International Flight Inspection Symposium

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The support of analysis tools to flight inspection activities

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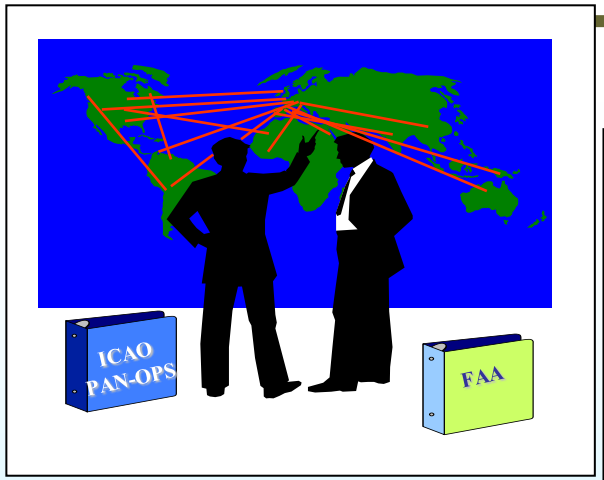
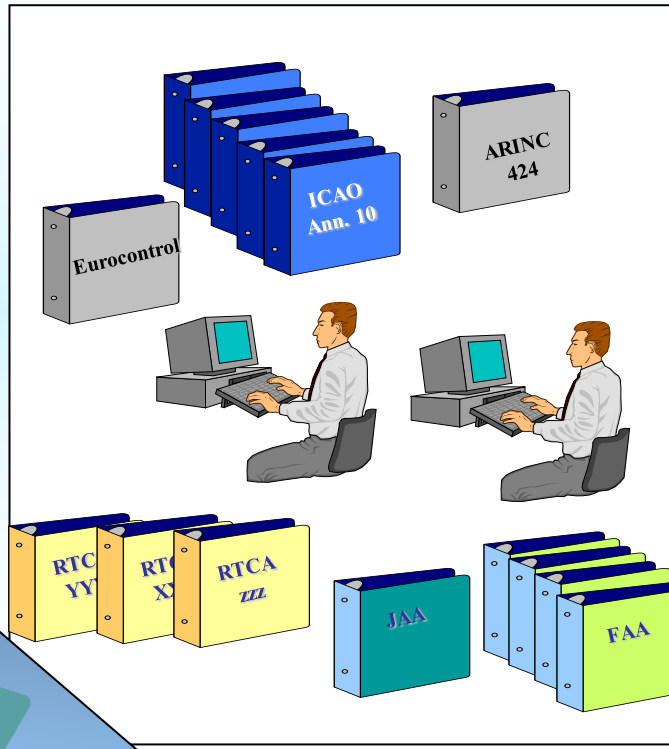
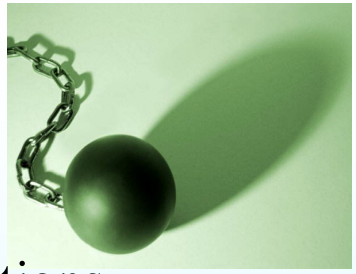
Introduction





Introduction (cont.)



Restrictions

Low flexibility

Constraints

classical use of the ground based radio-navigation aids

Not only good news, but also …

… new challenges and increased complexity

Area Navigation

Industry/Criteria Requirement

- Today's safe Nav procedures rely upon their reference to fixed ground Navaids
  - This cannot be assumed in future applications
- Recent RNAV safety cases highlighted risks and hazards associated with poor data quality
- Today's data integrity performance is far from that specified by ICAO.
  - ICAO requirements not met
  - No differences filed.
- Area Navigation and the potential to apply GNSS together depend ENTIRELY upon data quality.

Challenges

- **Interoperability and collaboration** is a key to the future ANS ORG
- Is reliant on
  - with data of the required content, quality & timeliness
  - **The right digital info, right place, right time**
- AIS is introducing ISO9001-2000, but for most it is process only
- What is required is the fixing of the process of "origination to publication",
- The co-operation of all actors in the data processing chain is fundamental and IDS actually have a proven solution to this requirement

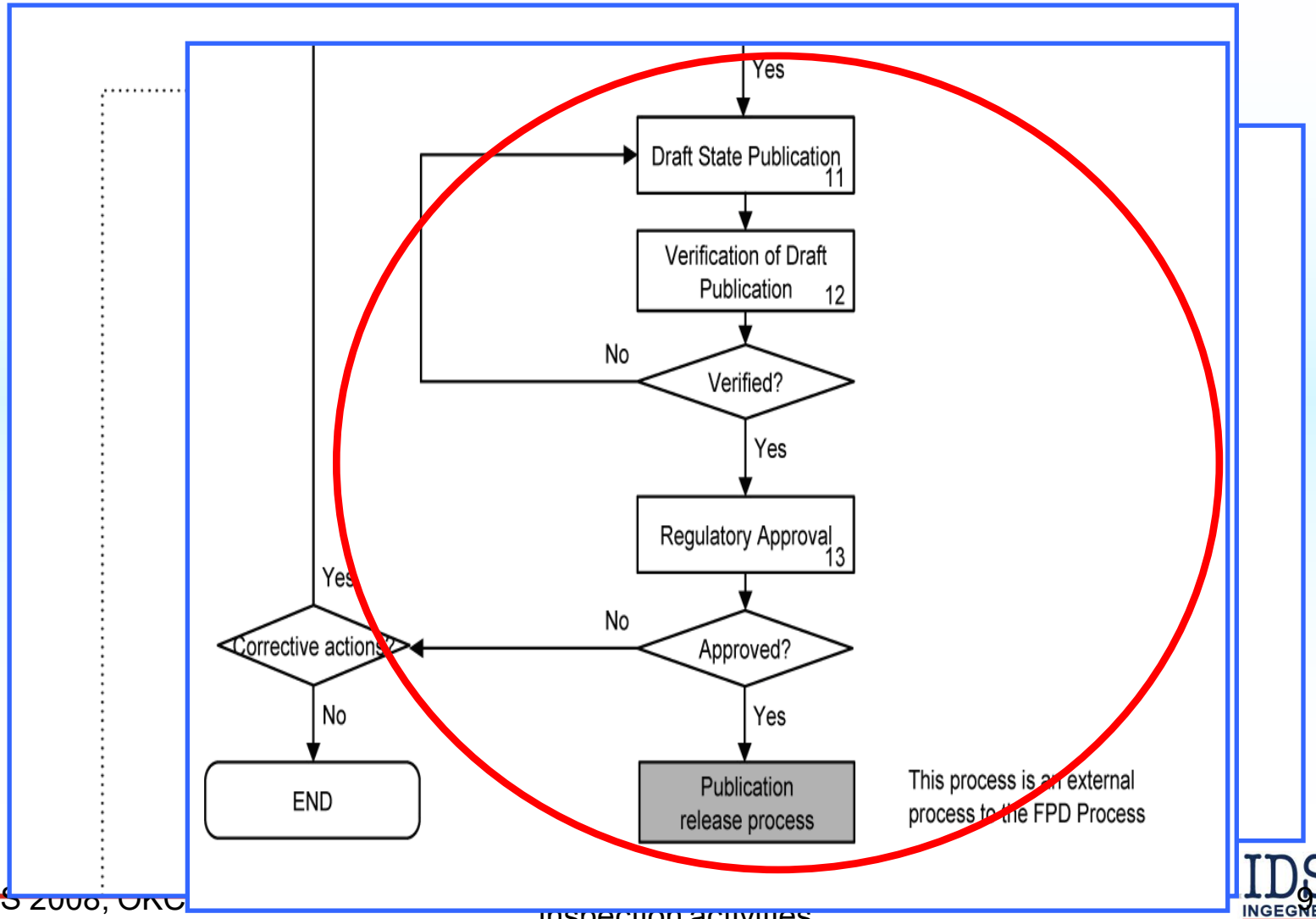
RNAV REQUIREMENTS

ICAO state in the “Flight procedure design Manual” (released in Q3 2008) that the procedure design process consists of different steps:

- Requirements and data collection
- Design and first ICAO rules checks
- Pre-Validation
- Flight check
- Publication

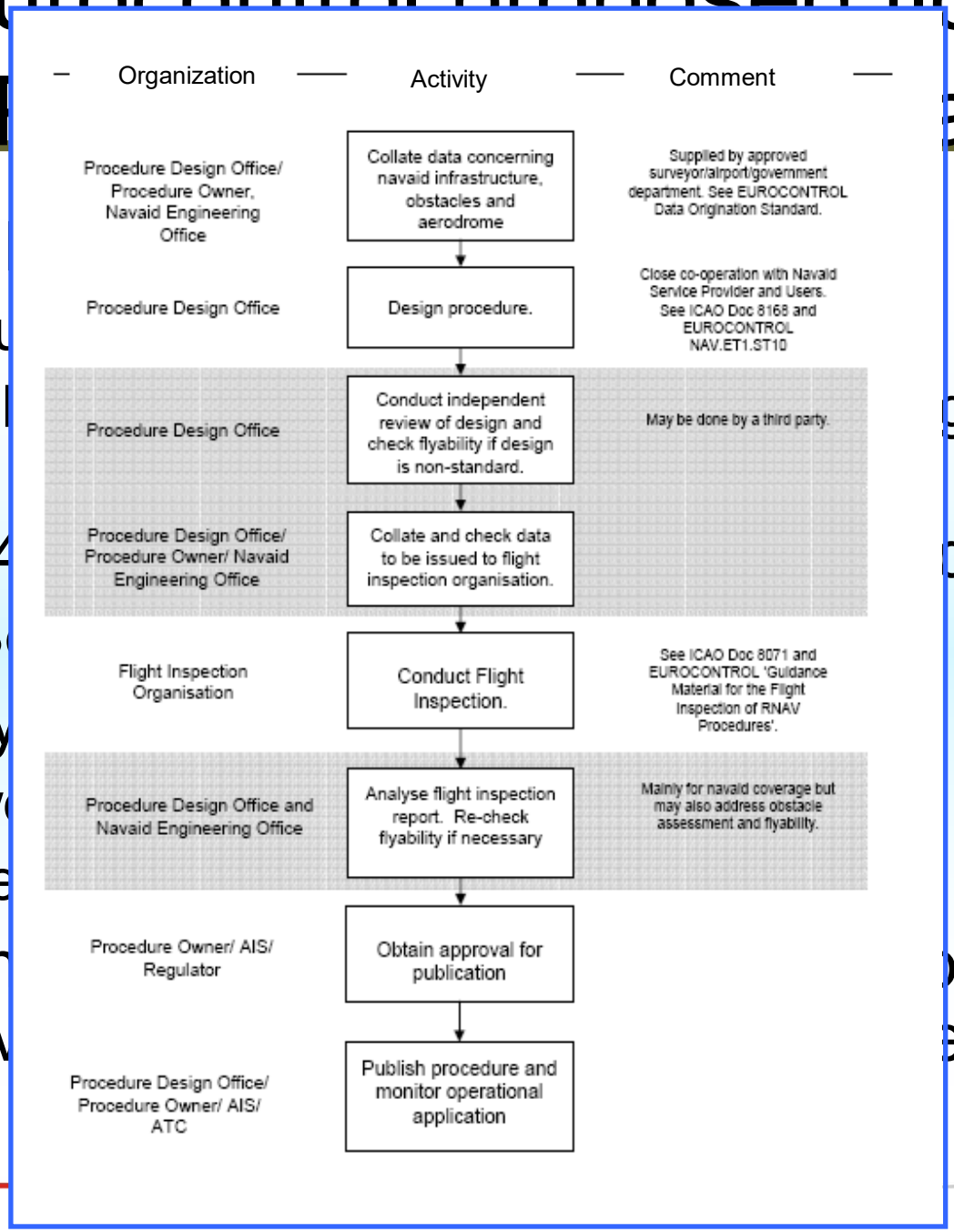
Eurocontrol stated in the “Guidance Material for the Validation of RNAV Procedures” the main steps to be performed in validating RNAV procedures

The ICAO proposed flow for the Procedure Design Quality

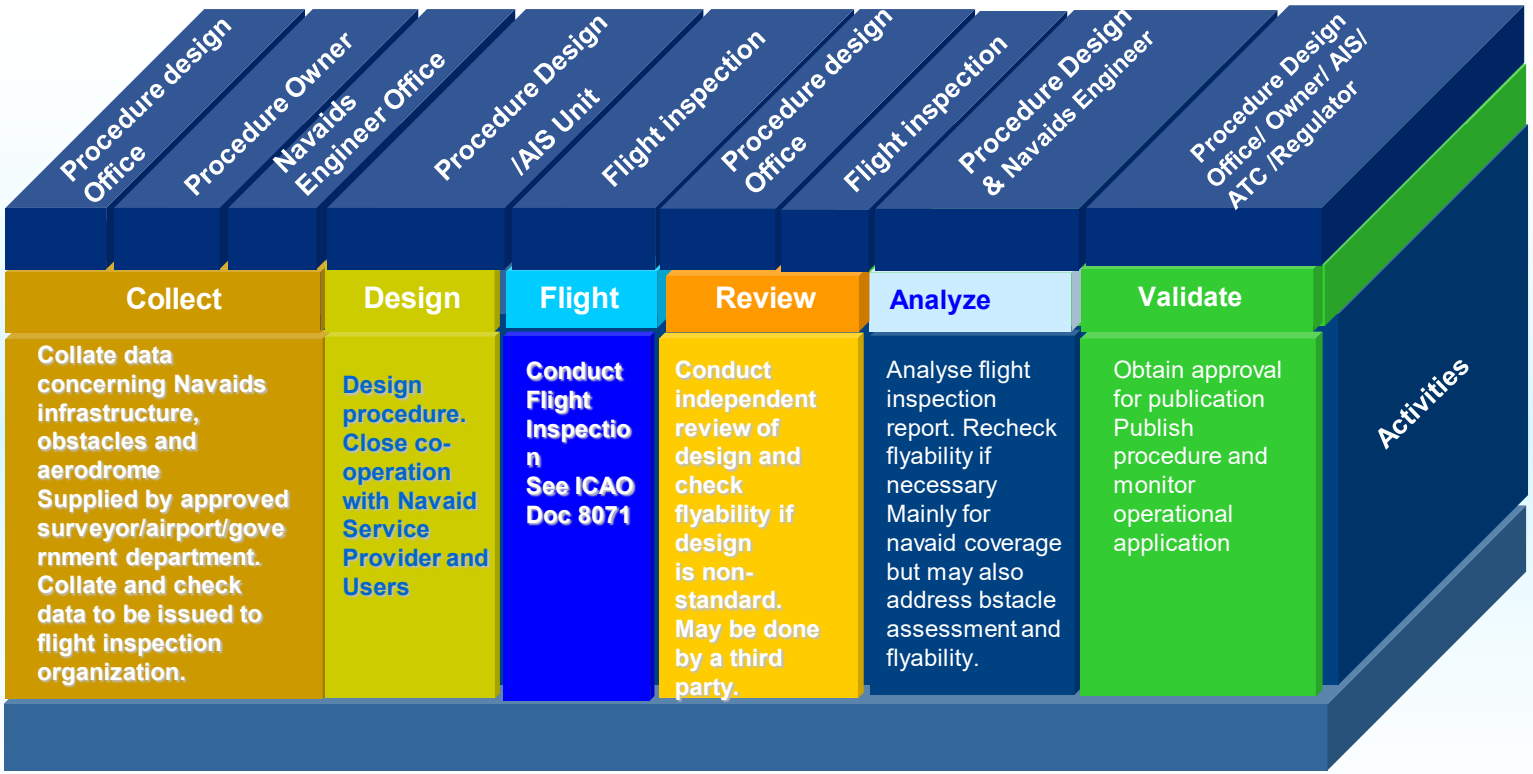


The Eurocontrol proposed flow for the I ality

- ICAO ru
  - Minimu
  - MCA (gradients, etc
- ARINC 4 dure
  - P&T S
- Flyability
  - Max w
  - Tempe
- Signal in le DME/DM etc)



Eurocontrol Guidance Workflow



New design challenges from RNAV navigation

GNSS related topics (*from ICAO, 2007, Manual on Testing Radionavigation Aids doc. 8071, volume II, Testing of Satellite-based Radionavigation Systems, chapter 1*):

- GNSS analysis
- geodetic survey
- GNSS monitoring
- Record keeping
- availability of prediction SW
- GPS selective availability

New design challenges from RNAV navigation PANS-OPS

DME/DME related topics (*from ICAO, PANS OPS-Doc 8168, "Procedures for Air Navigation Services - Aircraft Operations", Volume II Construction of Visual and Instrument Flight Procedures, vol. 2, part III, sec. I, ch. 3*): it's "*not possible to know which DME facilities the airborne system will use for a position update, a check should be made to ensure the appropriate DME coverage is available throughout the proposed route …*".

$$N_{DMEcouples} = \sum_{i=1}^{N-1} i \quad \Rightarrow \text{N=5} \quad N_{DMEcouples}=10$$

New design challenges from RNAV navigation – PBN -

DME/DME related topics (*from ICAO, NAVIGATION INFRASTRUCTURE ASSESSMENT IN SUPPORT OF PBN*): "Appropriate tools should be used to assess navigation infrastructure. While the assessment could be conducted using manual analysis and flight inspection, the use of a software tool is recommended in order to make the assessment more efficient.

The software tool should be tailored to allow evaluating the infrastructure in light of the requirements imposed by a specific navigation specification, such as RNAV-1.

In general, RNAV assessment tools should include a 3D terrain model with sufficient resolution and accuracy to allow predicting the line of sight visibility of navaids along a procedure service volume, including an analysis of their respective subtended angles and a variety of other geometric constraints."

New design challenges from RNAV navigation (cont.)

Procedure validation related topics: ICAO, JAA, and Eurocontrol recognize that the Flyability check is part of the quality process related to an IFP design and publication:

- Aircraft maneuvering in context of safe operating practices for the category of aircraft
- Cockpit workload
- Charting aspects
- Navigation database aspects

New design challenges from RNAV navigation – Annex 15

Data integrity related topics: ICAO in Annex 15 requires the "*Contracting States shall ensure that integrity of aeronautical data is maintained throughout the data process from survey/origin to the distribution to the next intended user. Aeronautical data integrity requirements shall be based upon the potential risk resulting from the corruption of data and upon the use to which the data item is put*"

The following classification and data integrity levels apply:

- routine: 1x10-3
- essential: 1x10-5
- critical: 1x10-8

New design challenges from RNAV navigation (FAA .52)

Instrument Flight Inspection data management related topics: (*from FAA Order 8240.52 "Aeronautical Data Management"*): the data must accurately reflect the references to be used in the performance of inspecting the systems supporting the National Airspace System (NAS). These data will be the references for certifying the quality of signal-in-space, and the instrument flight procedures

The IDS approach to the problem

- IDS has been involved by many years in the provision of system and services with qualified personnel

- IDS relies on advanced graphics and databases, integrating multiple data sources such as maps, photos, property records, survey and engineering data, inspections reports, traffic safety prescriptions, congestion statistics, documents, aeronautical charts.

- IDS solutions help the air transport industry to manage strategically and efficiently this information.

OSED - Methodology

Scenario Definition for Procedure Drafting

Aerodrome, Terrain, Obstacle

Defining IFP Design Constraints due to environment.

OSED (Operational Scenario and Environment Definition)

Geospatial Data, ATS Geography, Operational Data, Airport Constraints, Meteo

Defining IFP Design Constraints due to Airborne Usability of Signals in Air (ICAO Annex 10)

EMACS: Ground Based Navaids

EMACS TAMIA: potential EM interferences

EMACS ASUV: Signal Usability for GNSS and DME

FPDAM: drafting IFP for ground based and satellite based infrastructure

ENCODER: IFP ARINC 424 encoding (path terminations and WP types)

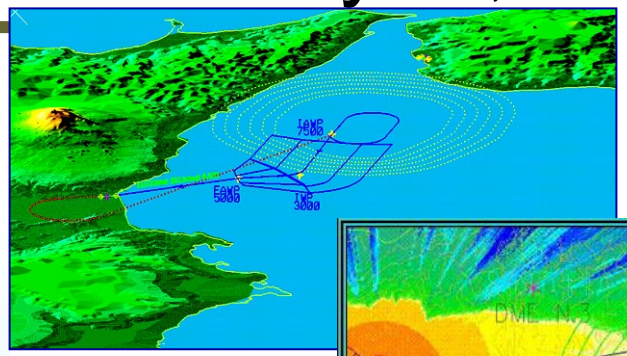
VESAS: PBN/RNAV/RNP performance prediction Pre-validation Phase Pre-Flyability Validation

AACS: Advanced Aircraft Cockpit Simulator
Pre-flyability checks
Pilots familiarization with new procedures

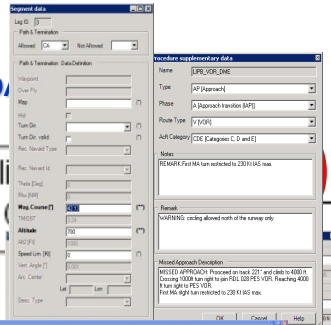
FLIPP: Flight Inspection Planning and Post Processing
Planning Mission
Data Acquisition
Combined with **VESAS** comparison between prediction and measurements

The support of analysis tools to flight inspection activities

An operational workflow from monitoring ,design and analysis, to pre-validation checks



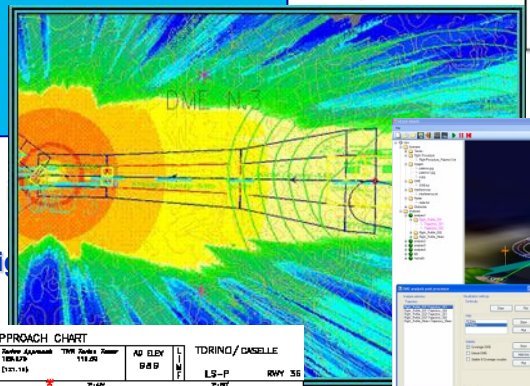
FPDAM
Procedure - SSA D



Packed database

Avionics manufacturer

All procedure



Database

EMACS
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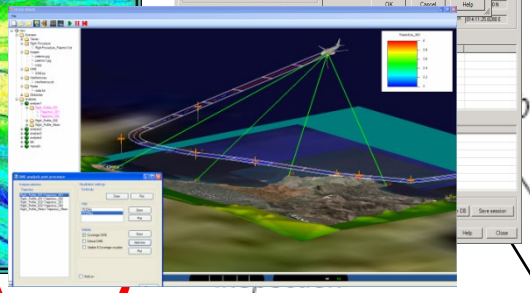

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Procedure description

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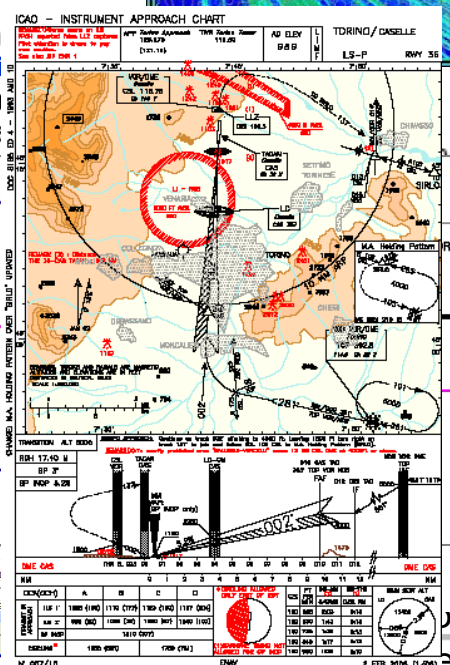

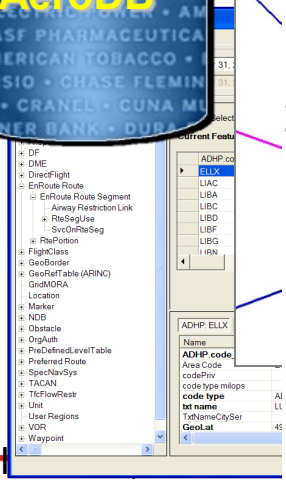

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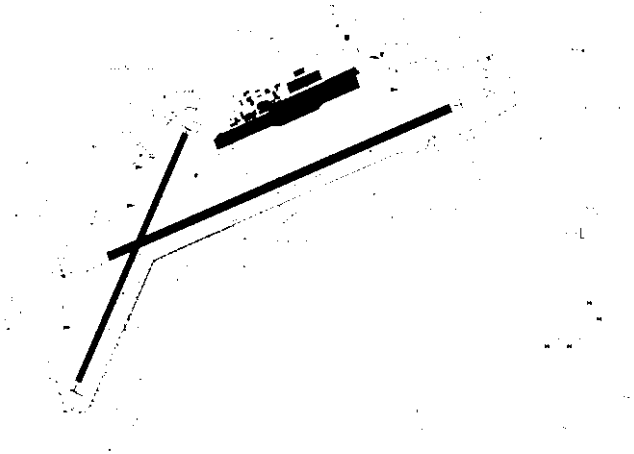
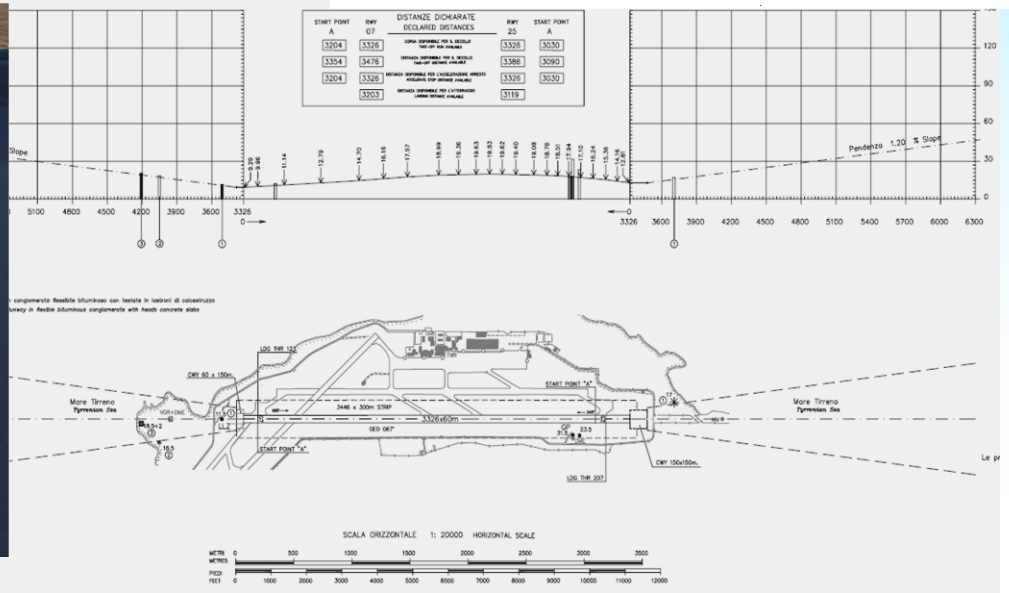
Airport Survey, Terrain & Obstacle Data Management (eTOD)

- Terrain 3D Modelling (WGS84 reference datum)
- GIS based geodetic calculations and projections
- Geo referencing Obstacles and Relief
- Airport layout
- Aerodrome ICAO type A & B Chart
- Terrain & Obstacle Database Management **e-TOD**.





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inspection activities

IDS Measurement Laboratory Services

Site Survey and Monitoring of GNSS Signals

Measurement Laboratory Services
GNSS Monitoring Station for Airports

Dual Frequency GPS antenna

GPS Receivers /splitters

Reference Oscillator

Spectrum Analyzer to monitor Interferences

Control PC

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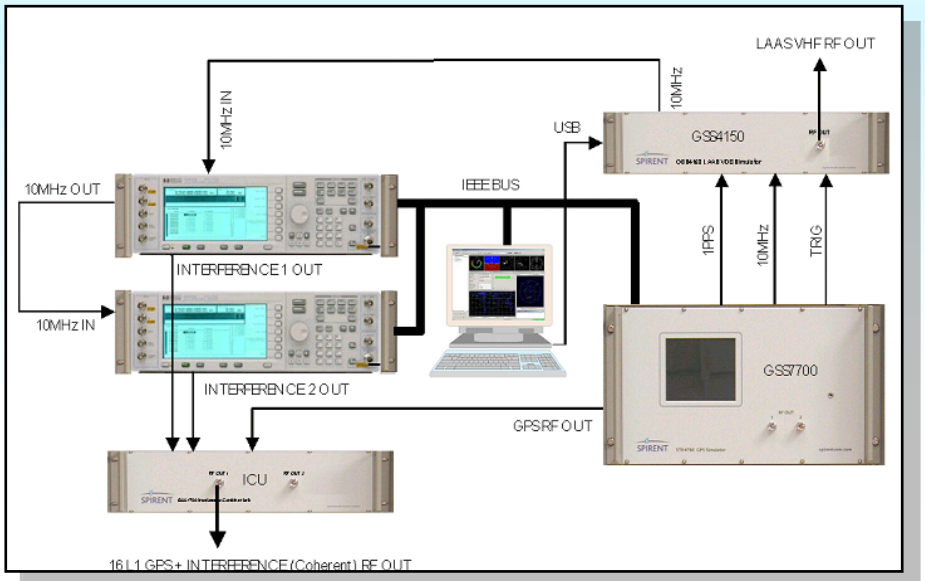
Measurement Laboratory

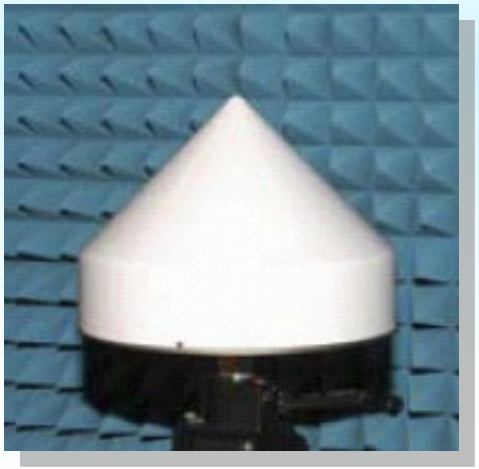
Instrumentation for setting up GNSS monitoring stations

IDS Signal simulator of L band signal as received from a simulated GNSS satellite constellation

GNSS signal Simulator



GPS Receiver



Antenna

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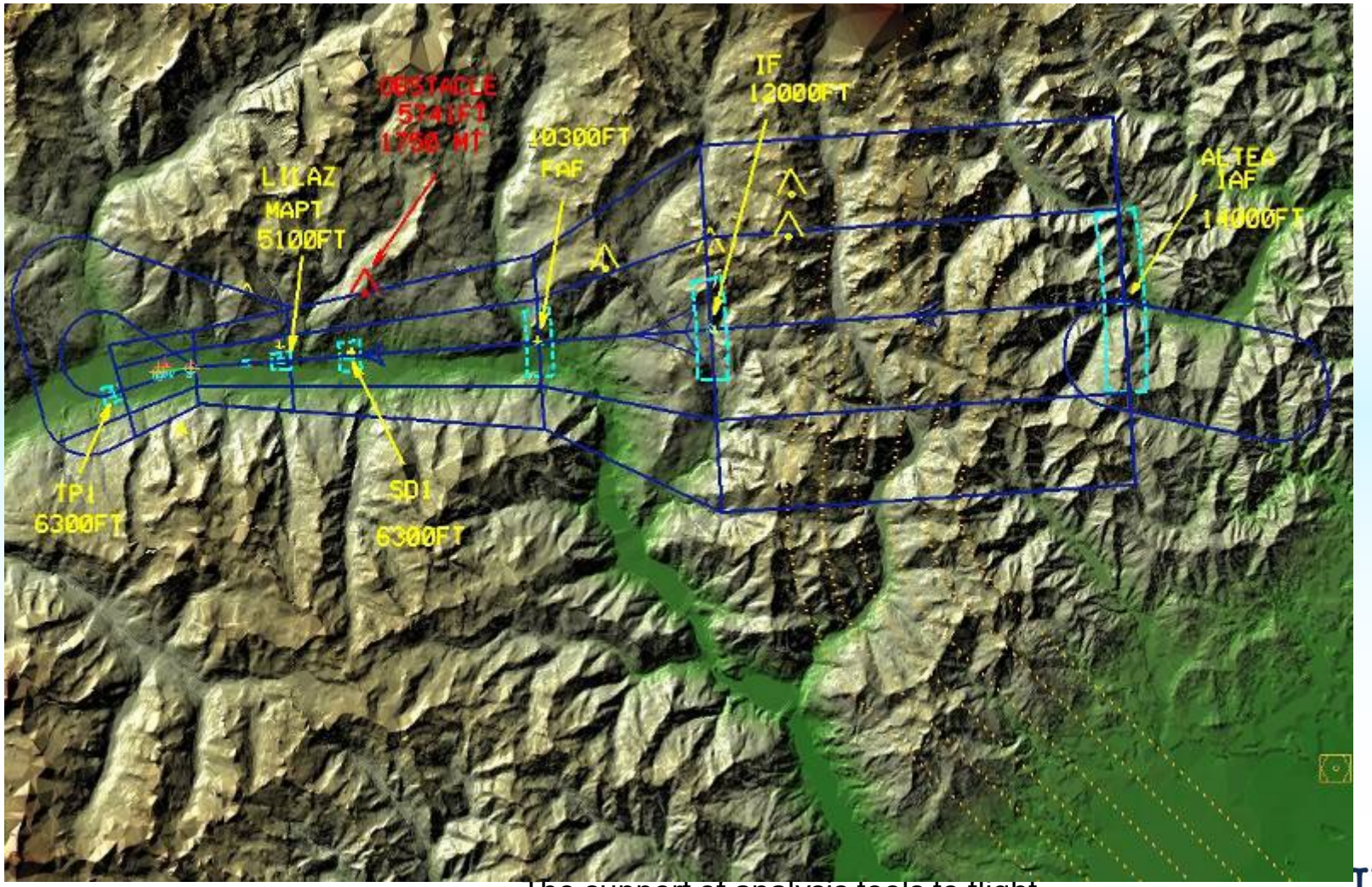
Procedure Design - FPDAM



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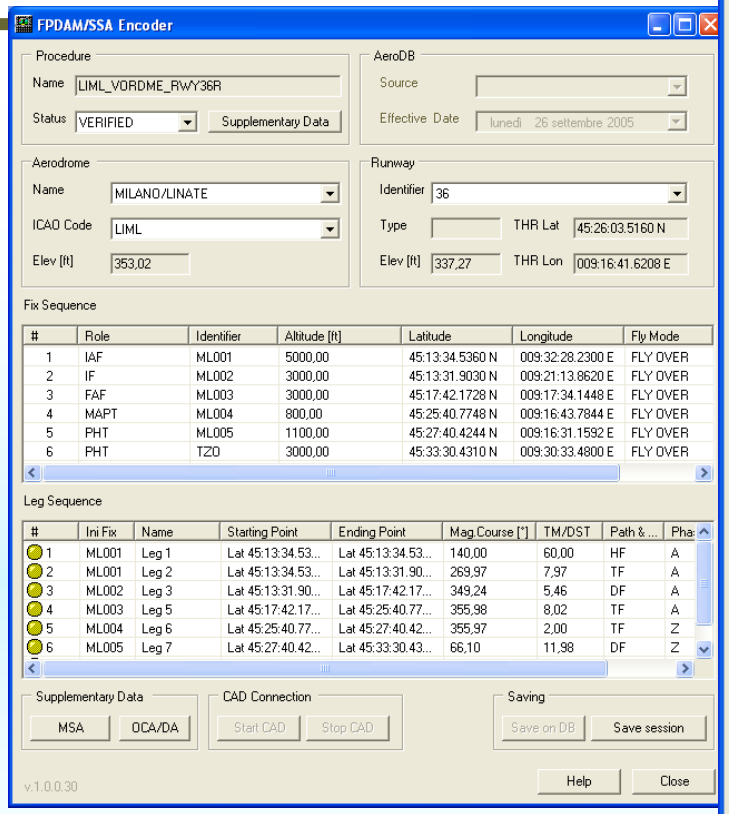

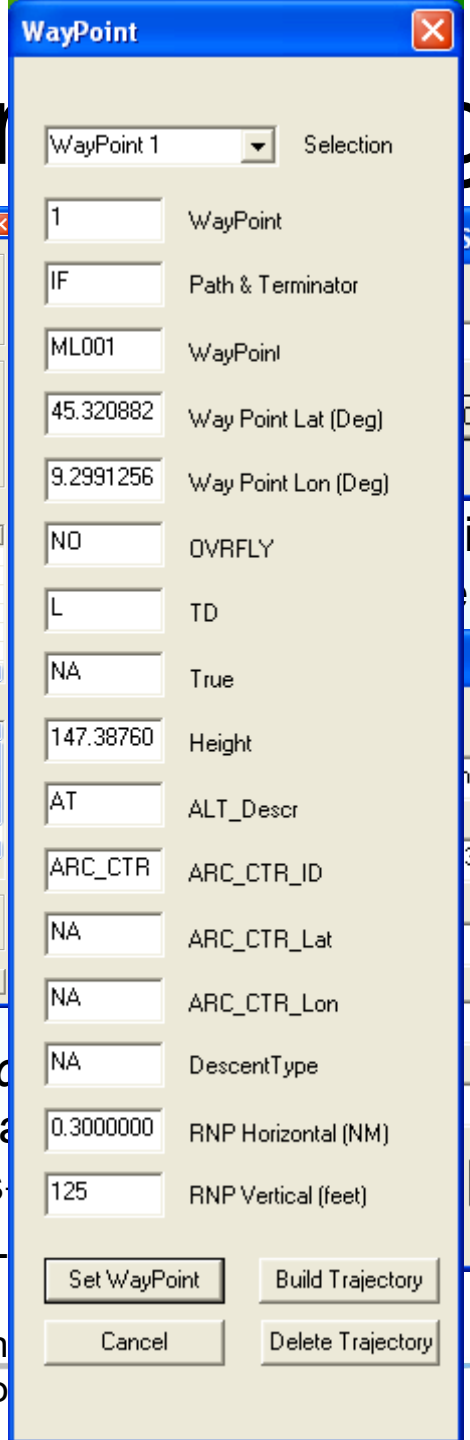

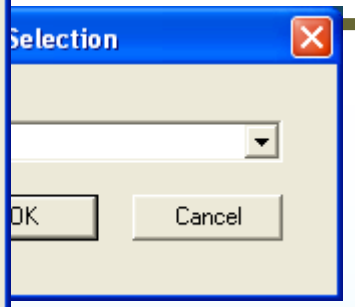

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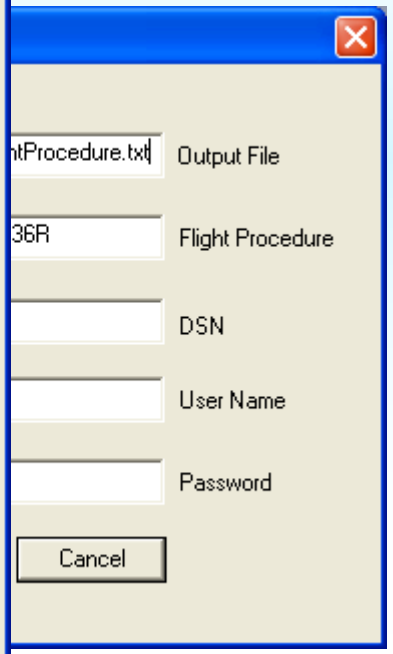

Loading flight proced

An existing flight procedure ca
FPDAM DB, by clicking Tools
local DB, by clicking Tools→L

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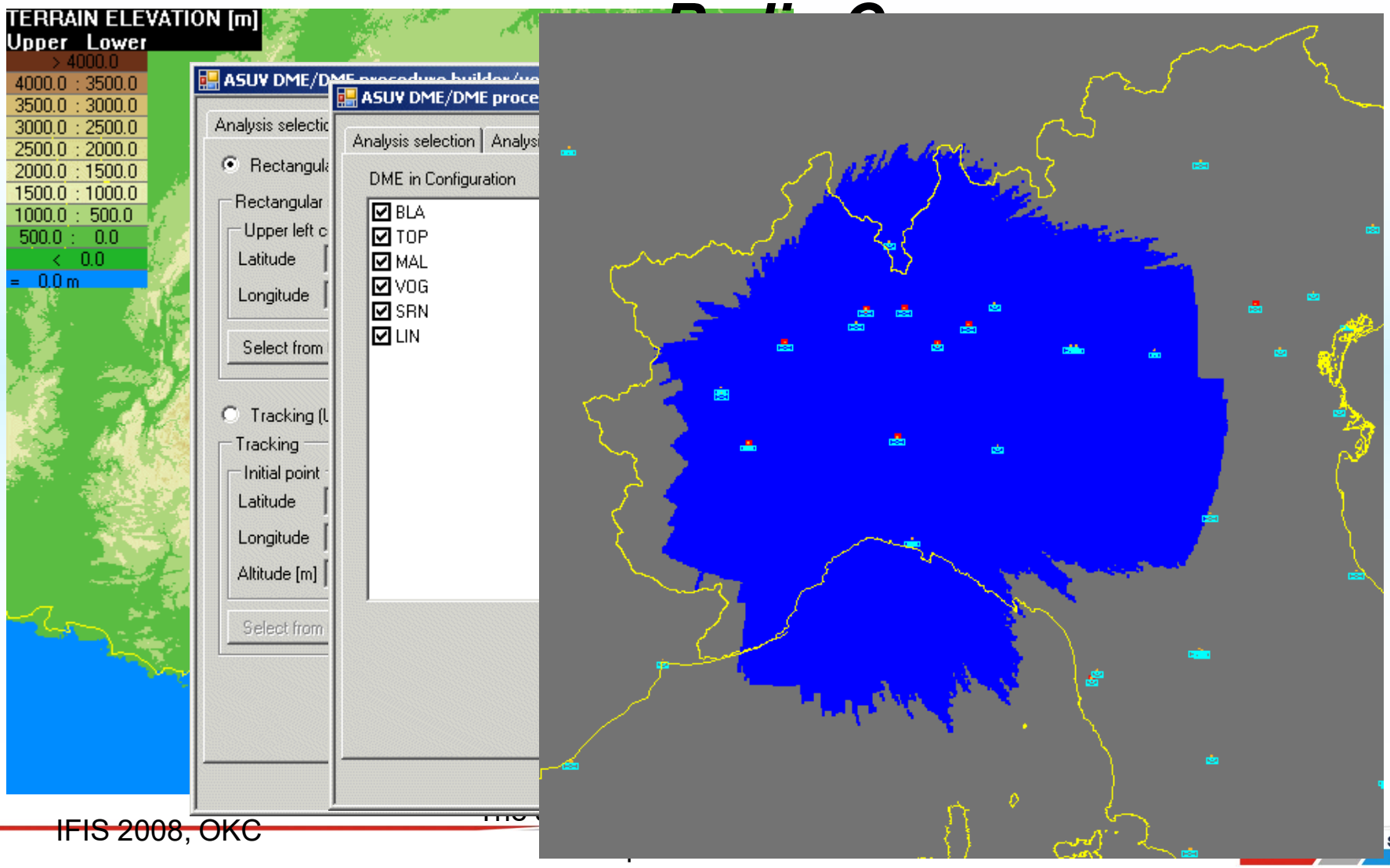
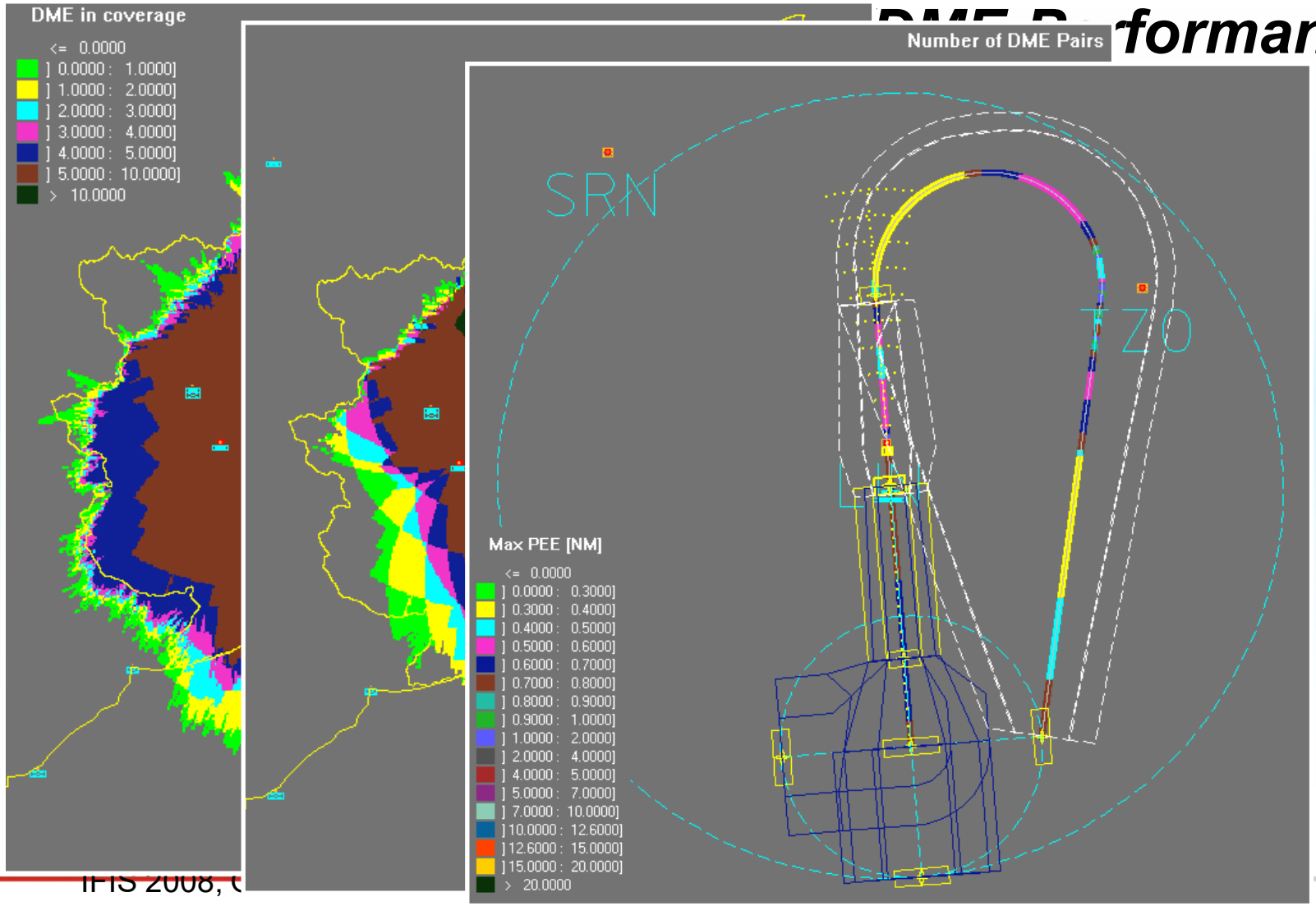
ASUV:Area/Airborne Signal Usability Verification DME/DME



ASUV:Area/Airborne Signal Usability Verification



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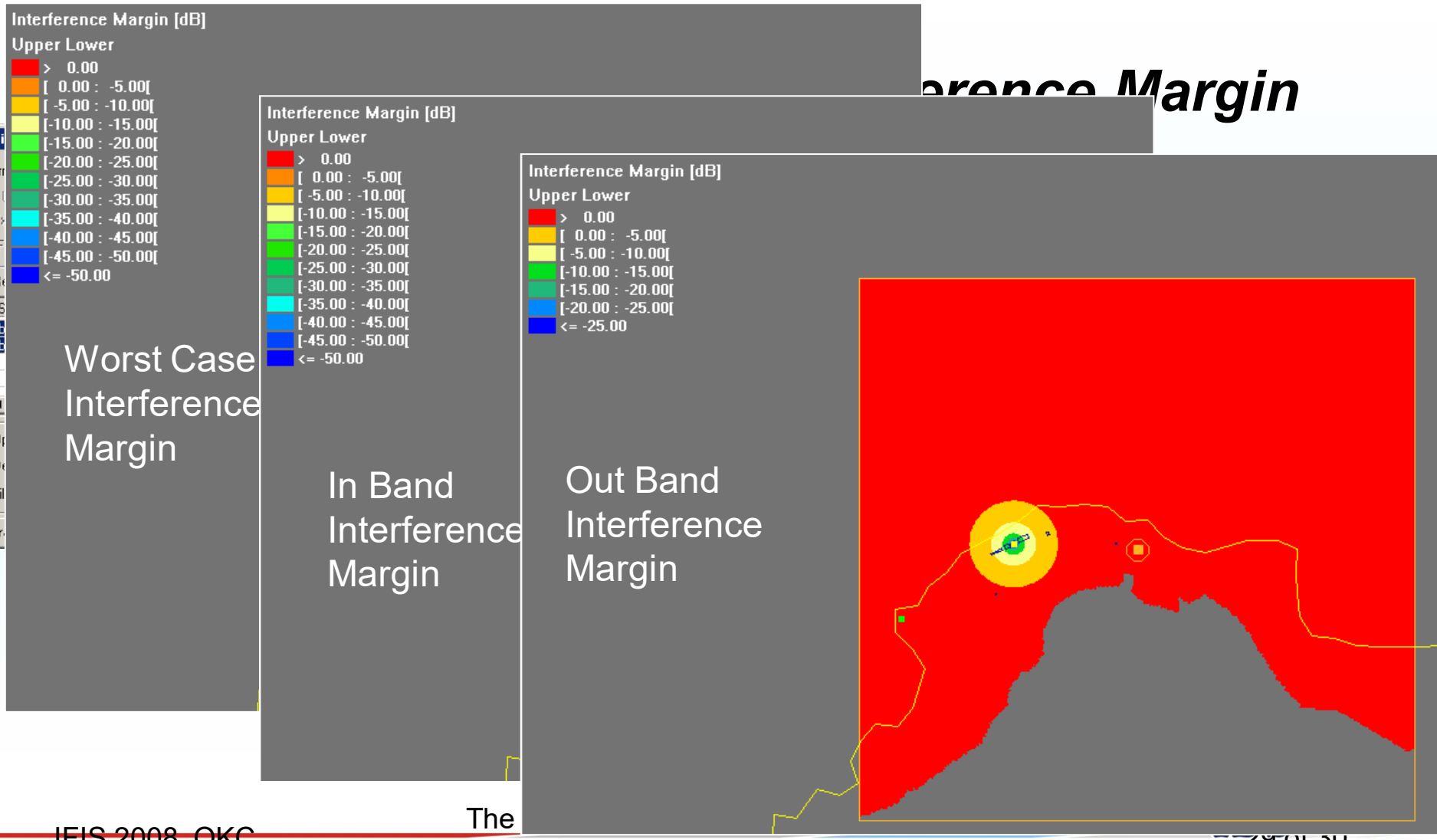
GASS:
Ground Augmentation System Siting



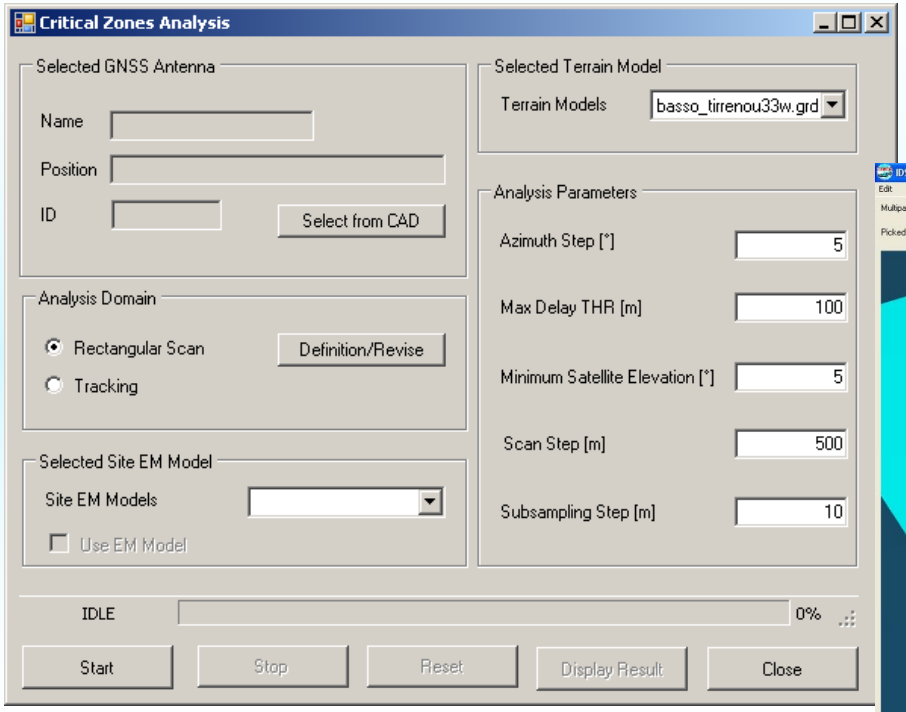
The

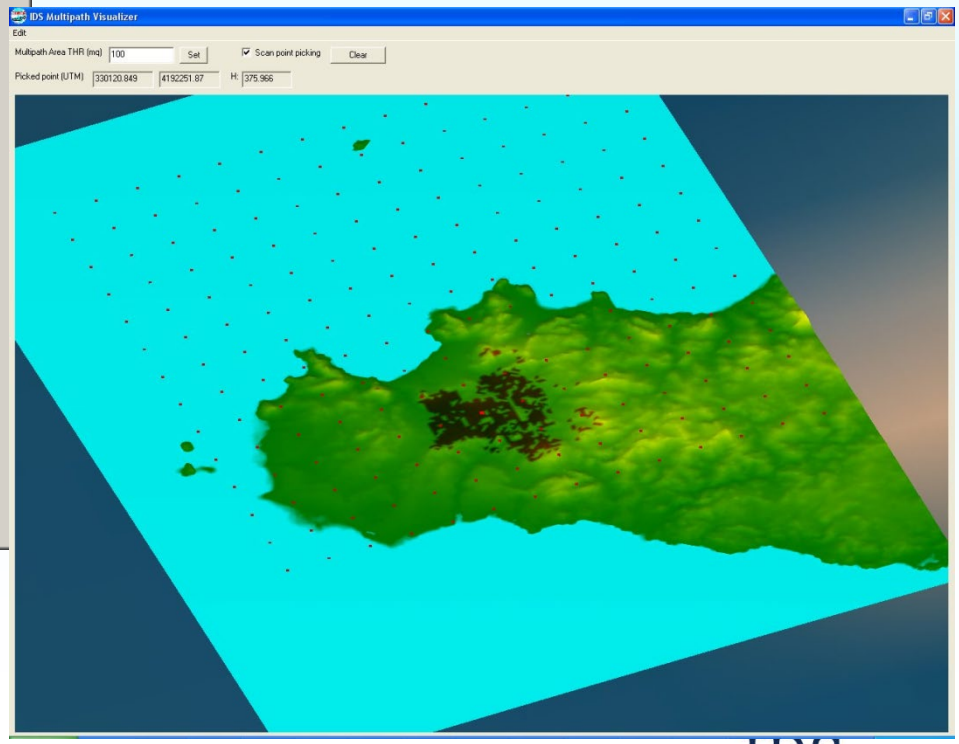
inspection activities

ASUV:Area/Airborne Signal Usability Verification

Critical zones analysis:

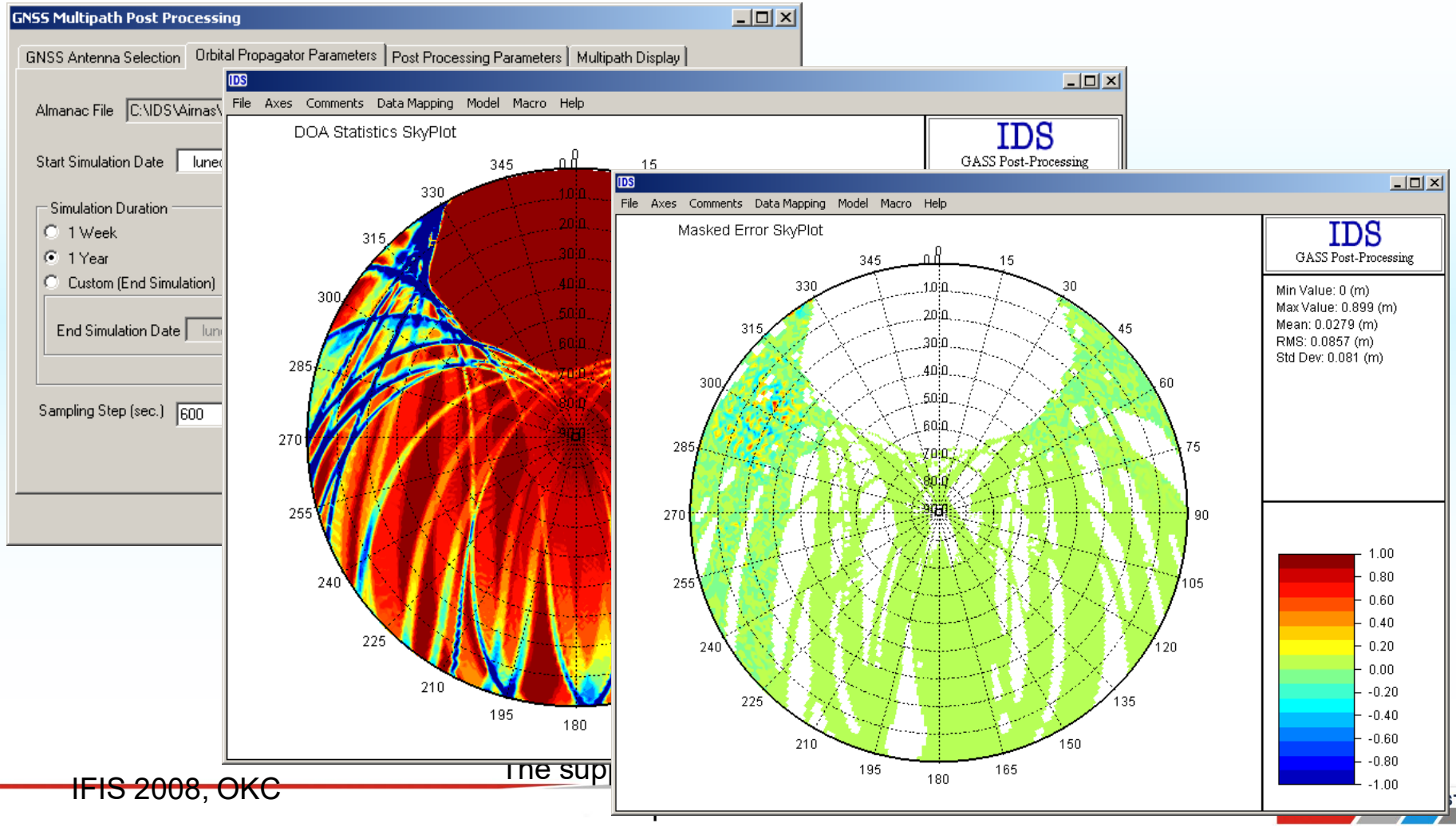
GNSS Performance analysis:



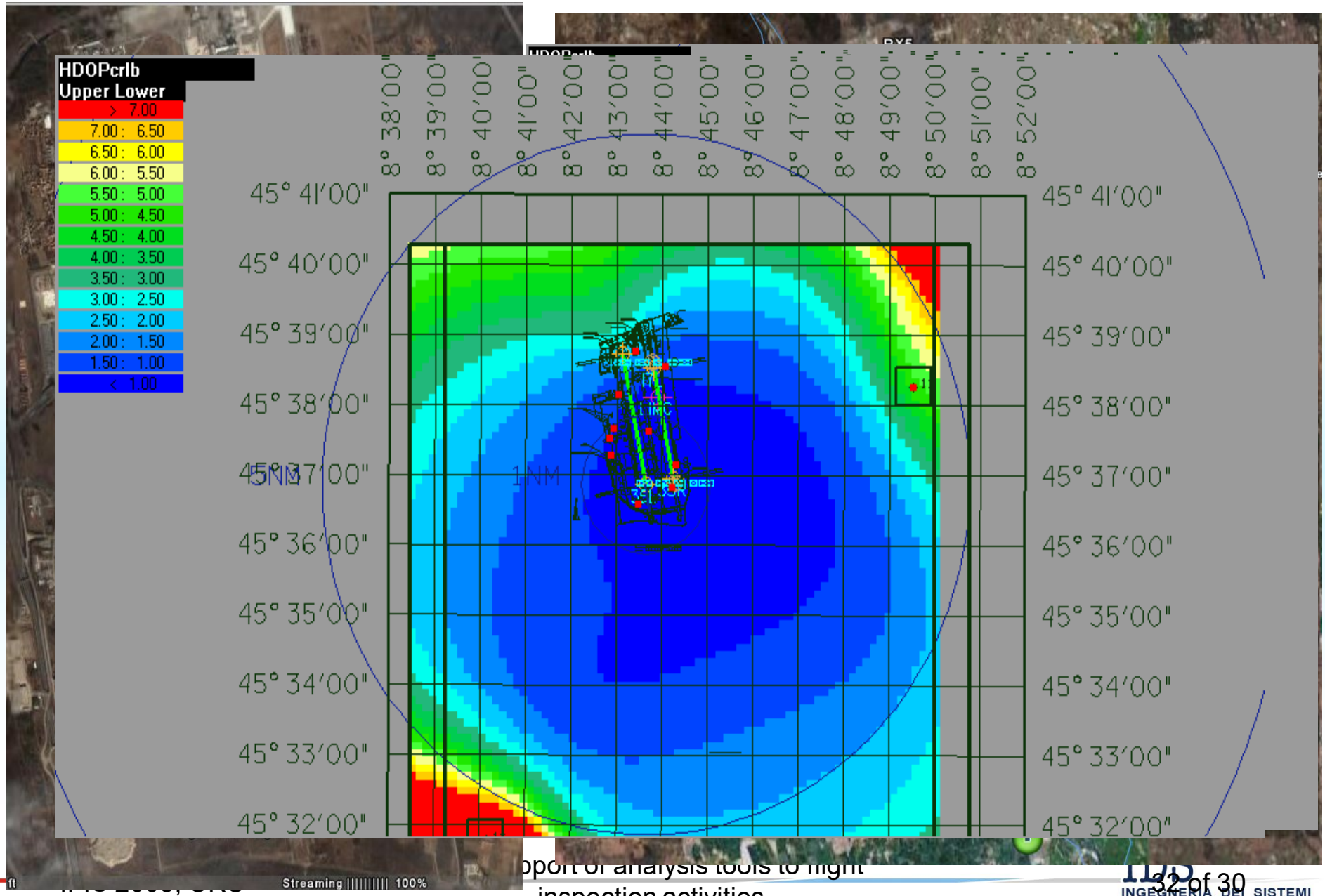


GASS: Ground Augmentation System Siting

Multipath analysis:



Wide area multilateration



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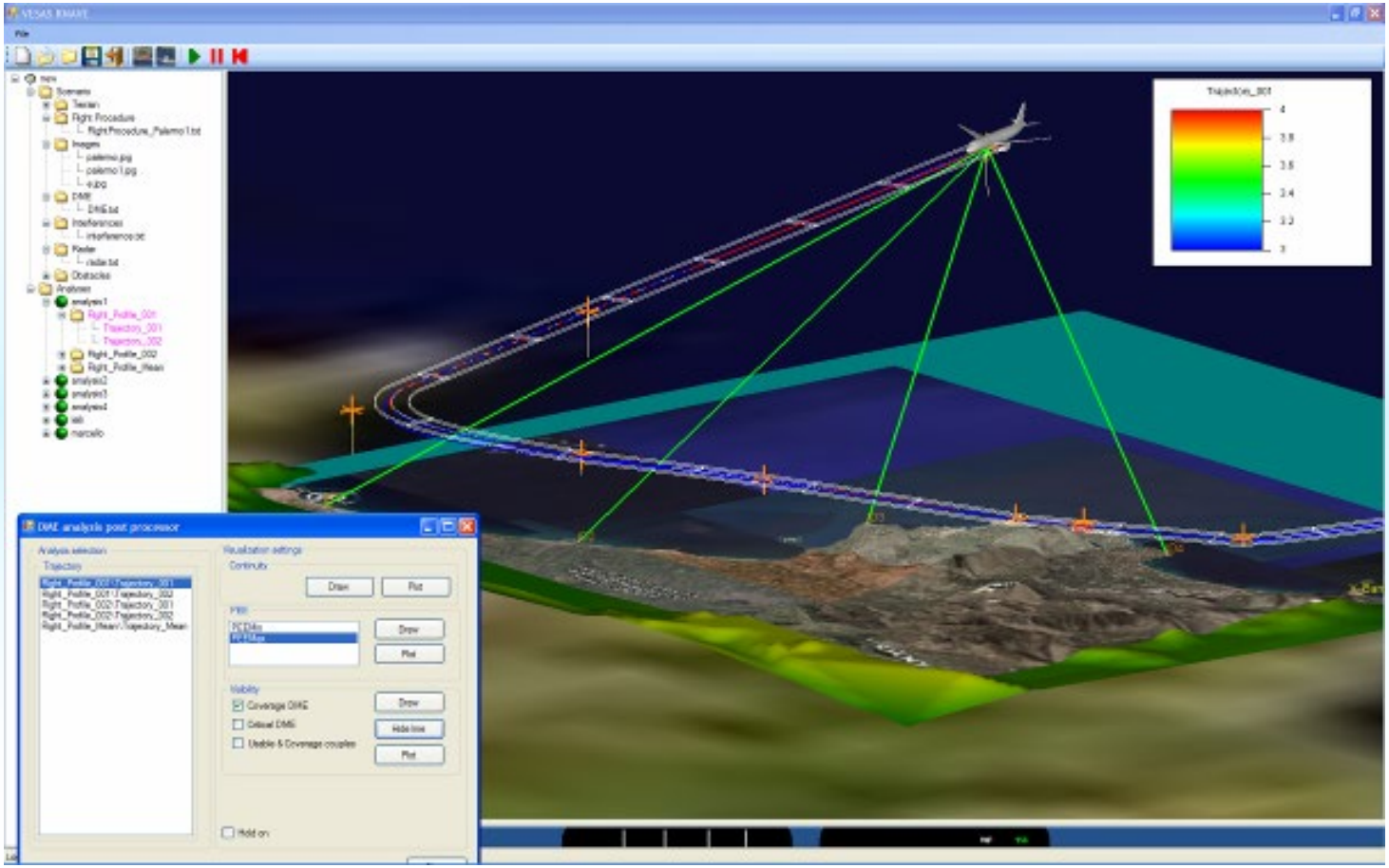
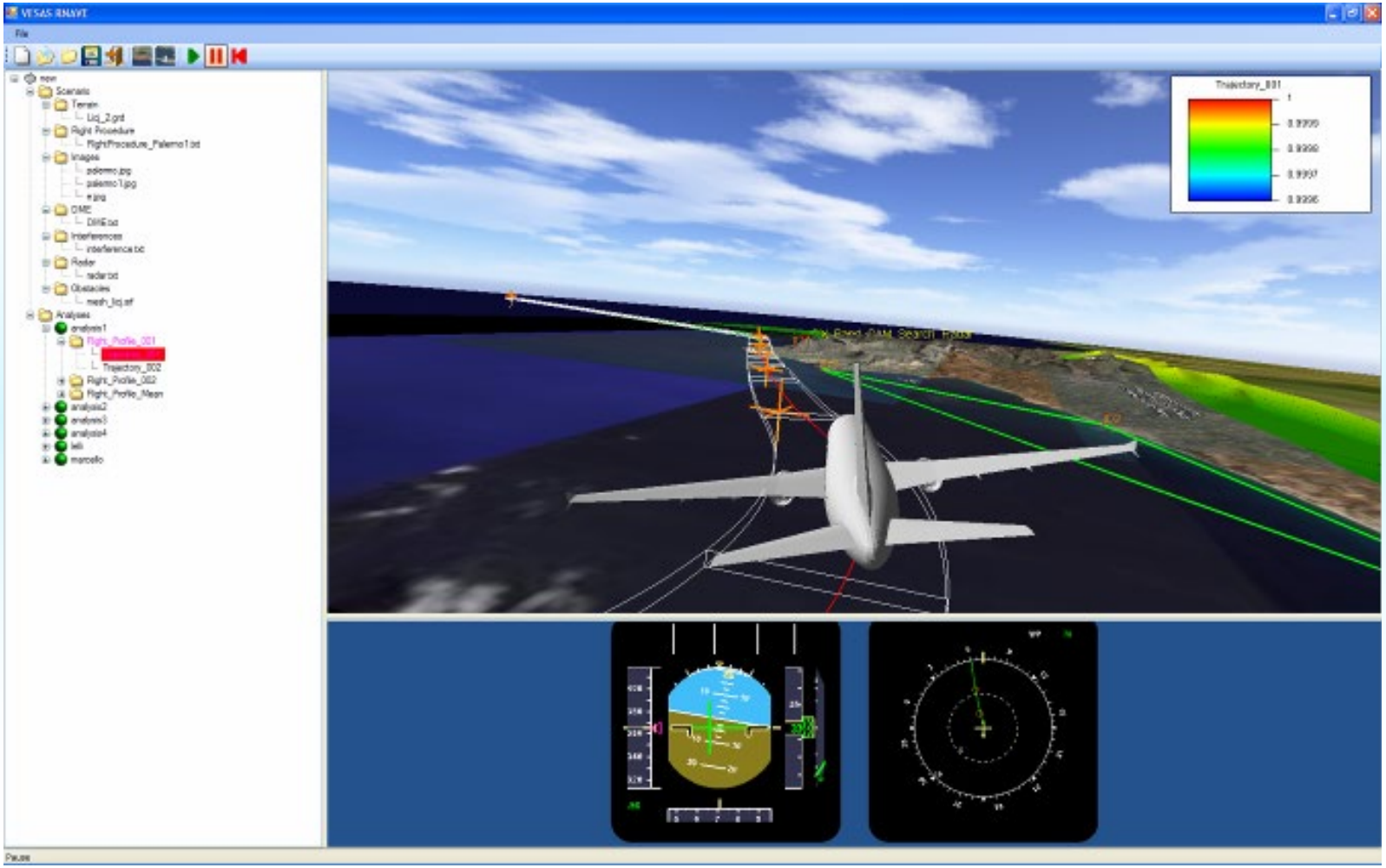
Pre Flyability check with different evaluation view(simulation)



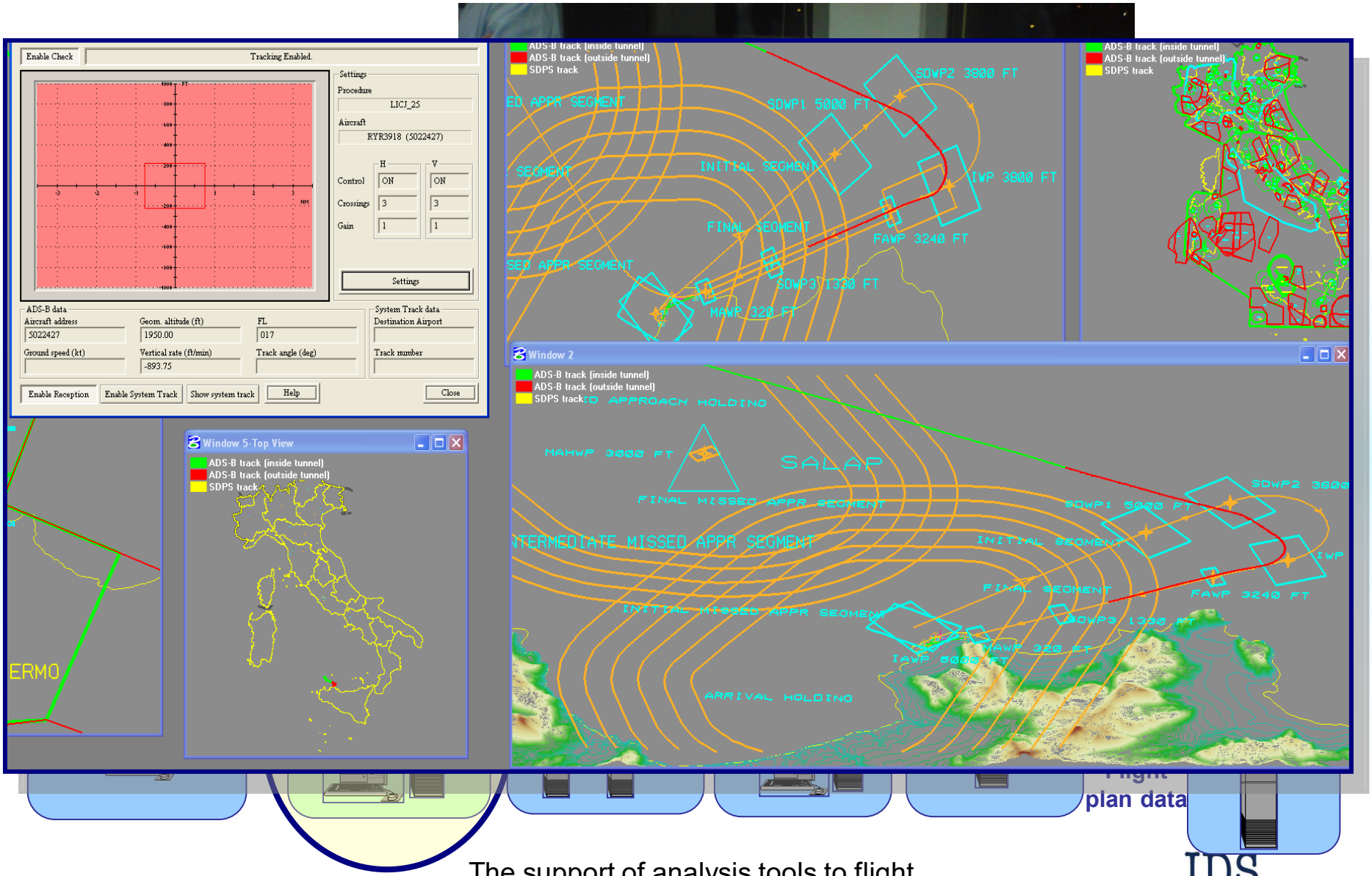
Procedure Virtual Flying (cockpit Simulator)



Landing Monitor
Real time monitoring of RNAV GNSS approaches

- Functionalities
- Flight tracks real time monitoring based on ADS-B data
- 2-D, 3-D protection areas display
- ATS data management
- RNP Tunnel-incident detection alarm
- Reception and decoding of ADS-B 1090 ES report (according to EUROCONTROL, ASTERIX 021) and system track (according to EUROCONTROL, ASTERIX 062)
- Automatic flight data display (ICAO Target Address, Target ID, Vertical rate, geometric altitude, ground speed,……)

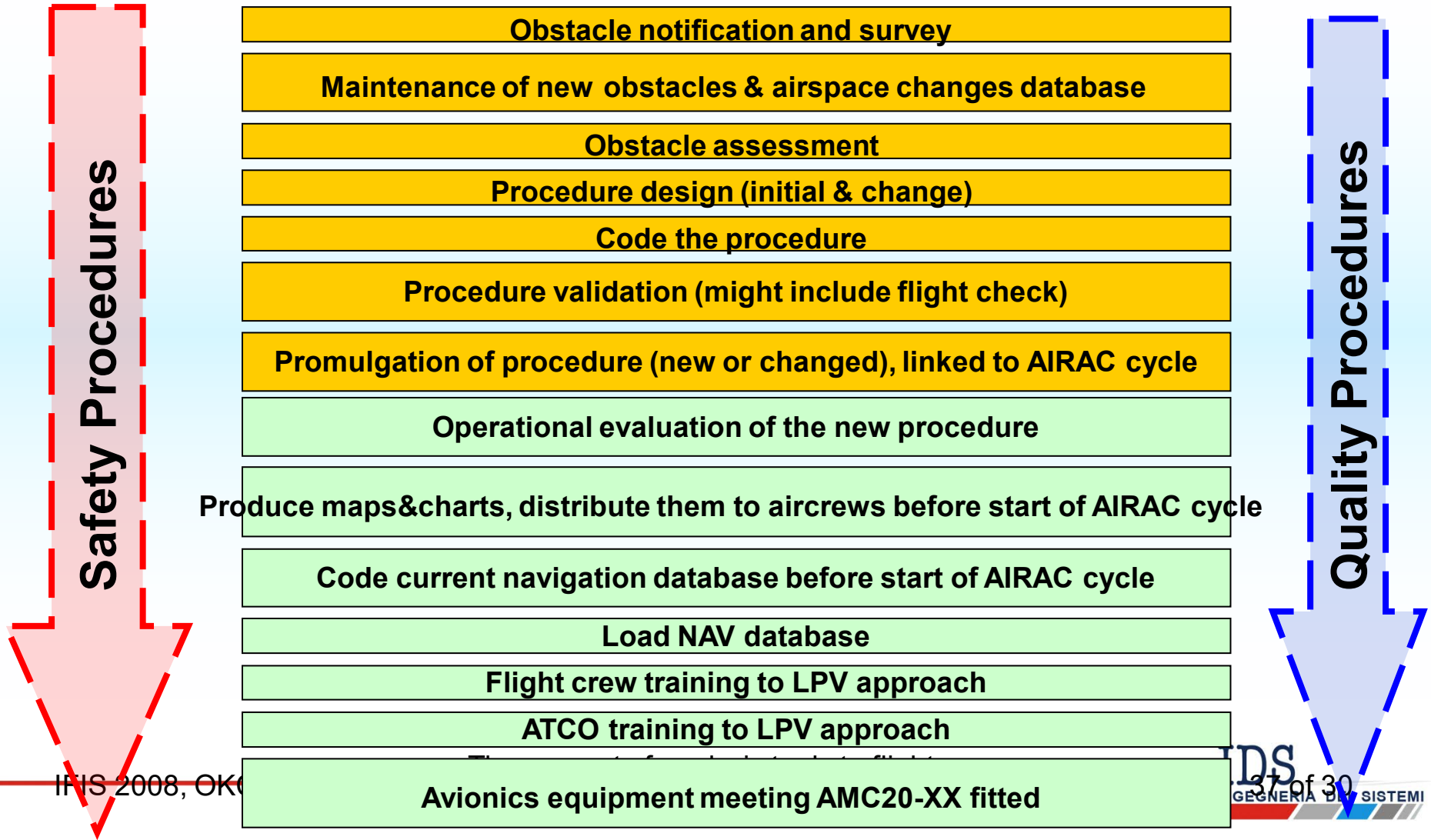
System Architecture and Landing Monitor



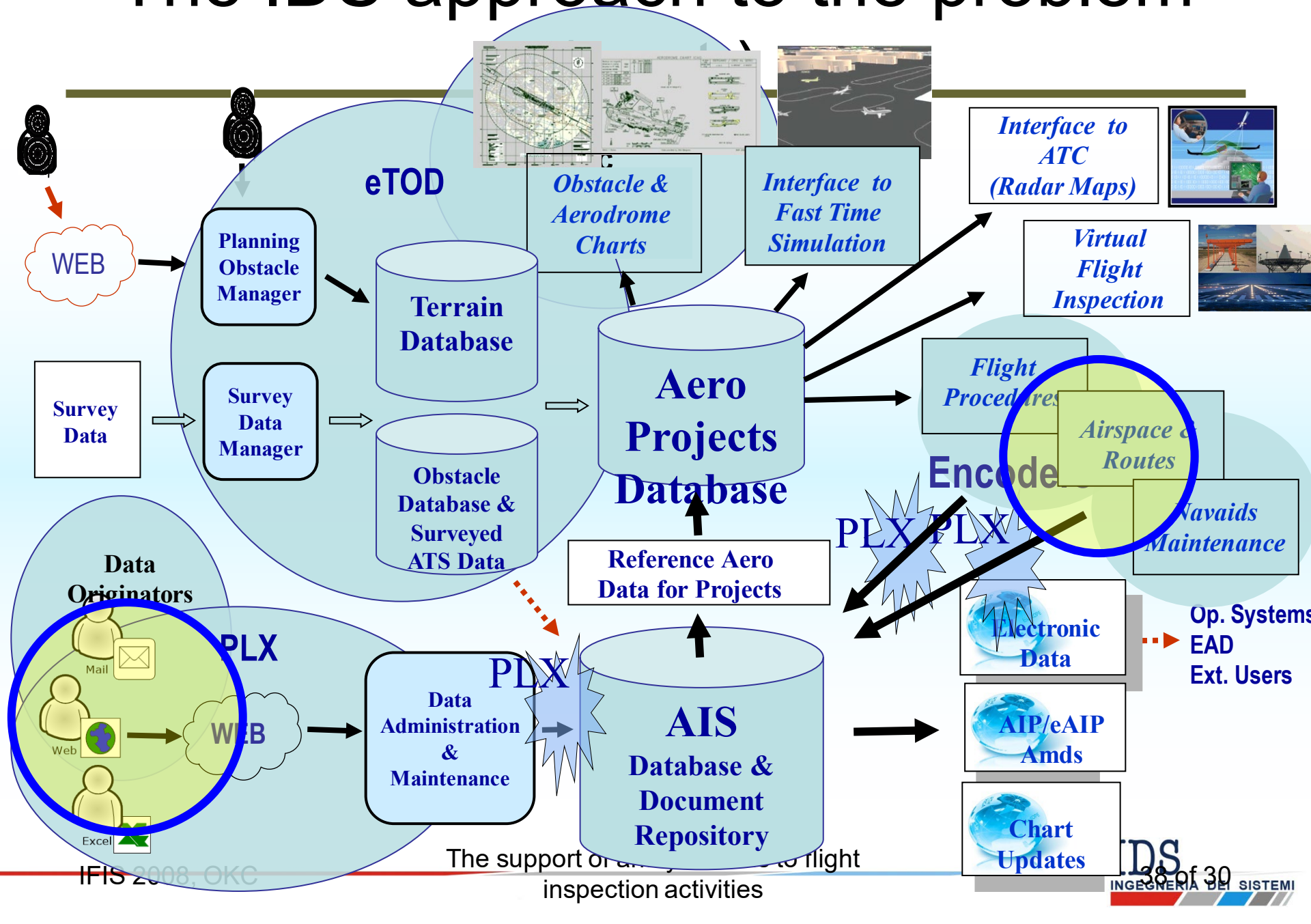
Safety/Quality procedures

Currently we are tuning ourapplications to fully comply with the workflow that integrates quality and safety procedures according to Eurocontrol SAfety Regulation Requirements (ESARRs) and Safety Assessment Methodology (SAM) following the ICAO PBN manual

RNAV Approach operation: Pre-operative phase

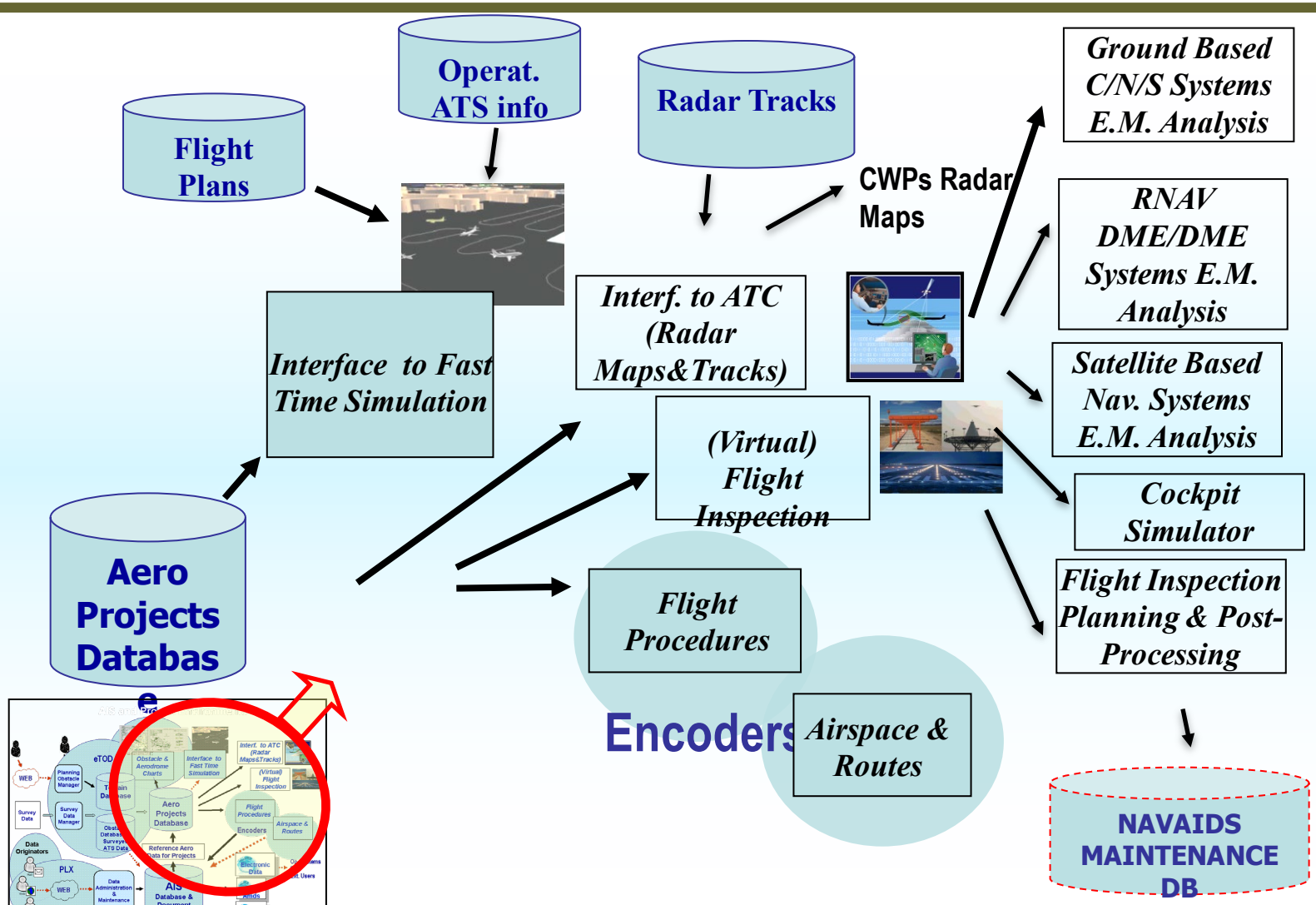


The IDS approach to the problem



The support of [illegible] to flight inspection activities

The IDS application framework



Conclusions and Recommendations

- The increasing use of RNAV routes and approaches/departures increase the challenges of flight inspection teams and cost connected activities

- The international rules from ICAO, Eurocontrol, JAA and FAA are asking for increased level of integrity in aeronautical data due to the fact that aircraft flying strongly rely in the data loaded in the navigation DataBase.

- This paper has given a short overview of those requirements and has given some snapshots of the solution developed by IDS to meet the though requirements which are asked from the regulators to the air navigation service providers.

ACKNOWLEDGMENTS

The authors wish to acknowledge ENAV (Italy's Air Navigation Service Provider) for its support in the AIRNAS system development

And JCAB for the contribution on the DME/DME requirement

Thanks for your attention!

Let's improve your performance with our solutions

QUESTIONS, COMMENTS, SUGGESTIONS, …