An interaction metric for an efficient traffic demand management: requirements for the design of data-driven protection mechanisms

Summary

It is well accepted that a major limitation of the current ATM system is the loss of effectiveness due to the limited integration between the layered planning Decision Support Tools (DSTs). While the Trajectory Based Operation (TBO) concept enhances the design of new DSTs that could deal with present demand/capacity balance in ATM, relying on a technological framework for information sharing (SWIM - System Wide Information Management), a word of caution comes into view at a practical level: ATM stakeholders realise that technological flexibility to regulate flights into a sector is not synonymous of performance, rather several negative effects can arise at global traffic level due to lack of analysis of interdependencies among regulated sectors.

Data-driven trajectory prediction methods pave the way not only for a better predictability but also for true integration at the ATM service system level in which present layered ATM planning could exploit the freedom gaps between the strategic/pre-tactical (ATFM) and tactical (ATC) to move one step forward to a competitive ATM system in which present ATC resources are used to attend AU's demands avoiding resource idleness and saturations that foster regulations and/or holdings.

Airspace digitisation opens a window of opportunities to support the modelling of airspace demand **at a micro level analysing data trajectories** to explore the detection of problems/interactions among trajectories that would require the mental effort of ATCs. The proper identification of the different interaction zones will allow the exploitation of new ATFCM mitigation measures in smaller volumes than sectors, providing the advantage of conservative measures such as sector capacity regulations which unfortunately used to over-constrain the full ATM when more than one regulation is activated using for some flights the most constraining CTOT. The granularity of the methodology should allow us to detect precise area of problems to manage.

In this project it is proposed to extend the PARTAKE (ER2 GA: No. 699307) data-driven prediction methods for digitisation, detection and analysis tools to **implement a new interaction metric** to better integrate strategic and tactical information to detect ATC problems (i.e. potential co-existence of more than one aircraft in the same airspace volume) while measuring the sector capacity to absorb potential solutions for a 4D interaction free planned trajectories. These tools will be enhanced with a macro level analysis of the interdependencies among interaction zones (distributed through different sectors or spatially concentrated in the same sector) to enable a proper understanding of the spatio-temporal interdependencies among fragmented sector capacity constraints to avoid the propagation of undesired interaction-zone dynamics through the full ATM system together with potential upstream and downstream negative effects of capacity regulations.

A quick-win of the project will be a **new interaction metric to evaluate the efficiency** of sector regulations **by identifying the demand-capacity imbalances** of sectors in terms of flight interactions causing the emergence of interaction zones with the otherwise unpredicted dynamics.

Furthermore, the **new interaction metric will guide the design of mitigation measures** for a smooth fine tuning of traffic demand at micro level considering the effects at macro level improving the network capacity performance. As a result, a modelling and simulation framework will be adapted to digitalise the ATM system to satisfy locally all capacity restrictions designing efficient and effective regulations at network level, enhancing and making the best use of the European ATM capacity, in a cost-effective manner.

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