Presented by
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Simulated Free Routing Operations in the Marseilles UIR:
Results and Issues from a Human Factors Perspective

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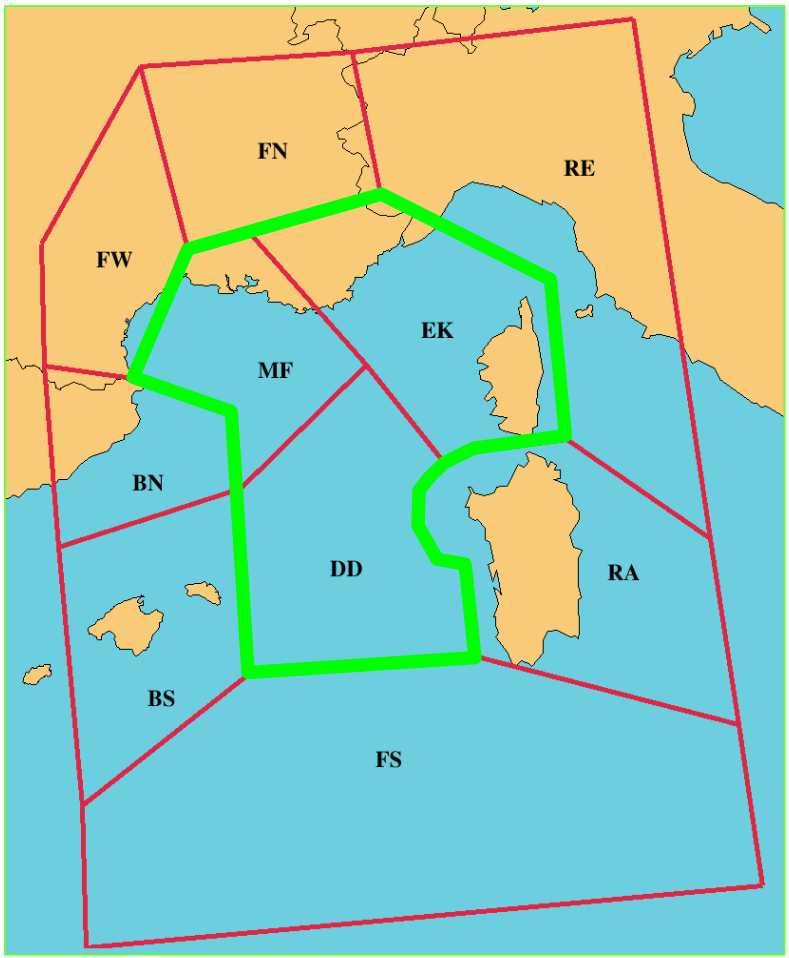
Presentation Plan

- The Free Route real time simulation trials, a participation of DSNA-SDER in the Mediterranean Free Flight (MFF) program:
  - Background and objectives
  - Simulation design and FR tools
  - Principles of the HF analysis
- Results on:
  - Integration of flights and memorization
  - Conflict detection
  - Workload
- Main conclusions from the human factors perspective

Background and Objectives

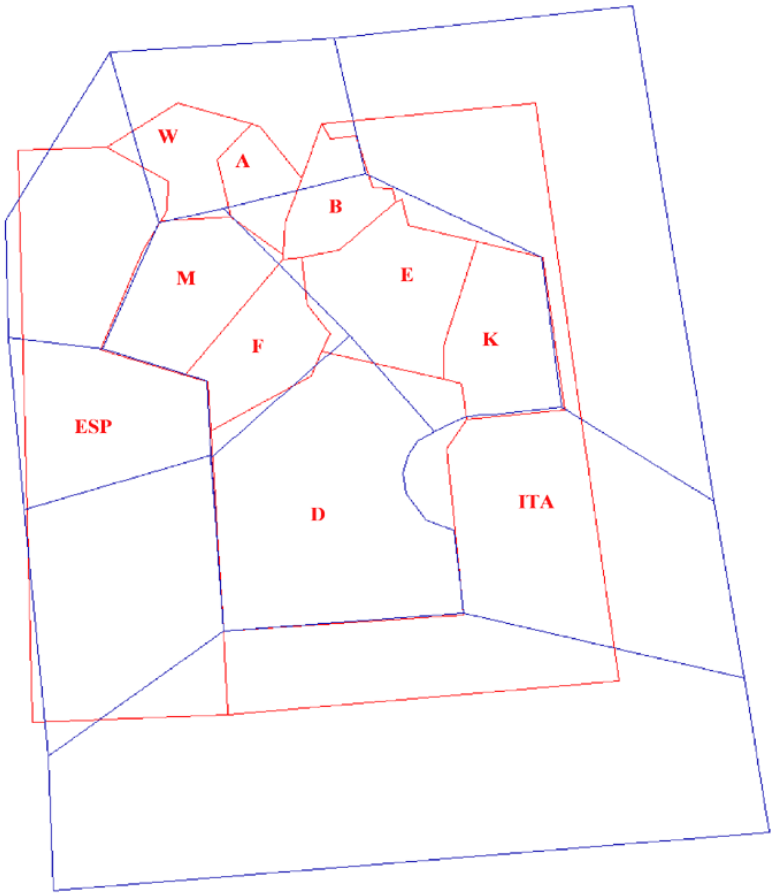
- Background:
  - MFF: study of a series of applications, from Free Route (FR) to Free Flight in a busy Mediterranean area
  - DSNA real time simulation trials focused exclusively on FR
  - FR operations:
    - flights planned without reference to a fixed route network in a designated FR airspace
    - Controllers retain responsibility for separation
- Objectives of the real time simulation trials on FR by the DSNA:
  - Get a feedback from controllers on FR with high density traffic
    - Can controllers effectively do their job ?
    - Are the proposed tools fit for the purpose ?
  - Investigate safety aspects in the simulated FR concept

Simulated Free Routing Operations



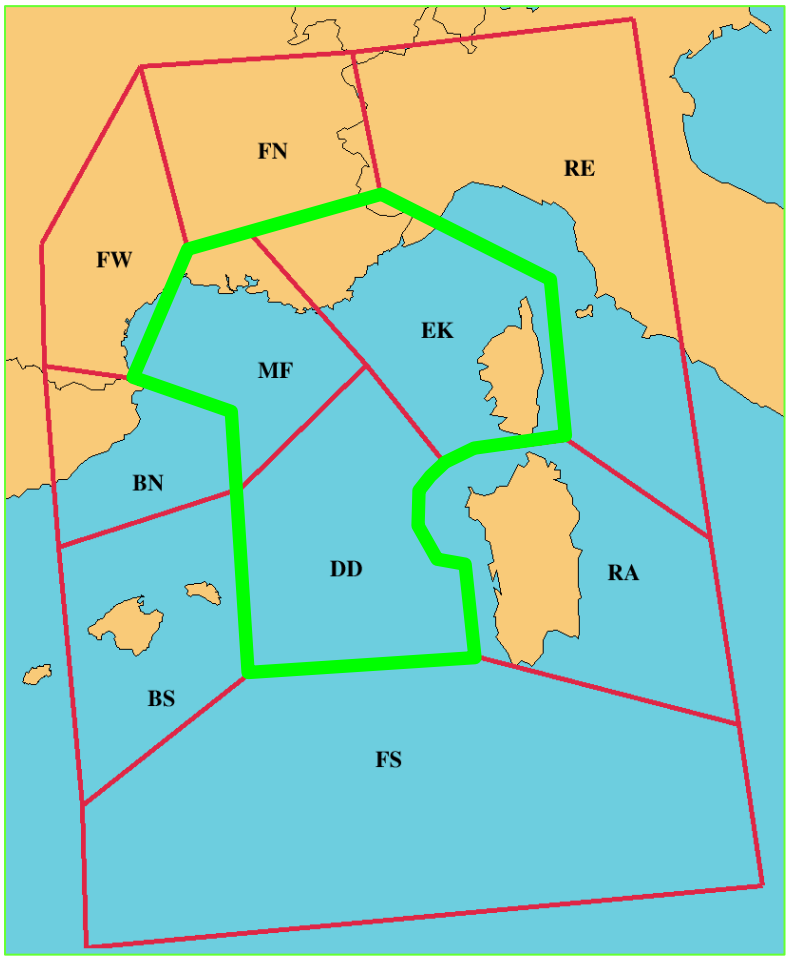
- Area in the Mediterranean airspace controlled by Marseilles
- FR airspace is above a floor level set at FL 285
- Design of the MF, EK, and DD sectors modified for FR operations

FR Sectors Design vs. Current Design



- **Current design**
- **FR design**
- FR sectors characterized by:
  - Larger flat areas
  - Simpler shapes

Simulated Free Routing Operations



- Area in the Mediterranean airspace controlled by Marseilles
- FR airspace is above a floor level set at FL 285
- Design of the MF, EK, and DD sectors modified for FR operations
- Scenarios from the unregulated traffic demand for peak days of 2002
- Direct routes between entry and exit of a FR airspace

Measured Control Units and FR Tools

- Two measured units / control working positions,
  each manned by an executive and a planning controller

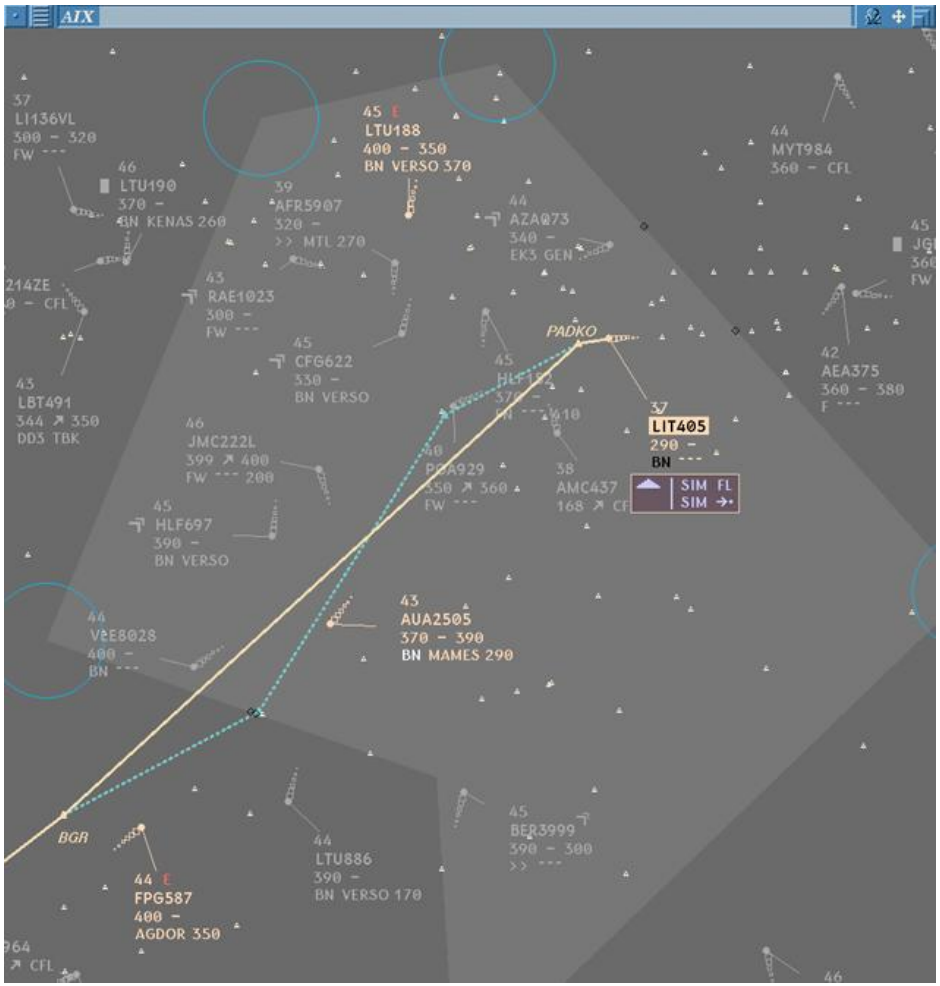
Control Working Position

- One such CWP for each measured unit
- Left hand side: executive controller
- Right hand side: planning controller

Measured Control Units and FR Tools

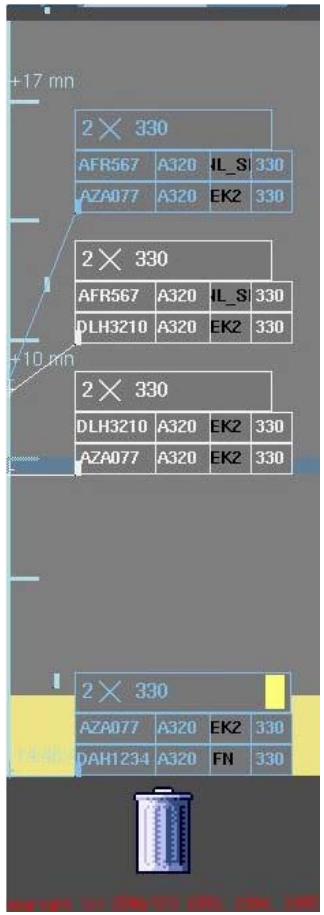
- Two measured units / control working positions, each manned by an executive and a planning controller
- FR tools integrated with functions of a state-of-the-art, stripless control working position:
  - Route editor
  - Medium Term Conflict Detection (MTCD), in the form of
    - Filtering functions
    - Tasks Scheduler

Example Display of Filtering



- Filtering in route edition mode for LIT405

Example Display of the Tasks Scheduler



Measured Control Units and FR Tools

- Two measured units / control working positions, each manned by an executive and a planning controller
- FR tools integrated with functions of a state-of-the-art, stripless control working position:
  - Route editor
  - Medium Term Conflict Detection (MTCD), in the form of
    - Filtering functions
    - Tasks Scheduler
  - Electronic inter-unit co-ordination tools
  - Controller-Pilot Data Link Communication (CPDLC) services, addition of the capability to uplink edited routes

Human Factors Analysis Principles

- Collection of qualitative and quantitative data:
  - Observations by HF experts on the measured positions
  - Post exercise questionnaire and individual interviews after each exercise
  - End of day debriefings
  - Post-simulation questionnaire at the end of the 2-week trials
  - Final round-table discussion
  - Automatic recordings (source of most of the quantitative data)
- Activity split for the analysis into:
  - **Integration and memorization**
  - **Conflict detection**
  - Conflict resolution
  - Anticipation
  - Co-operation
- Further analysis on tools and workload
- Controllers had opportunities to react to the interpretation

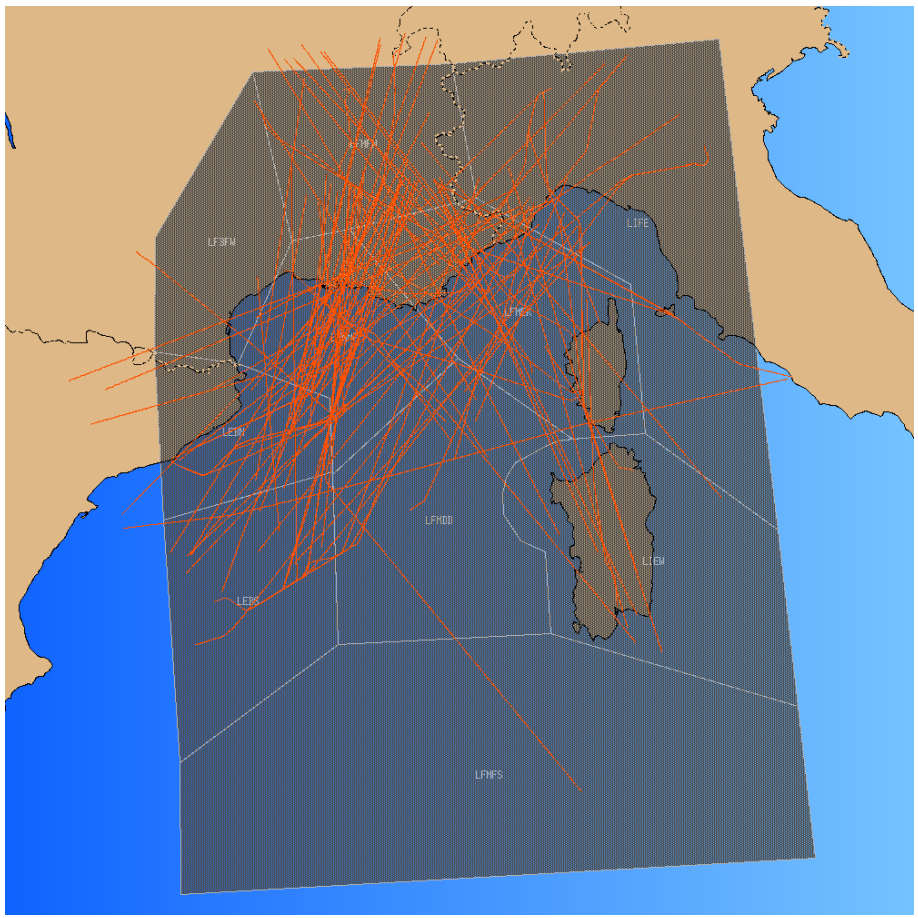
Integration of Flights and Memorization

- FR operation had a major impact on both integration of flights, and memorization
- Flights integration was made more difficult in FR:
  - Absence of stable geographical references
  - Existence of flights that remain near the edges of the units
  - Simultaneous entry of flights on unregulated trajectories in the same direction
- Memorization of diverse and variable trajectories was too costly:
  - Repeated consultation of information
- Provided filtering functions did not sufficiently facilitate the integration

Conflict Detection

- Conflict detection and resolution in FR are within the scope of expertise of the controllers
- Difficulties due to FR operation:
  - Possible points of conflicts numerous, unmarked, and not known in advance
  - Monitoring of flights at the edges of the units
  - Convergences in variable configurations

Example Recording of Simulated FR Flights



- Measured units:
  MF and EK
- Played hourly load:
  - About 80 flights in EK
  - About 70 flights in MF

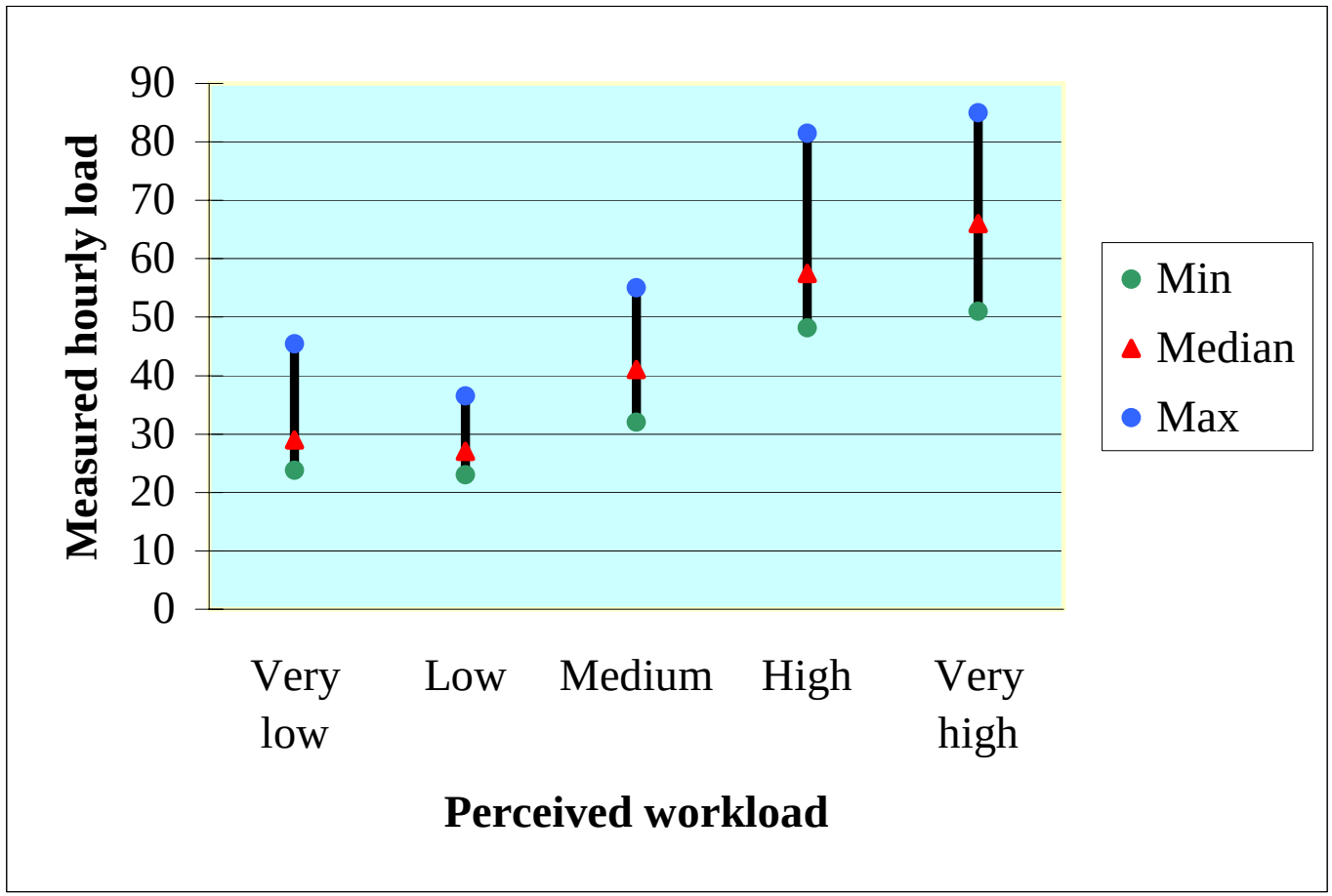
Conflict Detection

- Conflict detection and resolution in FR are within the scope of expertise of the controllers
- Difficulties due to FR operation:
  - Possible points of conflicts numerous, unmarked, and not known in advance
  - Monitoring of flights at the edges of the units
  - Convergences in variable configurations
- Management of climbing and descending flights particularly difficult:
  - More face to face situations than with the current fixed route network
  - Negative impact of entry and exit points at FL 285
- Wide agreement on judging the Tasks Scheduler useful, or even essential in principle, but:
  - Tools must be made totally reliable
  - Not efficient enough in high workload/high complexity situations

Workload

- Main variation factors on the perceived workload were:
  - 1 The traffic load

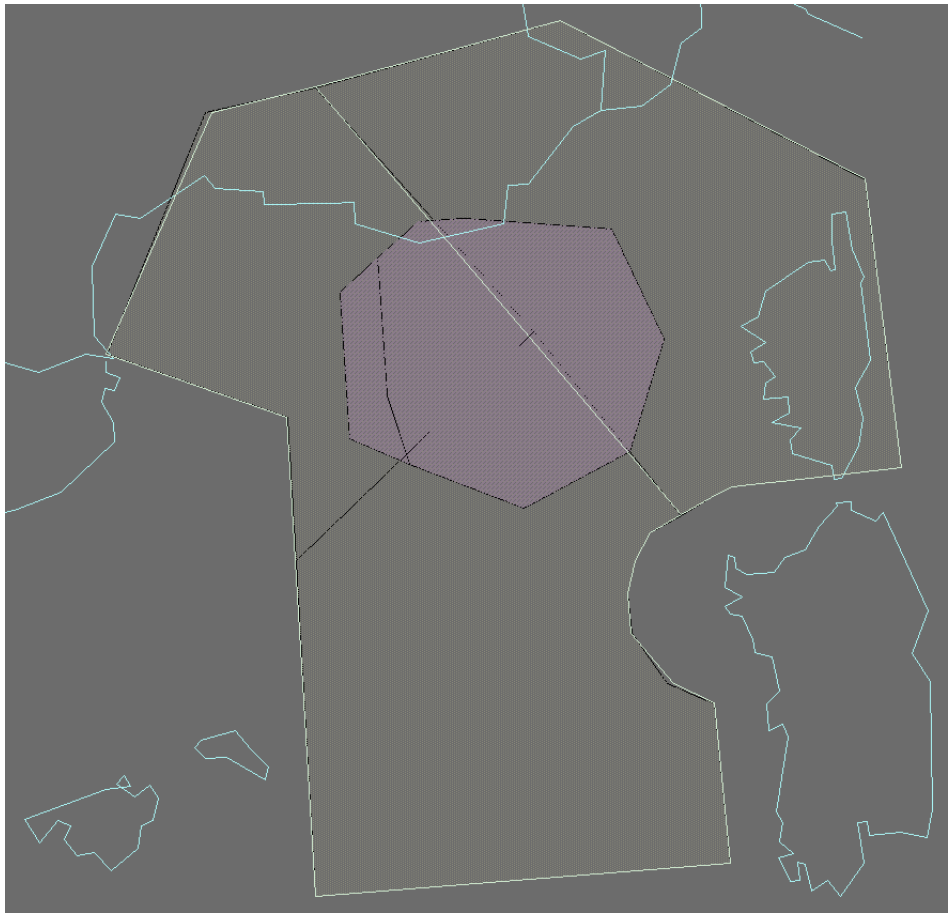
Perceived Workload and Traffic Load



Workload

- Main variation factors on the perceived workload were:
  - 1 The traffic load
  - 2 The activation of temporarily segregated areas

Extension of the D54A+B TSAs



Workload

- Main variation factors on the perceived workload were:
  - 1 The traffic load
  - 2 The activation of temporarily segregated areas
  - 3 Occasional problems with tools in the simulator
  - 4 Problematic traffic configurations
- Controllers could not maintain their workload within acceptable limits by working at a skill-based behavior level:
  - FR traffic remains diverse and variable
- The inability to maintain workload at a proper level generated a feeling of insecurity

Main Conclusions

- As proposed, FR operations would not be accepted for high traffic loads:
  - Workload cannot be maintained within acceptable limits in all the situations
  - Feeling that safety is jeopardized in heavy traffic
- FR makes memorization of routes and conflicts more difficult:
  - Loss geographical reference frames to speed up decisions
  - Repeated consultations of information
  - Processes lose their effectiveness as the traffic increases
- Restrictions to be clearly addressed for FR operations:
  - Traffic flow management
  - Airspace management
  - Design and **reliability** of aiding tools

Results Dissemination

- HF analysis of FR operations in the Marseilles UIR is part of the MFF results
- Official public web site of the MFF programme:

http://www.medff.it