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

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Reminder

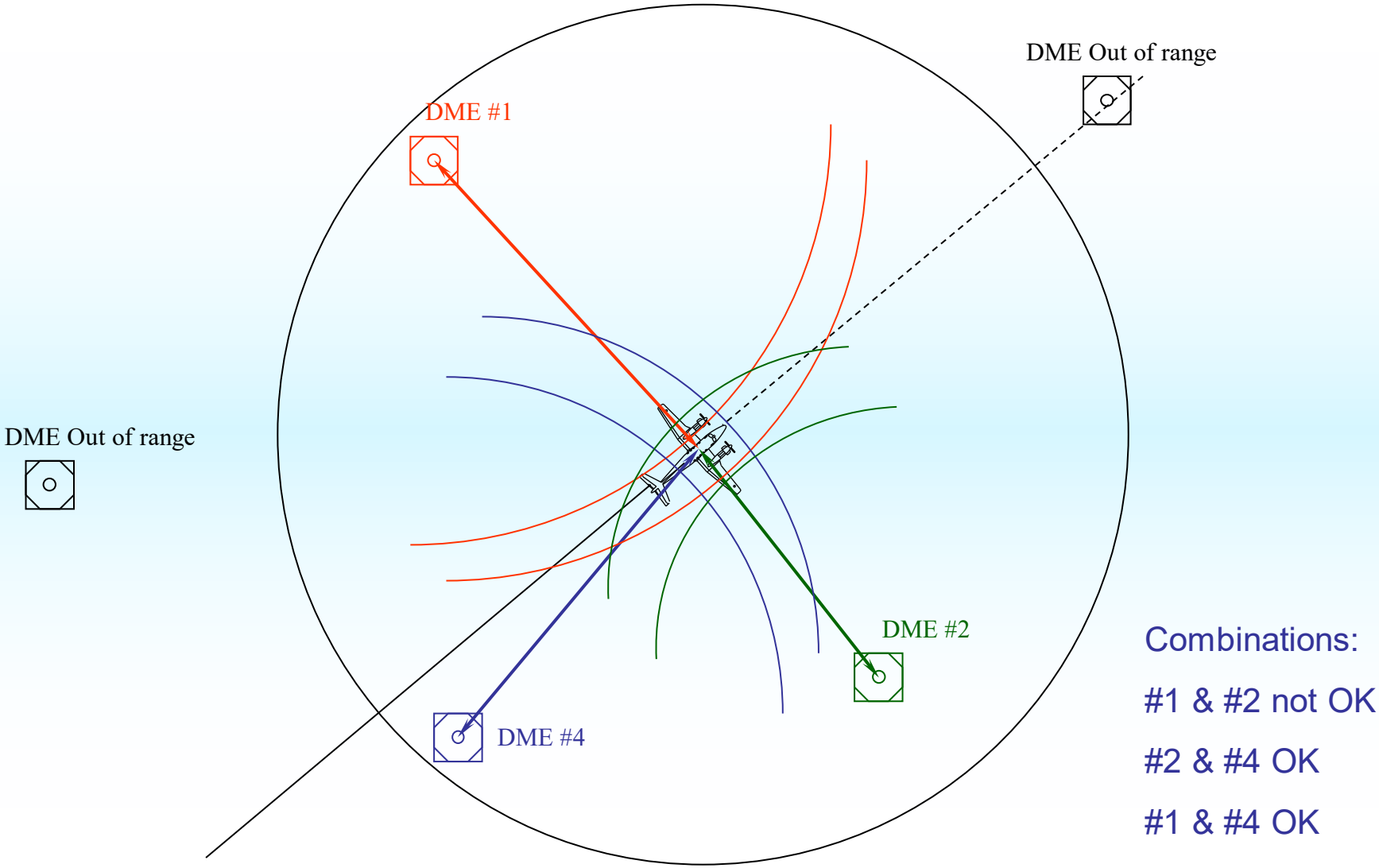
In addition to traditional applications, avionics have been developed that can interrogate multiple DME enabling determination of aircraft position:

• 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



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

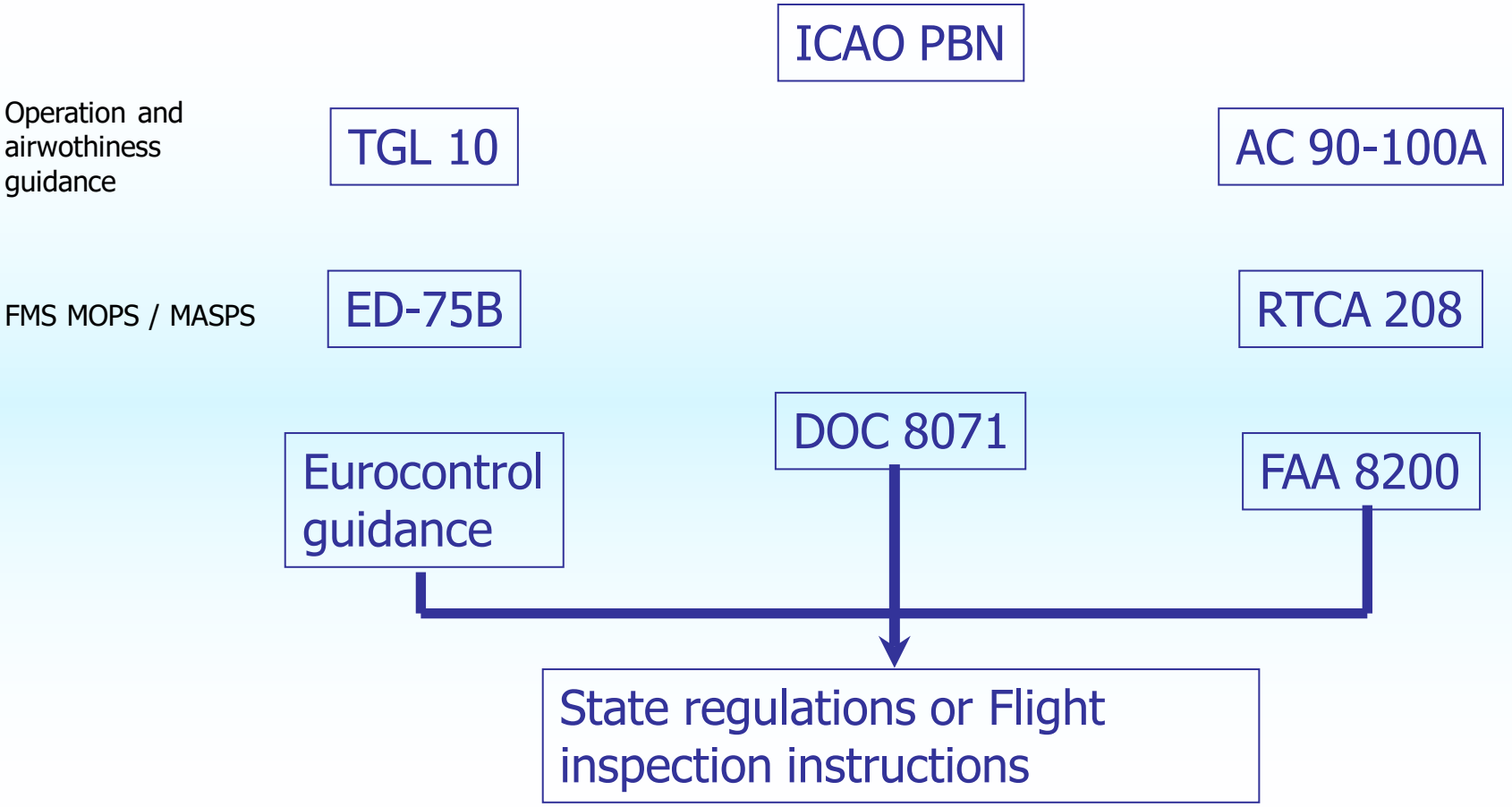
- The ITWG identified a list of documents on DME/DME Flight inspection

  (Ref. Published paper)

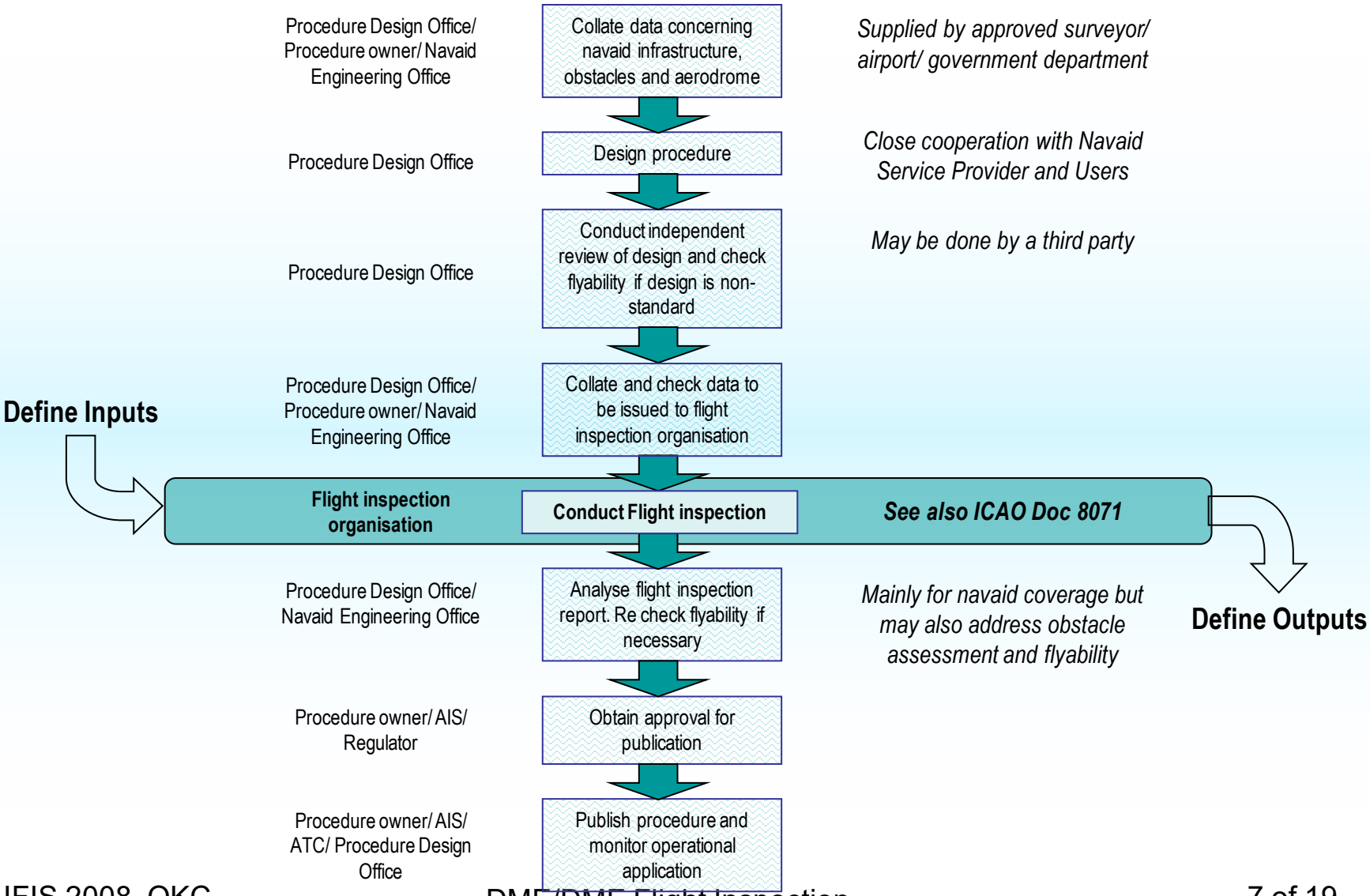
- Eurocontrol “Guidance Material for P-RNAV Infrastructure Assessment” found to be a good reference

  (Summary in published paper)

Connection between documents



Procedure design process



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

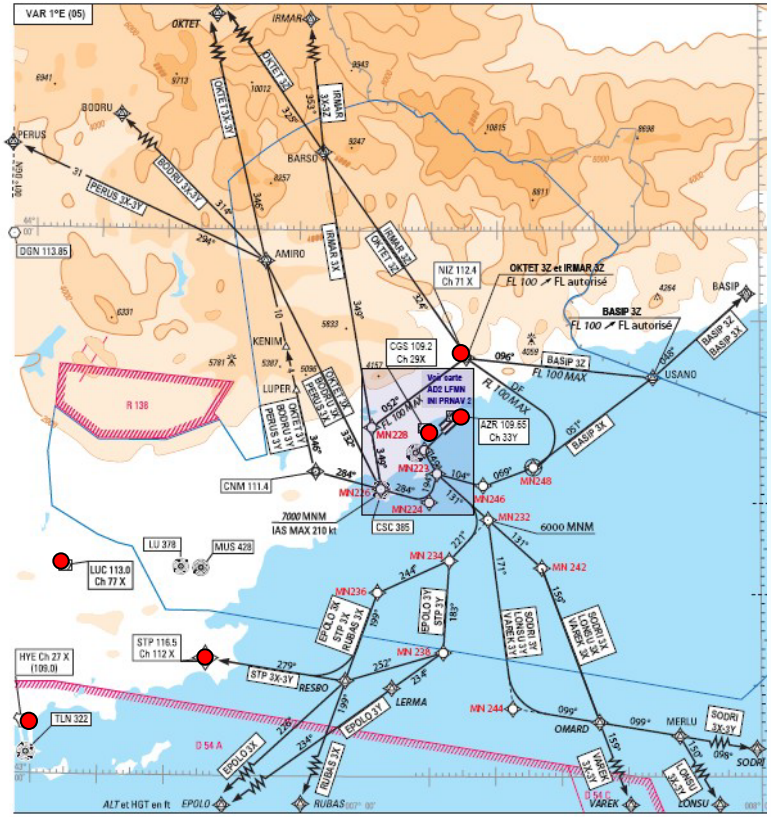
☞ Spectrum analysis of the entire L band

Record Signal in Space and assess multipath

Eg: Nice P-RNAV DME/DME SIDs

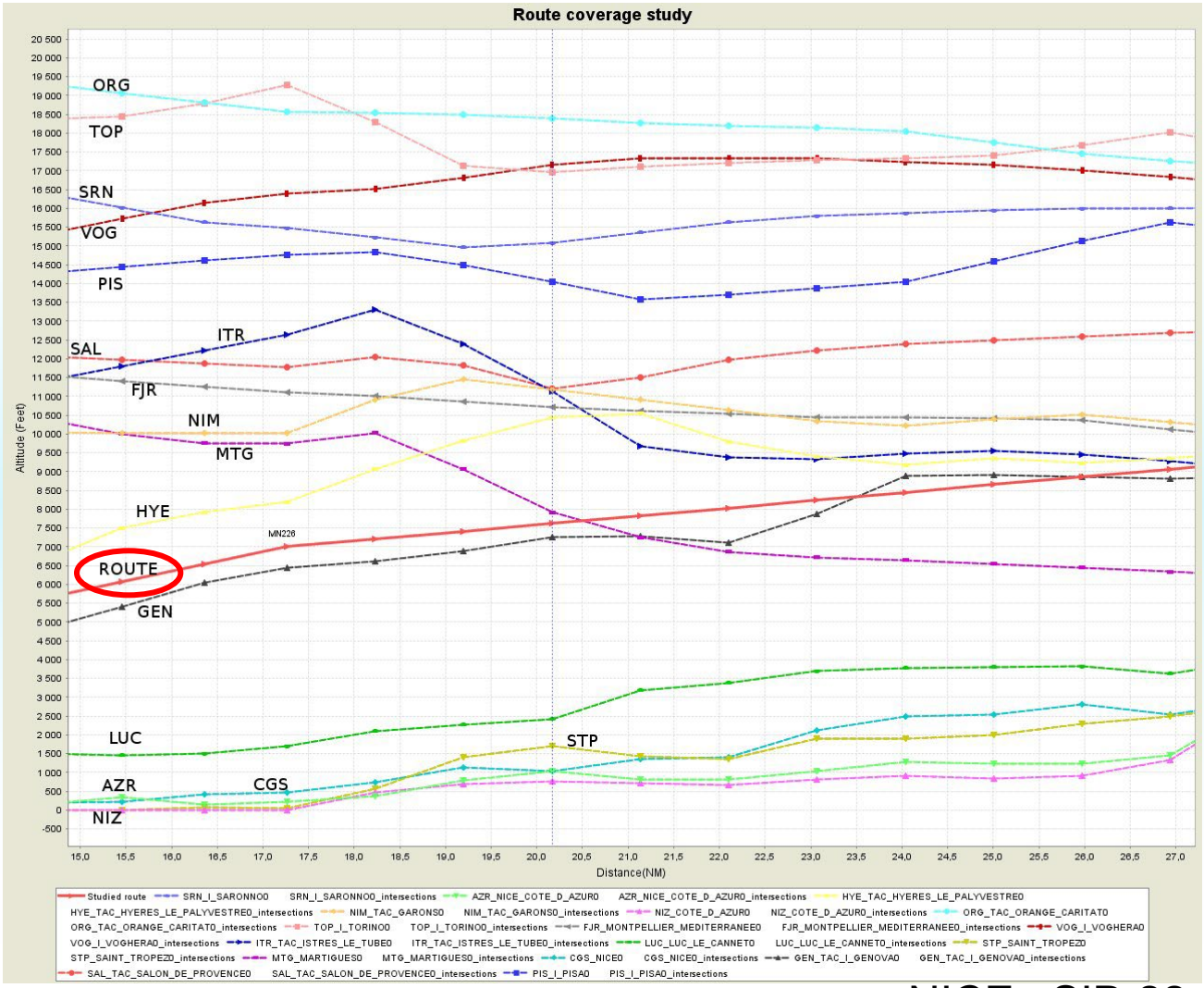
AD2 LFMN SID PRNAV 2
xx aaa xx

NICE COTE D'AZUR
SID PRNAV RWY 22L/R
(Protégés pour CAT A, B, C , D)



SNA SSE - Programme Espace
et Procédures
SID RNAV LFMN - V3 26 nov 2007

Ex: Nice P-RNAV DME/DME SIDs



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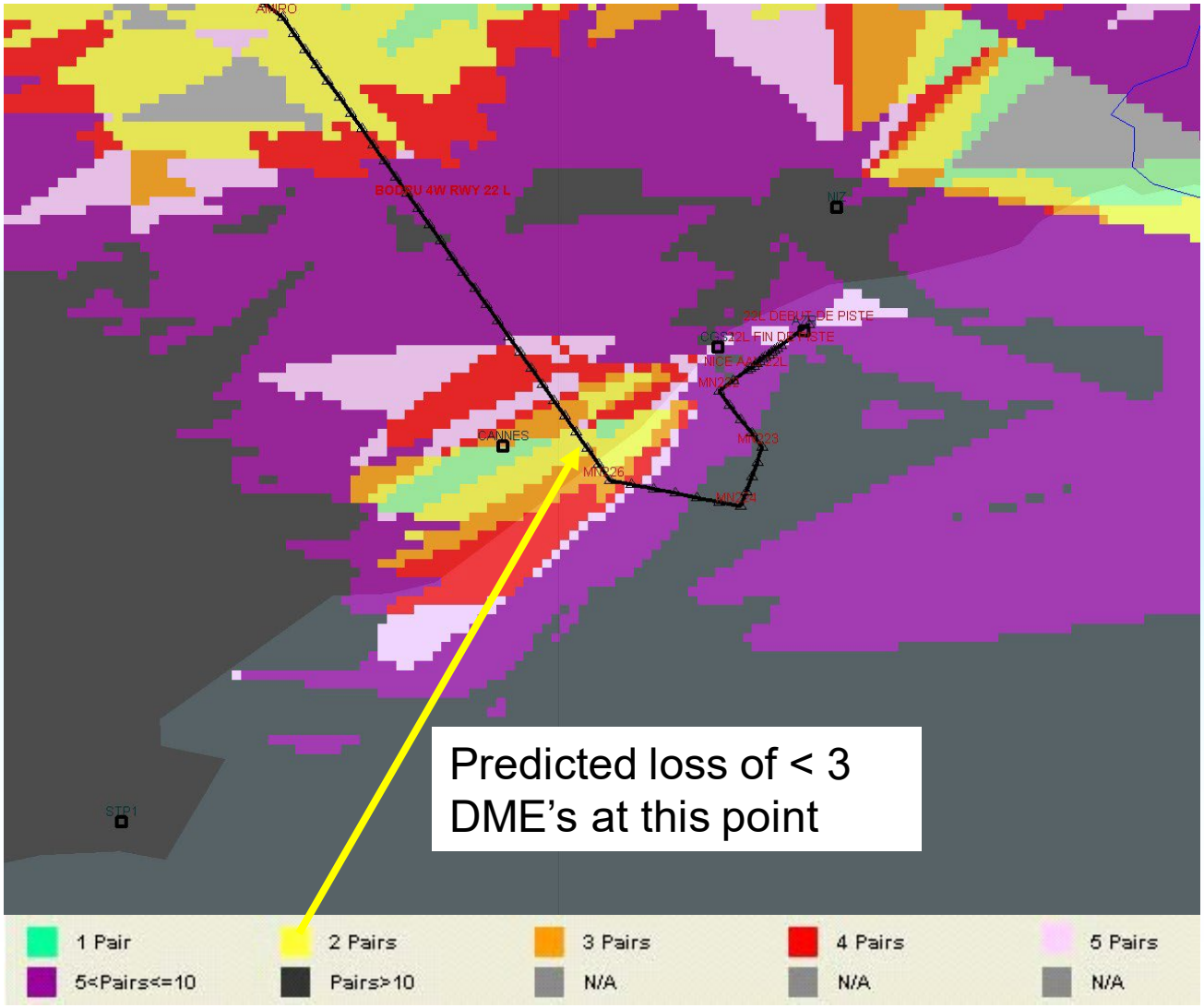
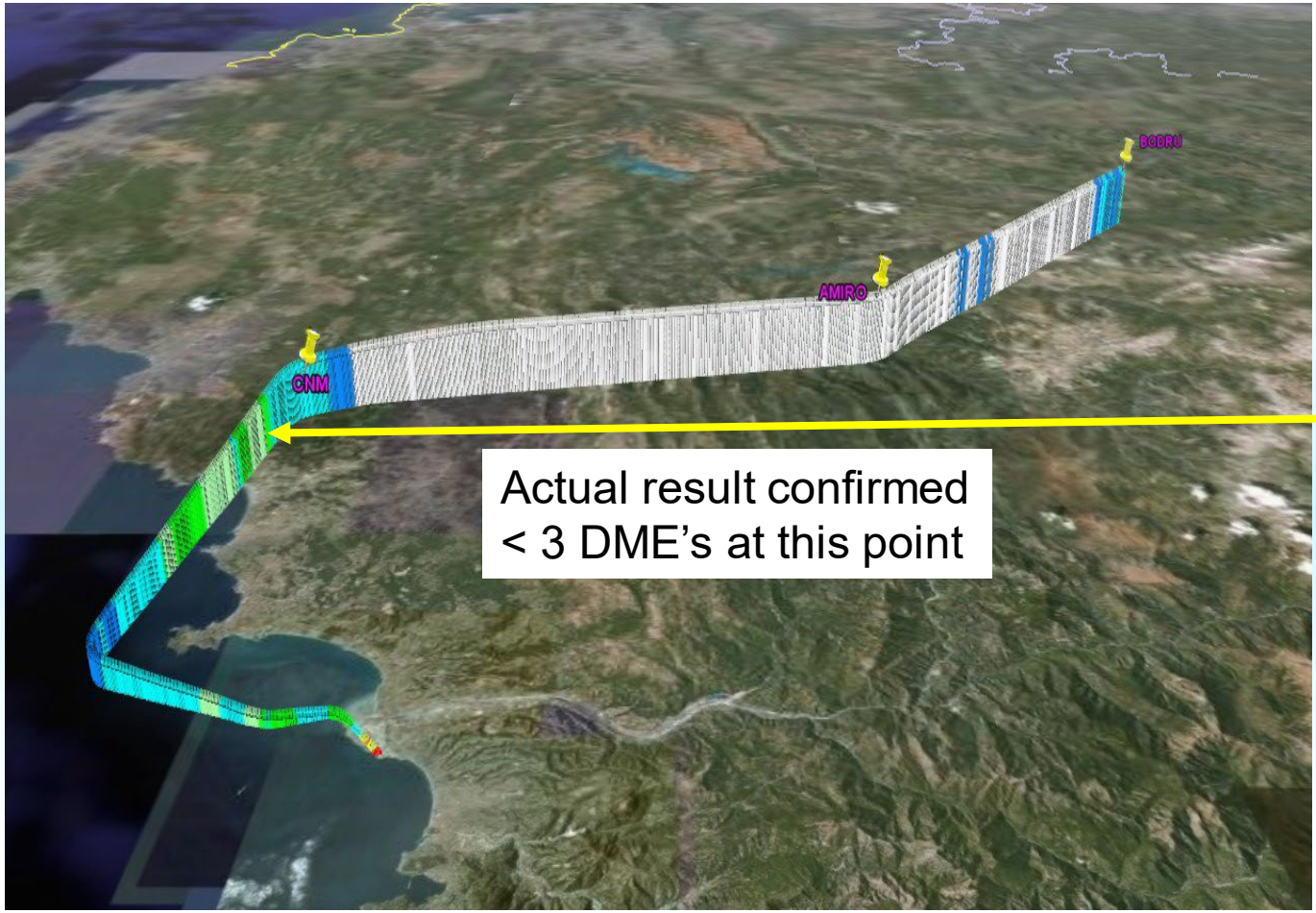
Predicted Coverage



Actual Coverage after flight



COULEUR	Nombre de paires de DME
	0
	1
	2
	3
	4
	5 à 8
	9 à 11
	>= 12

NICE : SID 22

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 !