optimum descent.
  - Plot SIDs around STARs with **5 NM** lateral separation:
    - Reduce radar separation from 5 NM to 3 NM to eliminate losses of radar separation.
  - ATC should offer **shortcuts** to aircraft on SIDs when there is **no conflicting traffic** around, by issuing clearances direct to the next fix or exit point.



Lateral Separation

gramme (AFPP)

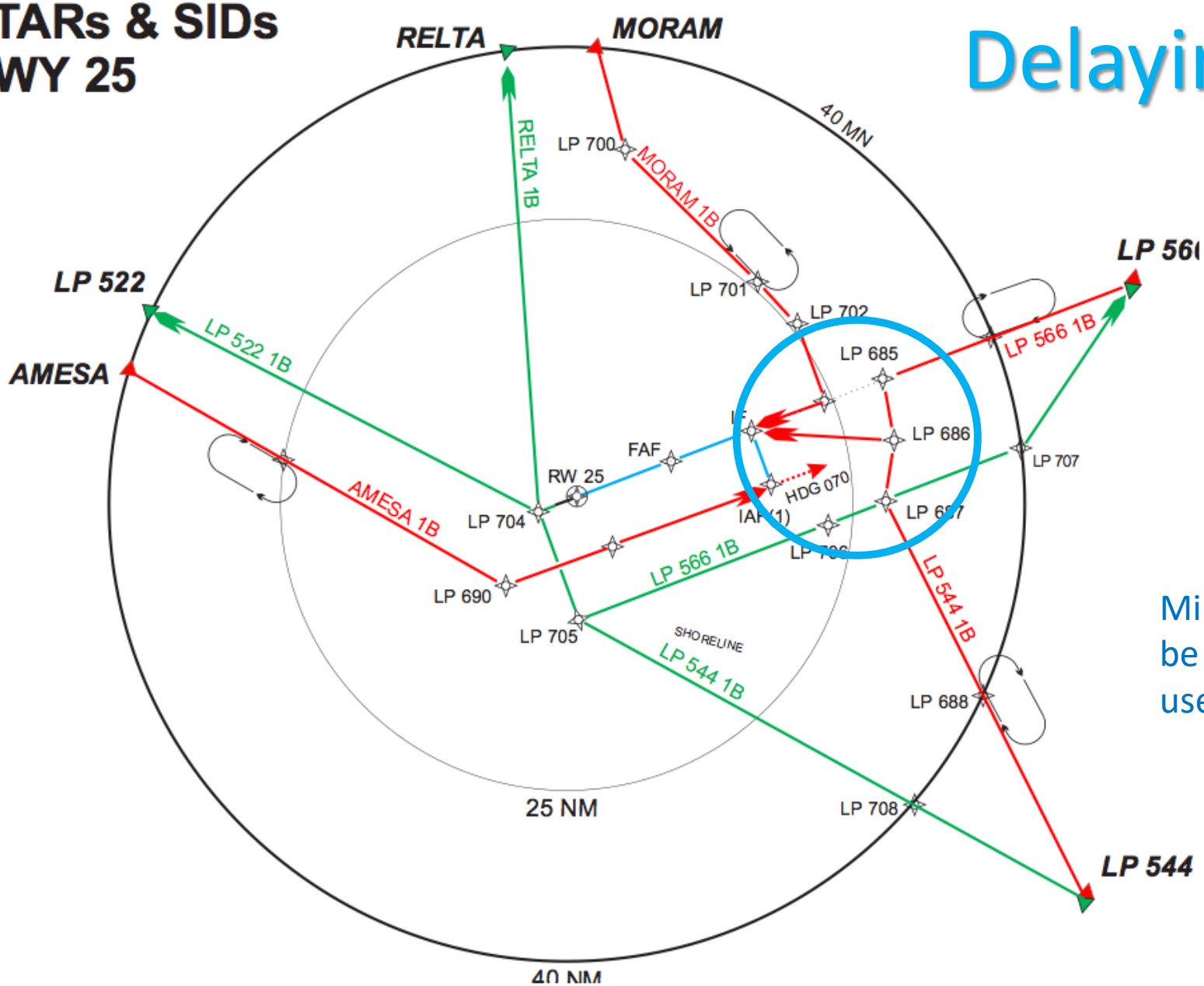


Lateral separation between STARs and SIDs should be **5 NM** if radar separation is **3 NM.**

Increase to **6 NM** if radar separation is **5 NM.**

Delaying Techniques

ican Flight Procedure Programme (AFPP)



Mini-Merge Point, delaying leg should be equal to lateral separation being used, typically **5 NM.**

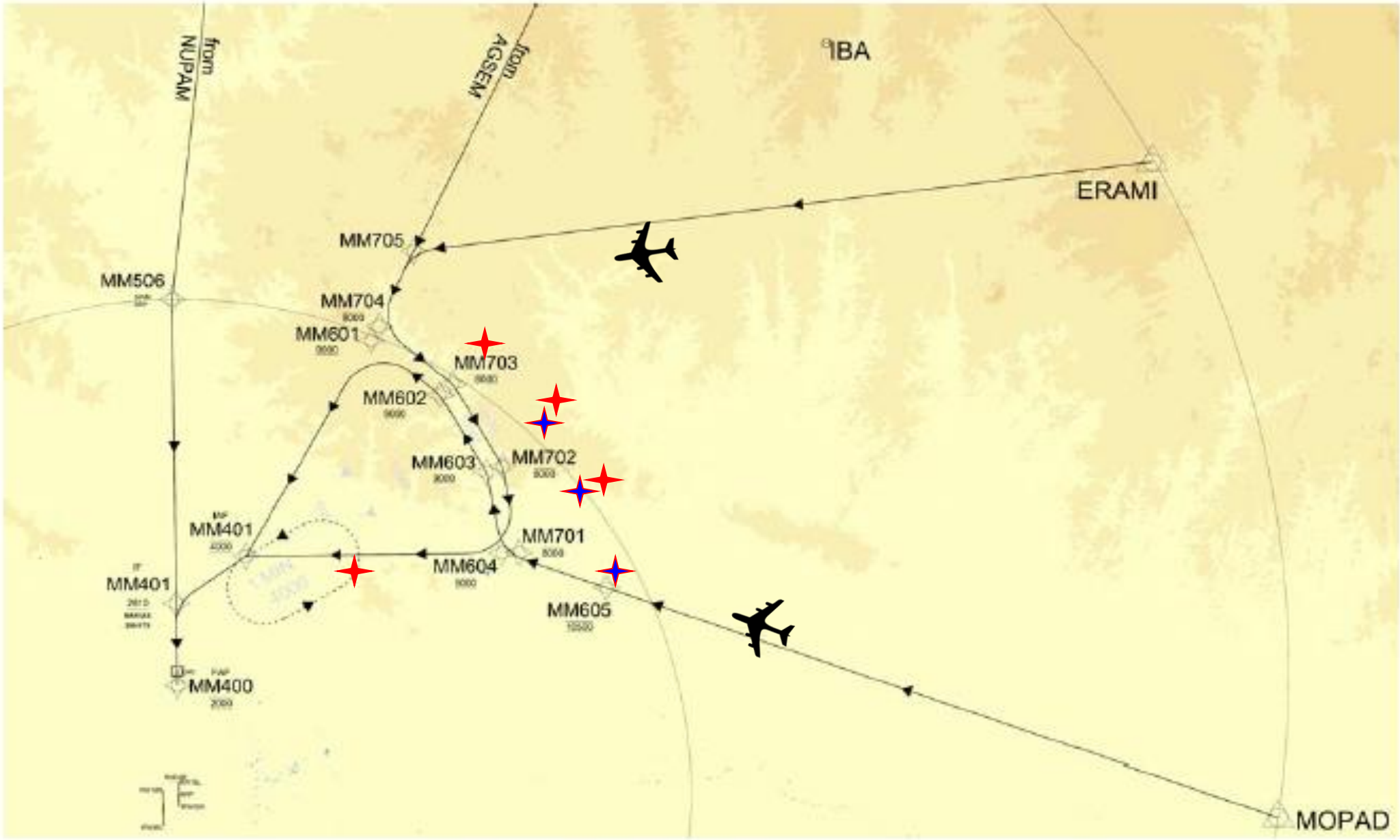
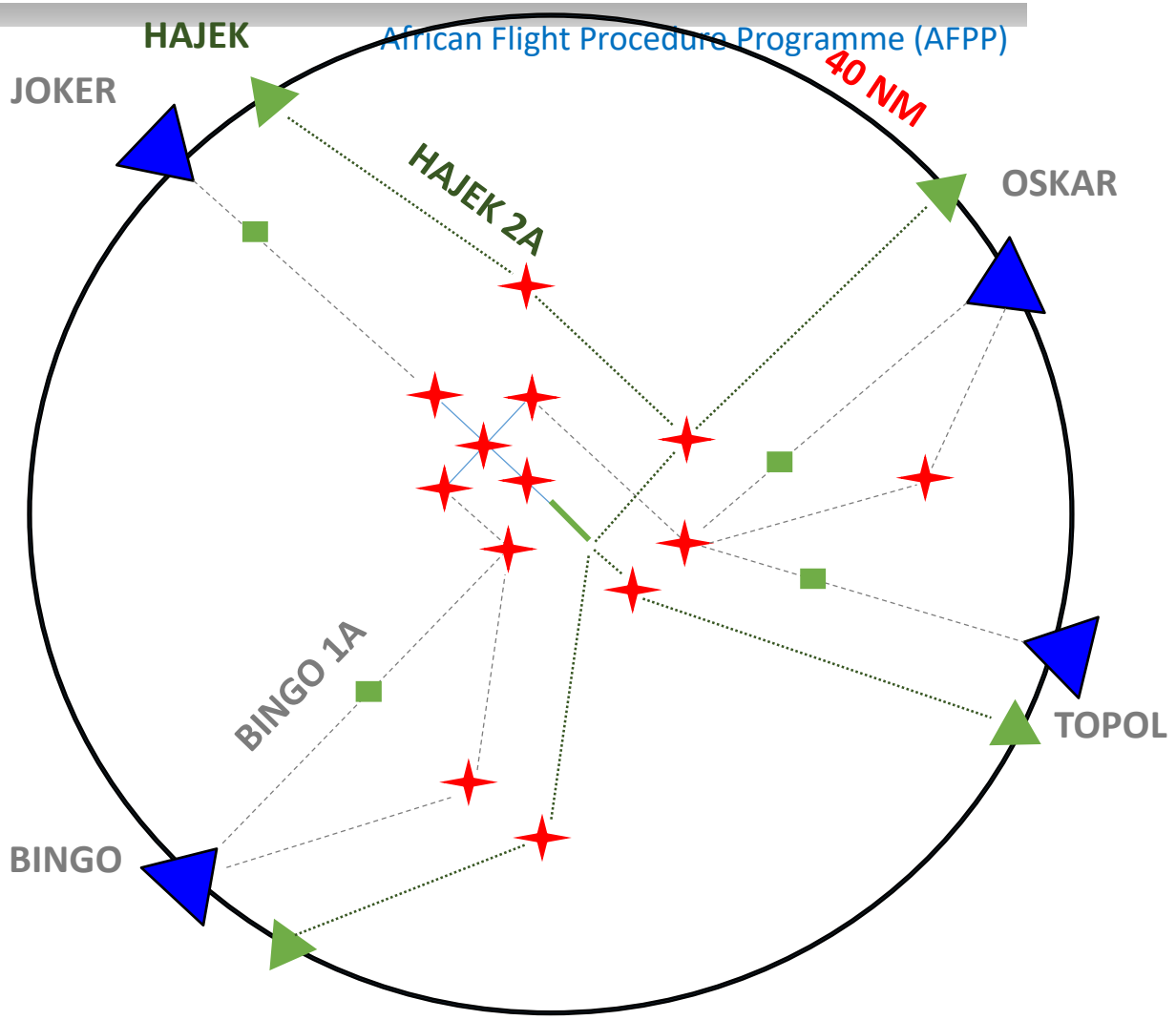


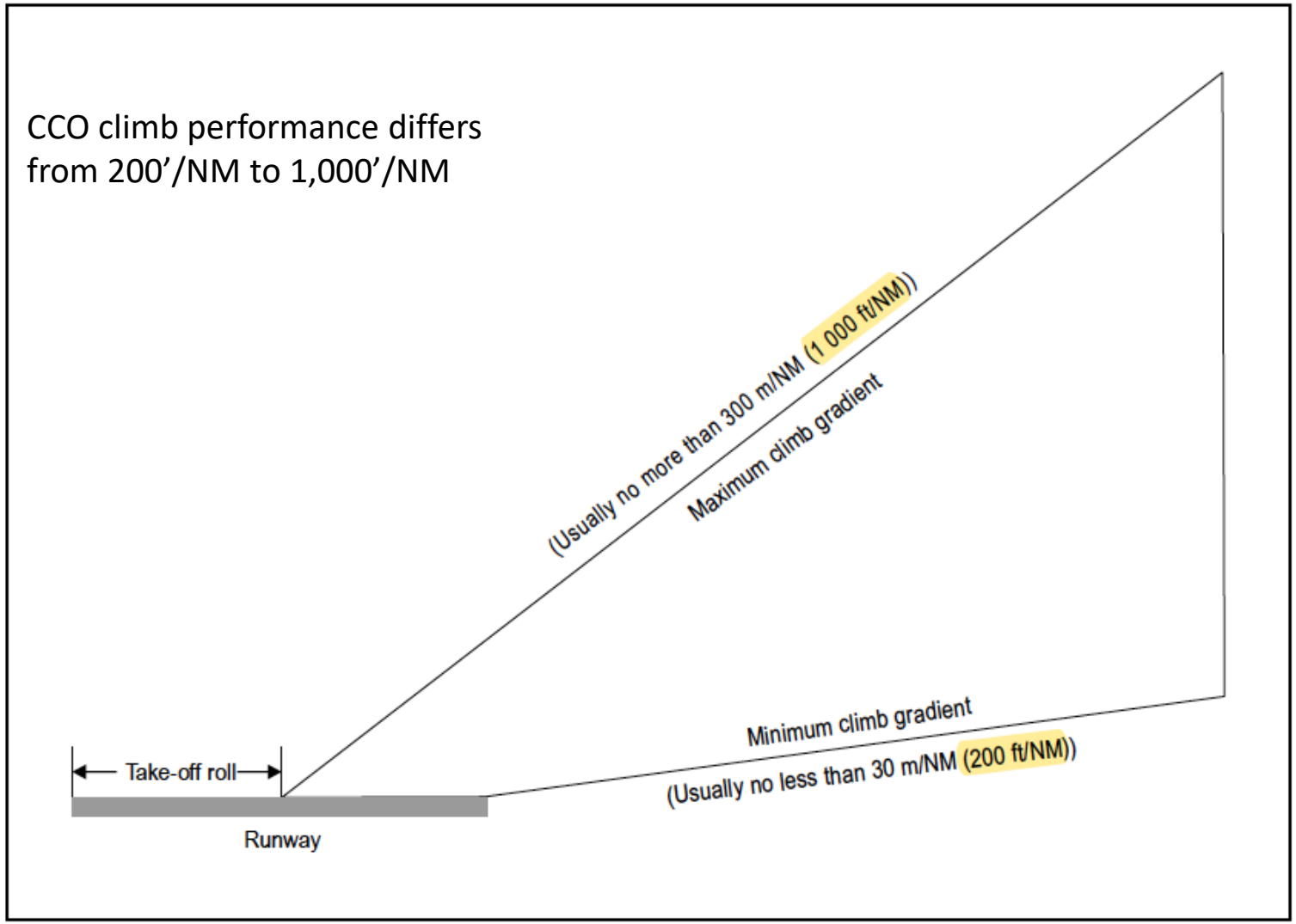
Figure 4 STARs RW 18L

STAR & SID Naming Convention

- ANNEX 11 - Air traffic services, appendix 3. Principles governing the identification of standard departure and arrival routes and associated procedures, Paragraph 2.1.1 states that the **Plain Language Designator** shall consist of the following:
  - **Basic** indicator; followed by,
  - **Validity** indicator; followed by,
  - **Route indicator**, where required; followed by,
  - The word "DEPARTURE" or "ARRIVAL".
- **BINGO ONE ALFA ARRIVAL** and **HAJEK TWO ALFA DEPARTURE**.
- **Charting: BINGO 1 A, HAJEK 2 A**.



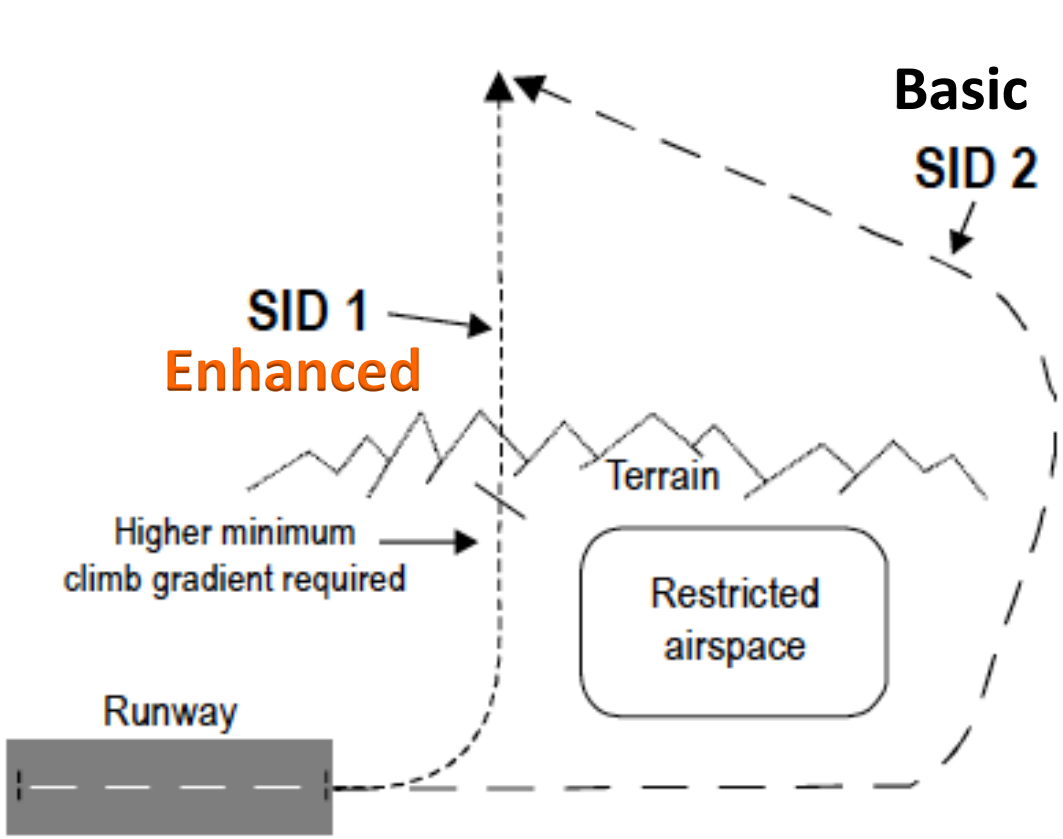
Two CCO Design Examples



- Basic CCO allows for unrestricted climb rates for all aircraft;
- It requires a significant amount of vertical airspace!
- May also extend the SID length to allow for lower performing aircraft.

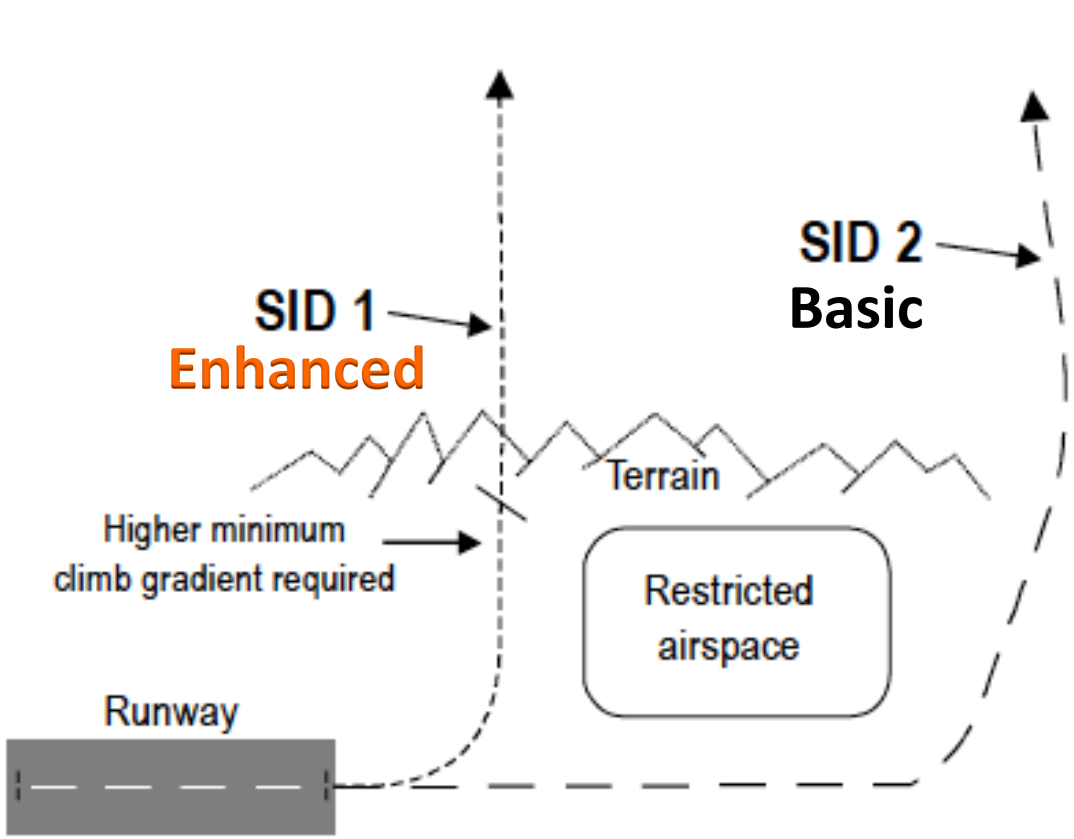
Two CCO Design Examples

Same exit point



May have to plan **two types** of SIDs for aircraft with different climb performance

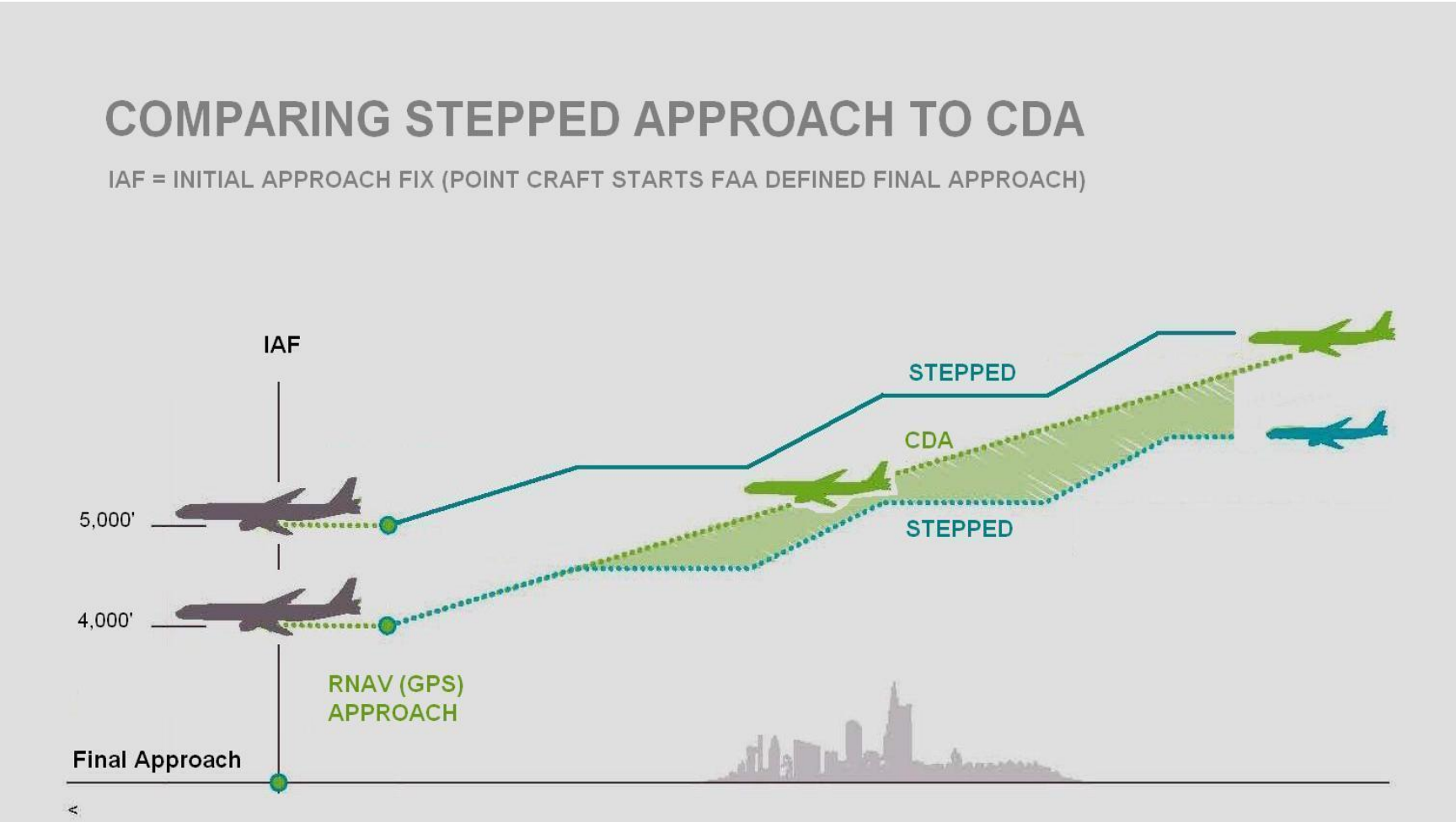
Two different exit points



Plan SIDs either to the **same** exit point or to **two different** exit points.

Putting it all together

- CCOs serve two different purposes, **fuel burn reduction** and **noise abatement** procedures:
  - ☞ NAPD 1 and NAPD 2 design criteria are in PANS-OPS.
- Keep the number of **crossing points** between STARs and SIDs to a **minimum;**
- Plan crossing points in airspace where both arrivals and departures **do not compete** for the **same altitude;**
- **Level segments** are a **greater detriment** on **CCOs** than CDOs, therefore if a level segment is required, plan it on the STAR.

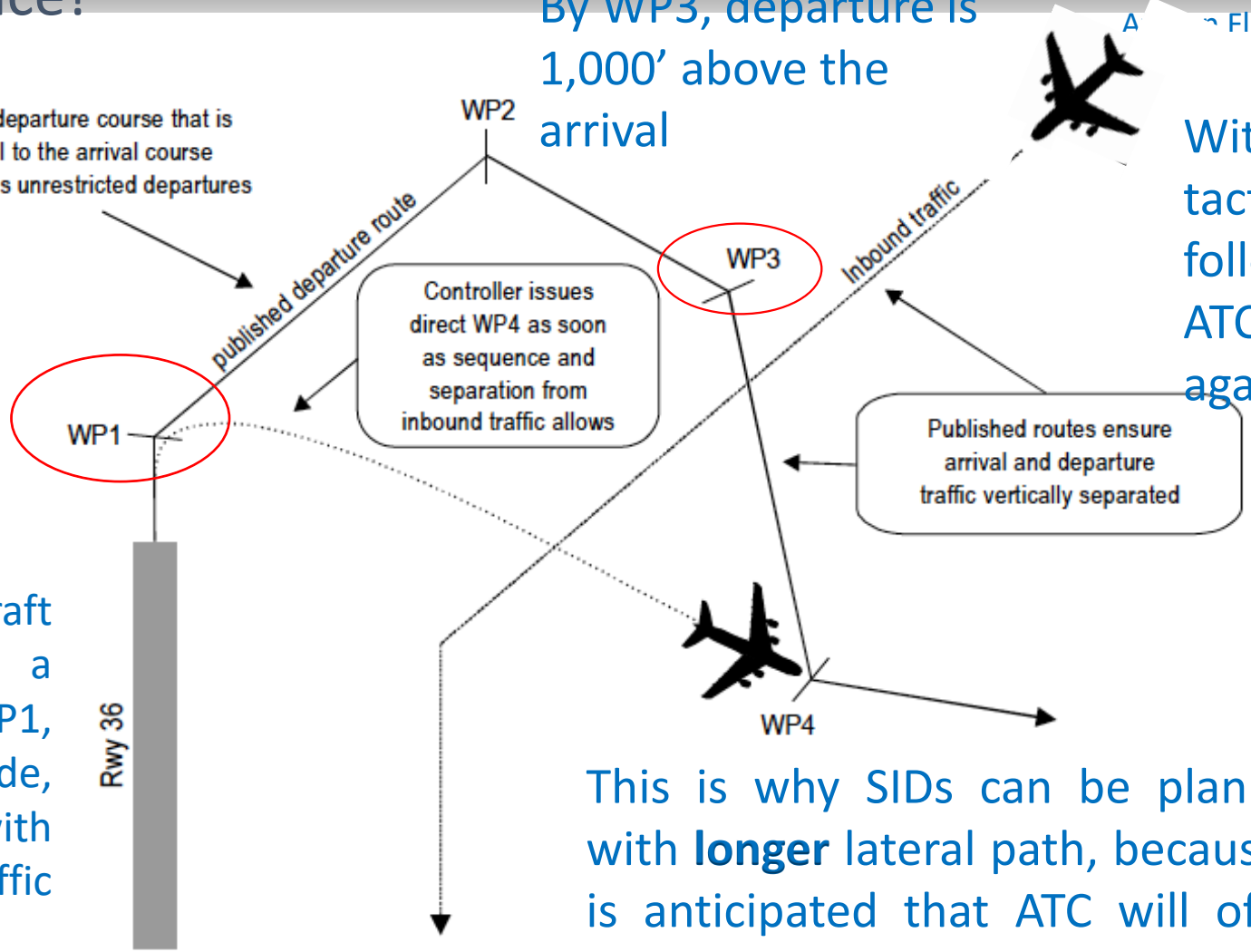


STAR altitude windows and procedure height constraints should be designed to allow most aircraft to descend unimpeded.

Shortcuts for aircraft on SIDs

Need surveillance!

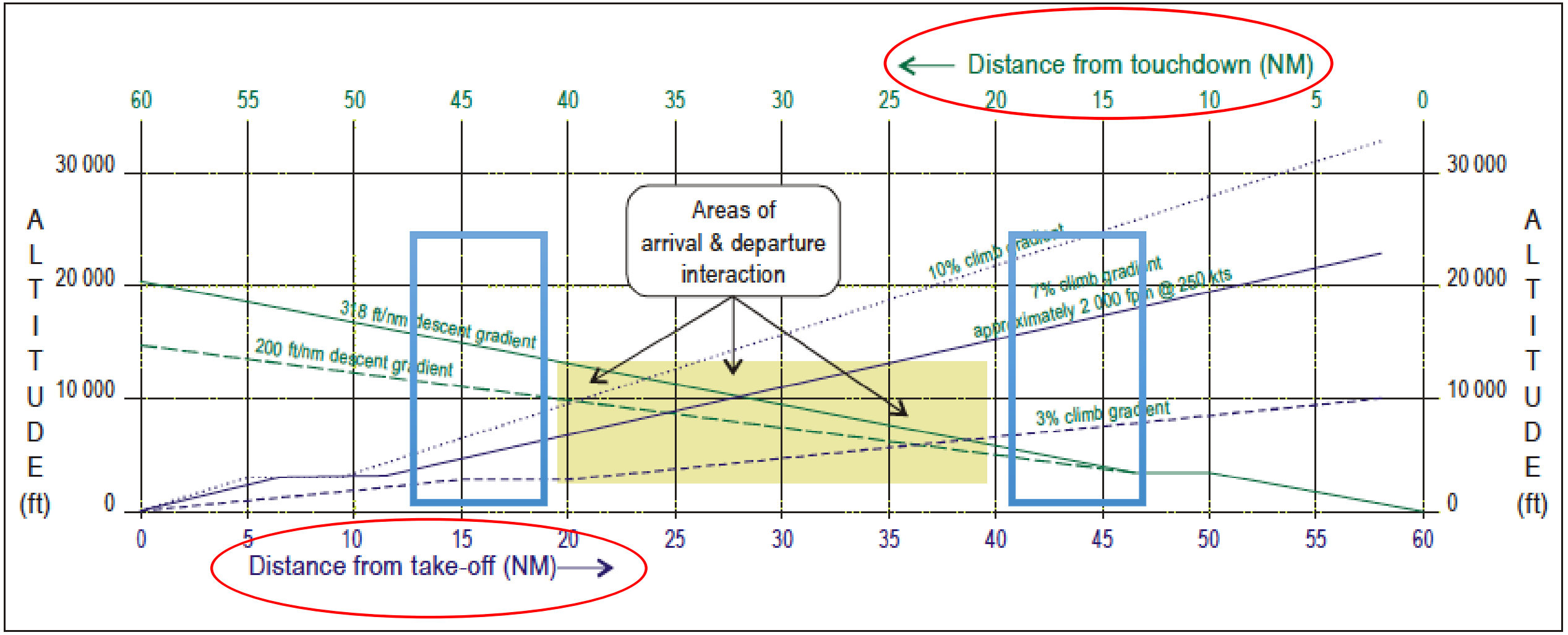
By WP3, departure is 1,000’ above the arrival



With arrival on the STAR, no tactical shortcut, departure follows SID to WP2, WP3… then ATC reassesses the situation again.

The departing aircraft can be given a shortcut after WP1, when at safe altitude, and no conflict with other (arriving) traffic exists.

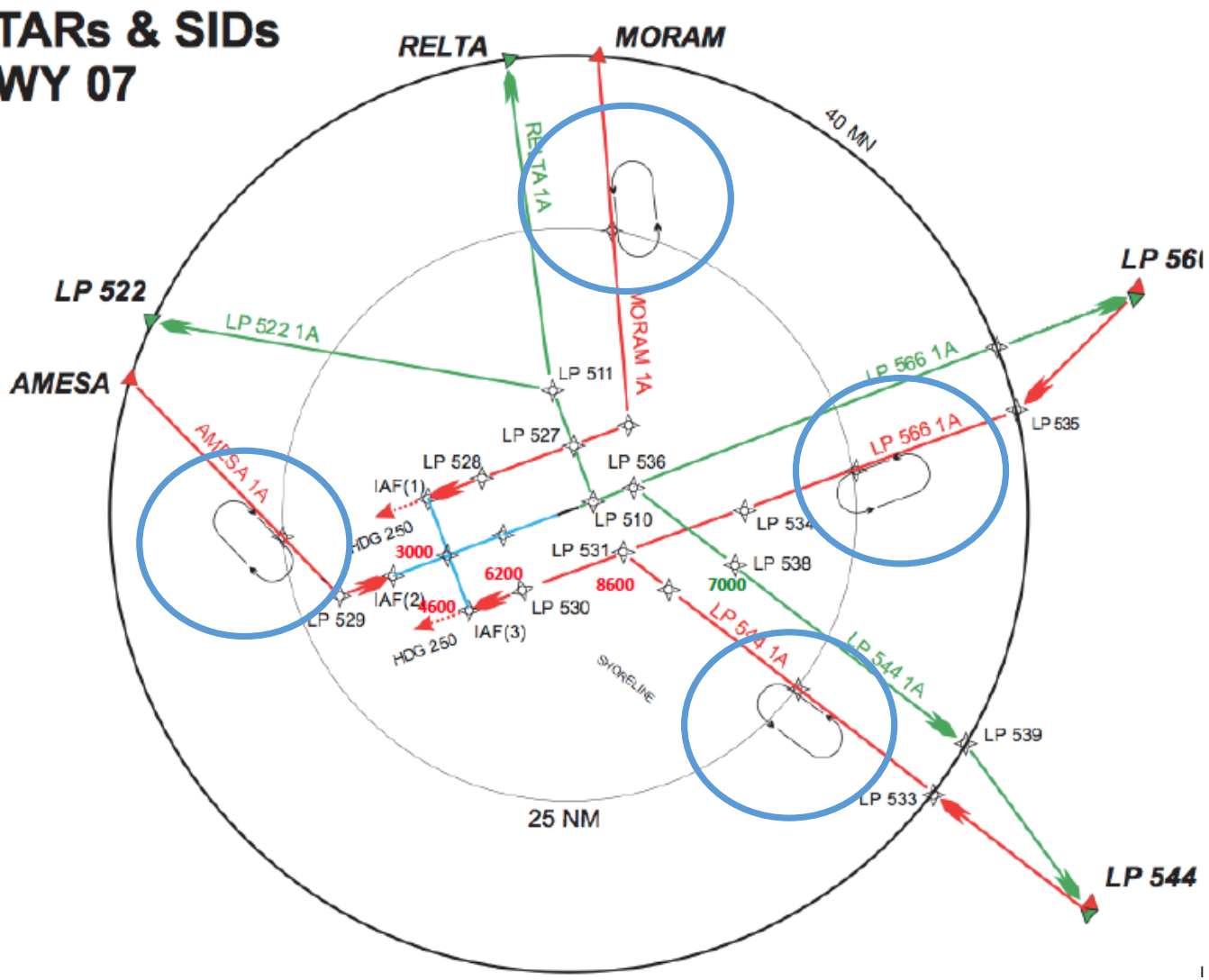
This is why SIDs can be planned with **longer** lateral path, because it is anticipated that ATC will often provide a “tactical” shortcut.



Possible vertical interaction between departing and arriving traffic

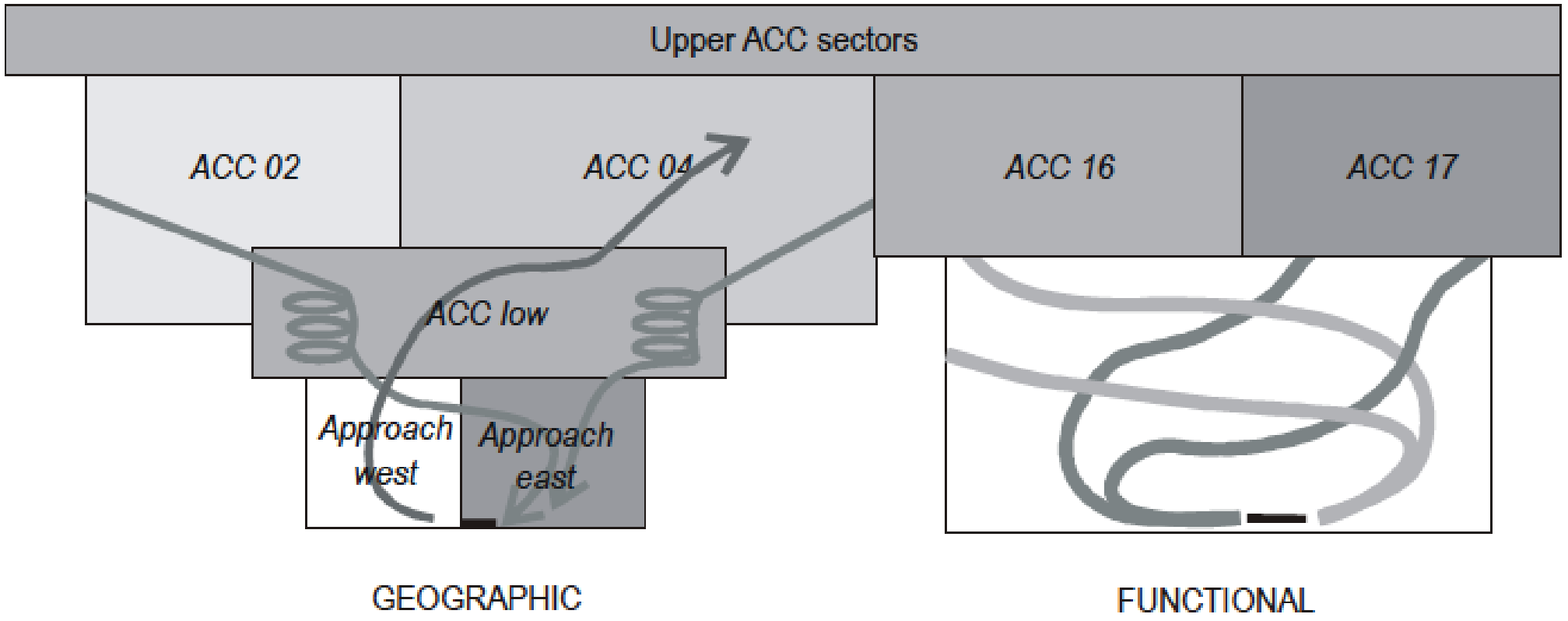
Holding Airspace

- Two types of holding airspace within the TMA:
  - Holds to compliment missed approaches, typically at one IAF (4,000’ AGL).
  - Holds to delay arriving aircraft on STARs during rush-hour traffic (25 – 30 NM from ARP (14,000’ AGL).
- Specify the direction of turns away from other traffic.



Sectorization

Sectorize airspace either to satisfy geographic or functional requirements



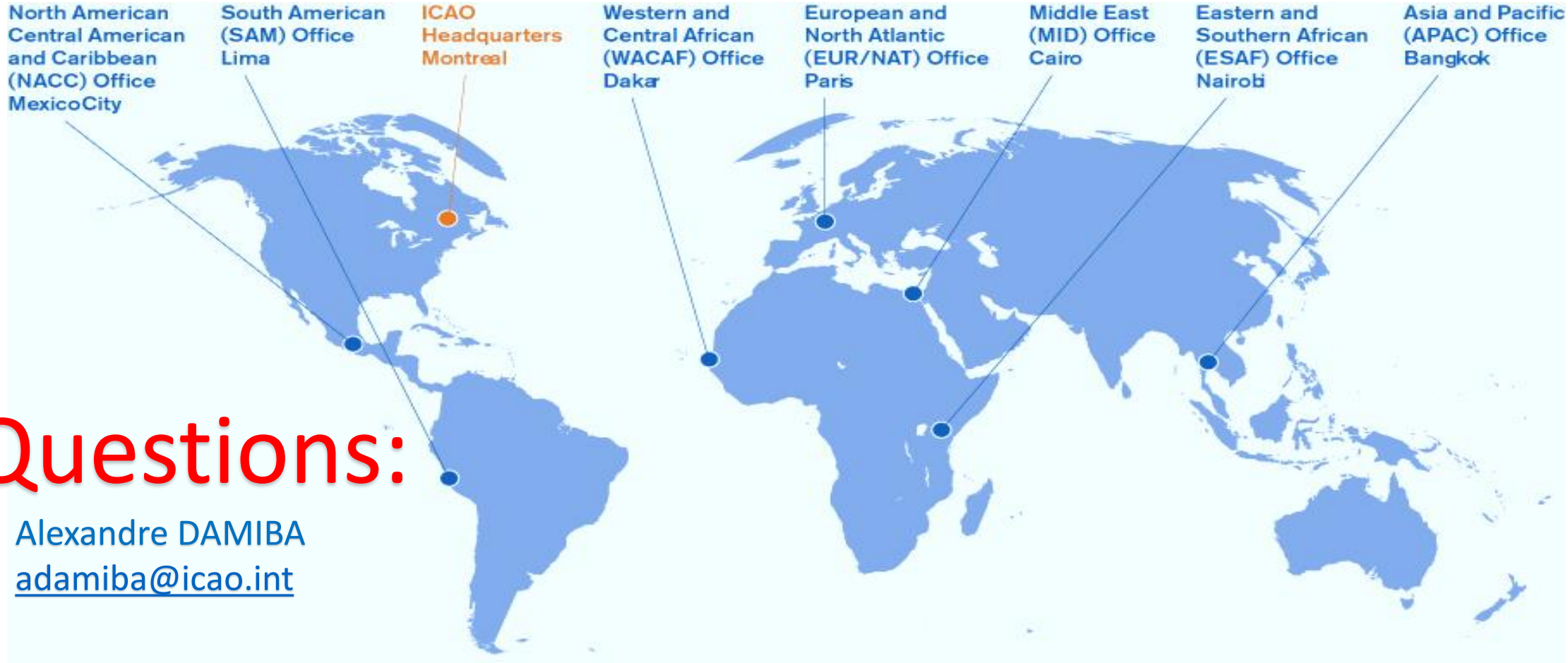
Validate airspace design to make sure actual aircraft performance matches that of assumed aircraft performance

Airspace Design

SUMMARY

Summary

- We started calculating STAR terminating levels… 3250’ + airport elevation
- TMA boundary and entry points… 4
- Open and Closed Path STARs, based on entry from Base- or Straight-in Sector
- Planning STARs… start with one carrying the most traffic
- Strategic Delaying Techniques – Path Stretching, Merge Point
- Sequencing with Structured Decision Points
- Planning SIDs… around STARs, lateral paths may be longer
- Lateral separation between STARs/SIDs… 5 NM
- Two CCO design examples… basic and enhanced
- STAR and SID Naming Convention… ANNEX 11, Appendix 3.
- Holding airspace, Sectorization



Questions:

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