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Sommario	Air Traffic Flow Management (ATFM) is the service responsible to guarantee that the available capacity of the air transportation system is efficiently used and never exceeded. It guarantees safety of air transportation by adopting a series of measures which range from strategic long-term ones to the imposition of ground delays to flights at a tactical level. These ATFM delays are imposed to individual flights at the departure airport prior to their take-off, since it is safer and less costly to anticipate on the ground any delay predicted somewhere in the system. They are assigned by a central authority according to a First-Planned-First-Served principle, without taking into account individual Airlines' preferences. This criteria of assignment can cause an aggregated cost of delay experienced by users, higher than the minimal one, due to the fact that the cost of delay is a non-linear function of the duration and it depends on many variables such as the type of aircraft, the specific origin-destination pair, ecc. This thesis tackles the issue of formalizing and analyzing alternative models for the assignment of ATFM resources which take into account individual airlines preferences. In particular mathematical programming models are analyzed, that extend the concept of ATFM slot currently adopted to the one of Target Window, as proposed in the CATS European project. Such a concept is in line with the SESAR program, recently adopted in Europe to develop the

	new generation system of Air Traffic Management, which imposes a direct involvement of Airspace users whenever external constraints need to be enforced that modify their original requests. The first Chapter provides a general introduction to the context of Air Traffic Management and Air Traffic Control. In the second Chapter the principles, methods and performances of the ATFM system are described according to the current situation as well as to the SESAR target concept. The problem of optimally assign ATFM resources is then described mathematically and then analyzed to uncover two fundamental structures that determine its tractability: one corresponds to the case in which there is a unique capacity constrained resource while in the second there is an unrestricted number of constrained resources. In Chapter three a number of properties are proved that give insight into the applicability of different mechanisms for a central calculation of the optimal solution by the ATFM authority. Since such mechanisms involve cost minimization for several agents they are formulated as exchanges, i. e. particular types of auctions in which each participant may buy and/or sell several indivisible goods. The last part of the thesis included in Chapter four deals with the design of iterative exchange mechanisms, whose application in real world presents several advantages with respect to centralized models, from the distribution of computational complexity among participants to the preservation of disclosure of private information by Aircraft Operators. In this case an optimal model based on the Lagrangian relaxation of the separable central problem is first formulated and analyzed. To overcome practical issues possibly deriving from its application in real operations, an heuristic iterative Market-based mechanism is finally formalized. This algorithm exploits some of the underlying characteristics specific to the problem to derive near-optimal solutions in an acceptable time. Computational results are obtained by simulating its implementation on real traffic data and they show that considerable cost savings are possible with respect to a First-Planned-First-Served central allocation. The contribute of this thesis is twofold. The first is to provide a mathematical description, modeling and analysis of the ATFM resource exchange problem faced by Airspace users when network capacity needs to be rationed among them. The second consists in the methodological innovation represented by the formulation of the Market Mechanism which is compliant with several requirements represented by legislative and practical constraints and whose simulation provided encouraging results. 2008/2009
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