



# WP2.2.2 Benefit Assessment

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# CATS Benefit assessment



The general objective of WP 2.2.2 is to assess the costs and benefits following the introduction of the Concept of Operations (Contract of Objectives and Target Windows) for ANSPs, aircraft operators and airports.



# CATS Benefit Assessment



It is structured in three parts

- Qualitative/Quantitative economic assessment of the CATS concept of operations.
  - It follows E-OCVM descriptions for a Business Case in accordance with guidelines from the CAATS II Project:
    - D19.2 Business good practices
    - D20 Guidance material for a typical business case
  - It considers both
    - Flight Planning phase
    - Flight Execution phase
- Introduction of a negotiation mechanism for TW assignment at the short-term planning level
- Evaluation of benefits if time windows of variable width exist (the Air Traffic Flow Management problem with Time Windows)



# Economic Assessment



- The CATS project is at an early stage of its life cycle
  
- We need a practical way to deal quantitatively with complex decision making problems based on qualitative judgements
  
- Expert group
  - Air France Consulting
  - ENAV
  - Unique Zurich Flughafen



# The AHP methodology

- Analytic Hierarchic Process (AHP)
  - It was proposed by Thomas Saaty in the '70s
  - It is based on an experts' group and literature figures
  - It converts experts' judgments into numerical values
  
- The first step consists in decomposing the decision problem into a hierarchy
- Easily comprehensible sub-problems are considered
- Each of them is analyzed independently



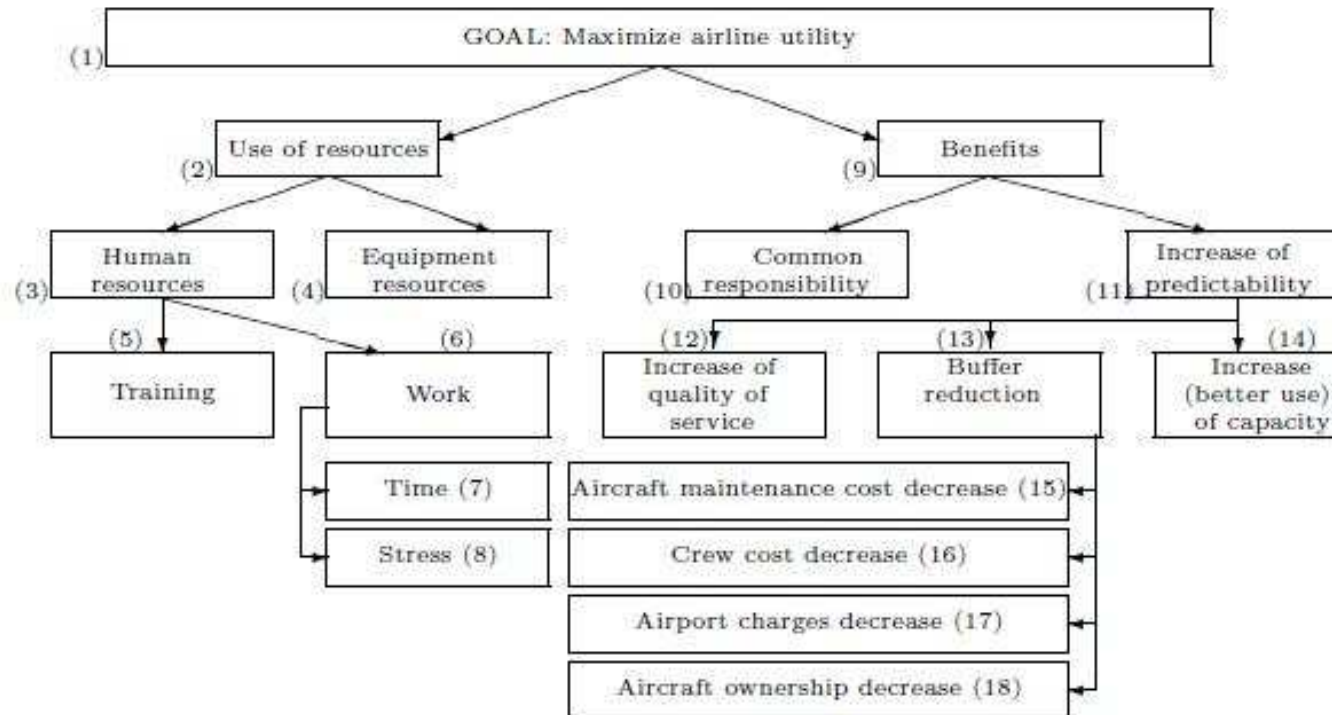
# Planning and execution phases



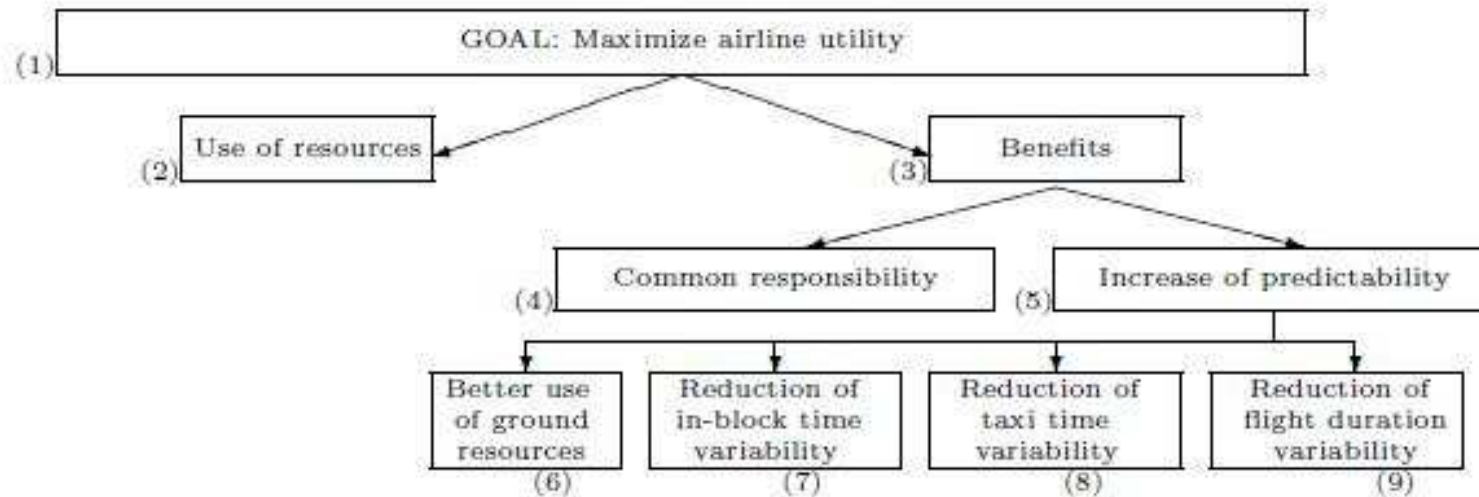
- Typically each flight is the result of a two step process: the planning and the execution phases
- In the planning phase long, medium and short term operational plans are developed and optimized
- In the execution phase, such operational plans are put in place
- Here we present the two hierarchies for airlines.



# Flight Planning phase - Airlines



# Flight Execution Phase - Airlines

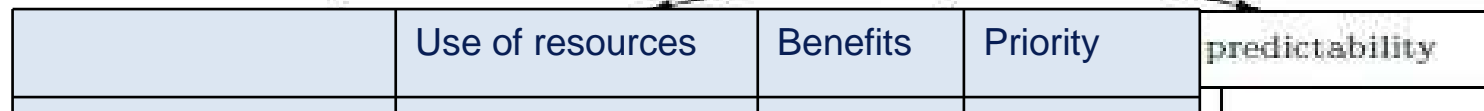


# Assigning weights to judgments

- Once the hierarchy is built, the decision makers systematically evaluate its various elements
- Pair wise comparisons are made at each level
- The AHP converts experts' judgments into numerical values
- A numerical weight or priority is derived for each element of the hierarchy

Judgment	Numerical value
Equally important	1
Slightly more important	3
Strongly more important	5
Very strongly more important	7
Extremely more important	9

# Results – Execution phase



<b>BENEFITS</b>	Common responsibility	Increase of predictability	Priority
Common responsibility	1	1/3	0.25

<b>INCREASE OF PREDICTABILITY</b>	Better use of ground resources	Reduction of in-block time variability	Reduction of taxi time variability	Reduction of flight duration variability	Priority
Better use of ground resources	1	1/2	1/3	1/5	0.083
Reduction of in-block time variability	2	1	1	1/4	0.160
Reduction of taxi time variability	3	1	1	1/4	0.180
Reduction of flight duration variability	5	4	4	1	0.577



# Results – Execution phase



- There is no significant impact of the implementation of CATS with respect to Business-as-Usual in terms of use of resources
- Benefits are going to be strongly improved

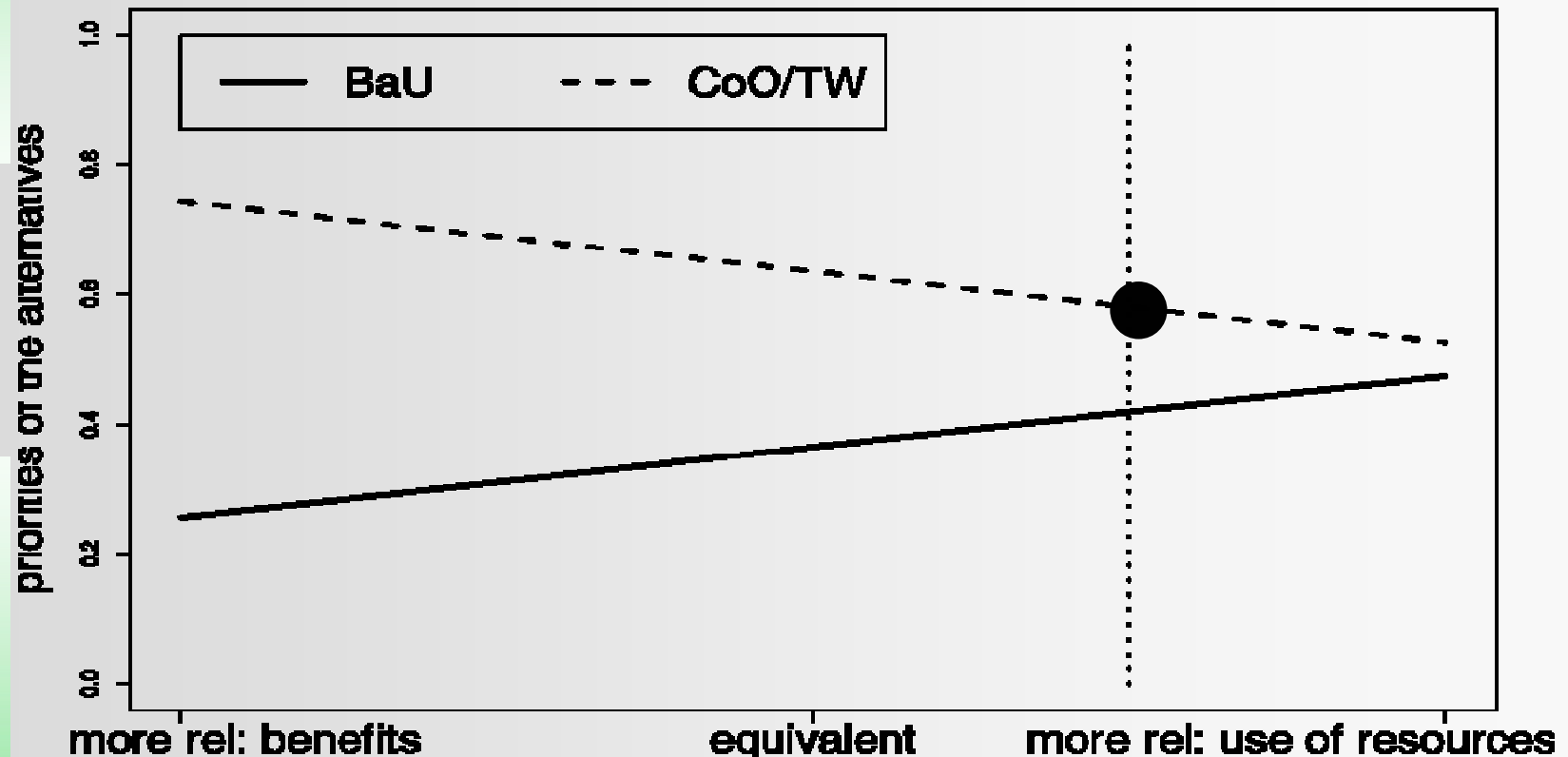
	Use of resources	Common responsibility	Better use of ground resources	Reduction of in-block time variability	Reduction of taxi time variability	Reduction of flight duration variability
Global priority	0.75	0.063	0.016	0.030	0.034	0.108
BaU	0.5	0.167	0.25	0.25	0.25	0.25
CATS	0.5	0.833	0.75	0.75	0.75	0.75



# Results of the AHP analysis - airlines

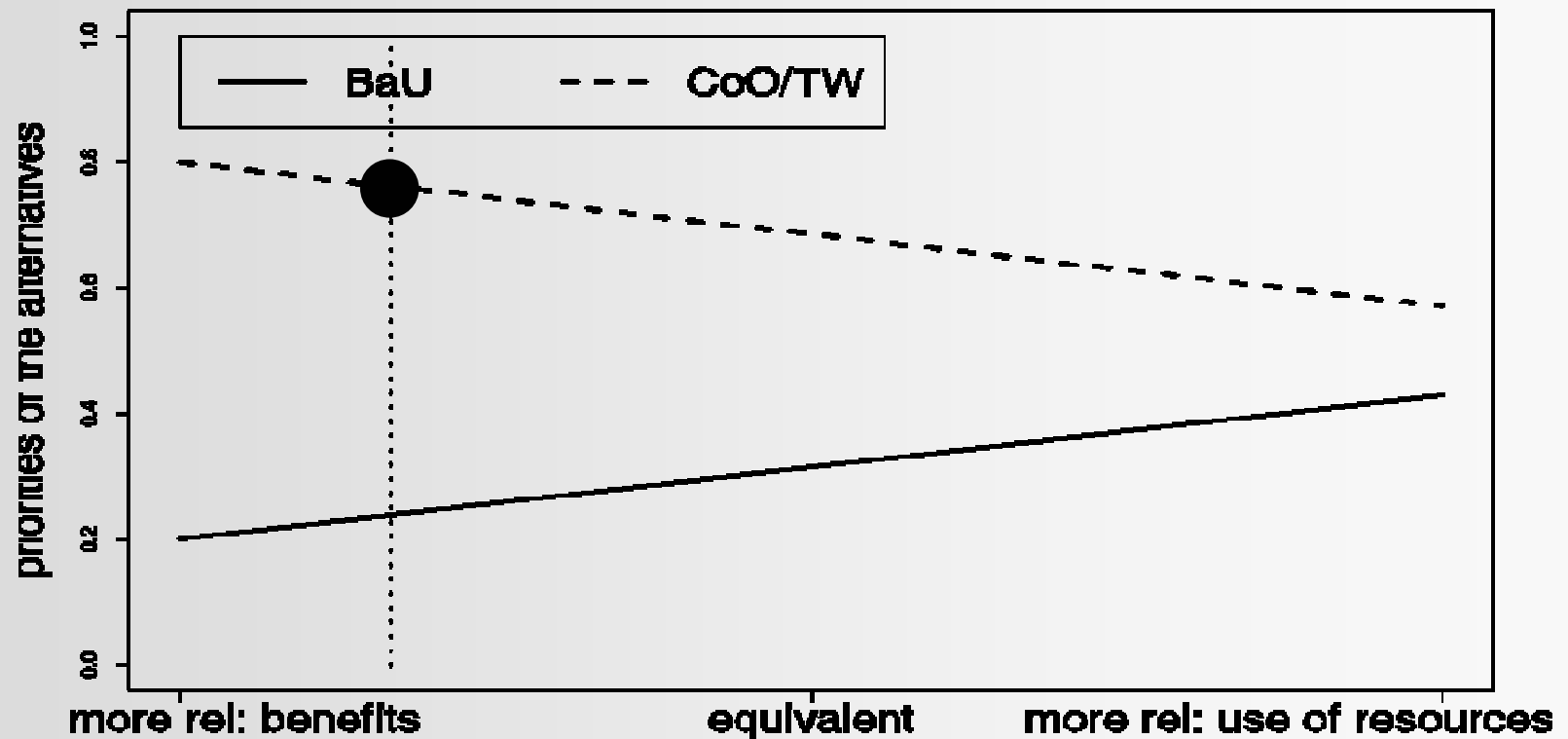
CATS is the preferable alternative:

Priority of 0.57 for both planning and execution phases



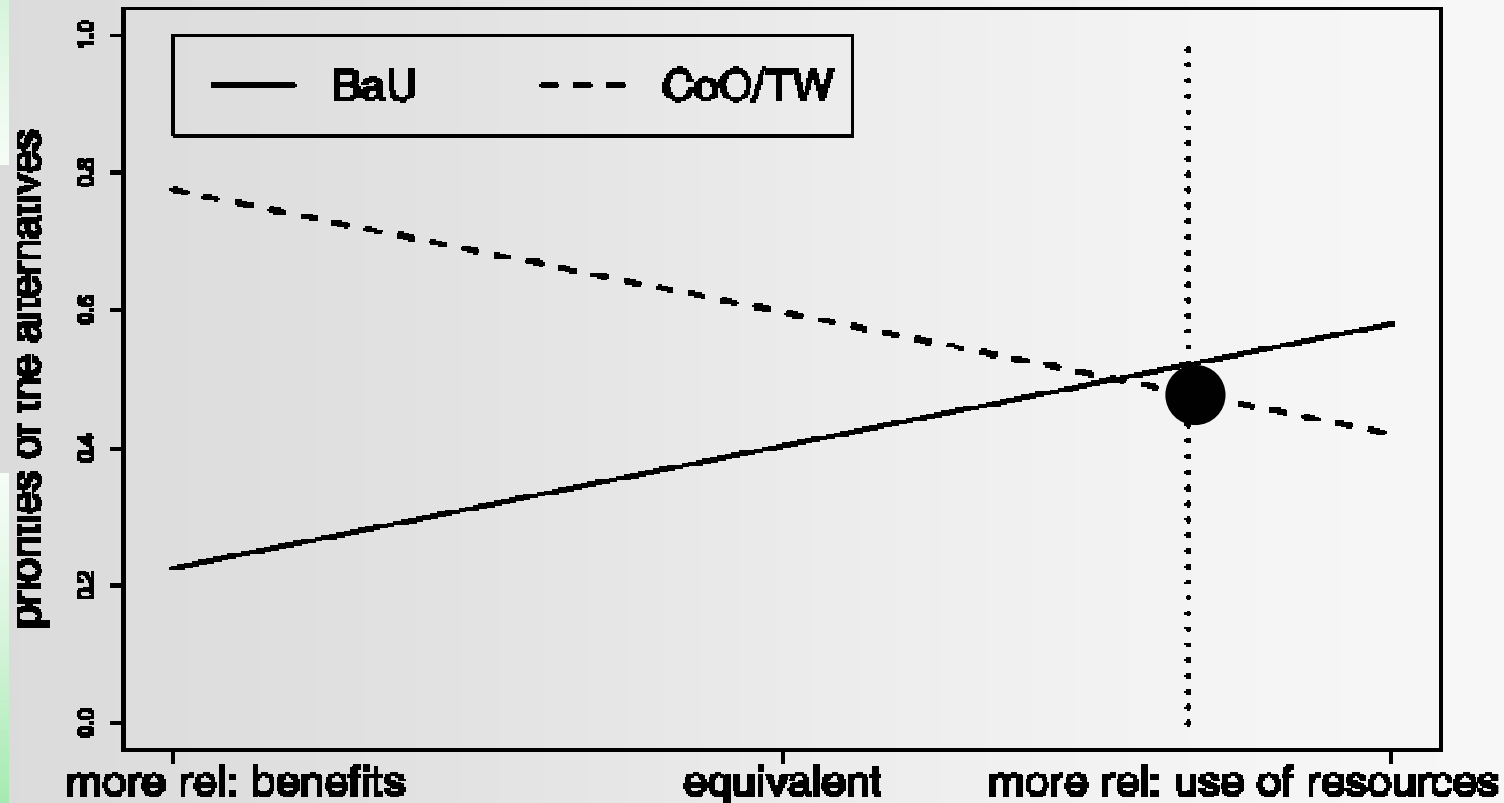
# Results of the AHP analysis - ANSPs

CATS is the preferable alternative:  
Priority of 0.73 (planning) and 0.78 (execution)



# Results of the AHP analysis - Airports

CATS is NOT the preferable alternative:  
Priority of 0.43 (planning) and 0.44 (execution)



# AHP – Final Results

	Planning Phase	Execution Phase
Airline	0.57	0.57
ANSP	0.73	0.78
Airport	0.43	0.44

Priority assigned to “implement the CoO/TW concept of operations” from the AHP models



# AHP - Conclusions

- Advantages from CoO/TW more relevant in the execution than planning phase
- Main benefits of CoO/TW
  - Common (or shared) responsibility
  - Increase of predictability
- CoO/TW to be preferred w.r.t. BaU for the Airline and the ANSP
  - This result is quite robust
- The Airport finds BaU more attractive
  - This result is NOT robust and strongly depends on the current economic situation
  - Zurich Flughafen already implements some CDM mechanism



# TW Negotiation

- According to the CATS concept of operations stakeholders shall negotiate TWs if a feasible assignment cannot be attained (e.g., mismatch between demand and capacity at the short-term planning level)
- Thus a priority rule involving users' preferences is put in place, as advocated by SESAR (e.g., UDPP)
- **SESAR: Improve equity**
  - *For priority management, ensure that more options will be available than just the 'first come first serve' rule*
  - *Ensure that priority rules will always be applied in a transparent, correct manner*
- 'First-Come-First-Serve' rule:
  - Perceived as fair by Airlines
  - Imposed centrally by CFMU irrespectively of their local preferences



# TW Negotiation principles

- At the (Mature) Shared Business Trajectory level, TWs could be assigned on a *FCFS* basis whenever there is a mismatch between demand and capacity (business-as-usual scenario)
- Users can successively trade these TWs with other TWs and/or with side payments to compensate delay increases
- Flights with a higher cost of delay can reduce their delays by acquiring earlier TWs from flights with a lower cost of delay



# TW Negotiation desirable properties



- Individual rationality
  - each airline has a non-negative payoff for participating in it
- Budget balance
  - the mechanism does not require subsidization from outside to run properly.
- Allocative efficiency
  - the mechanism produces an allocation which optimizes the sum of the costs reported by the airlines.
- Incentive compatibility
  - the mechanism is designed so that no airline can increase its payoff by misrepresenting its costs, provided that all other airlines are truthful.

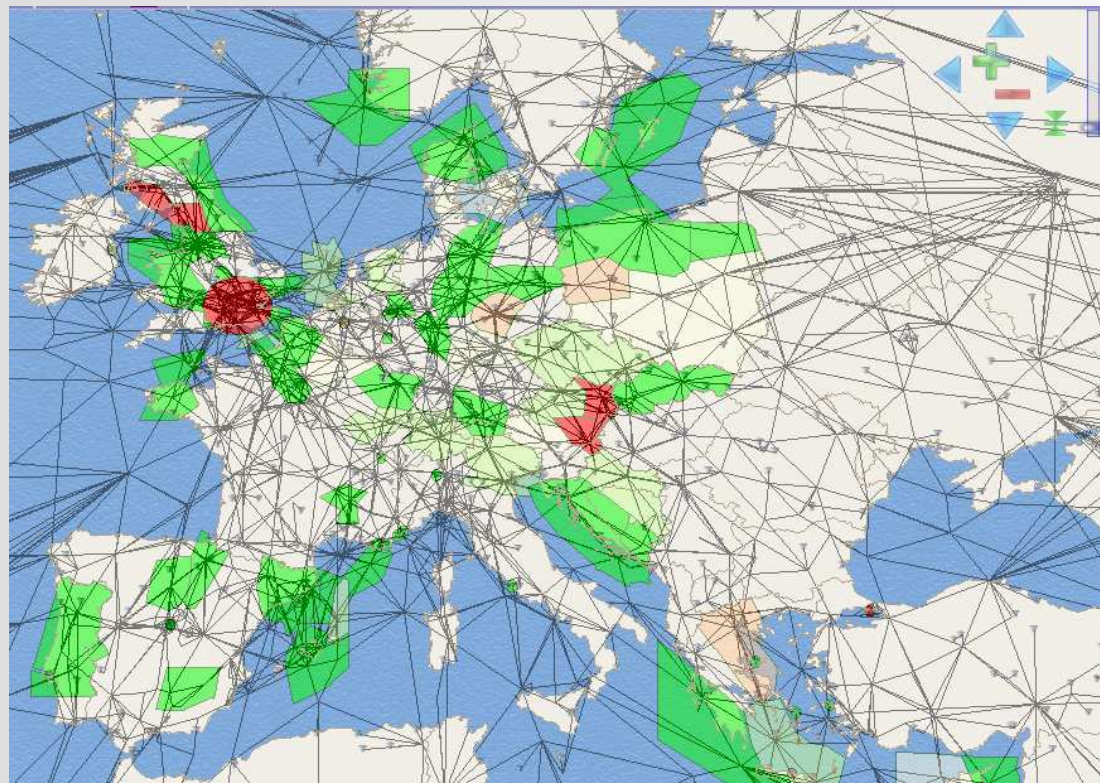


# TW Negotiation levels

- The negotiation mechanism can be implemented under two different configurations
- Central or Sealed-bid exchange
  - A central authority collects all relevant data from users (costs and desired TWs), solve the problem and communicates optimal exchanges and compensations to users
- Distributed or Iterative exchange
  - The central authority calculates the price for different TWs according to the excess of demand, communicates these prices to the users, who respond with the desired TWs at current prices

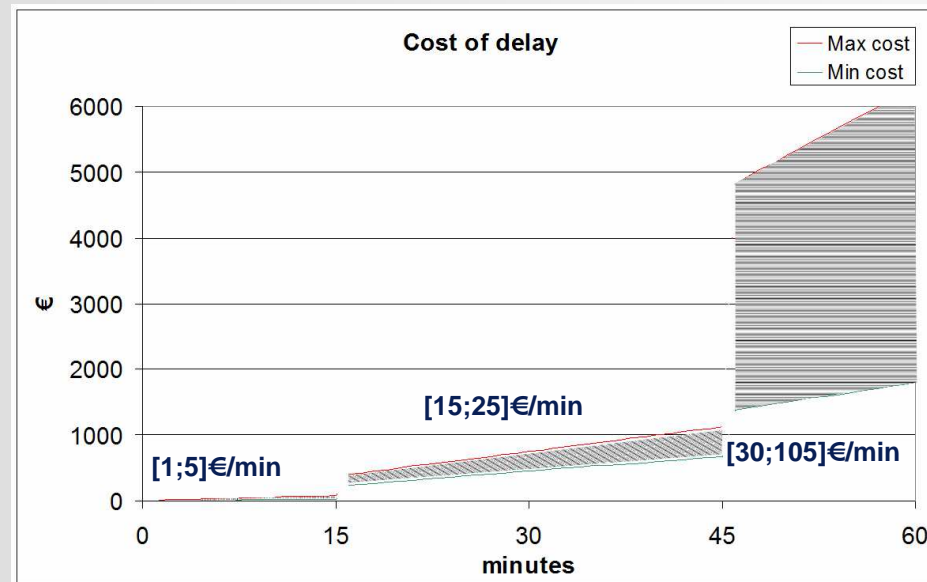
# Simulations

- Dataset extracted from real data (15/08/2008, 9:00 - 11:00)
- 485 regulated flights
- 60 capacity-constrained resources (sectors + airports)



# Simulations

- Cost of delay per flight (according to the Westminster Report)



- Global cost of delay under different TW assignments:

FCFS	Central EXCH	Distr EXCH
740 187 €	620 692 € (-16%)	634 438 € (-14%)

# Conclusions



- The AHP analysis shows that benefits from CATS outweigh limitations, especially for airlines and ANSPs
  - Both at the flight planning and execution phases
  - This result is quite robust
- In a better economic situation, the same findings apply to airports as well
  
- An additional benefit of the CATS concept derives from the direct involvement of users in the process of assigning scarce resources (i.e., TWs)
  - A possible TW negotiation scheme at the short-term planning level provides a significant reduction of the cost of delay for airspace users.

