



# Contrail Mitigation in Flight Planning

Dr. Benedikt Annweiler

Lufthansa Systems GmbH

November 8<sup>th</sup>, 2023

# D-KU<sup>IMPACT</sup>LT

Gefördert durch:  
 Bundesministerium für Wirtschaft und Klimaschutz  
aufgrund eines Beschlusses des Deutschen Bundestages



Lufthansa Systems



Lufthansa



AIRBUS

# The Flight Planning Problem



# The Flight Planning Problem – Total Cost Optimization

Minimize



Fuel Costs

+



Time Costs

+



Overflight Charges

Constraints

s.t.



are legal and flyable

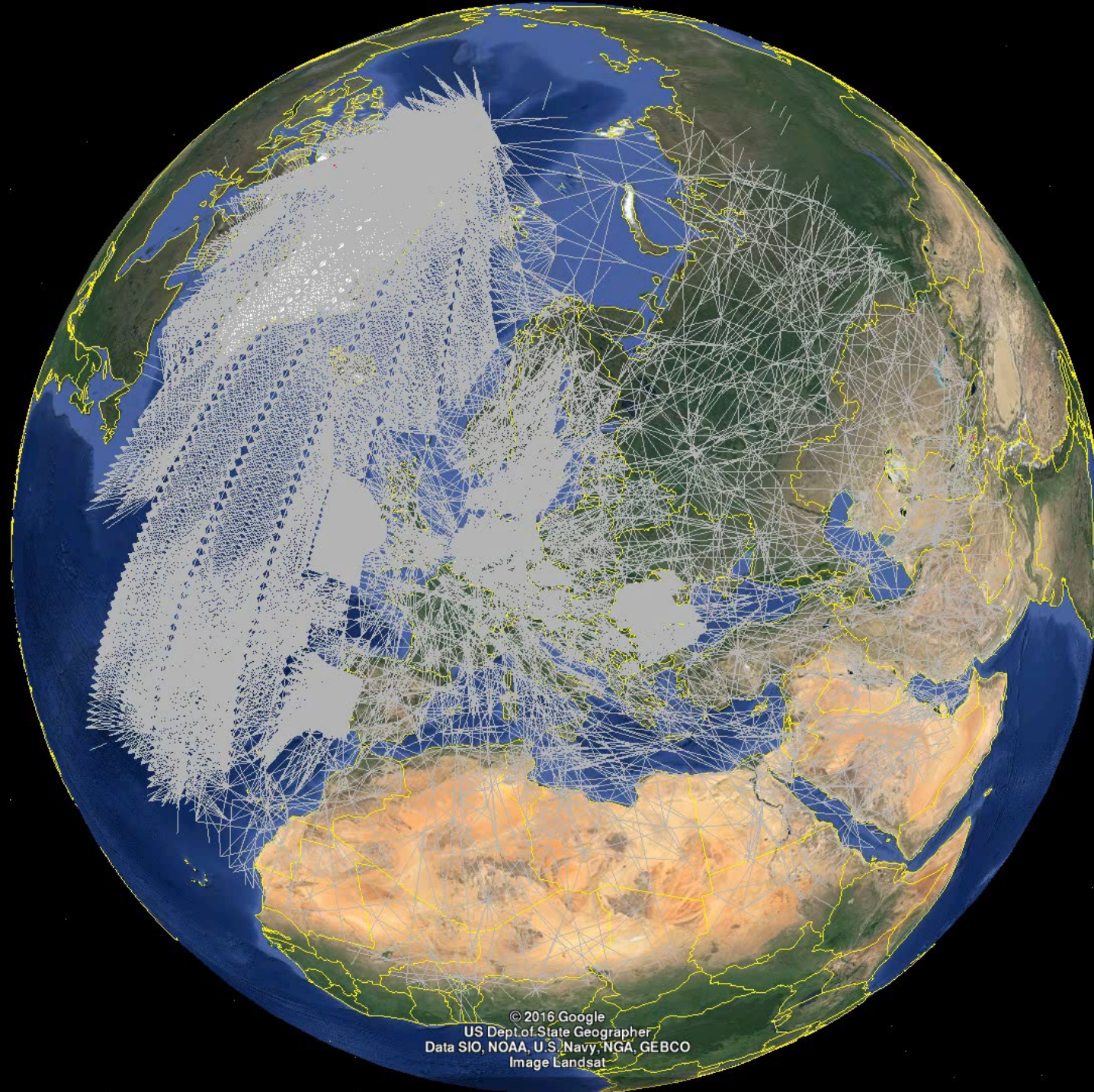
Output



Cost-Optimal  
Legal Trajectory

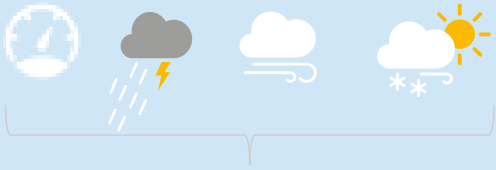


Fuel Value



© 2016 Google  
US Dept. of State Geographer  
Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image Landsat

# Lido Flight 4D helps to mitigate contrails



Lido Flight 4D is using predicted weather information to identify contrail areas

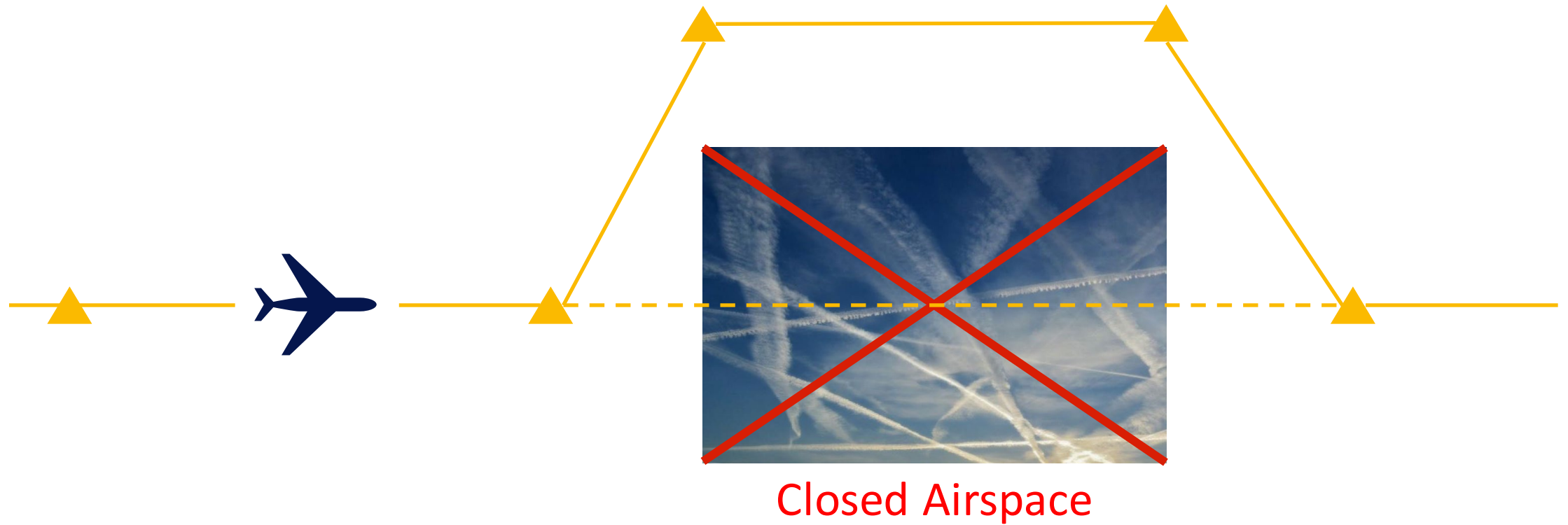
**Lido Flight 4D**



- 1 Mitigate contrails by adjustment of flight route (vertically and horizontally)
- 2 Flight route causing contrail in contrail area

# Ways of adding contrail costs

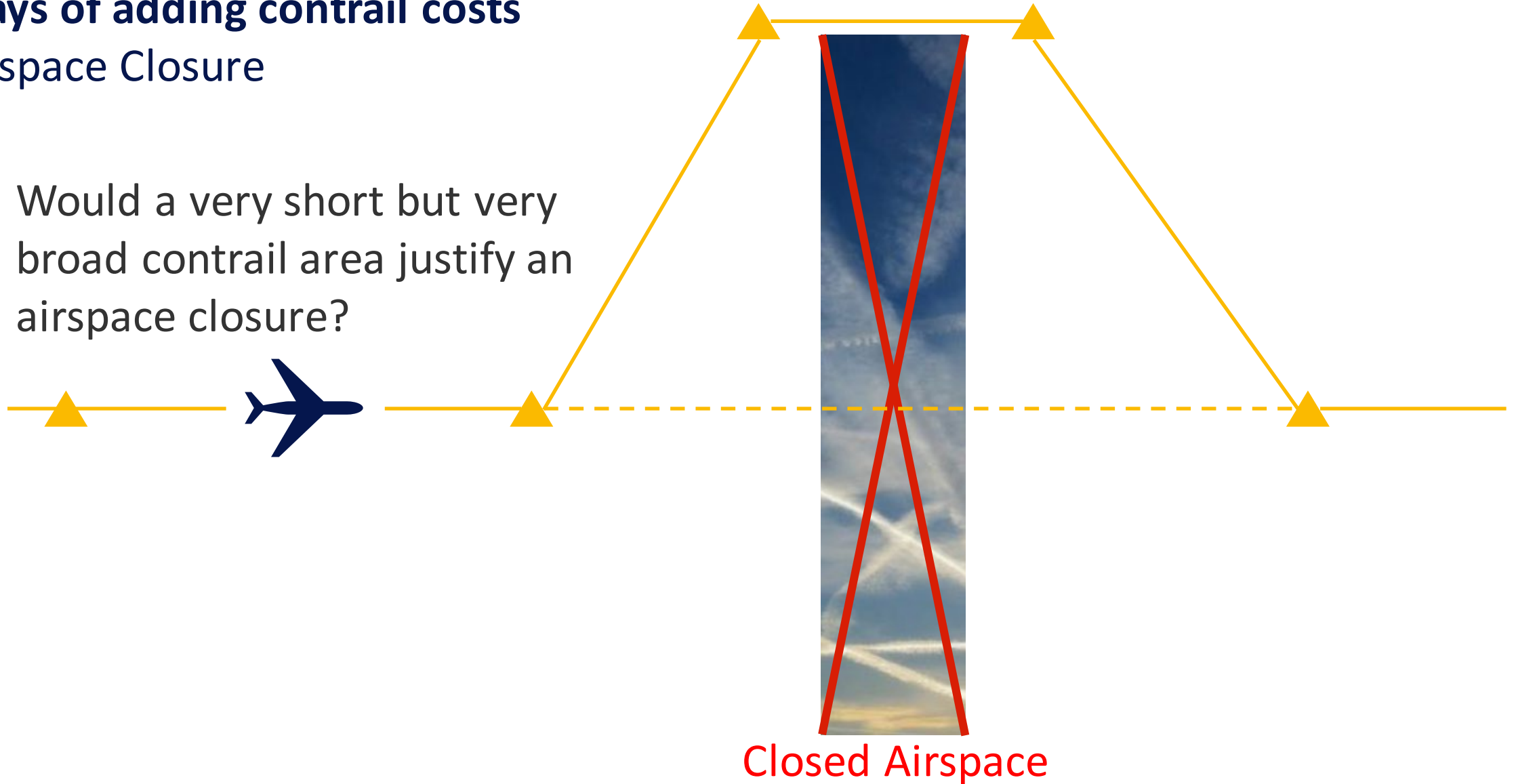
## Airspace Closure



# Ways of adding contrail costs

## Airspace Closure

Would a very short but very broad contrail area justify an airspace closure?



# The Flight Planning Problem – Total Cost Optimization

Minimize



Fuel Costs

+



Time Costs

+



Overflight Charges

+



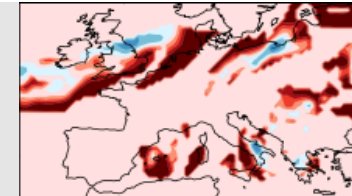
Environmental  
Costs

Constraints

s.t.



are legal and flyable,



Output



**Eco-Friendly** Cost-Optimal  
Legal Trajectory



Fuel Value

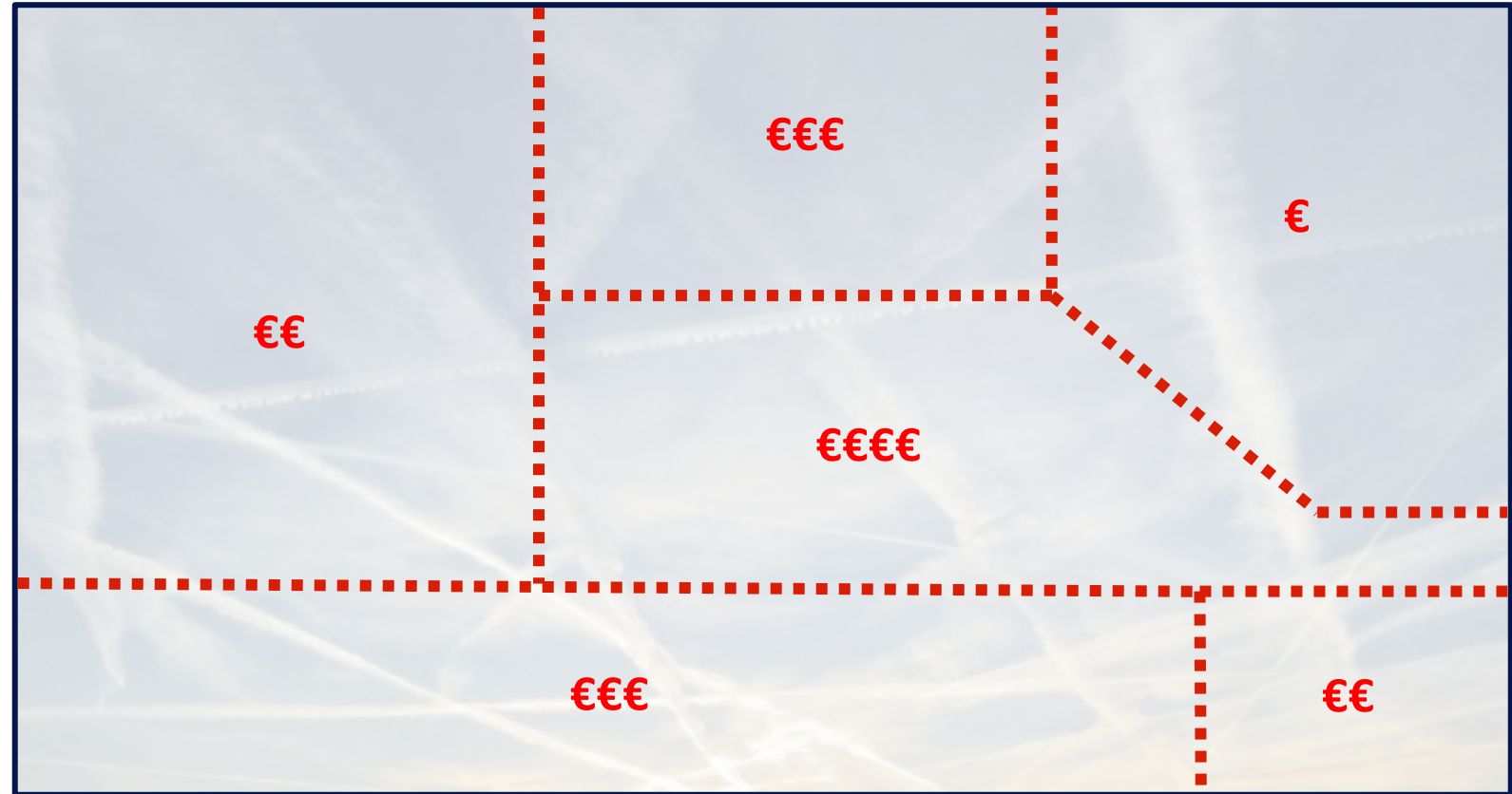
# Ways of adding contrail costs

## Attach Costs to Contrail Formation Areas



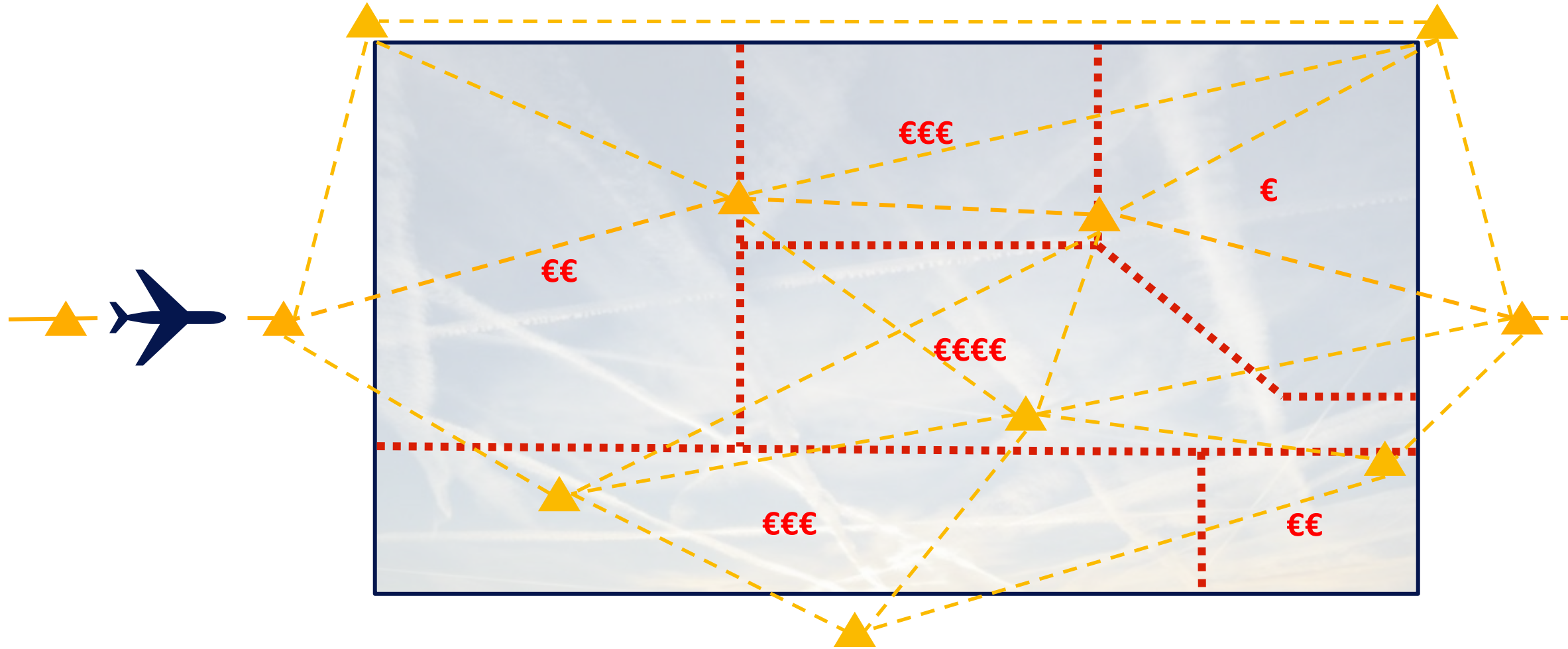
# Ways of adding contrail costs

## Attach Costs to Contrail Formation Areas



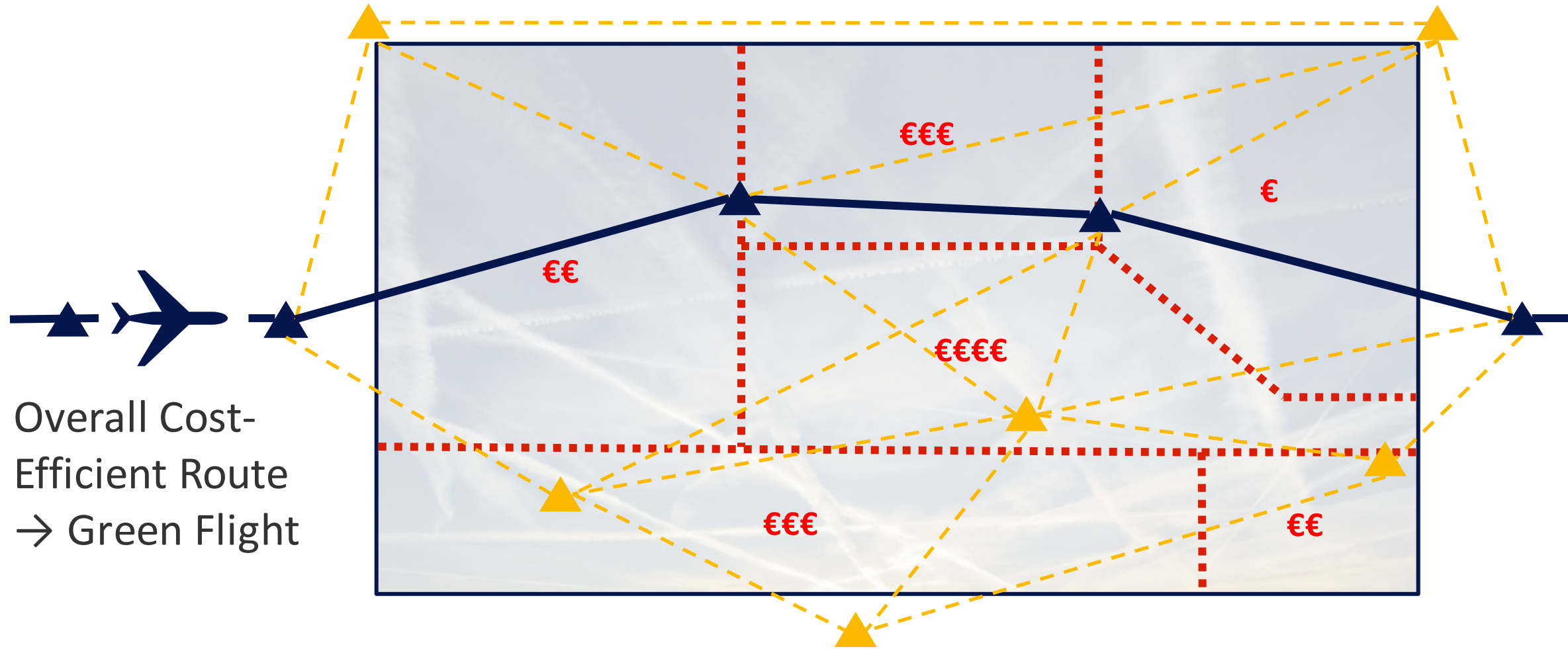
# Ways of adding contrail costs

## Attach Costs to Contrail Formation Areas



# Ways of adding contrail costs

## Attach Costs to Contrail Formation Areas



Overall Cost-  
Efficient Route  
→ Green Flight



## Contact

Dr. Benedikt Annweiler

[Benedikt.annweiler@lhsystems.com](mailto:Benedikt.annweiler@lhsystems.com)