The ICASC Technical Working Group View on R-NAV DME/DME Flight Inspection

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Reminder

In addition to traditional applications, avionics have been developed that can interrogate multiple DME enabling determination of aircraft position:

- B-RNAV ± 5 Nm   95%
- P-RNAV (aka RNAV1) ± 1 Nm   95%

☞Two Navigation Aids or Sensors : GNSS and DME/DME (DME/DME used as back-up for GNSS)

☞ For DME/DME each combination of navigation aid needs to be assessed and potentially inspected

DME/DME Navigation Example

DME Out of range

DME #1

DME Out of range

DME #2

DME #4

Combinations:

#1 & #2 not OK

#2 & #4 OK

#1 & #4 OK
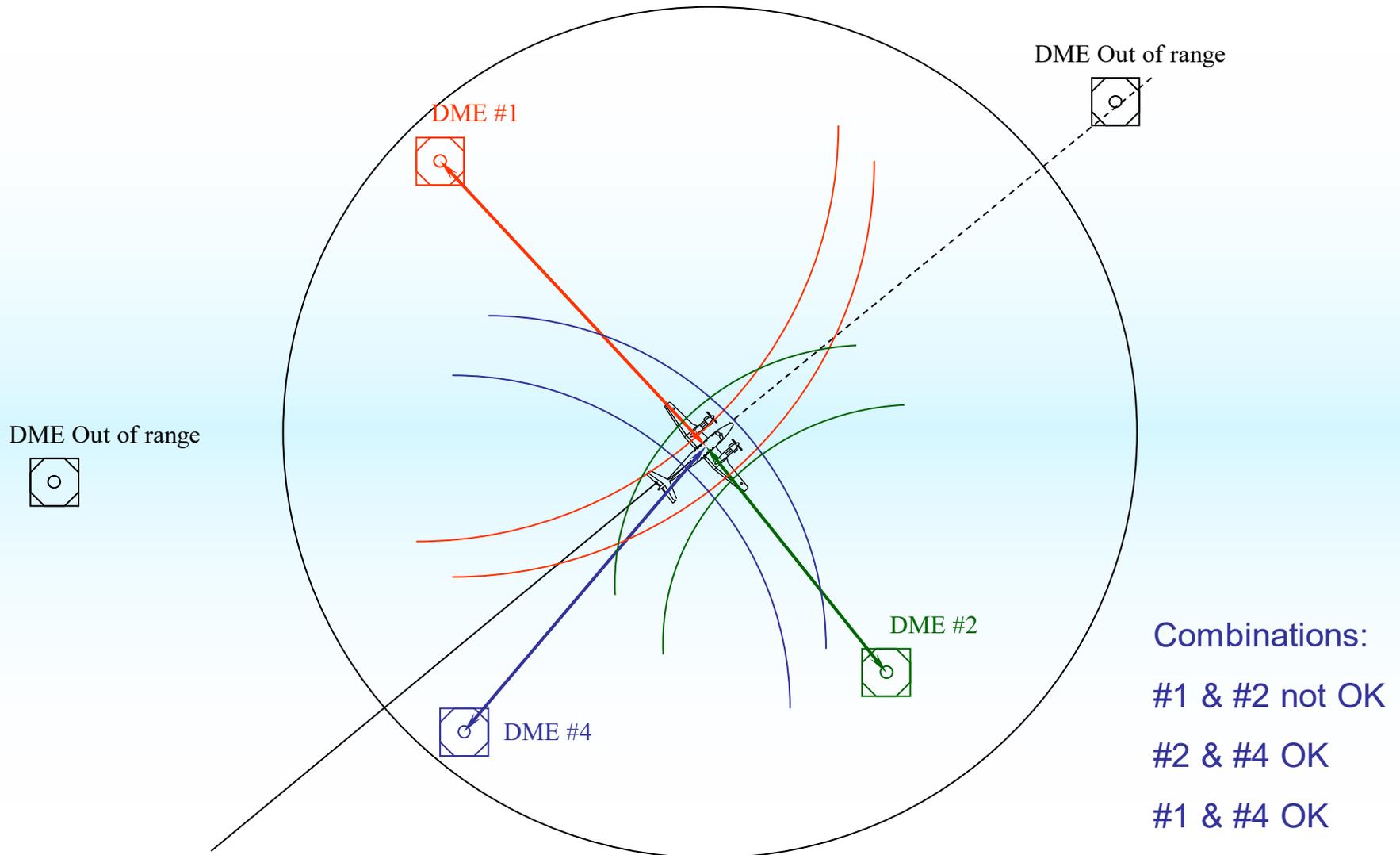
FI of DME/DME procedures

- Flight Inspection of DME/DME procedures was identified as an issue of concern for ANSP and FI providers

- Presentation of ICASC technical working group view

    - Documents
    - Implementation for a FI organisation
    - Role of FI – Principles
    - Input / Output list
    - Equipment
    - Examples
    - Recommendations

# DME/DME flight inspection Reference Documents

☞ The ITWG identified a list of documents on DME/DME Flight inspection

  (Ref. Published paper)

☞ Eurocontrol "Guidance Material for P-RNAV Infrastructure Assessment" found to be a good reference

  (Summary in published paper)

Connection between documents

ICAO PBN

Operation and
airwothiness
guidance

TGL 10

AC 90-100A

FMS MOPS / MASPS

ED-75B

RTCA 208

DOC 8071

Eurocontrol
guidance

FAA 8200

State regulations or Flight
inspection instructions
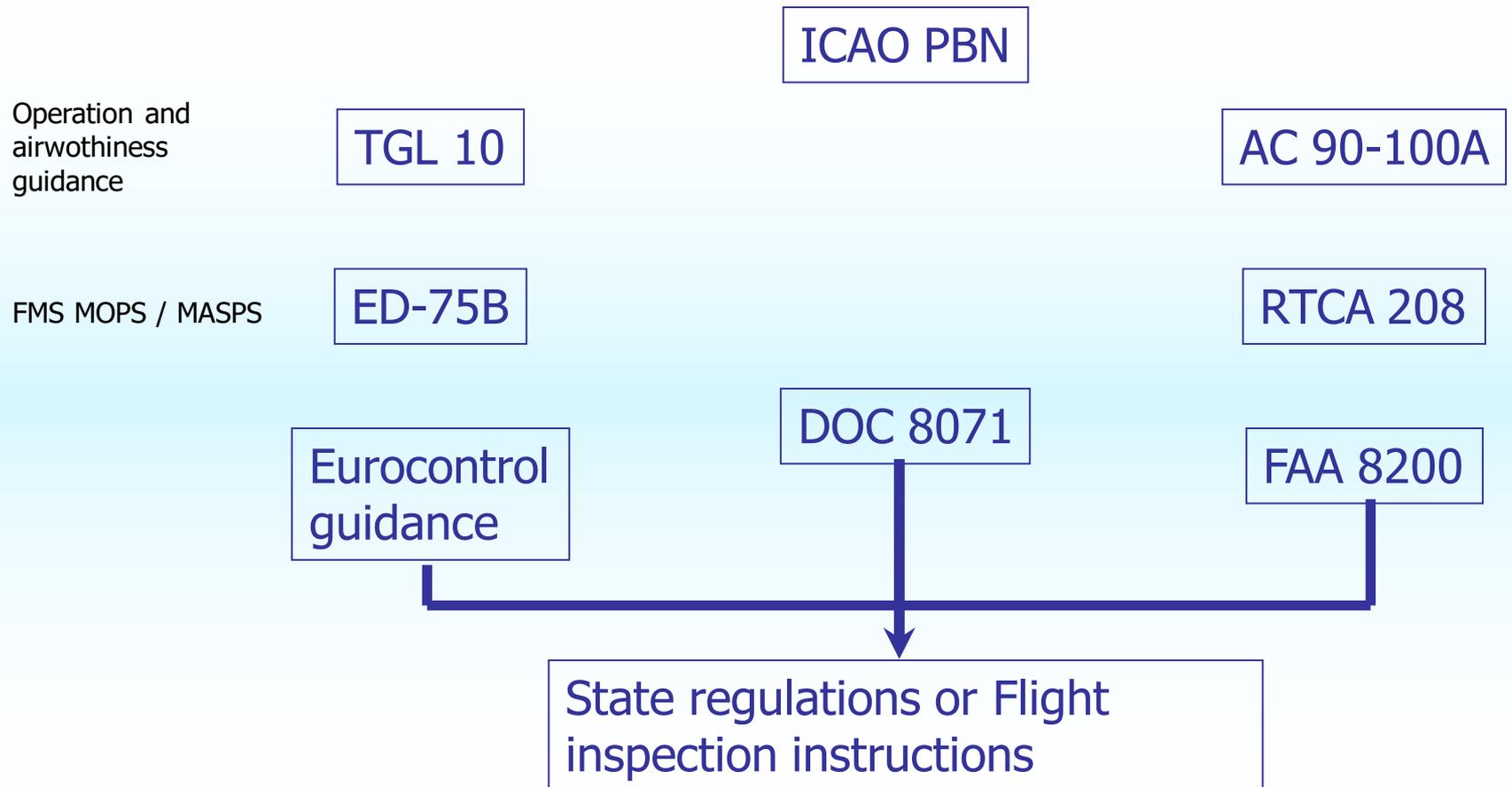
Procedure design process

Responsible party	Process step	Notes
Procedure Design Office/ Procedure owner/ Navaid Engineering Office	Collate data concerning navaid infrastructure, obstacles and aerodrome	*Supplied by approved surveyor/ airport/ government department*
Procedure Design Office	Design procedure	*Close cooperation with Navaid Service Provider and Users*
Procedure Design Office	Conduct independent review of design and check flyability if design is non-standard	*May be done by a third party*
Procedure Design Office/ Procedure owner/ Navaid Engineering Office	Collate and check data to be issued to flight inspection organisation	

Define Inputs

Flight inspection organisation	**Conduct Flight inspection**	***See also ICAO Doc 8071***

Define Outputs

Procedure Design Office/ Navaid Engineering Office	Analyse flight inspection report. Re check flyability if necessary	*Mainly for navaid coverage but may also address obstacle assessment and flyability*
Procedure owner/ AIS/ Regulator	Obtain approval for publication	
Procedure owner/ AIS/ ATC/ Procedure Design Office	Publish procedure and monitor operational application	

Input list

- **Required**

  - Identification of critical DME's

  - Intended procedure (WP data and position of DME's)

  - List of DME's that are part of the procedure design

  - Identification of facilities that are to be used outside of their currently defined operational volumes

- **Desirable**

  - Predicted coverage of DME's to be inspected

  - Consideration of expanded service volumes

  - List of restrictions applicable to the DME's under inspection

  - Review of existing DME Flight Inspection records

Output list

- Required
  - Basic DME accuracy
  - Signal in space, peak power pulse density
  - Operational (designated operational coverage, consideration of Extended Service Volume)
  - Critical DME performance
  - scanning or individual fixed mode
  - Potential DME interference
  - Feedback to Procedure designer
  - Notification of any DME that causes the PEE to exceed tolerance

- Desirable
  - PEE for measured sample
  - TSE for measured sample
  - Location of DME unlocks
  - DME/DME or DME/DME/IRU
  - Flyability
  - Validation of DME/DME modelling
  - Comparison of FMS vs Flight Inspection System

Important issues for DME/DME

Software tool highly recommended :

- identify individual qualifying DME facilities

- determine which DME are within line of sight

- define all possible combinations of pairs at each point usable by
  FMS   (3NM≤range≤160NM, angle ≤ 40°) :

- evaluate the subtended angle (30° ≤ α ≤ 150°)

- calculate the PEE (must be ≤ 0.866)

- identify critical DME

Flight Inspection Role

- Confirm :
  - signal in space compliance with ICAO Annex 10
  - initial assessment made by the software tool

☞ It is generally sufficient to flight inspect the procedure on the defined path at the lowest published altitude

☞ It is not necessary to flight inspect the totality of the procedures if the number of suitable DME's are sufficient

☞ According to experts experience and previous results, some flight inspection may be omitted or indeed increased

Flight Inspection Equipment

- It is recommended to use a Flight inspection equipment with the capability to record multiple DME simultaneously and accurately

☞ Independent single channel transponders

Record Signal in Space and range errors

☞ Scanning DME transponders

Record range errors only, use lock status for analysis

☞ Spectrum analysis of the entire L band

Record Signal in Space and assess multipath

Eg: Nice P-RNAV DME/DME SIDs

Ex: Nice P-RNAV DME/DME SIDs
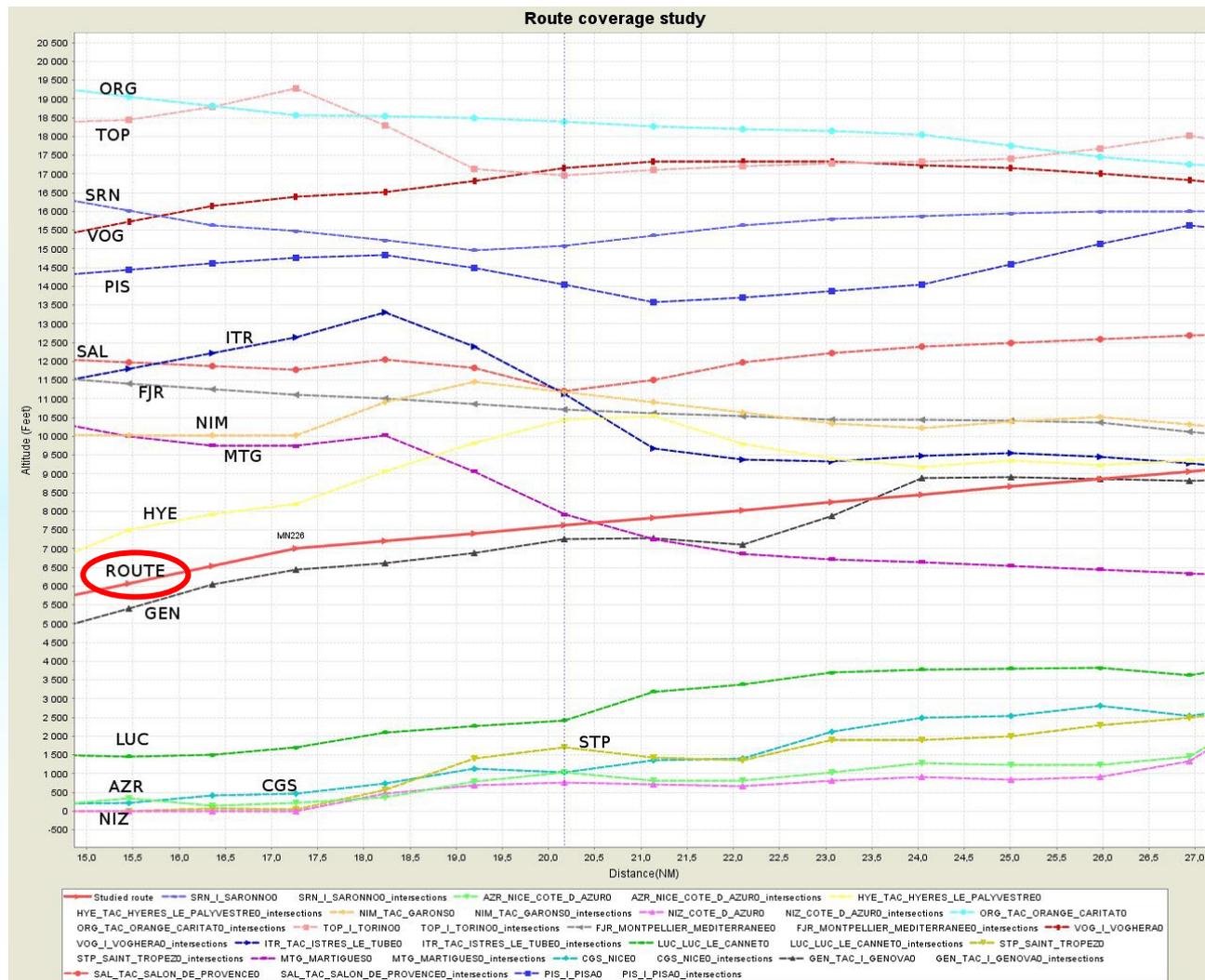
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Predicted Coverage

Predicted loss of < 3 DME's at this point
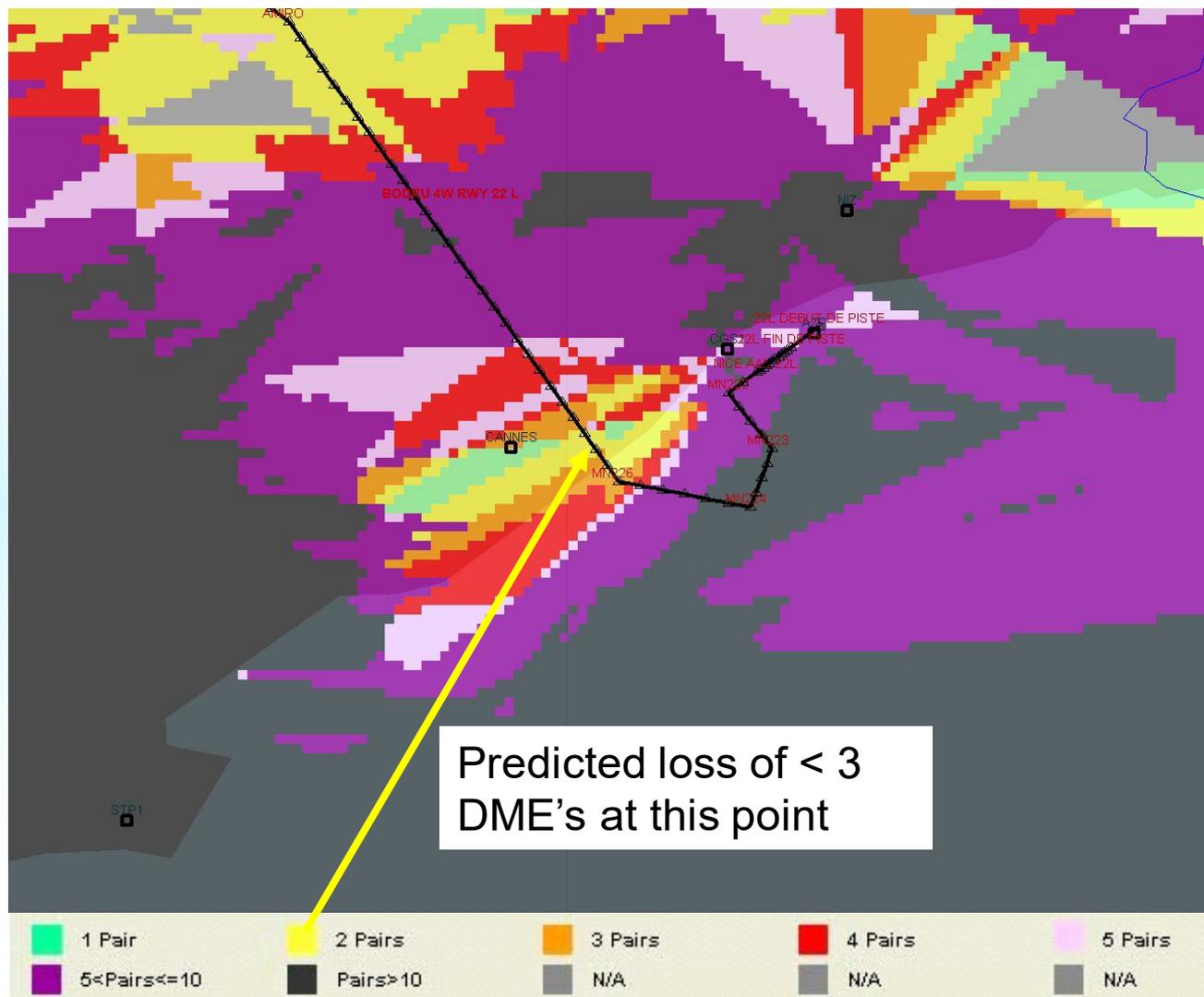
Actual Coverage after flight
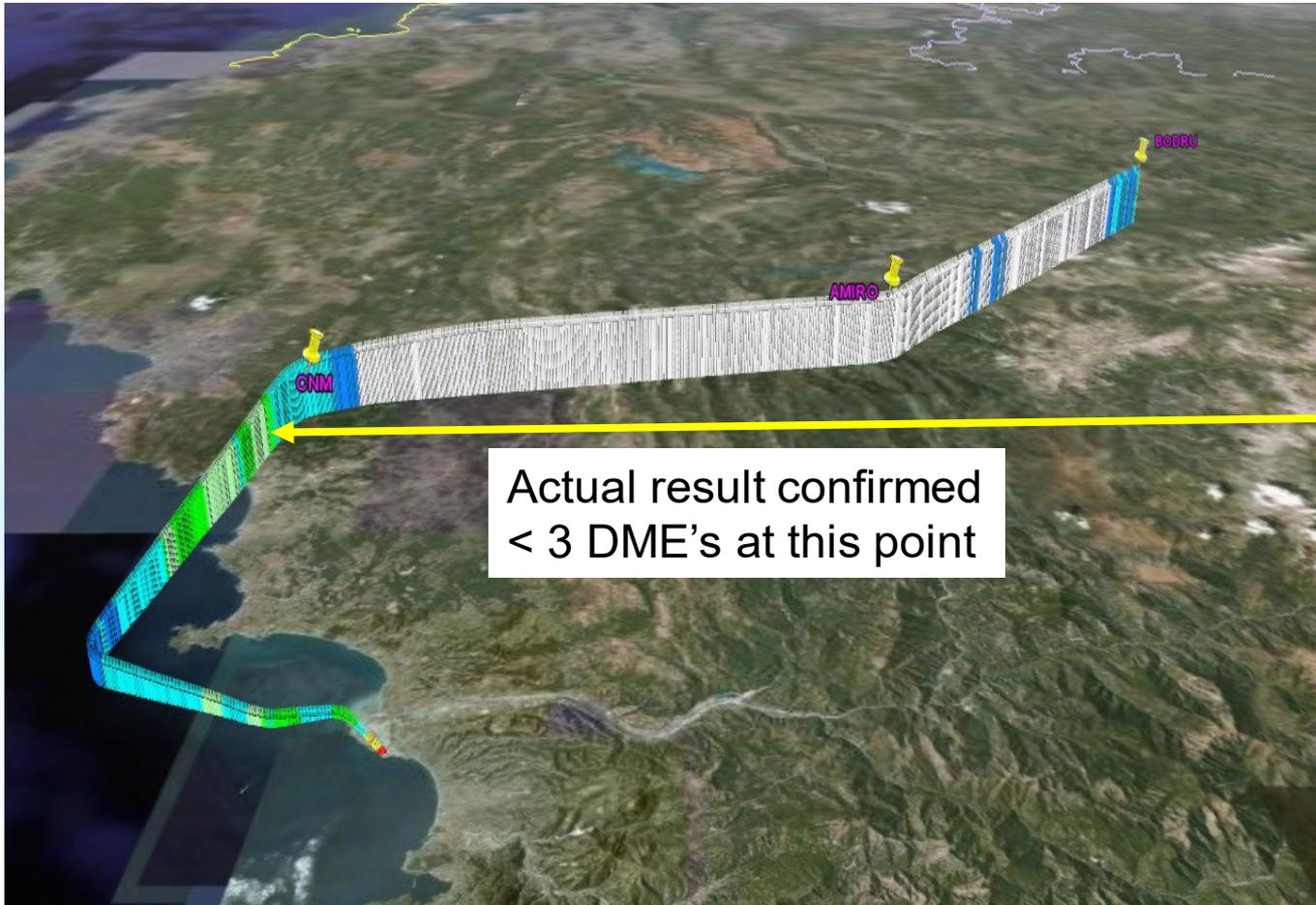
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A few recommendations

- When commissioning R-NAV procedures it is prudent to:
  - Check the "real world"
  - Detect potential interference

- Clearly define the boundaries of FI
- Use modelling techniques to reduce flying time (using a validated model)

- Consider the content of Eurocontrol P-RNAV, FAA 8200 and DOC 8071

Conclusions

- Use of DME/DME RNAV procedures are increasing throughout the World

- The ICASC paper presents some guidance to standardise the methods and processes used to check those procedures

- No further detailed work on this subject is planned for the ITWG, however……

Thanks for your attention !