



## Evaluating the Cost of ASM/ATFMMeasures

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# ATM PERFORMANCE INDICATORS

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## ATM performance indicators

Title of presentation: cost of ATFM

*New title of presentation: evaluating the cost of ASM/ATFM measures*

### Abstract

The density of traffic over Europe has been steadily increasing for several years. In 1996, the traffic growth rate has been close to 5% which means that, at the turn of this century, the average number of aircraft per day will be close to a 1996 peak day traffic.

We have been designing and implementing mock-ups and prototypes for airspace and air traffic flows managers. The experimental platform SHAMAN is being developed for providing operators with a relevant evaluation of the cost of a set of regulation measures, as efficiently and as quickly as possible.

SHAMAN slot allocation module is based on constraint programming. The cost function is the sum of delays. The constraints we treat are airport and sector capacity constraints, flow rates, and the maximal delay associated to an individual aircraft or to a traffic flow.

Different slot allocation strategies (heuristics) have been experimented: "first planned, first served", "first on the most saturated constraint, first served", and more generally, "the cheapest flight, the first served" with the cost of the flight depending on the minimal delay to get the flight outside a constraint and on the level of saturation of the constraint. Results will be given during the presentation.

The evaluation of the quality of a slot allocation process cannot be restricted to the output of the total delay generated. Different cost indicators have been defined: the distribution of delays, the sum of delay progression, the individual cost of a constraint, the marginal cost of a constraint, the distribution of the demand, the use of capacity.

Beyond the interest of evaluating slot allocation strategies, the module we have implemented aims at analysing the cost of airspace and flow management techniques :

- in the field of airspace design and organisation: evaluation of the gain of increasing the hourly capacity of a sector (marginal cost) and calculation of the maximal capacity of a sector, keeping the ATC context unchanged.
- in the field of ASM, in the context of the flexible use of airspace (EATCHIP):
  - ◆ aid for scheduling the use of temporary segregated areas, evaluating the cost of the activation of a military area using differential capacities for the sectors interfering with the latter;
  - ◆ evaluation of the gain of using a conditional route;
- in the field of ATFM:
  - ◆ both pre-tactical and tactical phases are concerned by the evaluation of the cost of an ACC configuration: depending on the number of control positions available at one time, flow managers have to find out which configuration of the ACC suits the demand in the most effective way;
  - ◆ during the pre-tactical phase, the definition of a minimal set of restrictions has to be done. The smaller the set is, the easier and the more efficient the slot allocation will be;
  - ◆ strategic ATFM: evaluation of the cost, for the rest of the traffic demand, of assigning maximal departure delay to the flights bound to or coming from scheduled airports;
  - ◆ during the pre-tactical and the tactical ATFM phases, flow managers have to evaluate the cost of a re-routing: using a new route means decreasing the load of sectors while increasing the load of others. Moreover, a new route can be selected combining a change of one ACC configuration.

Computational results that will be given during the presentation have been worked out using real data sets that correspond to daily capacity and traffic over France.