LUFTHANSA GROUP

Is Airspace Geometry untouchable?

An AI-based analysis of Vertical TMA Efficieny and a solution approach

FABEC Vertical Flight Efficiency Workshop

07.12.2022, DLH AO/FF & DFS OL/PA

Joachim Scheiderer (LH) and Christian Ruppert (DFS)

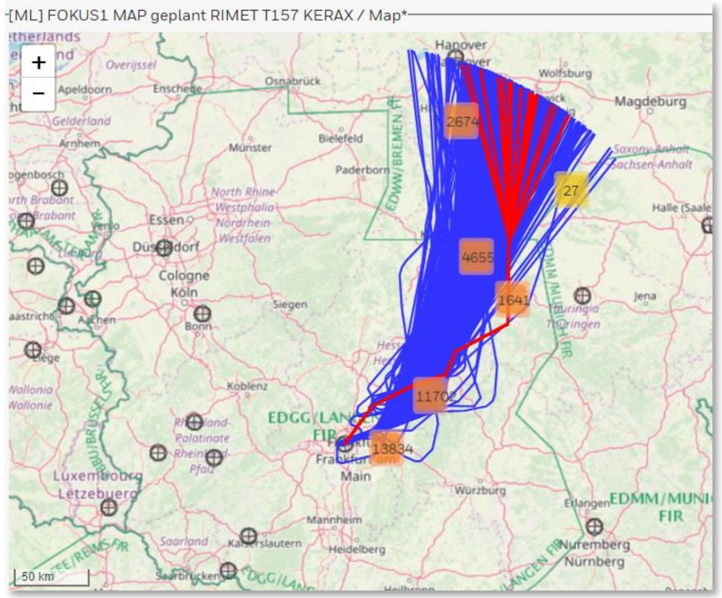
Intern

DFS Deutsche Flugsicherung

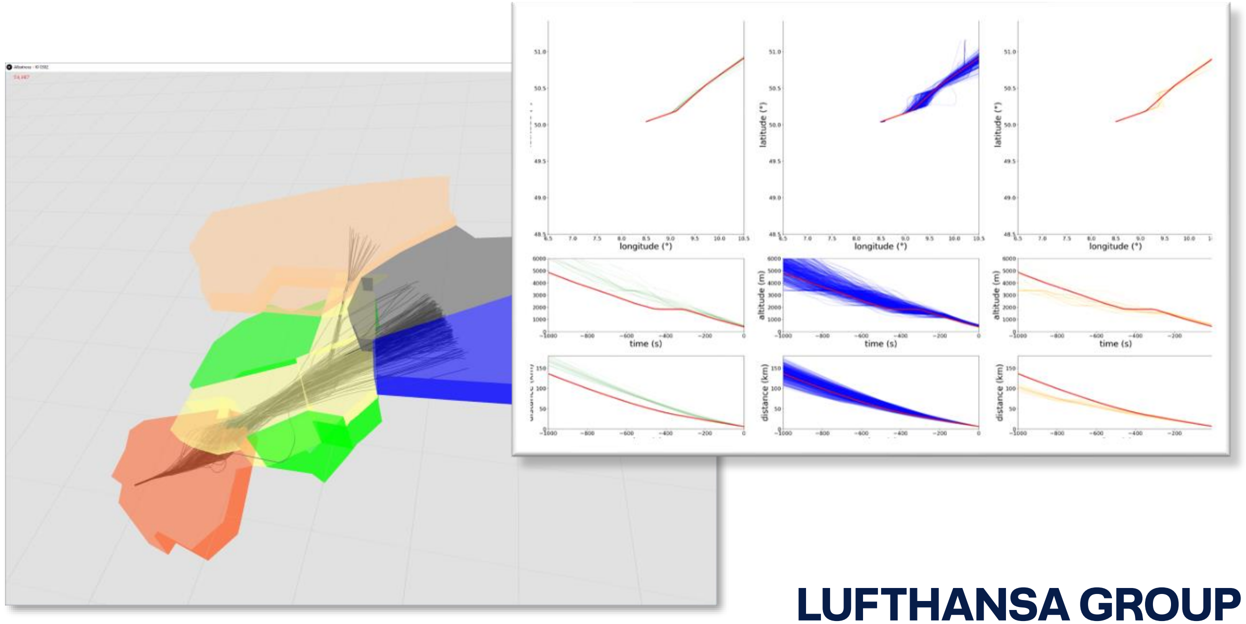
Tradition vs. „freak stuff“

AI-based analysis opens up new insights by comparing „similar trajectories“

- The traditional approach of trajectory analysis takes into account all flights in a given period
- No distinction is made with regard to environmental or operational conditions



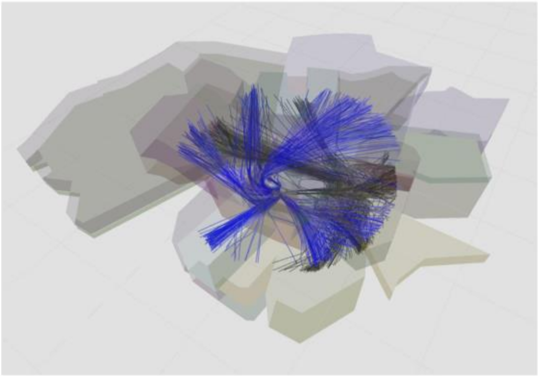
- AI-based trajectory analysis is able to cluster similar flights performed under comparable and similar conditions in terms of weather, sector configuration and traffic flow.
- Machine learning algorithms enable the identification of contributing factors that were relevant to the trajectory

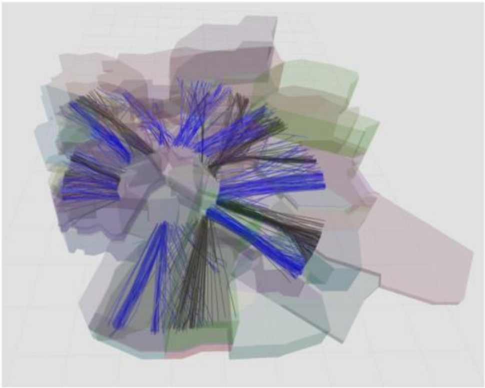


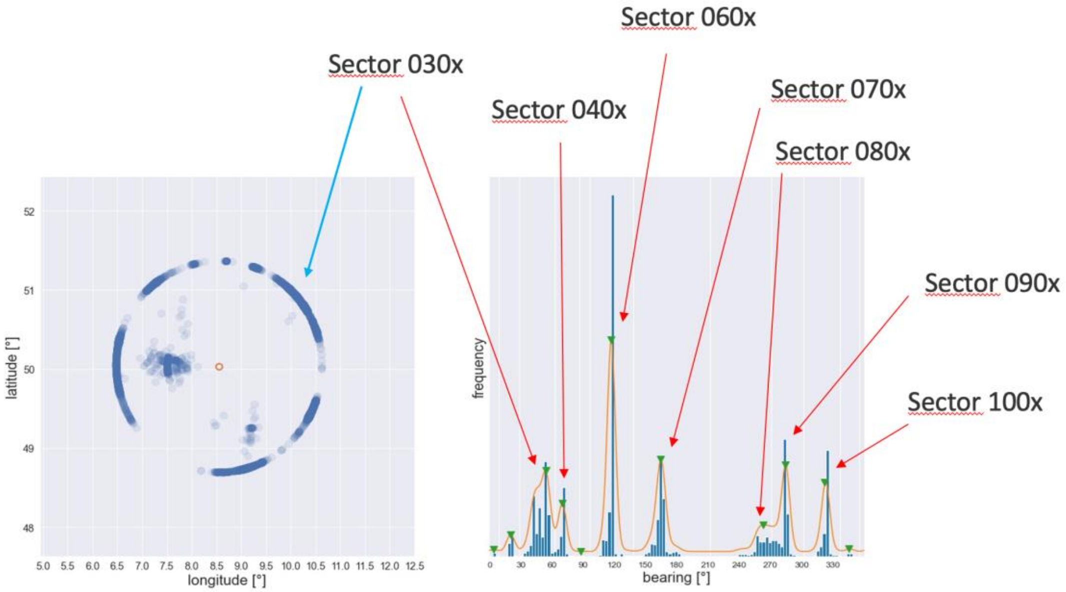
DFS Deutsche Flugsicherung
LUFTHANSA GROUP

The AI-Project Setting - Investigation of multilateral correlations of trajectory efficiency in the TMA

- Data analysis of all flights within a 120 NM radius around FRA and DUS/CGN (March and September 2019)
- Special focus on a radius of 40 NM and 80 NM around the airport
- Project is in close collaboration with the German DFS.
- This project is part of ALBATROSS and has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017678







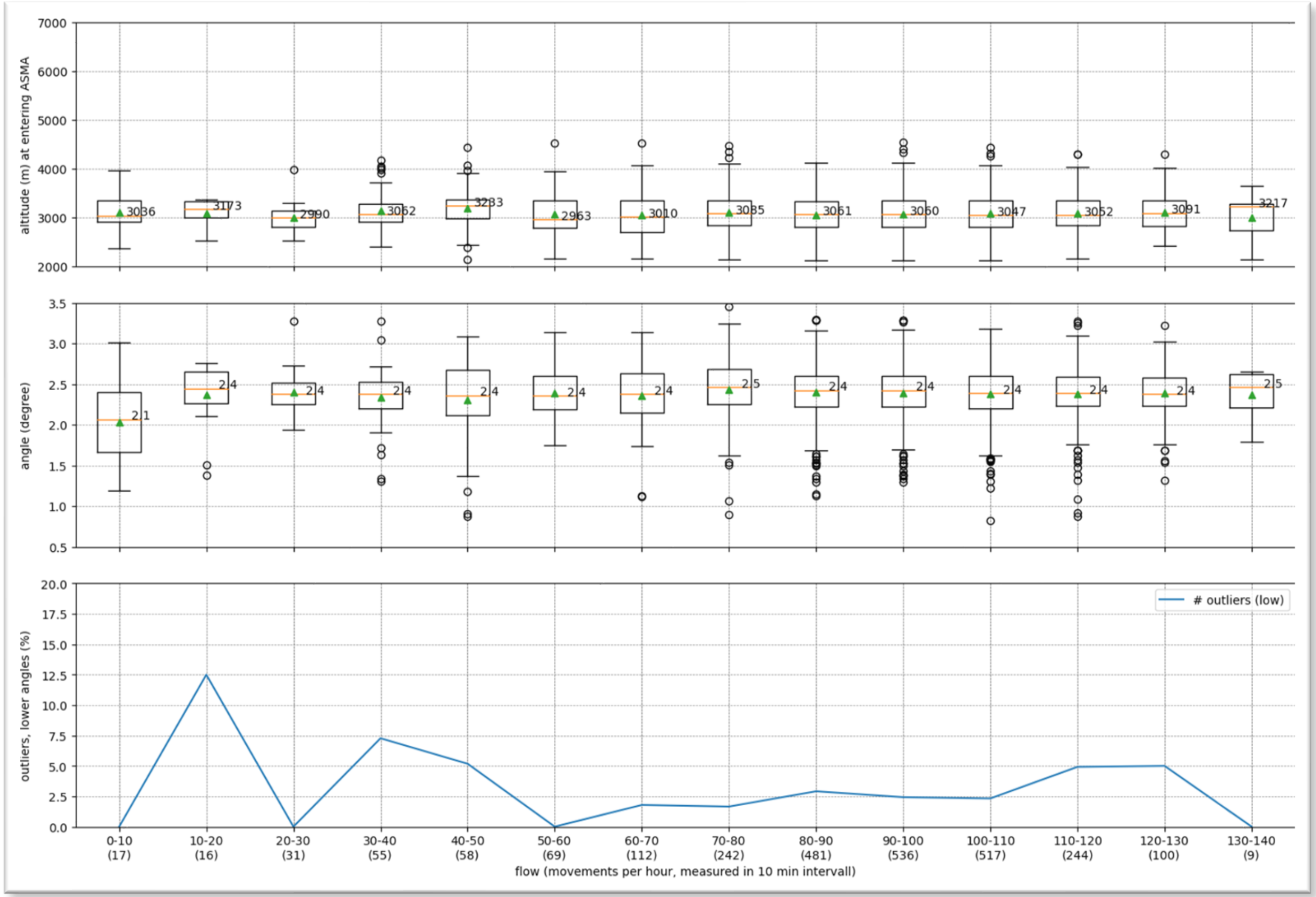
sesar JOINT UNDERTAKING
Co-funded by the European Union

DFS Deutsche Flugsicherung

LUFTHANSA GROUP

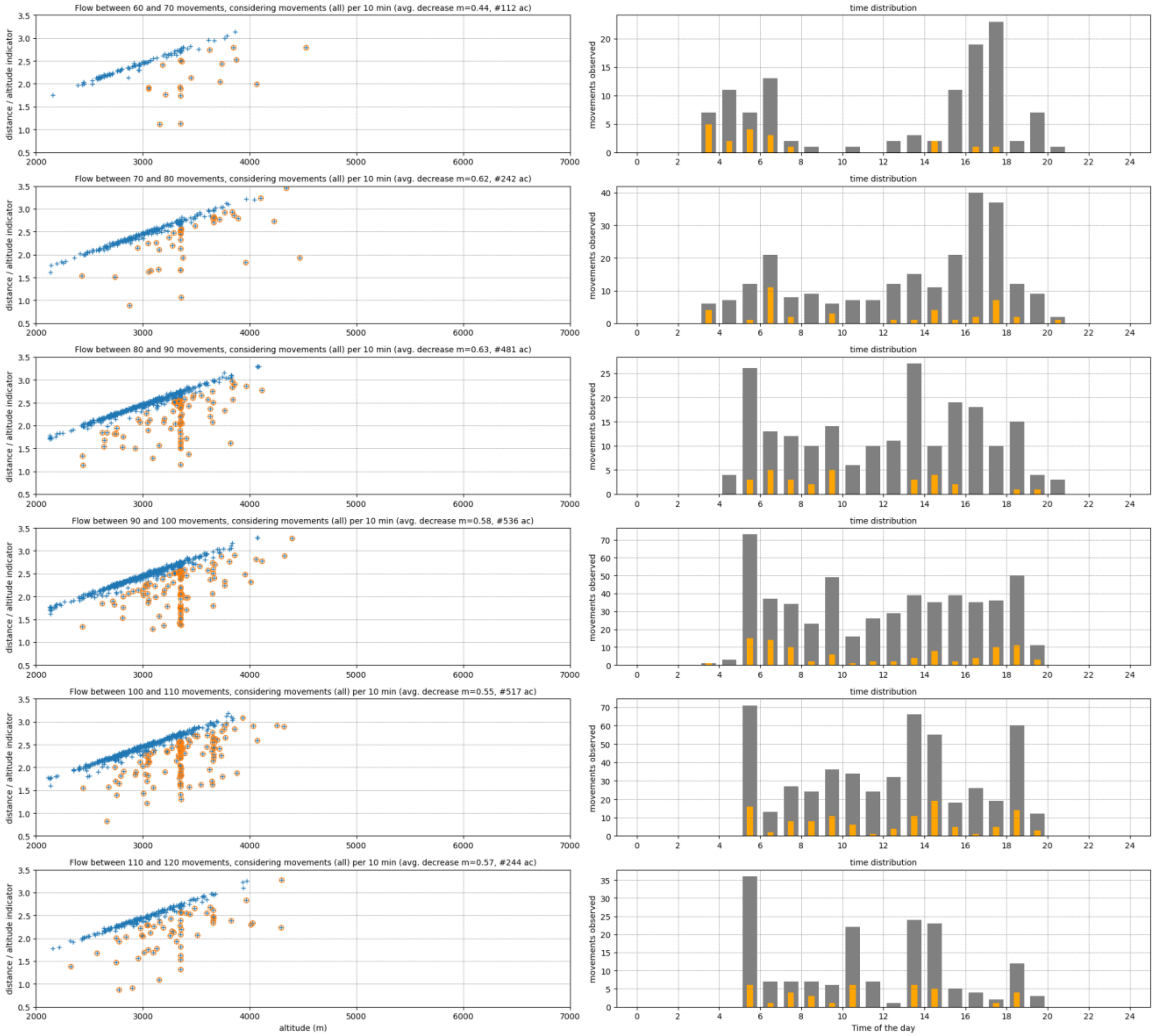
Main Findings based on an Example Cluster „North-East“ at FRA

- Mean entry altitudes and descent angles of similar flights change little as a function of traffic volume
- Number of outliers increases towards smaller descent angles with increasing traffic
- In all scenarios, an average descent angle can be seen at medium to high sector loads, which in some cases is significantly (1° -2.5°) below the optimum of 3°.
- To improve this ratio, a planned (known) longer distance would require a higher entry altitude.



Further analysis identified inefficient ratios of entry altitude to actual observed remaining distance within a 40 NM radius

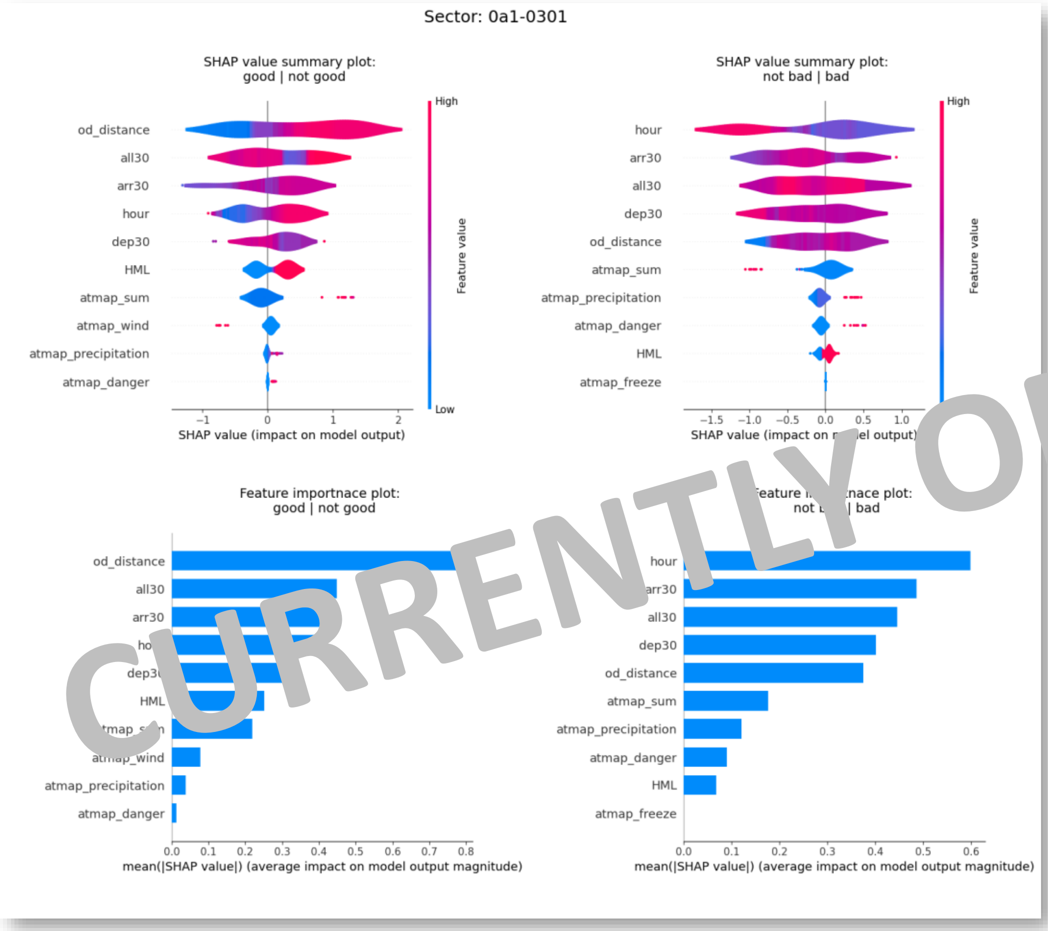
- The „Actual Distance To Go“ from ASMA entry (40 NM around the airport) to touchdown has no influence on the entry altitude.
- The time dependence shows, at what time do inefficient events accumulate
- The analysis shows, that more efficient flights were actually possible **<u>under the same conditions!</u>**

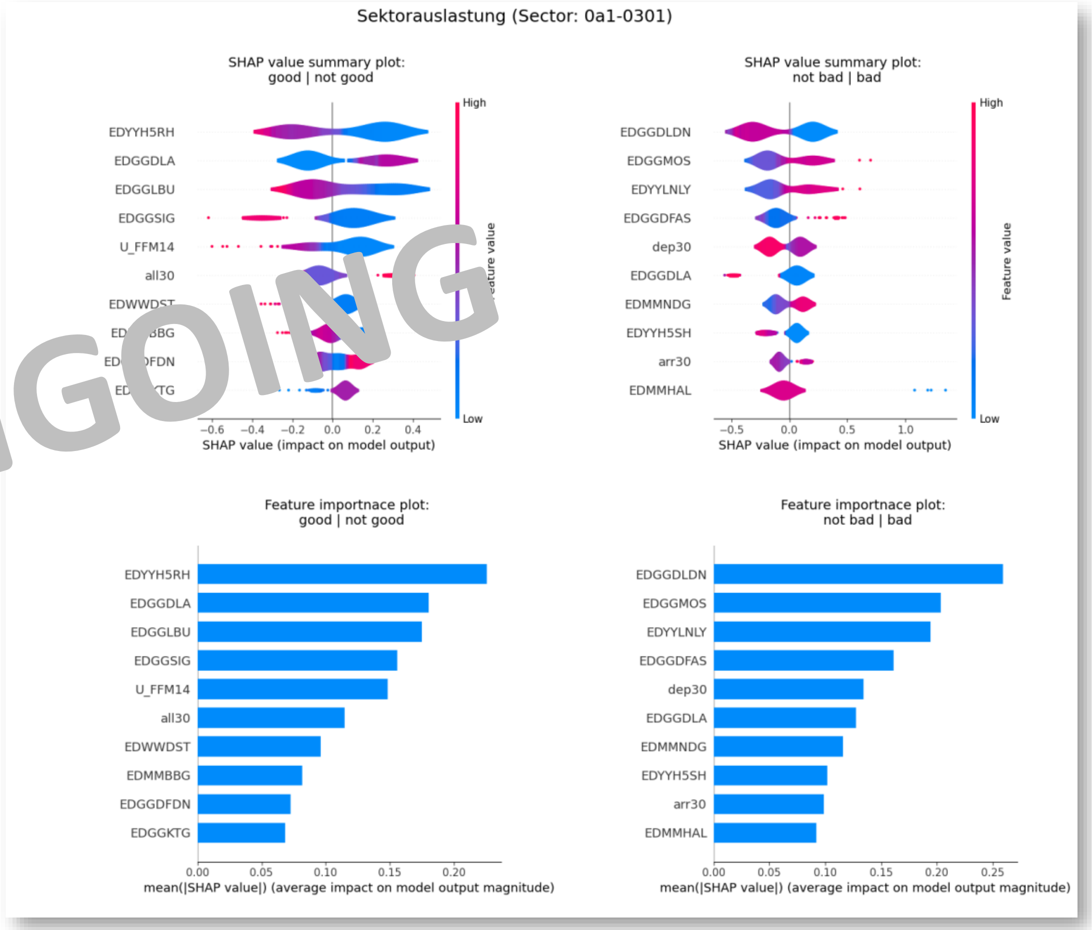


Further investigation is needed to find the correlations and causalities

DFS Deutsche Flugsicherung

Outlook… Further Deep Learning Algorithms reveal correlations. It is up to us to evaluate the causalities





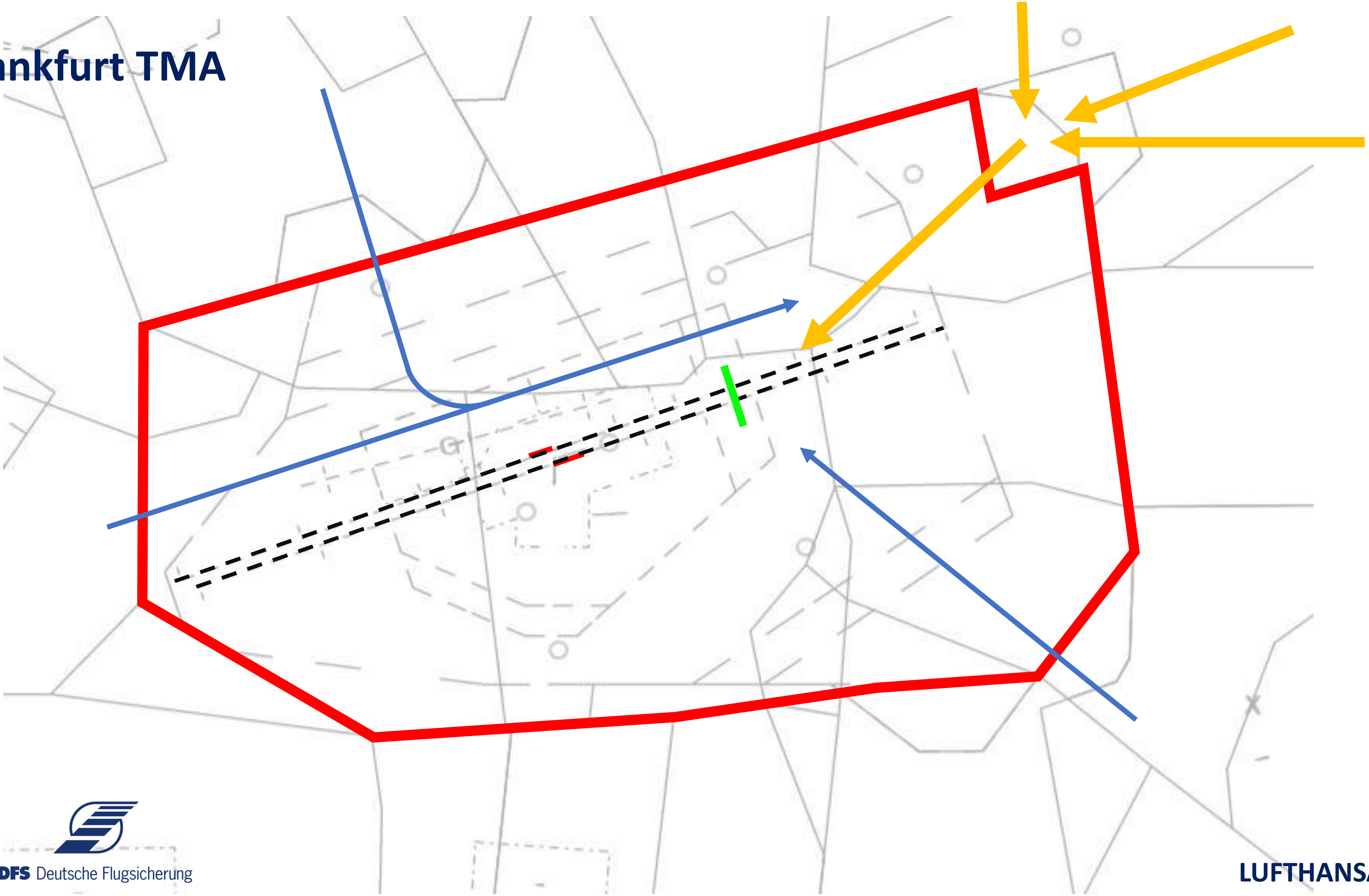
DFS Deutsche Flugsicherung

LUFTHANSA GROUP

Possible solutions for traffic from the north-east

- To improve the descent angle, a planned (known) longer distance would require a higher entry altitude
- Adaption of operational agreements (LOA) that allow for a runway direction-dependent entry altitude
- Adaption of airspace geometry (installation of „balcony“) to foster a more efficient traffic flow from the north-east

Frankfurt TMA

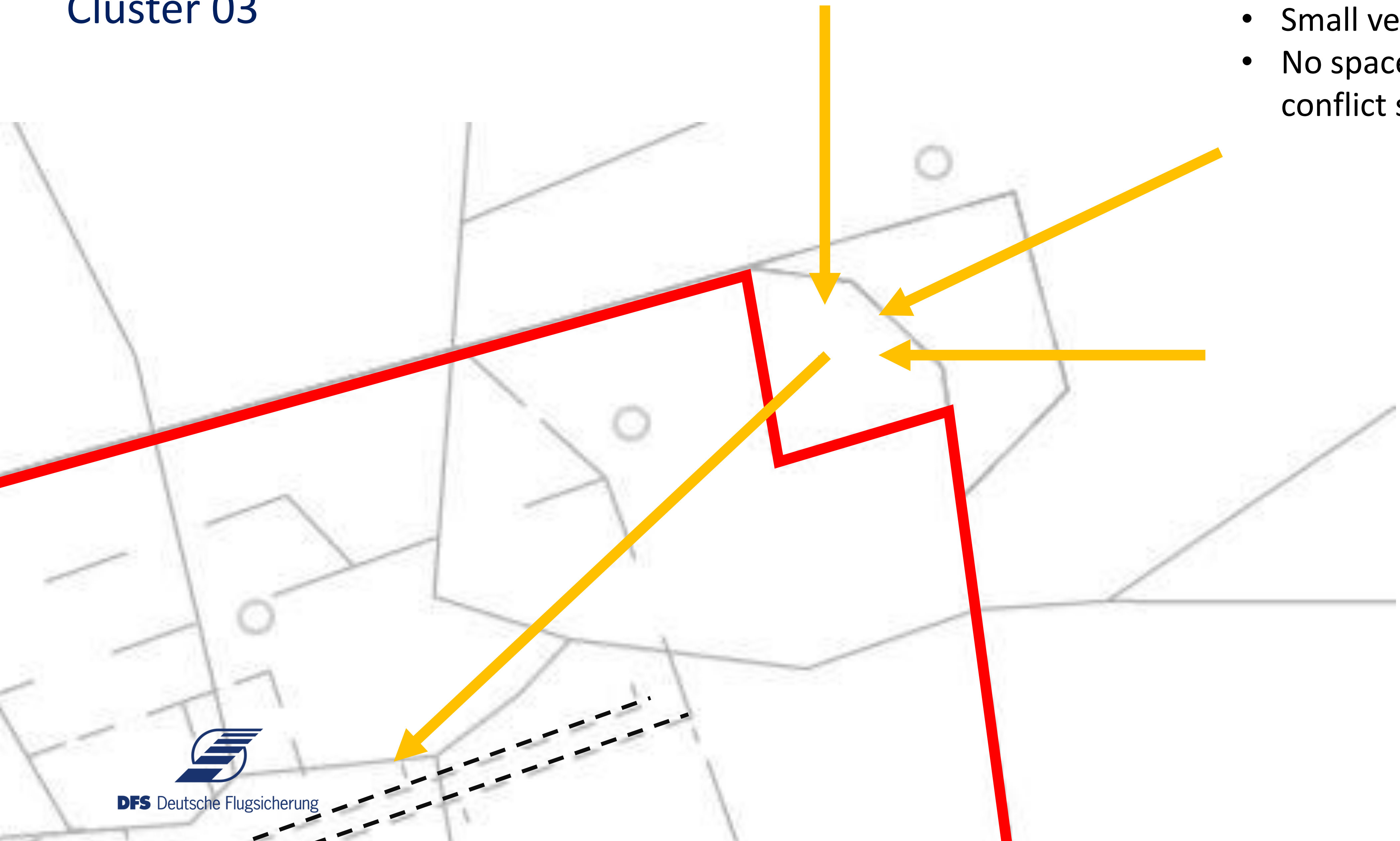


DFS Deutsche Flugsicherung

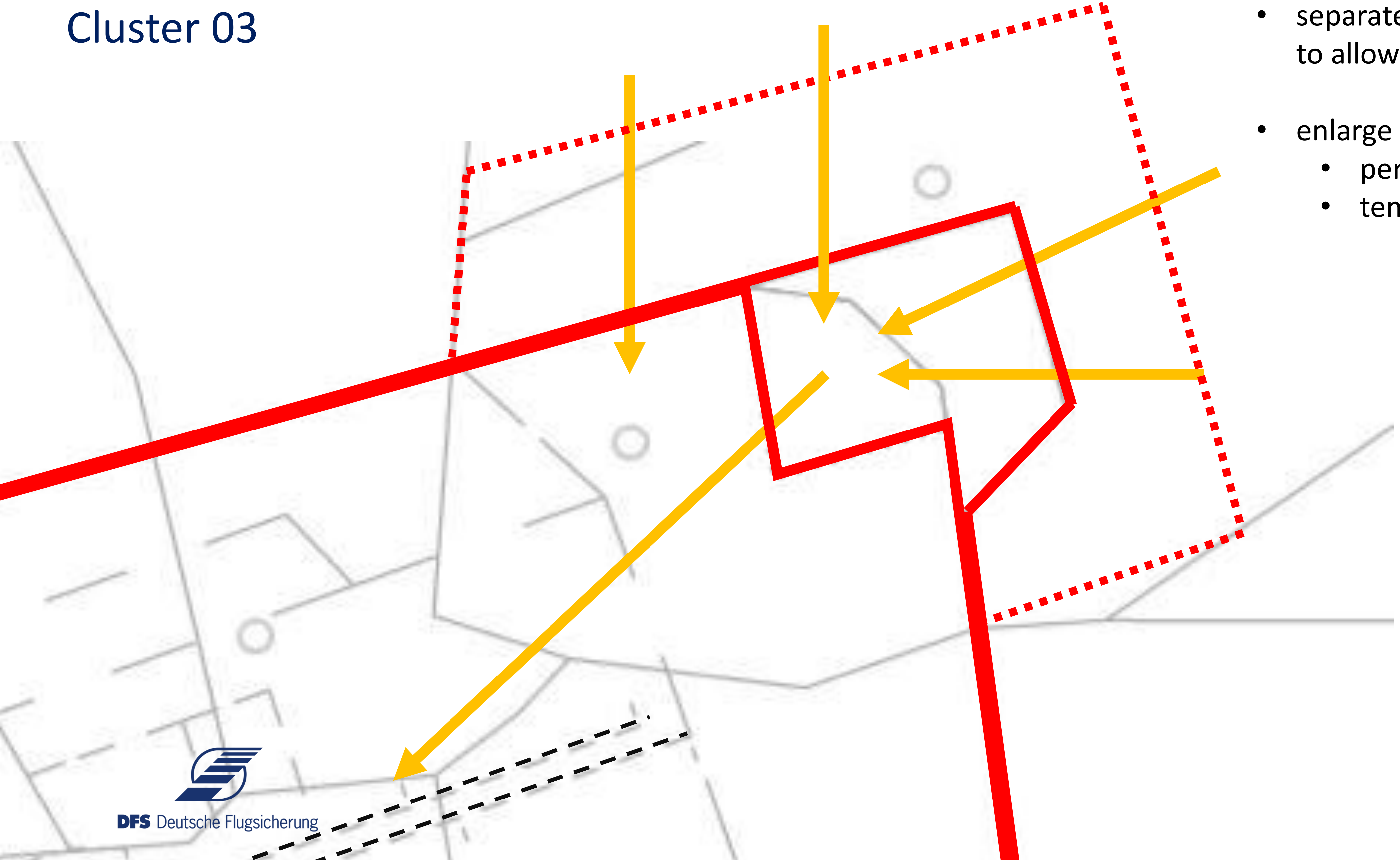
LUFTHANSA GROUP

Frankfurt TMA
Cluster 03

- Small vectoring airspace
- No space for lateral conflict solutions



Frankfurt TMA
Cluster 03

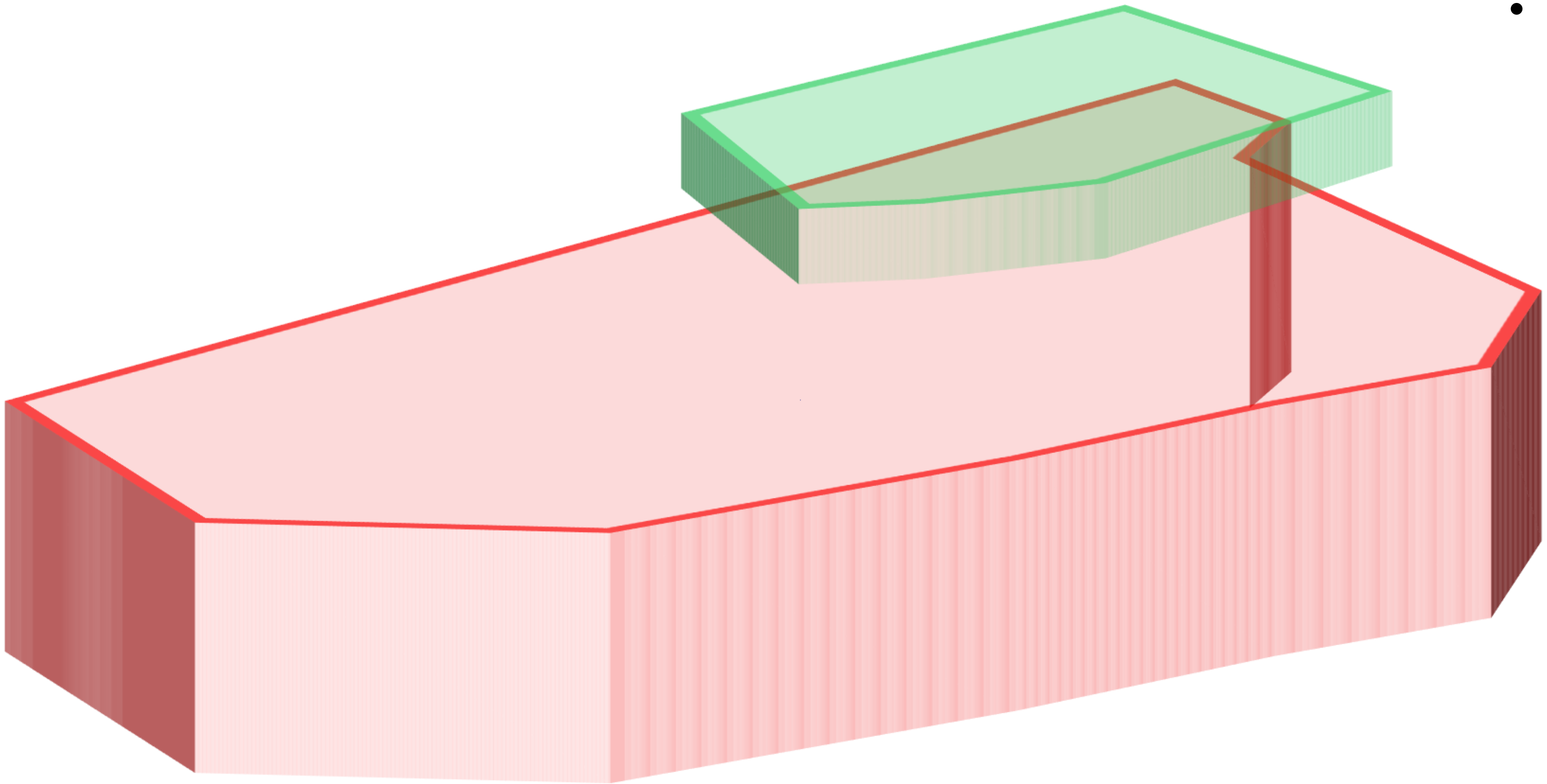


- separate inbound routings to allow for lateral solutions
- enlarge vectoring airspace
  - permanently
  - temporary

DFS Deutsche Flugsicherung

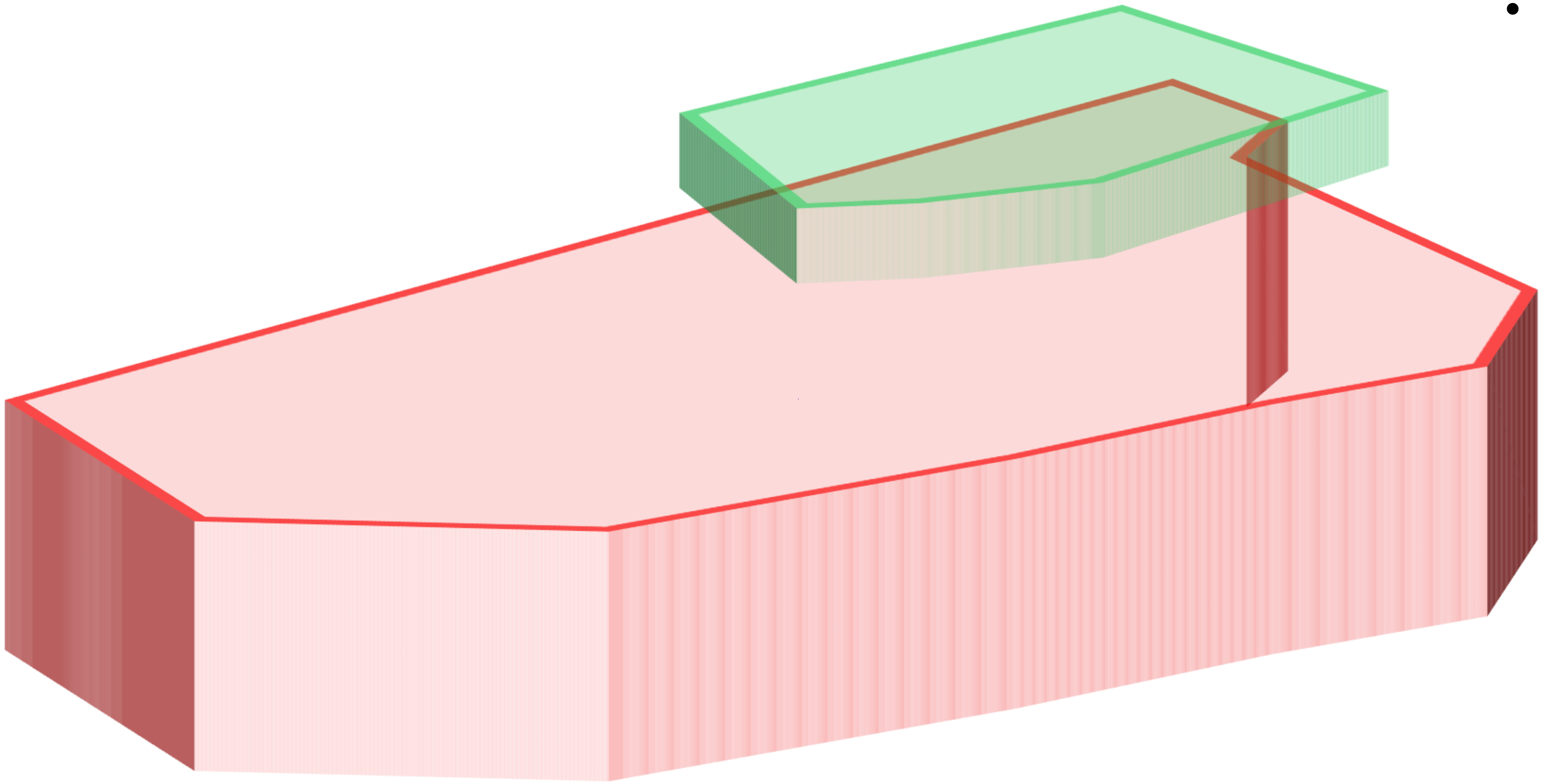
LUFTHANSA GROUP

Vertical Improvements
Cluster 03



- Raise KERAX Transfer Level from 110 to 130
- Potential higher Transfer Levels coordinated individually via AMAN

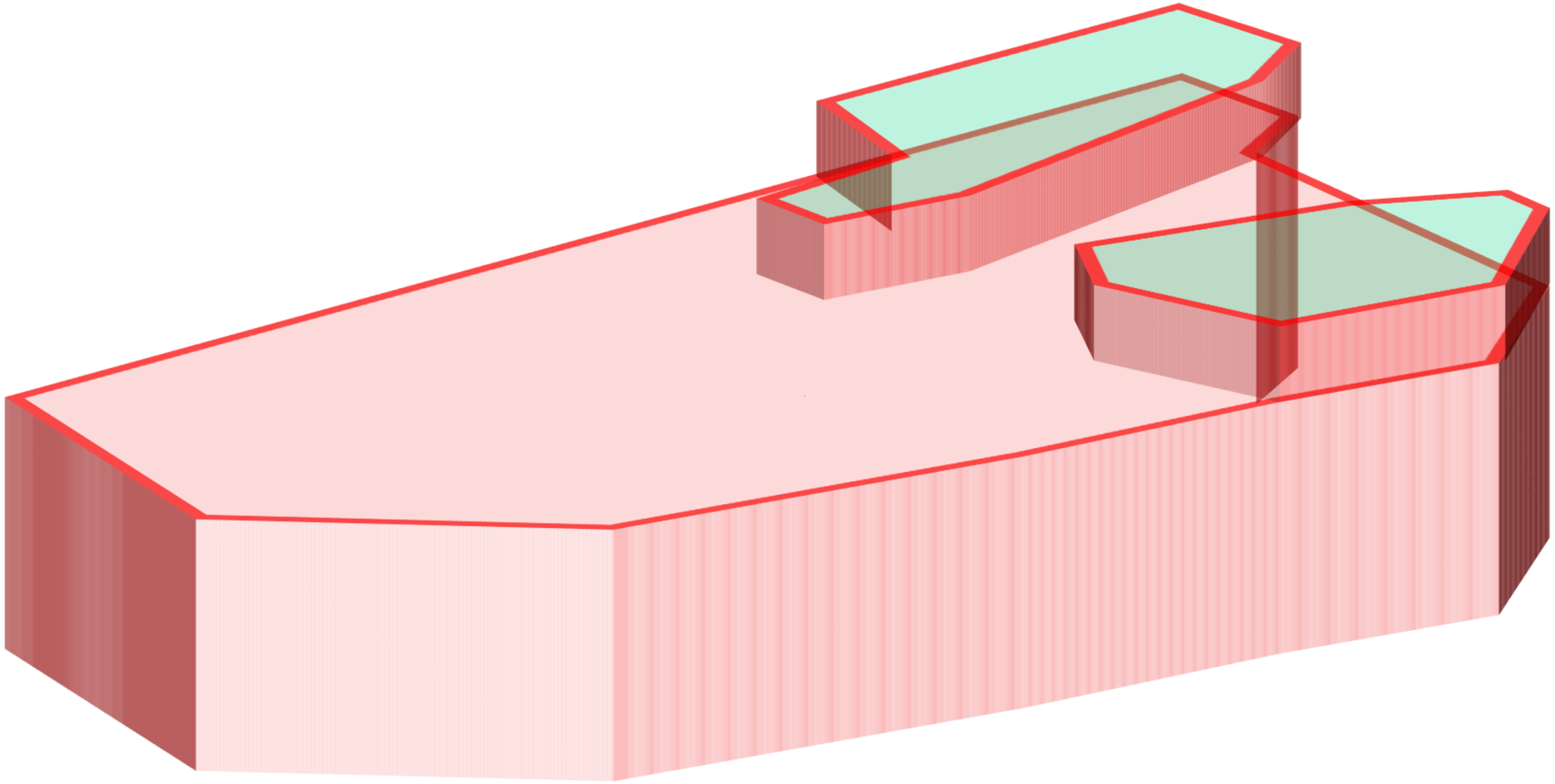
Vertical Improvements
Cluster 03



- Raise KERAX Transfer Level from 110 to 130
- Potential higher Transfer Levels coordinated individually via AMAN

Vertical Improvements
Cluster 03

Descend Windows for
Landing Direction 07

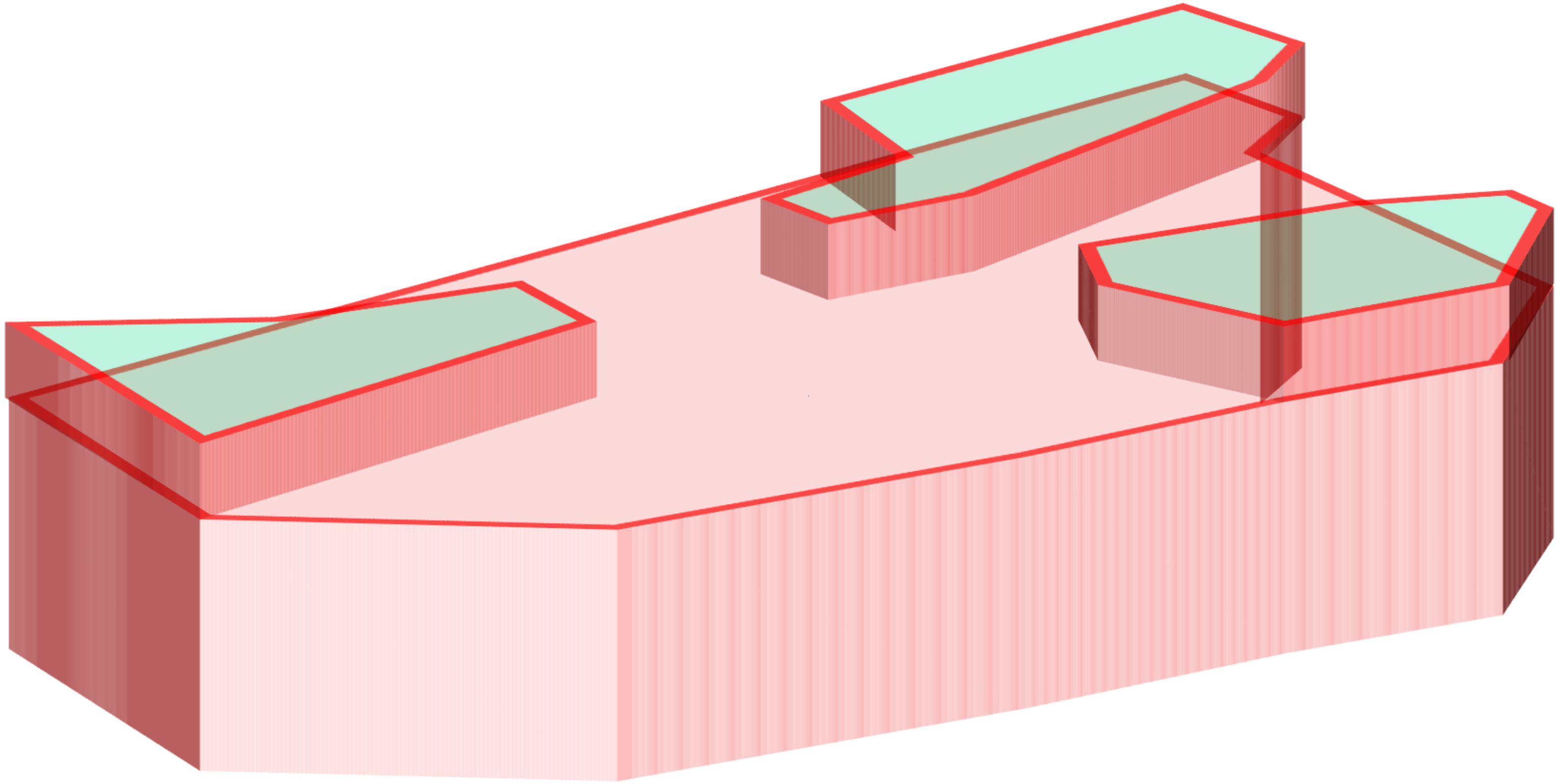


DFS Deutsche Flugsicherung

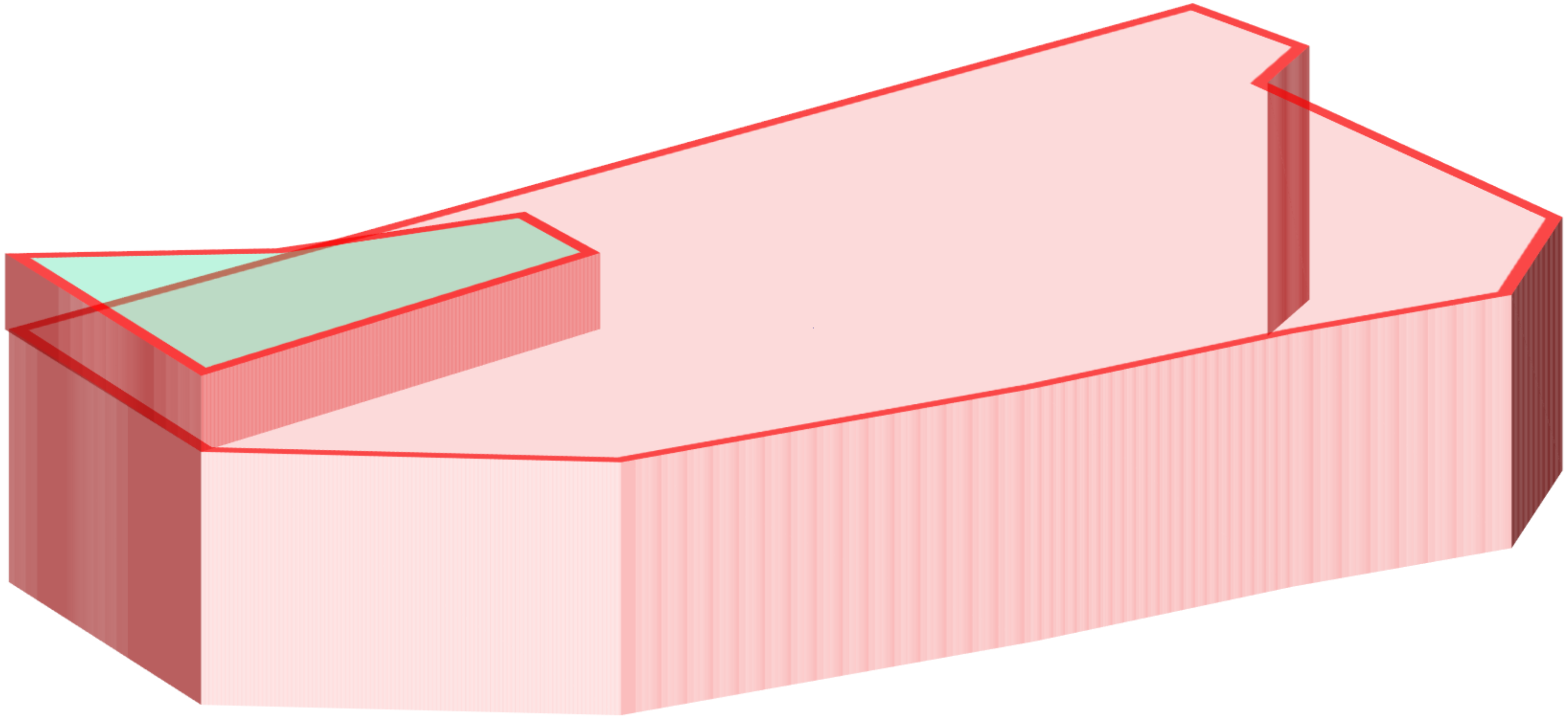
LUFTHANSA GROUP

Vertical Improvements
Cluster 03

Descend Window for Landing Direction 25



Vertical Improvements
Cluster 03



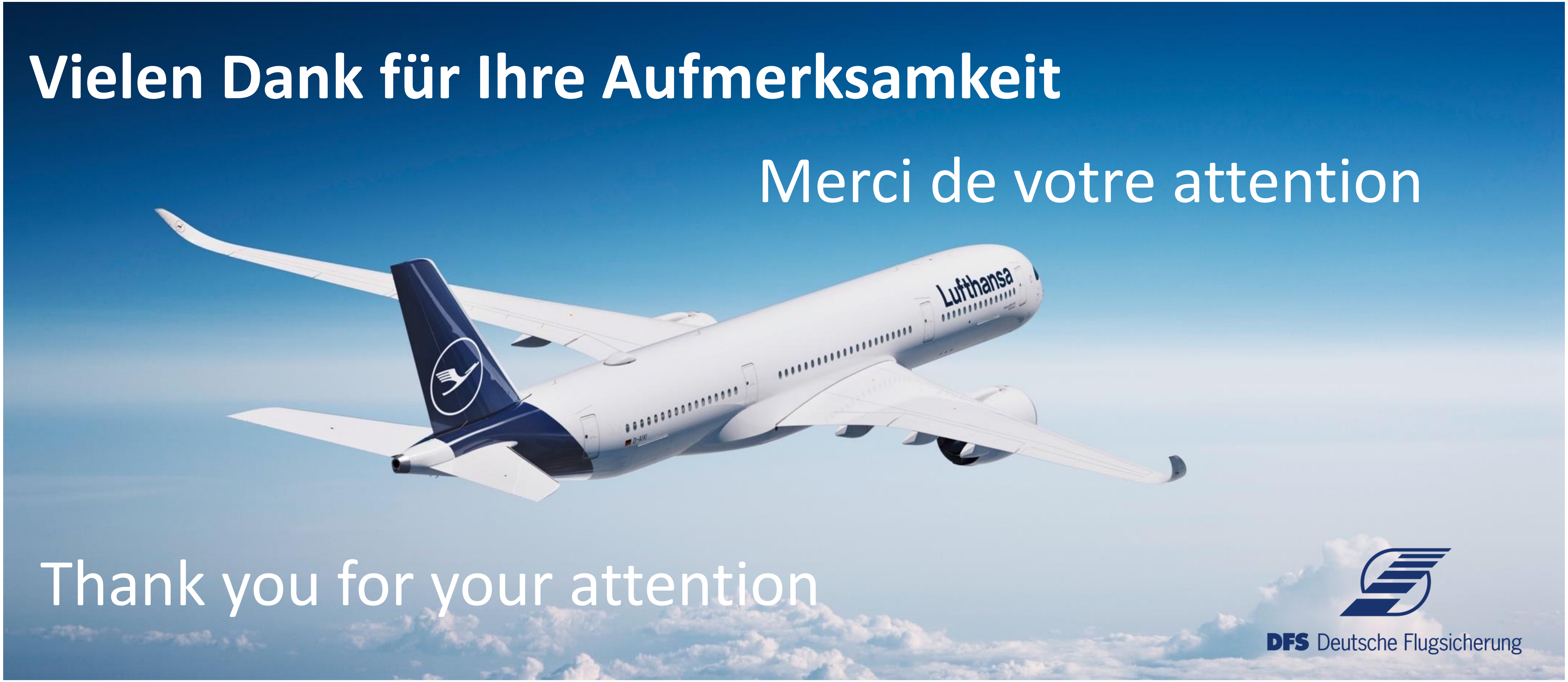
DFS Deutsche Flugsicherung

LUFTHANSA GROUP

DFS Deutsche Flugsicherung

LUFTHANSA GROUP

- a larger airspace for lateral sequencing and separation allows for more efficient vertical flight profiles
- individually (via AMAN System) coordinated higher transfer levels allow for a higher percentage of continuous descends
- flexible descend windows allow for optimal use of airspace considering the Runway in use


Vielen Dank für Ihre Aufmerksamkeit
Merci de votre attention
Thank you for your attention
DFS Deutsche Flugsicherung