



# 4D contracts elaboration process

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THE FRENCH AEROSPACE LAB



THALES



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Second Demonstration Workshop

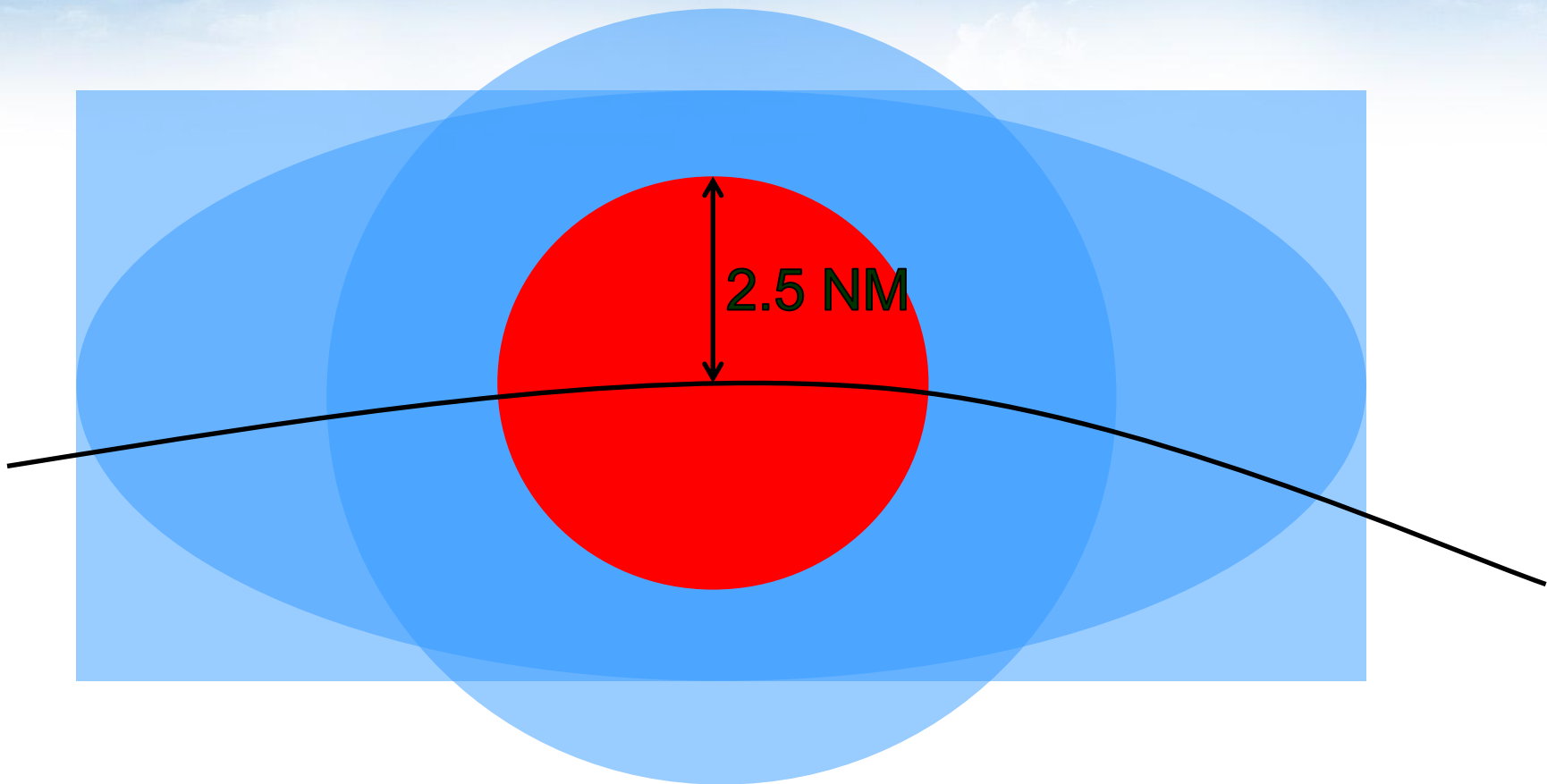
Braunschweig, Germany

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# Contract definition

- What is a contract ?
  - A 4D trajectory
  - A safety bubble, centered on the aircraft, ensuring its safety
  - A contract bubble, where the safety bubble can move
    - Separated from other contract bubbles
  
- The freedom bubble
  - Freedom Bubble = Contract Bubble – Safety Bubble
  - Volume where the aircraft can move

# Bubble shapes



# Shape of a 4DCo-GC bubble

- A contract bubble is a rectangle
  - Trade-off between
    - Lateral : trajectory optimization
    - Longitudinal : time optimization
    - Vertical : climb / descent optimization
- Freedom sizes
  - Longitudinal
    - up to 8NM
    - 1 min ~ 2 min
  - Lateral
    - up to 6.5NM
  - Vertical
    - up to 1500 ft



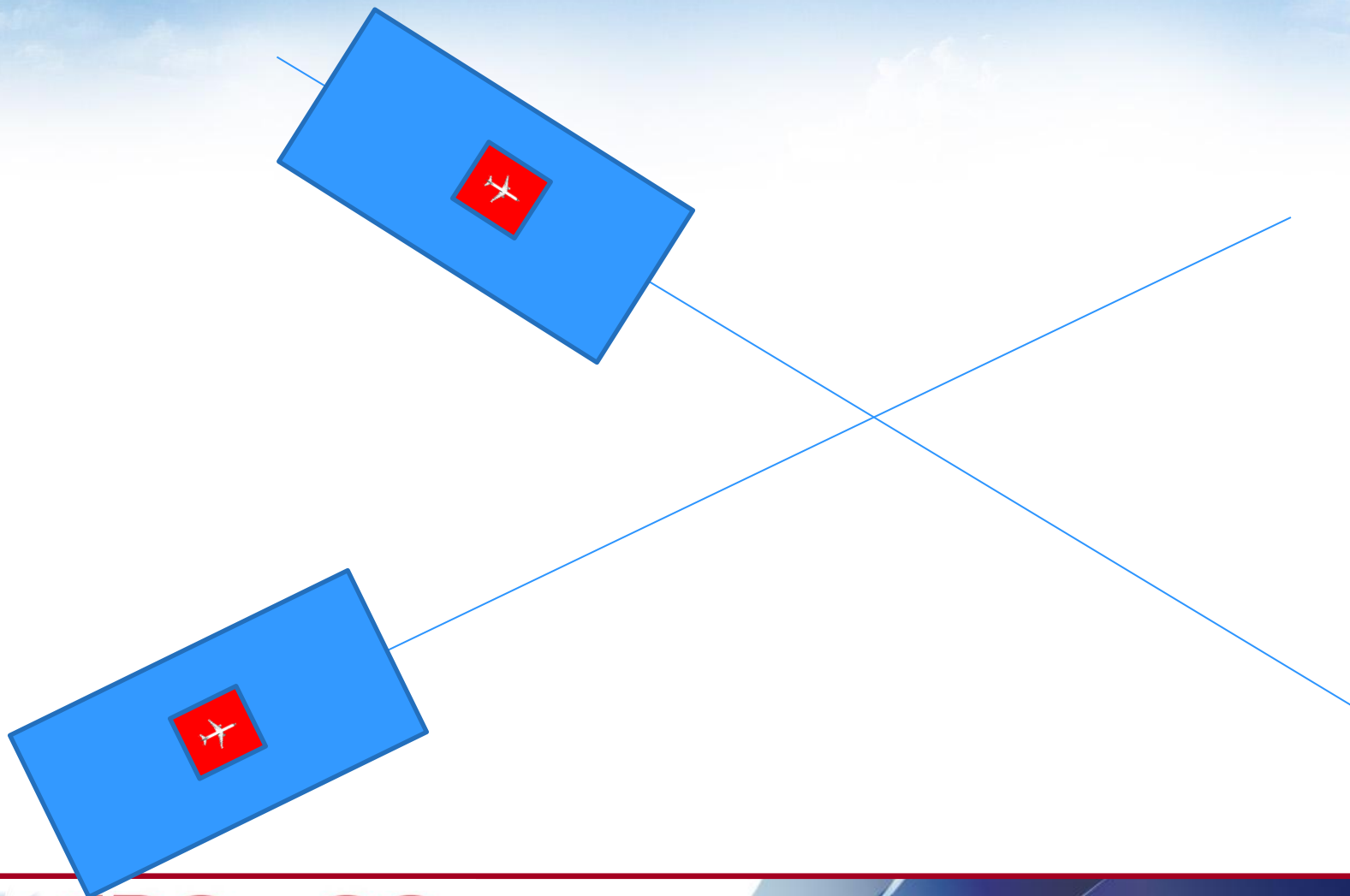
# Contract generation

- Based on deconfliction methods
  - Use of deconfliction methods with separation values higher than usual (8 NM instead of 5 NM, 6 instead of 3)
  - Contract and safety bubbles inside the separation
- Pros
  - Easy
  - Constant freedom
- Cons
  - It is difficult to find a solution
  - Capacity loss in high dense areas
  - Freedom loss in low dense areas

# Contract generation

- Based on deconfliction methods and trajectory analysis
  - Use of conventional deconfliction values
  - Safety bubble inside the separation
  - The trajectories are analyzed to find the contract bubble
- Pros
  - Use of classical methods to deconflict
  - Variable freedom
- Cons
  - Sometimes, the freedom is reduced whereas a little change in the trajectory would keep this freedom

# Contract generation



# Contract generation

- Method to explore
  - The values to deconflict depend on the temporal density of the area
    - At least 5 NM / 2.5 NM in high dense area
    - Higher values in low dense area
  
- Should result in a trade-off between freedom and trajectory deviation / time shift
  - Do what you want in the bubble but with a non-optimal trajectory
  - Optimal trajectory but with 4D windows to respect