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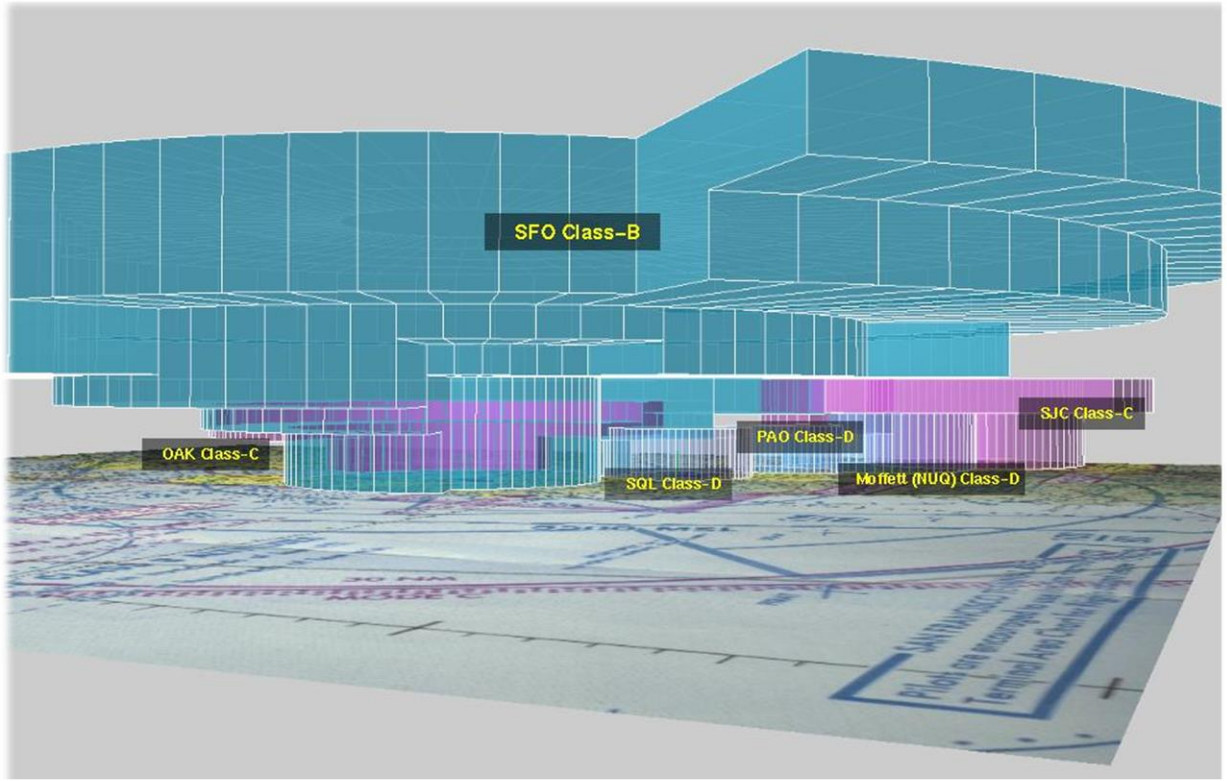
Workshop on PBN airspace Design

31 May - 04 June 2021

Airspace Design and ATC Techniques

Content

- ❑ Completing the Airspace Design
- ❑ Delaying Techniques
- ❑ Lateral separation between SIDs and STARs
- ❑ Holding Airspace
- ❑ Sectorization
- ❑ Validation
- ❑ SIDs & STARs naming convention



Airspace Design

COMPLETING THE AIRSPACE DESIGN

Starting the Design

- Start with plotting the approach to determine at which altitude the STAR will terminate:
  - ☞For this example we use the RNP APCH.
- We start with the fixes…
  - ☞FAF, IF and three (3) IAFs… we will use 5-NM segments (Example).
  - ☞Threshold crossing altitude (TCA) = 50’
  - ☞FAF altitude… 5 x 320’ = 1 600’ add 50’ for a total of **1 650’**
  - ☞IF altitude… 5 x 160’ = 800’ add 1 650’ for a total of **2 450’**
  - ☞IAF altitude… 5 x 160’ = 800’ add 2450’ for a total of **3 250’**
  - ☞Finally add the airport elevation… for Dakar this would be 85’ then round up
    - At Dakar the STAR termination altitude would be around **3 350’.**

Continuing the Design…

- Then we plot the Entry points:
  - ☞No more than four (4), max 5.
- Start with the STAR that carries the most traffic:
  - ☞STARs from the Straight-In sector are of the Closed path design;
  - ☞STARs from the Base Sector are of the Open path design.
- The Open path STAR will lead from the Entry point to abeam the airport, not directly to the IAF!
- Merge only two STARs at a time, always think what will ATC do when two aircraft start merging:
  - ☞Remember, CDOs and speed control do not mix!
- **So let's look at some strategic delaying techniques.**

Airspace Design

DELAYING TECHNIQUES

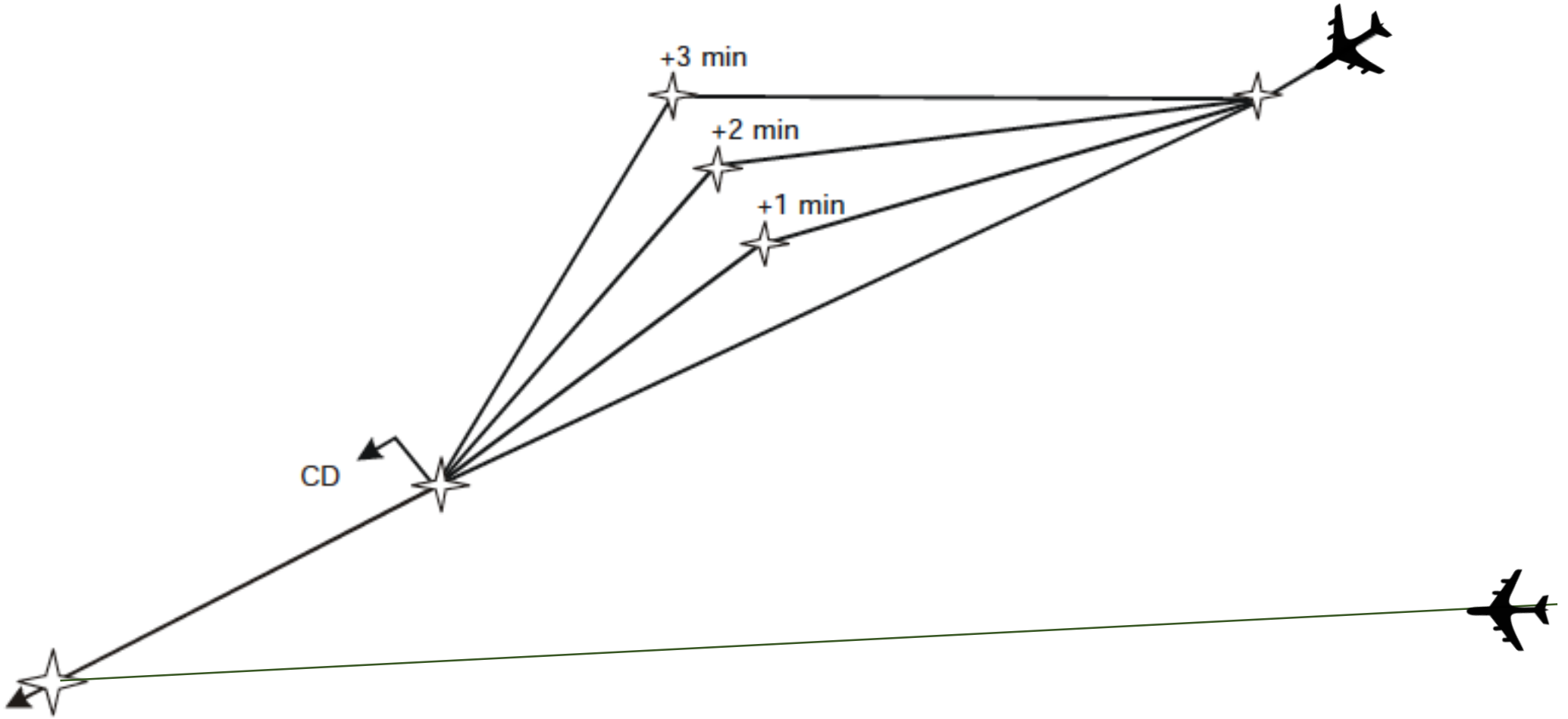
Delaying techniques

- We need to build in STRATEGIC "**delaying techniques**".
- This is because TACTICAL delaying techniques put an aircraft on the STAR either below or above the optimum vertical path:
  - ☞The FMS calculate the TOD base on the total distance to fly, based on a 320-foot descent per NM, and the VNAV is now flying this profile.

Delaying techniques

- So any **extension** for **delaying reasons** to this calculated "flight path" will place the aircraft **below the optimum vertical path**, and any **short cut** of the "flight path" will place the aircraft **above the optimum vertical path**.
- In the first case, **more thrust** may be required to achieve the desired arrival or approach descent profile.
- Secondly, **additional drag** which can create both an increase in noise on the ground and an uncomfortable ride for passengers may be required to recapture the optimized profile or approach path.

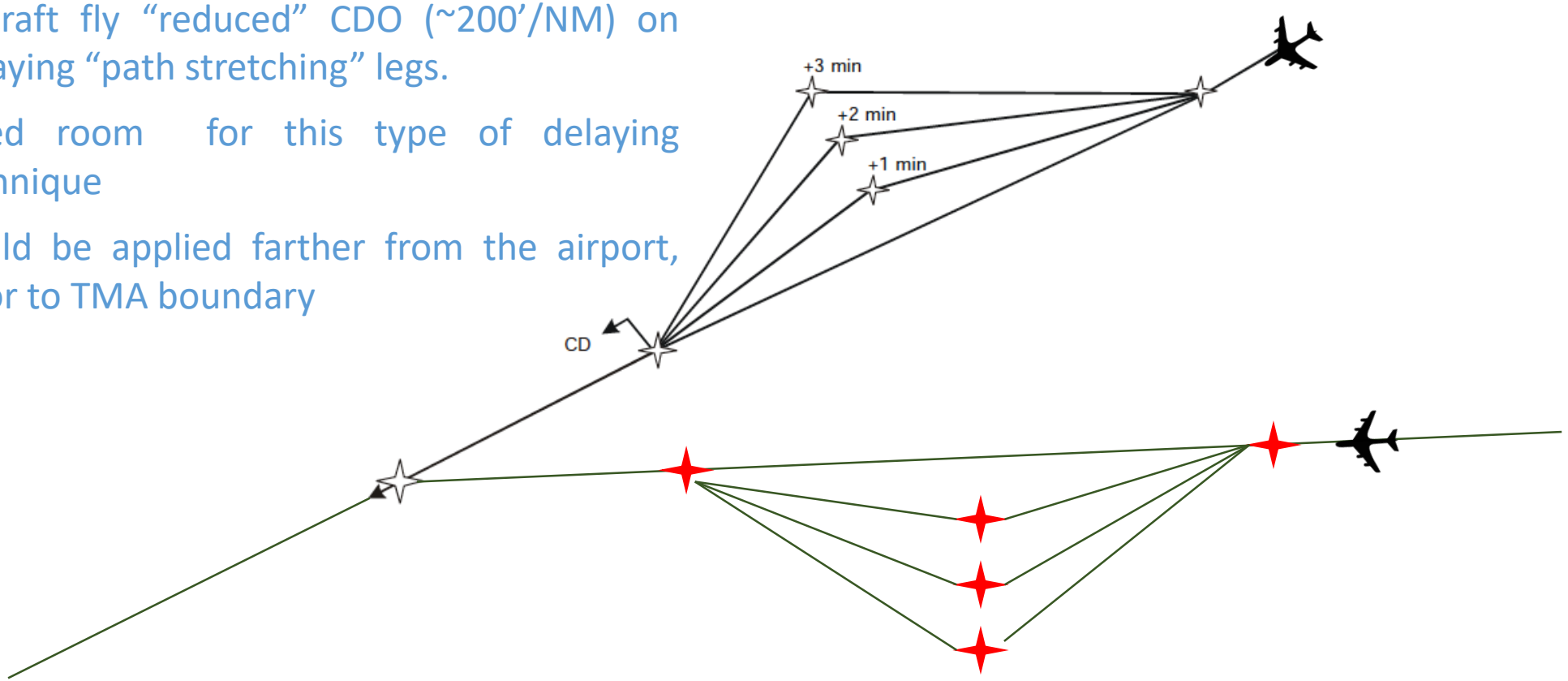
Path Stretching



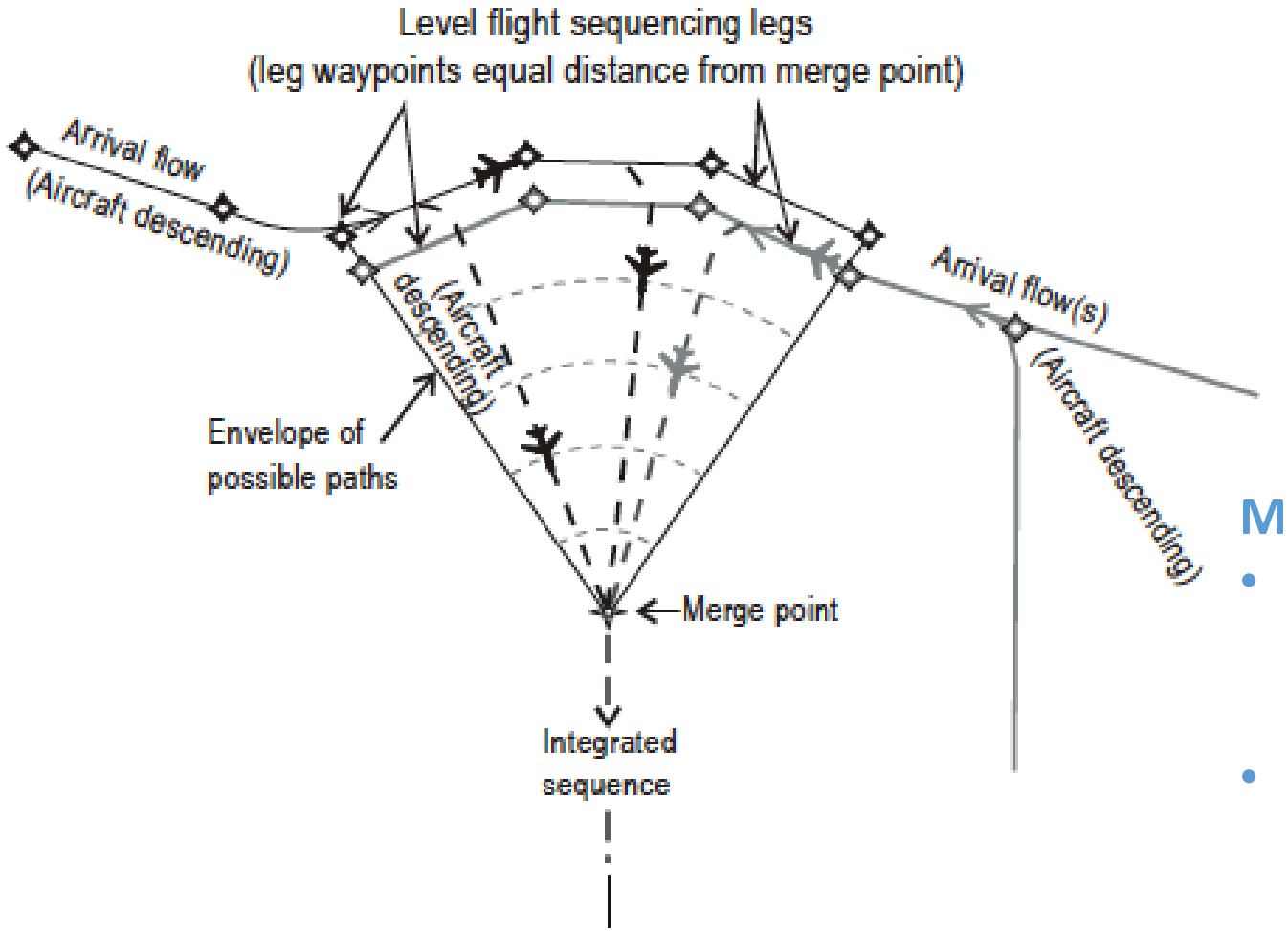
Path Stretching

Path Stretching

- Aircraft fly “reduced” CDO (~200’/NM) on delaying “path stretching” legs.
- Need room for this type of delaying technique
- Could be applied farther from the airport, prior to TMA boundary



Merge point



Merge Point

- Works best for airports where majority of aircraft arrive from same sector
- Aircraft fly level on delaying arcs

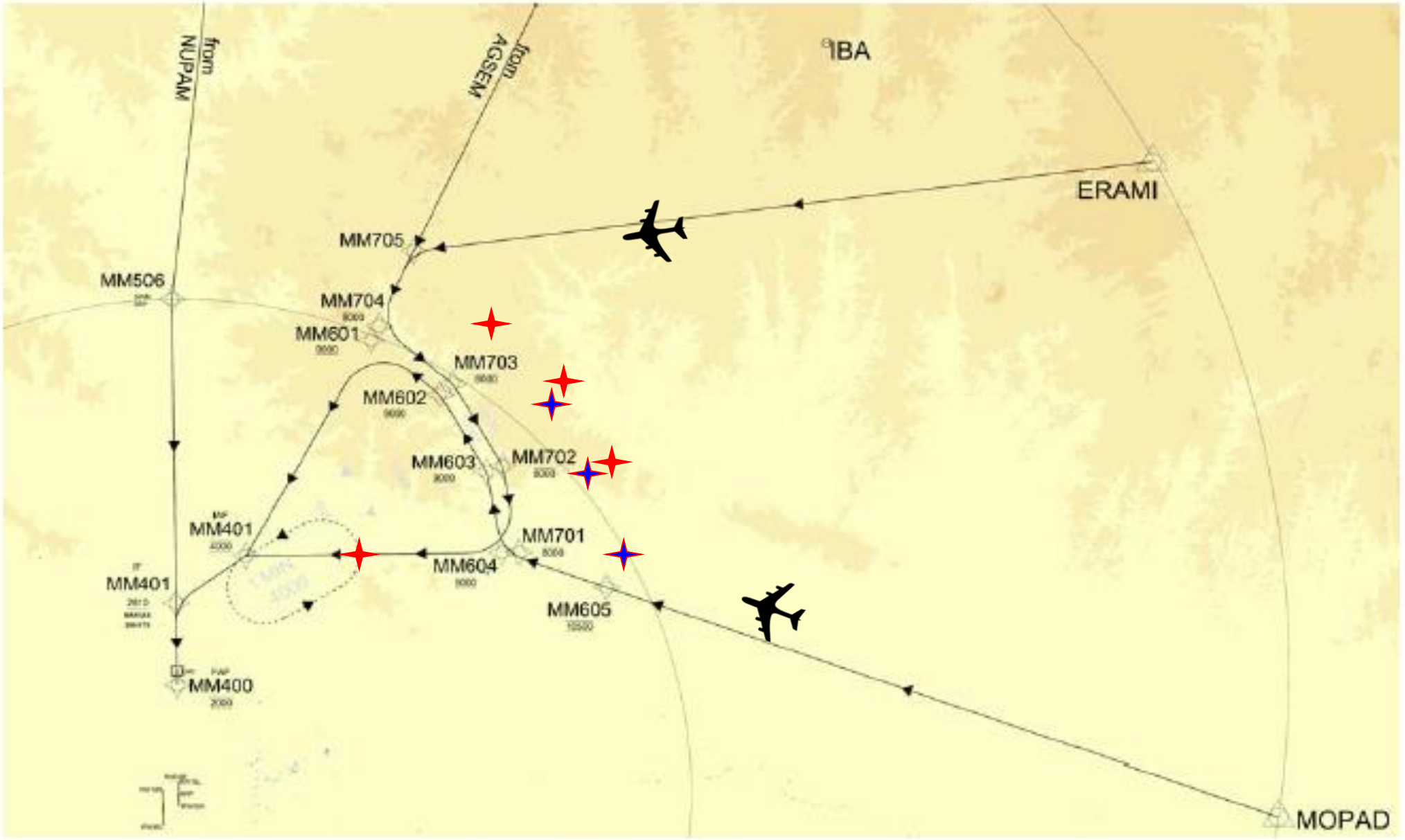


Figure 4 STARs RW 18L

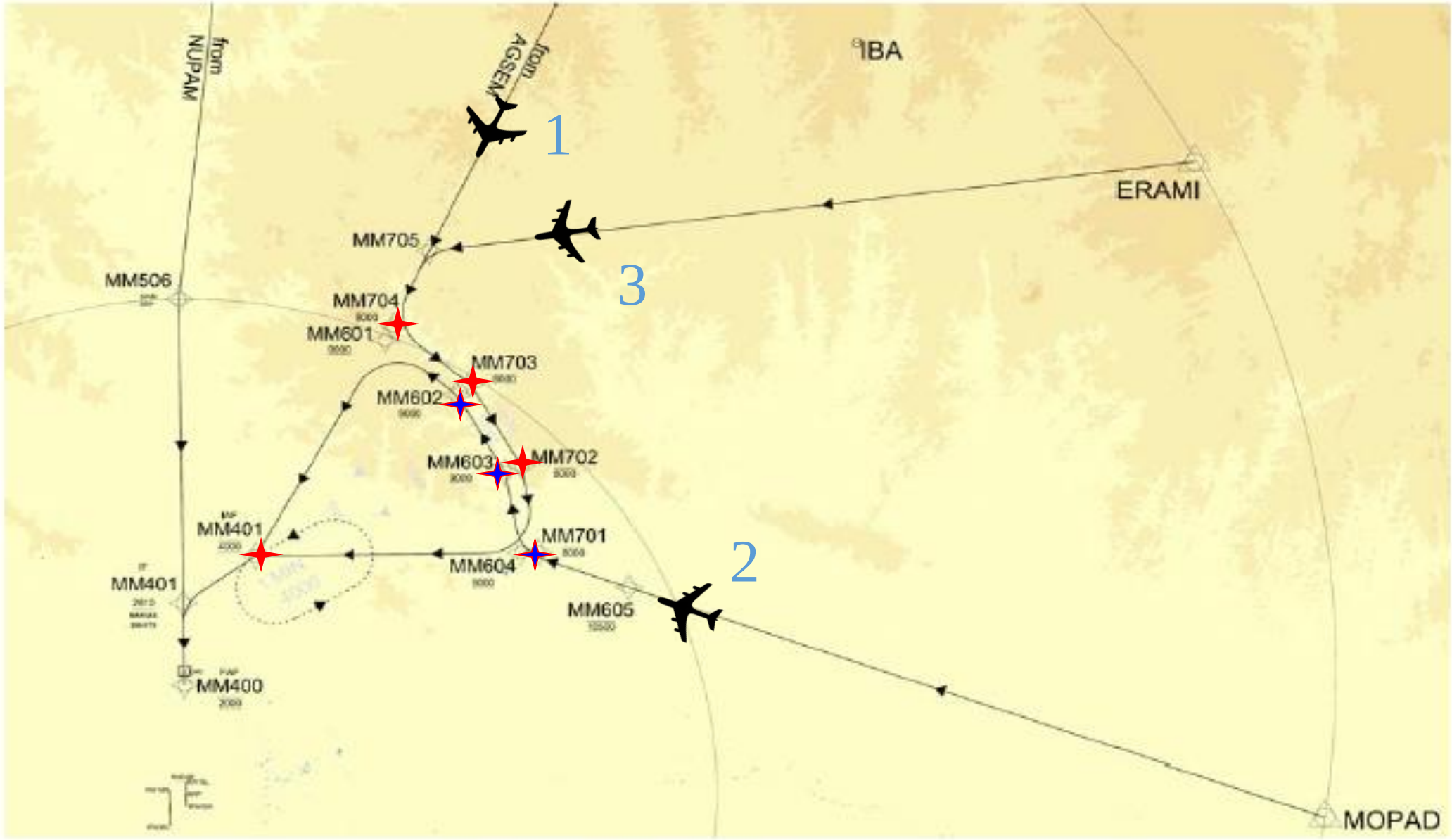
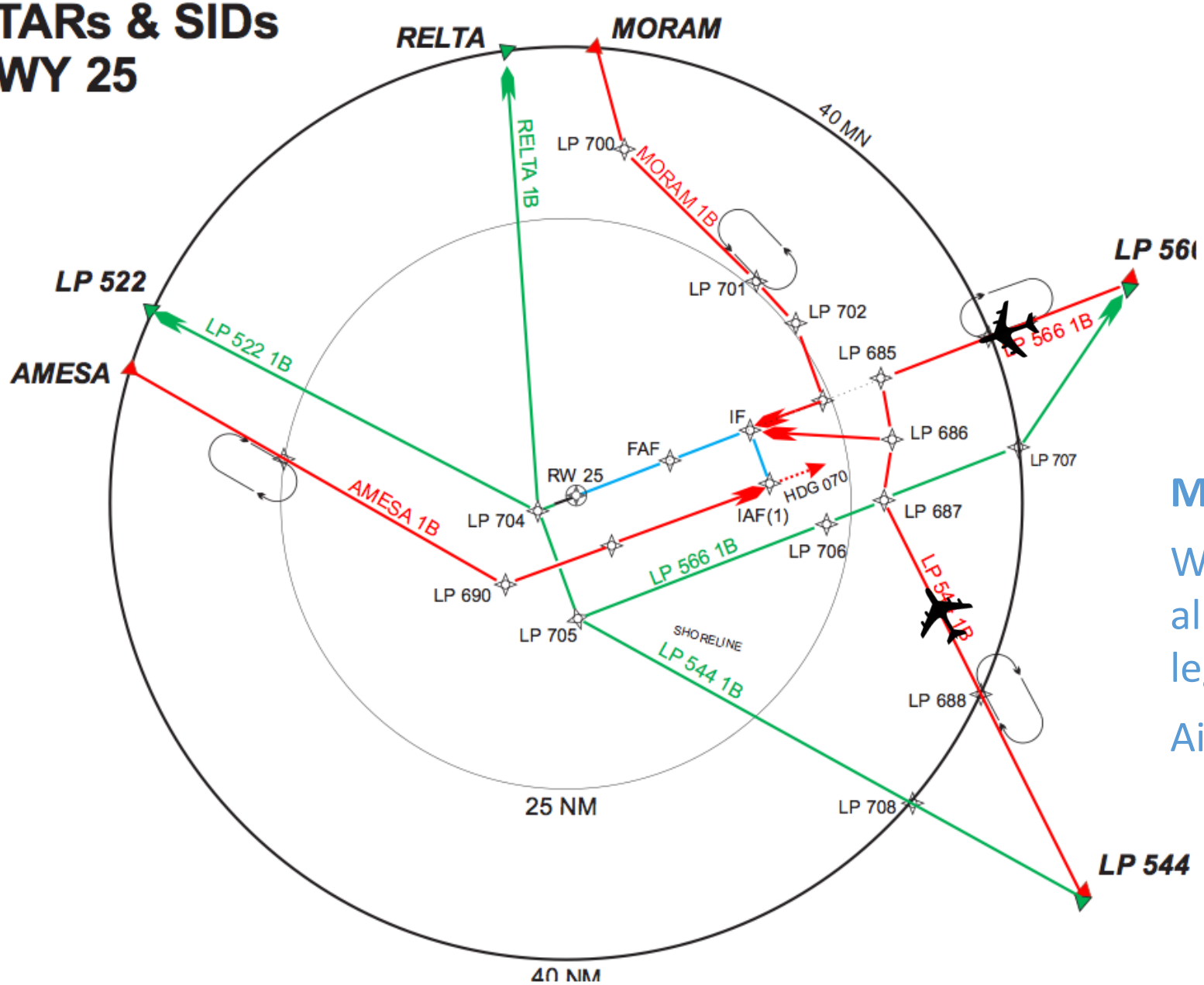


Figure 4 STARs RW 18L

Merge point

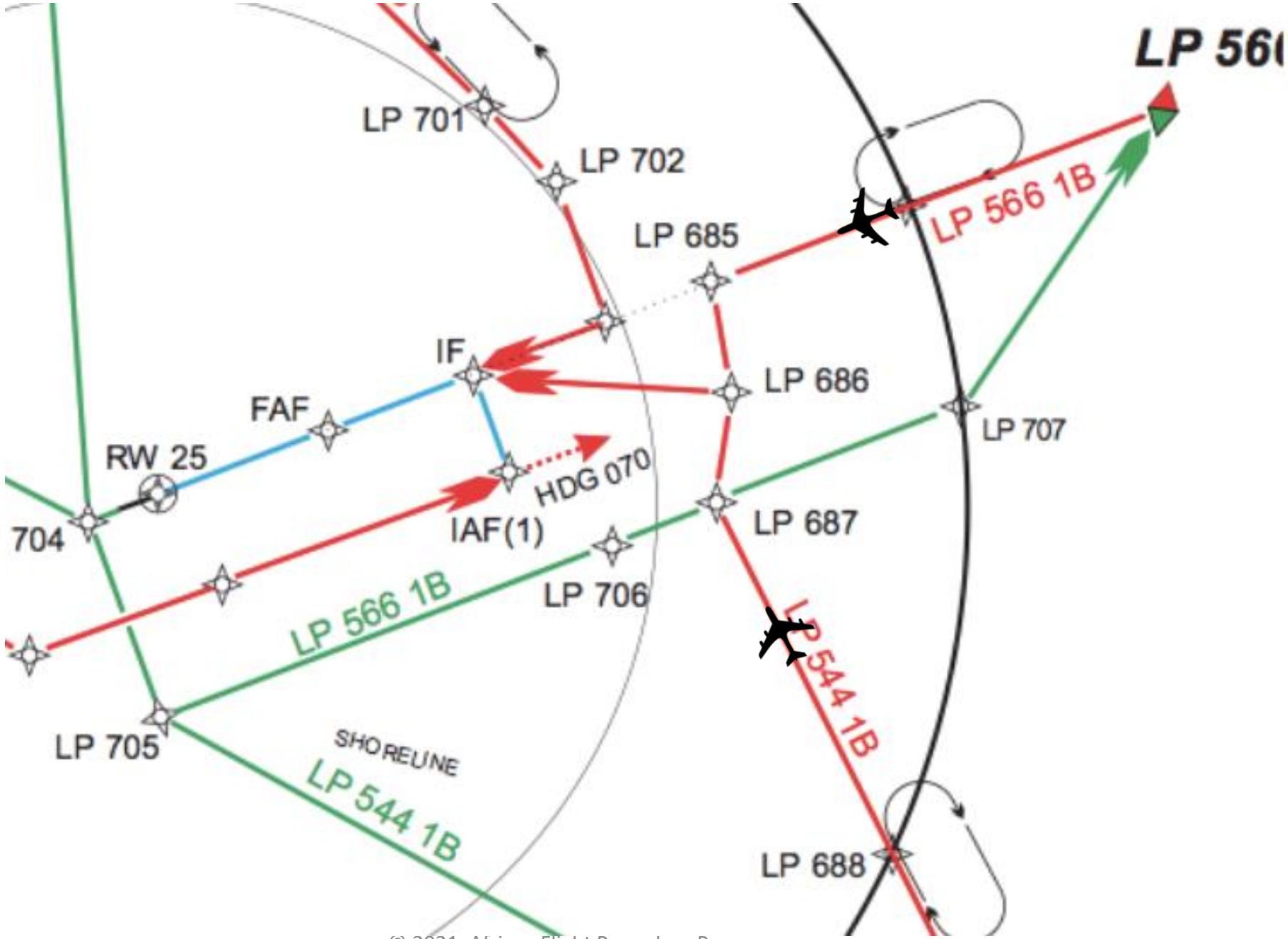
African Flight Procedure Programme (AFPP)



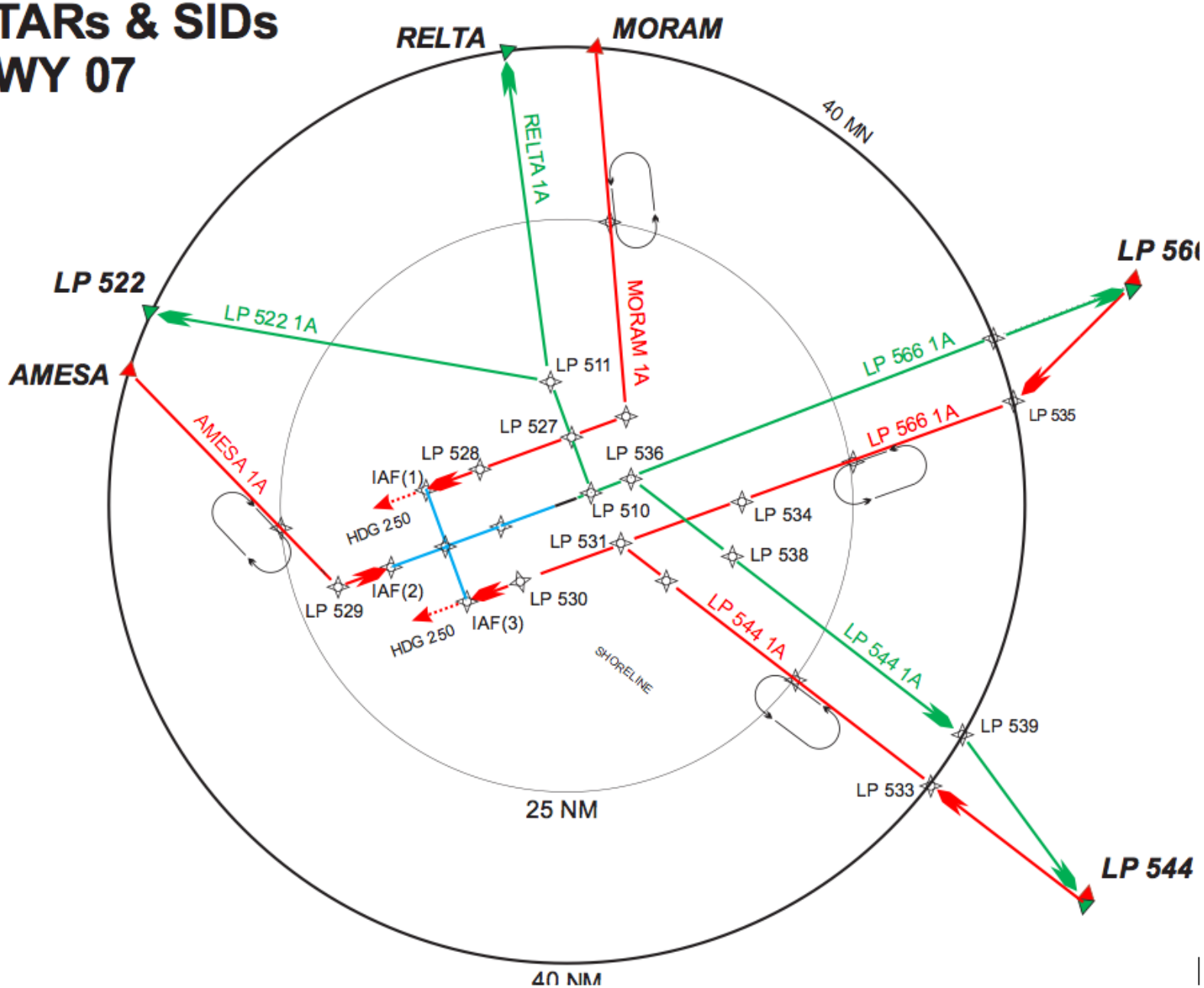
Mini-Merge Point

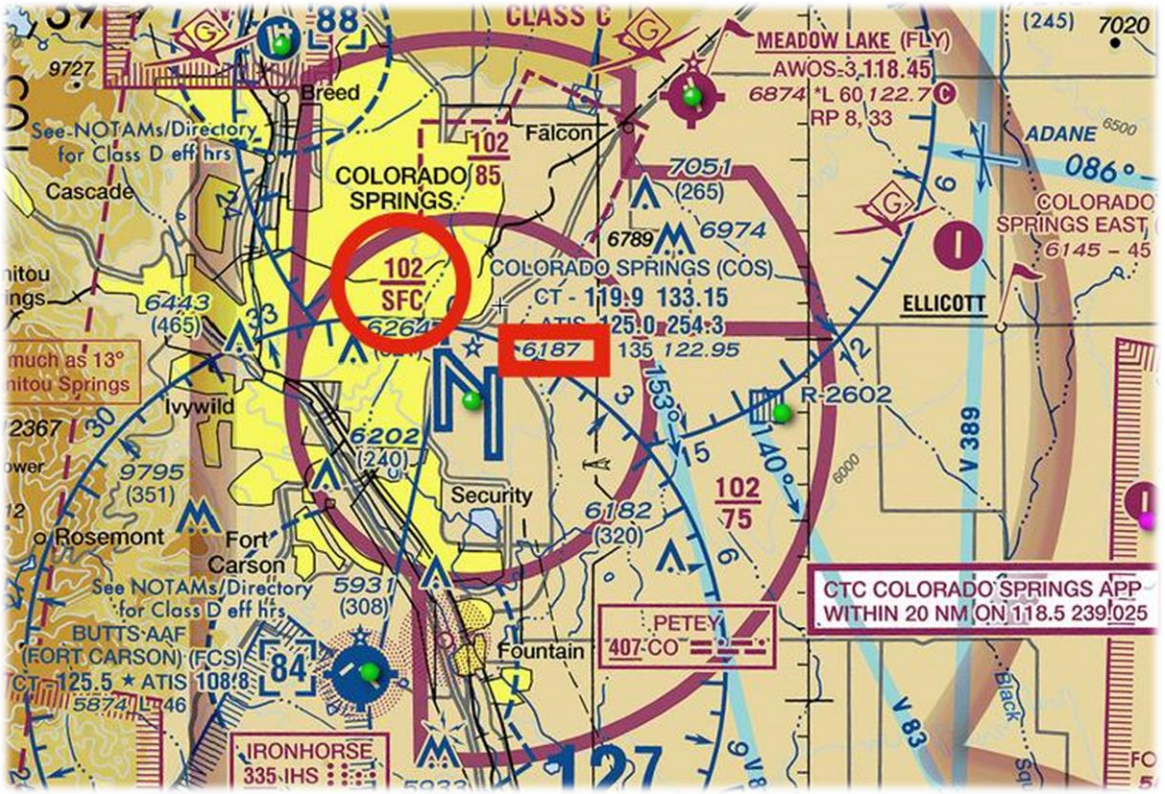
Works well if airspace does not allow for “path stretching” delaying legs

Aircraft fly level on delaying arcs



STARs & SIDs
RWY 07





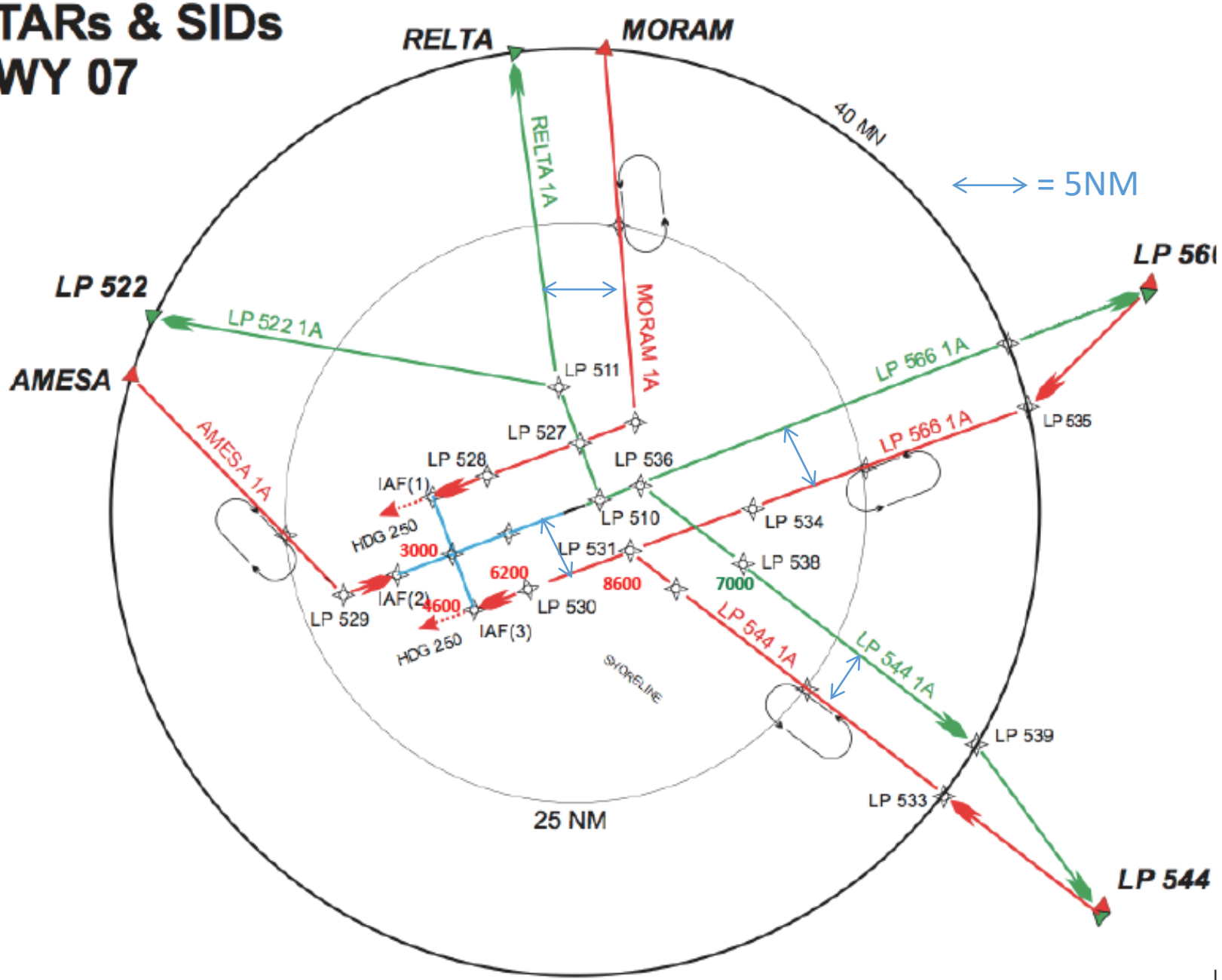
Airspace Design

LATERAL SEPARATION BETWEEN STARs & SIDs

Lateral Separation

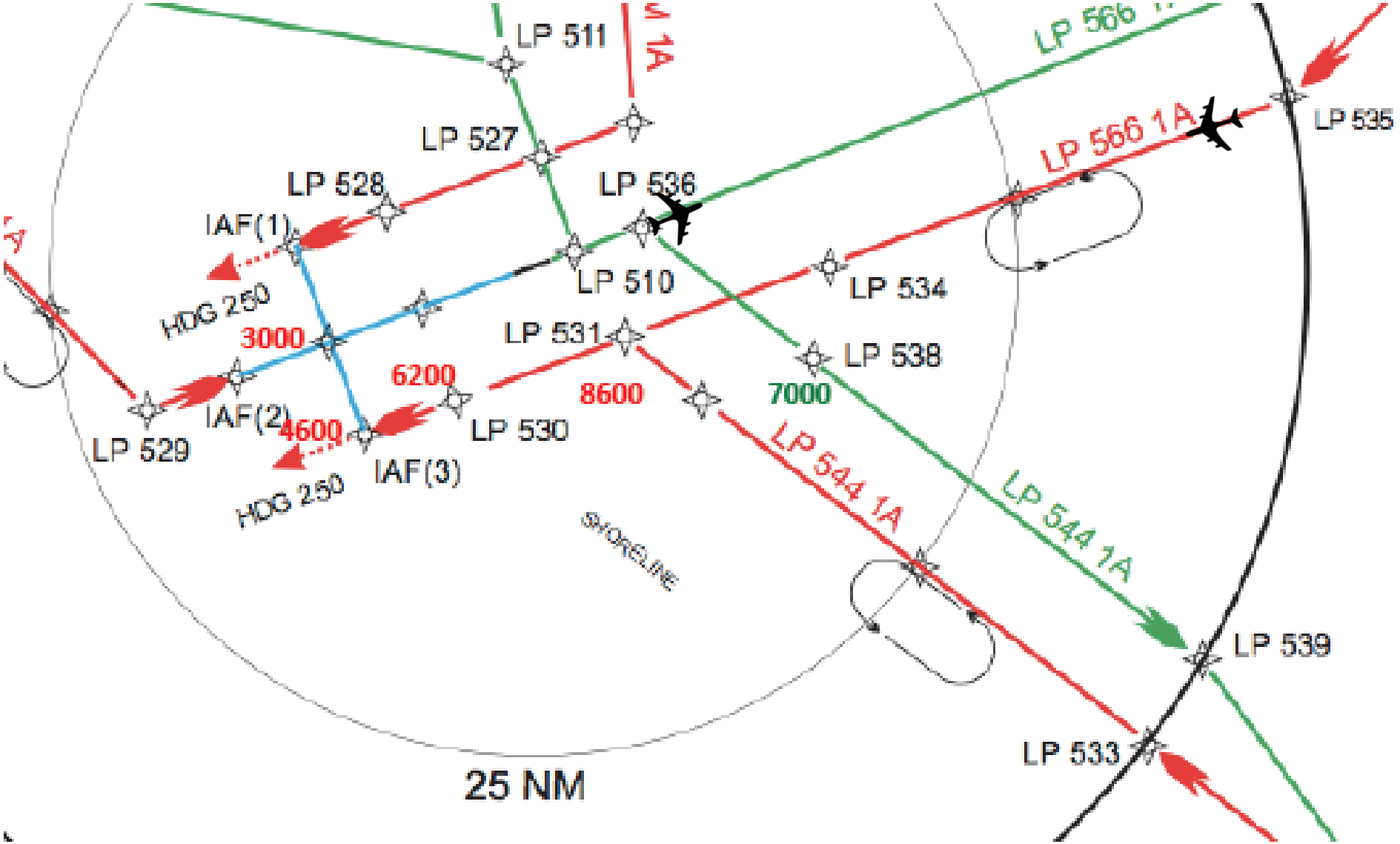
- We already learned that to make CDOs and CCOs work, STARs and SIDs need to be segregated, in other words, separated from each other laterally;
- STARs and SIDs will be based on either RNAV 1, RNP 1 or RNP 1 with RF legs.
- All routes based on these Nav Specs need to be laterally separated by 5 NM minimum:
  - ☞Plan this lateral separation until 30 NM from the Airport Reference Point (ARP)
  - ☞After, or before this boundary, aircraft should be vertically separated

STARs & SIDs
RWY 07



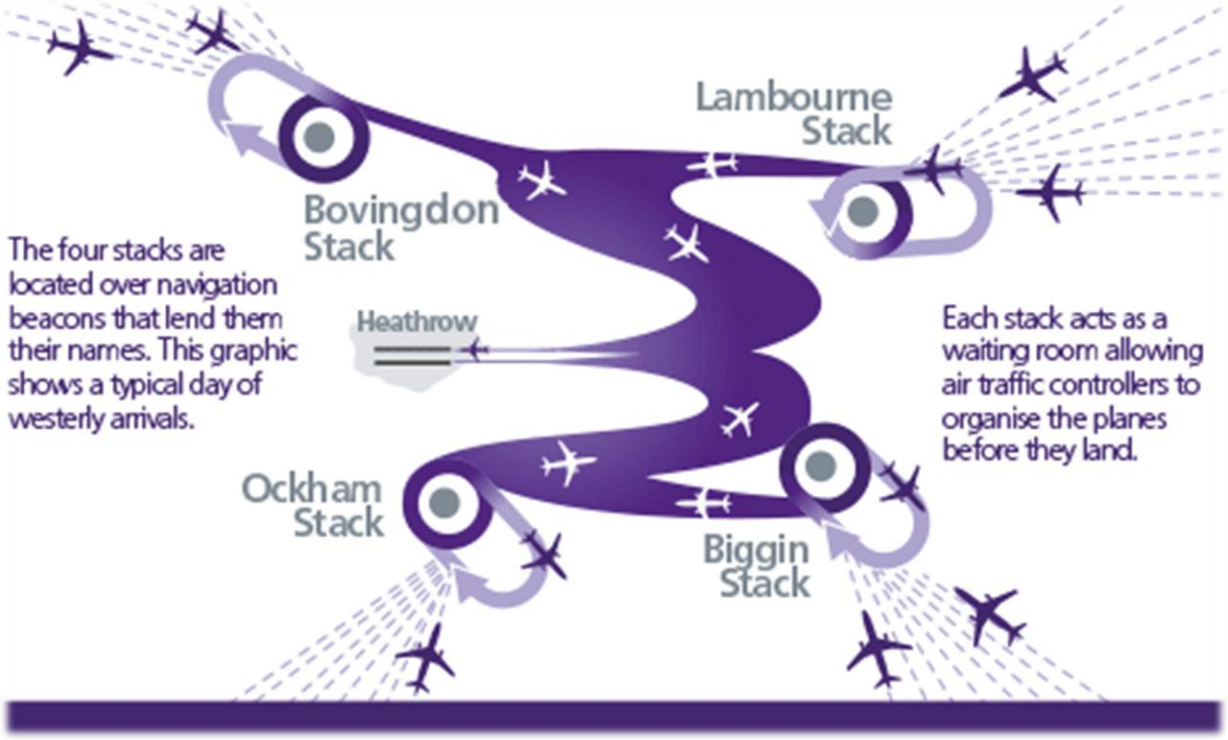
Lateral Separation

- If your radar separation within your TMA is also 5 NM, you'll need to separate the STARs and SIDs by 6 NM!
- Because if there are any lateral deviations by aircraft while passing each other without vertical separation, the controller will incur a separation loss.
- The way to avoid having to increase the lateral separation to 6 NM, is to reduce the radar separation to 3 NM:
  - ☞The understanding will be to continue using 5 NM…
  - ☞But this will buy you 2 NM of buffer!!



Airspace Design

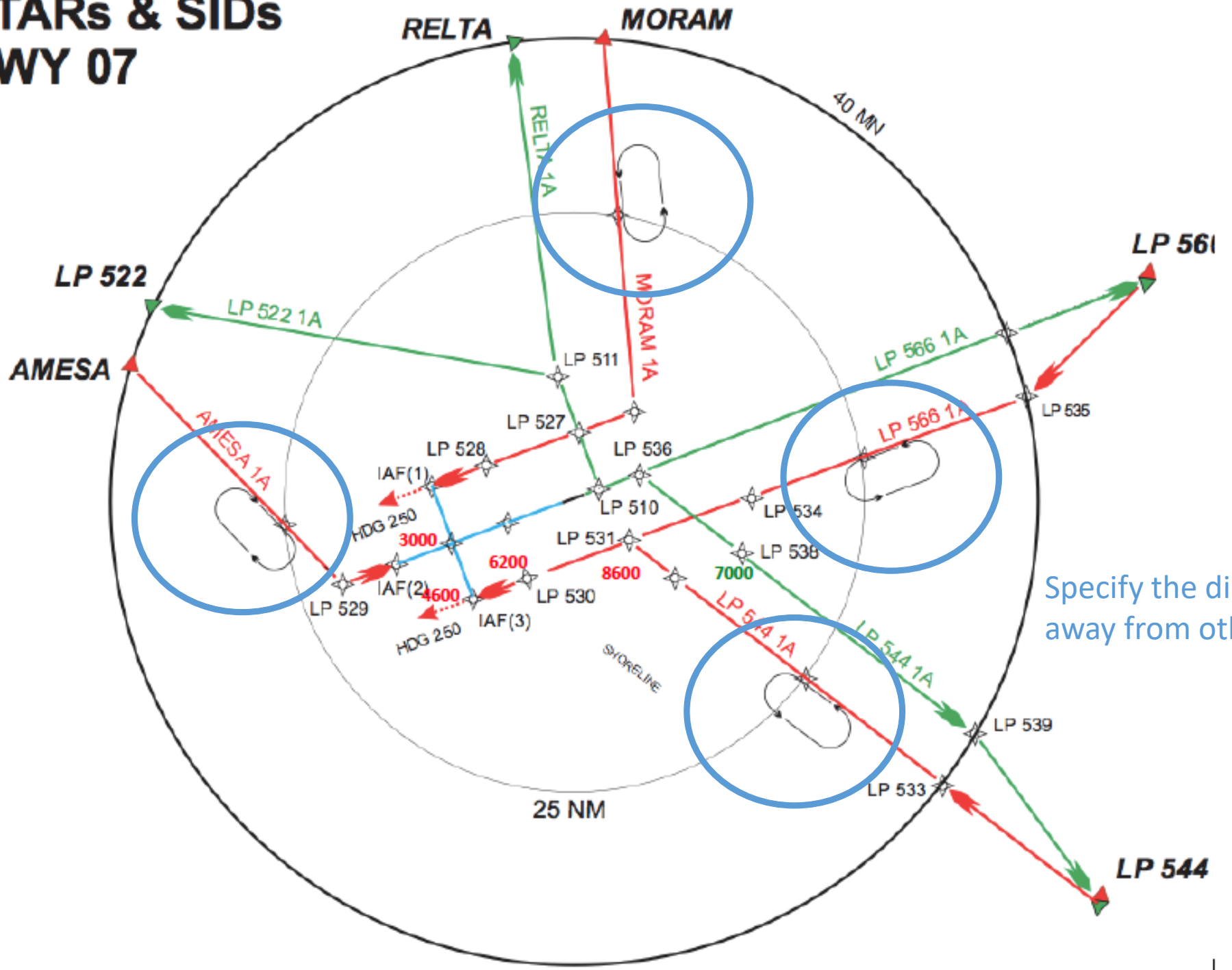
HOLDING AIRSPACE



Holding Airspace

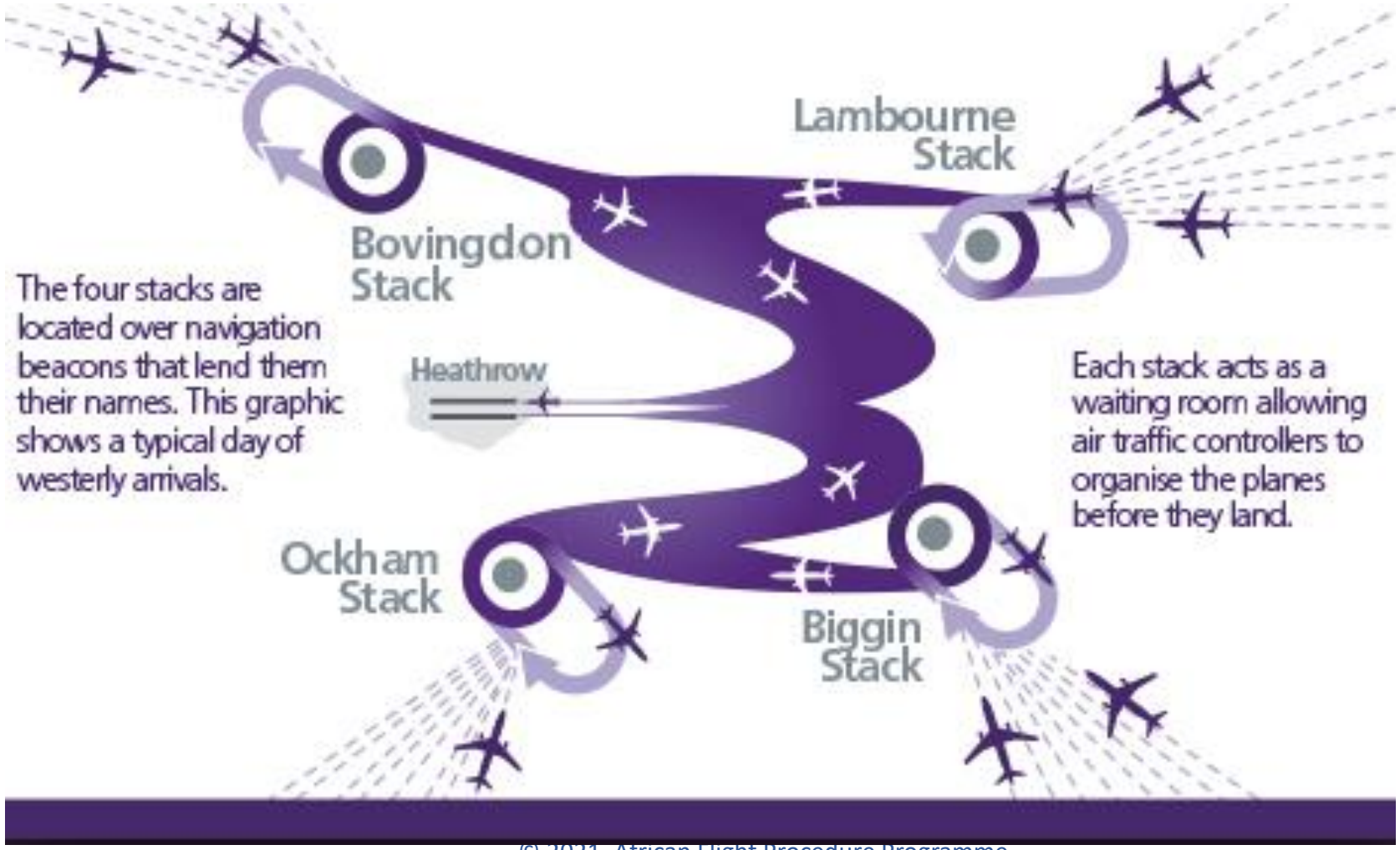
- There will be two types of holding airspace within the TMA:
  - Missed Approach Holding airspace at low altitudes/levels;
  - Holding airspace for delaying aircraft on STARs during rush-hour traffic.
- MA Holding airspace:
  - Usually collocated with one of the IAFs, about 1,000 to 2,000’ above IAF altitudes
    - Therefore around 4,000’ (AGL).
- STAR delaying Holding Airspace:
  - Around 25 - 30 NM from ARP, around 14,000’ (AGL) or whatever the altitude of the arriving aircraft is when passing the holding fix.

STARs & SIDs
RWY 07



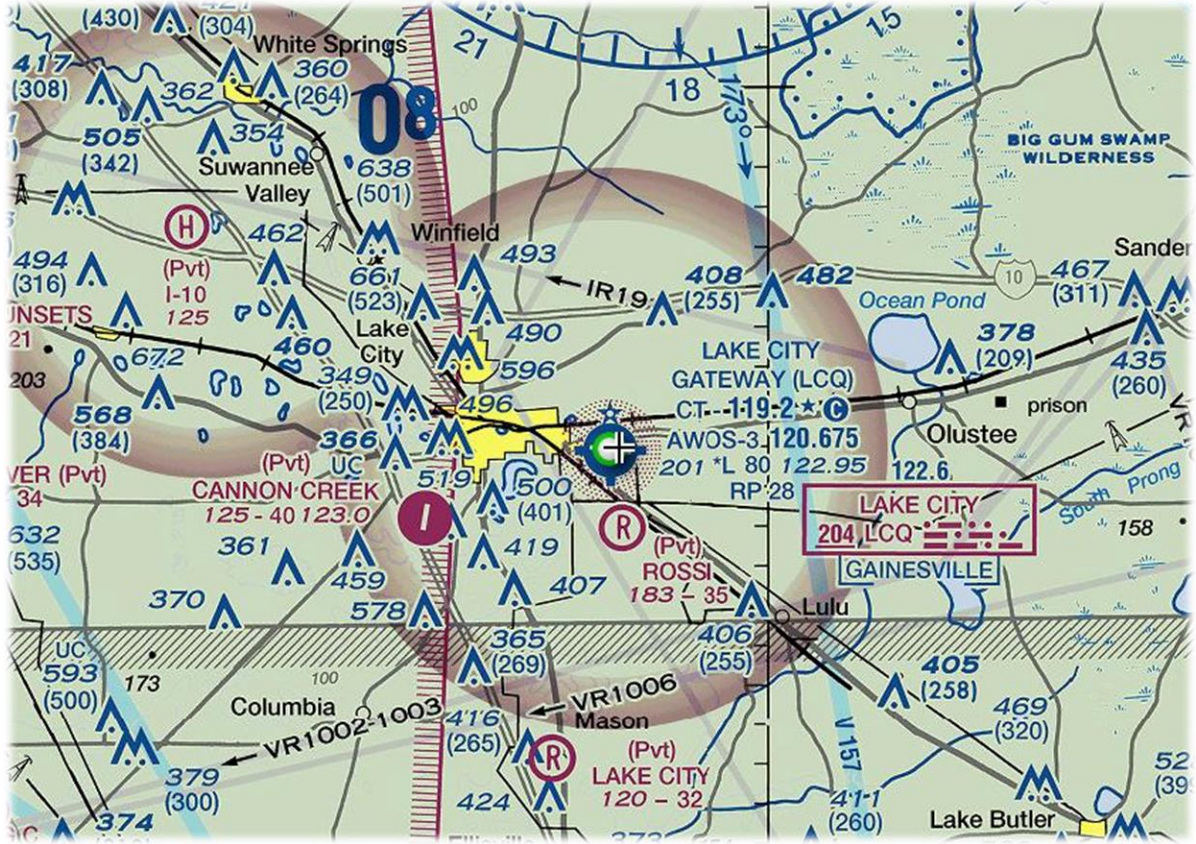
Specify the direction of turns away from other traffic

Holding Airspace

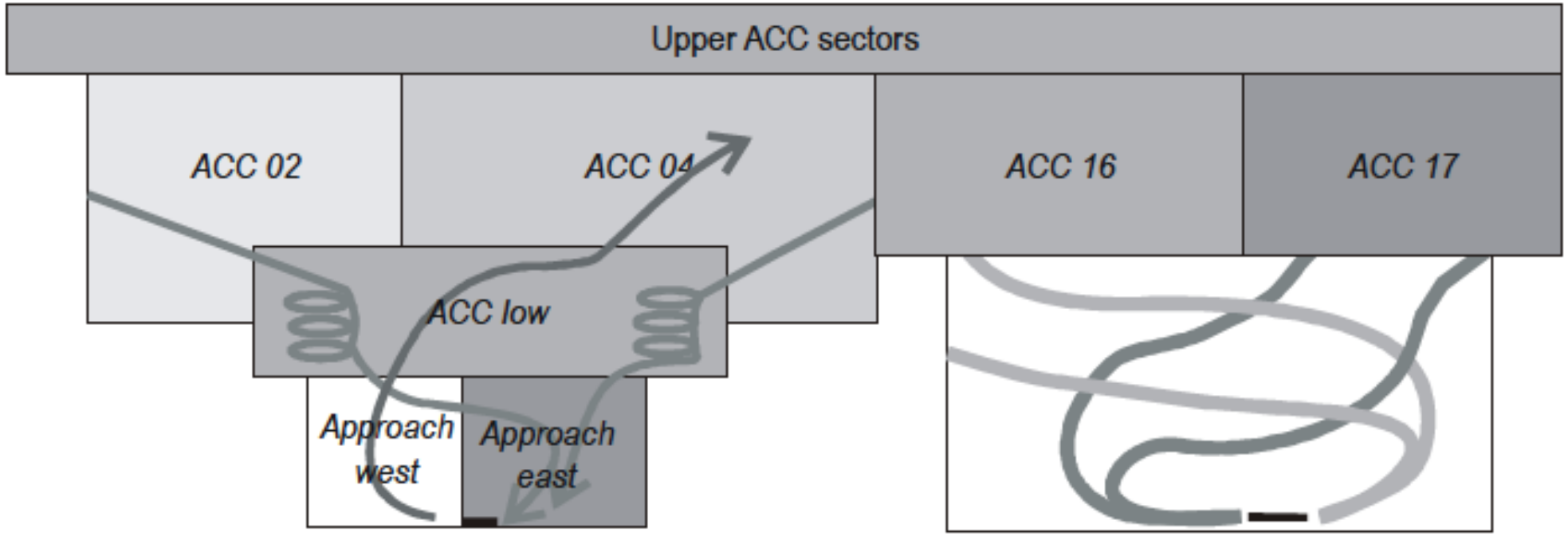


Airspace Design

SECTORIZATION



Sectorization



Two types of Sectorization types are Shown… GEOGRAPHIC and FUNCTIONAL

Airspace Design

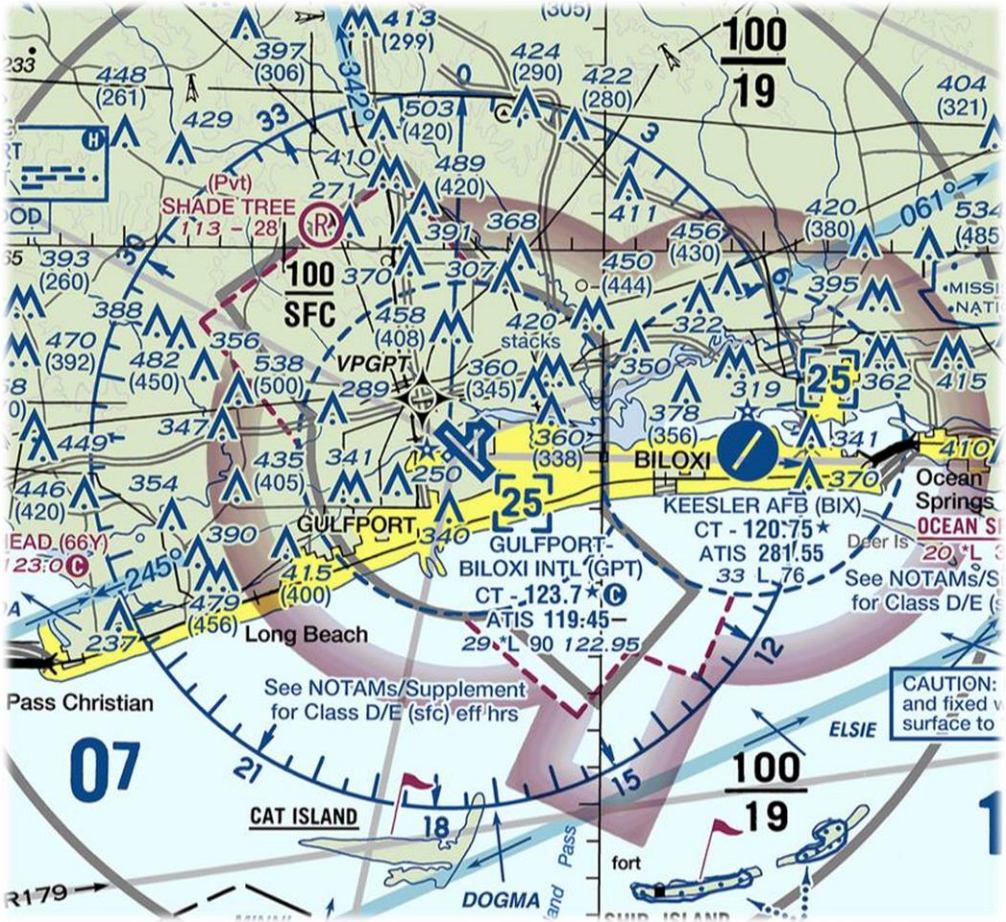
VALIDATION

Validation

- Validation of an airspace concept takes many forms.
  - ☞There is the validation initially by **fast time simulation** and ultimately by **live ATC trials** that verify if **the airspace concept works.**
- The capacity of the airport should be not compromised by the application of CCO and CDO, and the controllers should be able to manage the workload.
- However, there is **one most important "test"** to see if the airspace design will work...
- What is this?
  - ☞Make sure adequate ATC training has taken place.
  - ☞You'll need ATC buy-in.

Airspace Design

STAR & SID NAMING CONVENTION



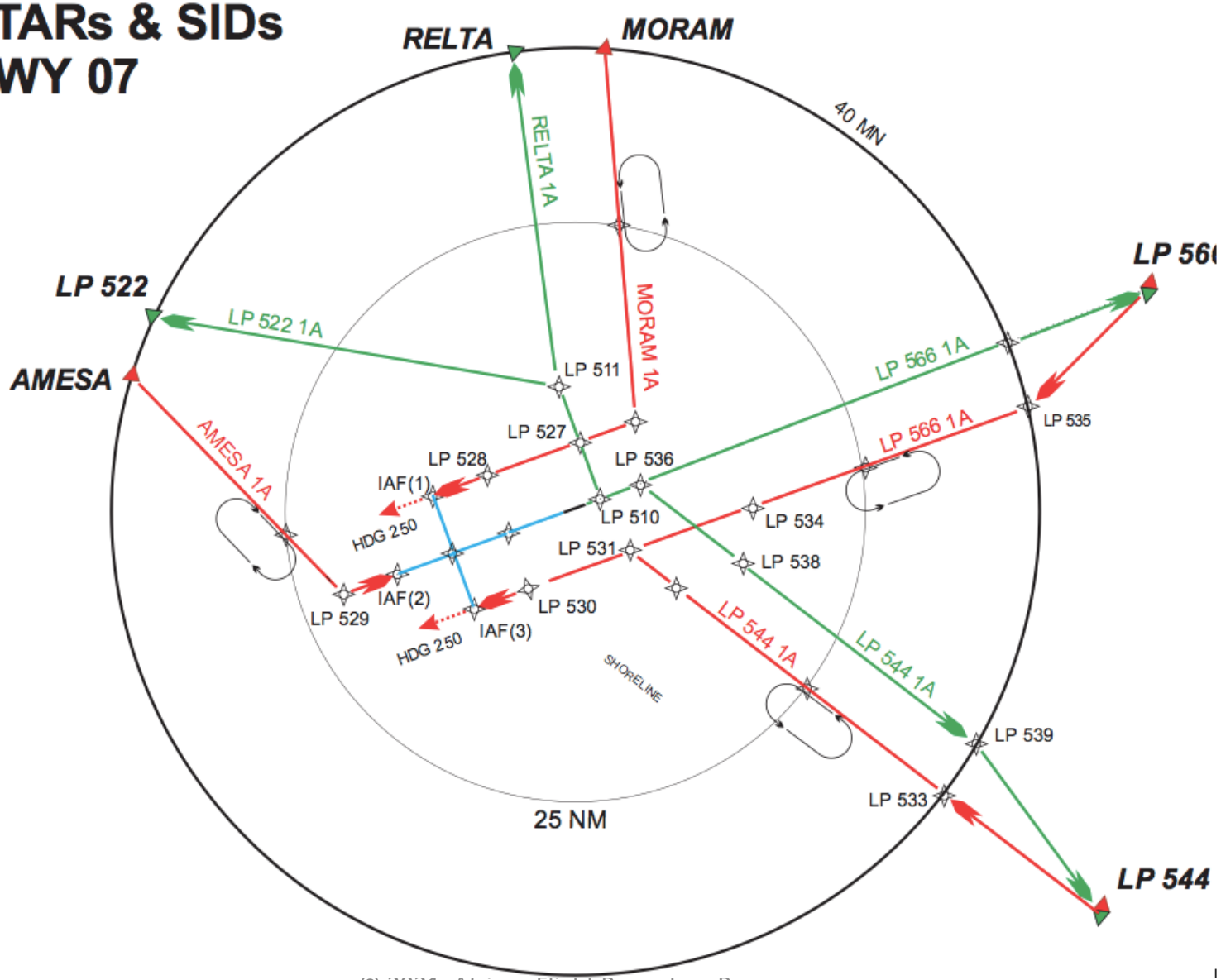
Naming Convention

- 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 (taken from the name of the Entry/Exit fix); followed by
  - ☞**Validity** indicator (which version of the procedure); followed by
  - ☞**Route** indicator (from Entry point to which RWY), where required; followed by
  - ☞the word "**DEPARTURE**" or "**ARRIVAL**"
    - DESDI **SEVEN HOTEL ARRIVAL (RWY 12L/R)**
      - Charting – DESDI 7H ARR
    - MIADA **THREE KILO DEPARTURE (RWY 12L/R)**
      - Charting – MIADA 3K DEP

RNAV SID/STAR Designation

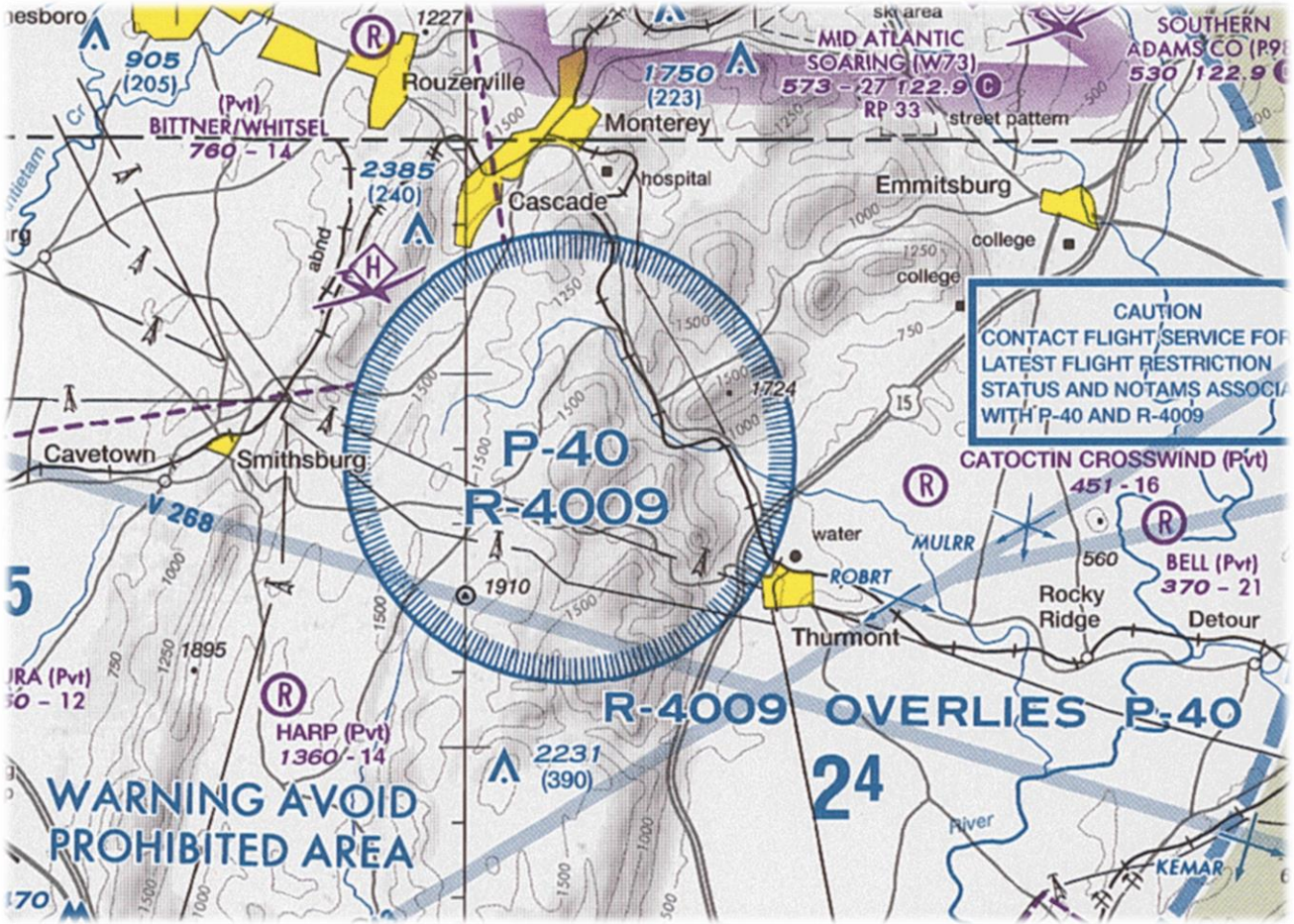
- Examples...
  - A **basic** indicator (**MORAM**); followed by;
  - A **validity** indicator (**1..** or **2**, **3**, etc.); followed by;
  - A **route** indicator, where required (**A**, **B**, **C**, etc.) depending to which runway the procedure is leading to/away from; and
  - The word "**DEPARTURE**" or "**ARRIVAL**" (**ARR/DEP**)
    - **MORAM 5 A ARR** (RWY 25)
    - **AMESA 1 A DEP** (RWY 07)

STARs & SIDs
RWY 07



Airspace Design

SUMMARY



Summary

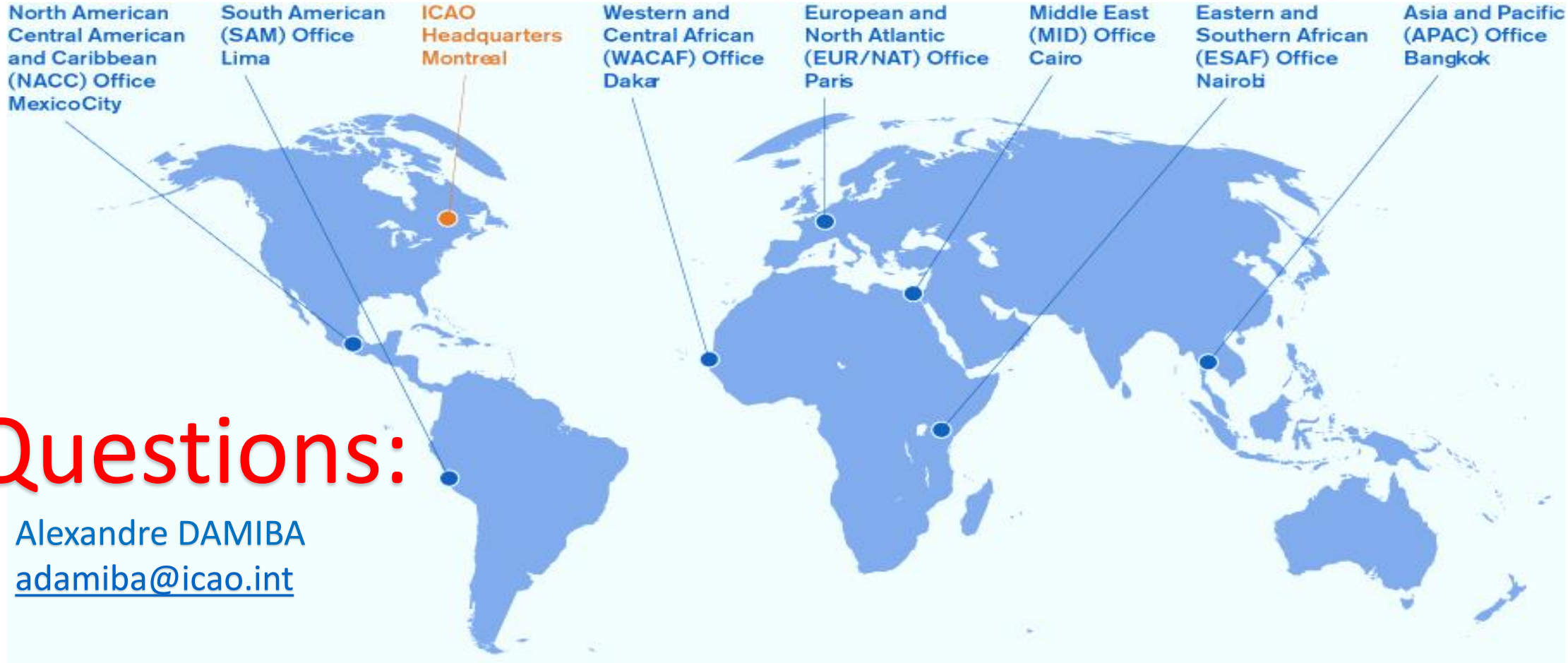
- Lateral separation between STARs and SIDs;
- Sequencing with Strategic Delaying Techniques:
  - ☞Merge Point;
  - ☞Mini Merge Point.
- Holding airspace:
  - ☞For missed approaches and for delaying aircraft on STARs
- Sectorization… by geographic or functional requirements;
- Validate airspace design to make sure the Airspace Concept works;
- Name the STARs and SIDs according to ANNEX 11, Appendix 3, Paragraph 2.1.1

Comprehension check

1. What is the first procedure we should start designing?
2. How many STARs should we aim to merge at the same time?
3. What are the two objectives of SIDs?
4. What route spacing should be applied between STARs based on RNAV 1, RNP 1 or RNP 1 + RF?
5. Why are “strategic” delaying techniques preferred over “tactical” delaying techniques?
6. What rate of CDO should be applied on the delaying leg of “path stretching”?
7. What type of holding airspace should be applied in the TMA?
8. Name two types of sectorization?

Comprehension check

1. What is the first procedure we should start designing?
   ☞ Approach
2. How many STARs should we aim to merge at the same time?
3. What are the two objectives of SIDs?
   ☞ Reduce fuel burn and noise abatement.
4. What route spacing should be applied between STARs based on RNAV 1, RNP 1 or RNP 1 + RF?
5. Why are “strategic” delaying techniques preferred over “tactical” delaying techniques?
   ☞ TACTICAL delaying techniques put an aircraft on the STAR either below or above the optimum vertical path
6. What rate of CDO should be applied on the delaying leg of “path stretching”?
   ☞ Rate of descent: 200 ft/NM
7. What type of holding airspace should be applied in the TMA?
   ☞ Missed approach and delaying holding airspace
8. Name two types of sectorization?



Questions:

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