Exploring future UDPP concepts through computational behavioural economics

Summary

During the Air Traffic Flow and Capacity Management (ATFCM) tactical phase, when the capacity of an en-route sector or at the destination airport is expected to be exceeded by the demand, flights are delayed at the origin airport and assigned new take-off times through ATFM slots. This results in so-called **ATFM delay**, which represents a significant cost for airlines, passengers and the ATM system as a whole. The policy used today to allocate ATFM delay is the First Planned First Served (FPFS) principle. FPFS minimises the total delay, but due to the cost of delay being highly non-linear and varying from one flight to another, it may not be the optimal solution from the point of view of Airspace User (AU) costs. The possibility of rearranging flight sequences when facing situations of demand-capacity imbalance offers remarkable potential to reduce the impact of ATFM delay. To realise this potential, SESAR has developed the **User Driven Prioritisation Process (UDPP)**. Early UDPP developments have introduced a number of mechanisms that provide AUs with increased levels of flexibility to prioritise their flights and distribute delay according to its impact on AU operations and costs. However, the level of flexibility provided by these basic UDPP concepts is still relatively low. Other, more flexible flight prioritisation instruments are proposed in the literature, including market mechanisms, but their implementation is hindered by the **difficulties to design, test and validate such instruments**. Classical modelling approaches from economics and operations research, such as game theory and linear programming, have been used for this purpose, but the strong assumptions behind these approaches, such as agents' rationality and perfect information, make such models unrealistic in certain circumstances, which may lead to overlooking the risks and the potential unintended consequences of certain mechanisms when stakeholders' behaviour departs from these rigid assumptions.

The goal of the project is to develop **new modelling approaches enabling a rigorous and comprehensive study of highly flexible, advanced UDPP mechanisms**. To this end, we are adopting the paradigm of computational behavioural economics, as a particularly suitable framework for the representation of features that are not properly captured by classical approaches, such as bounded rationality, evolutionary behaviour, and asymmetric, imperfect and uncertain information. The specific objectives of the project are the following:

1. develop an **assessment framework for the comprehensive evaluation of the impact of UDPP mechanisms** on network performance and on ATM stakeholders, including aspects such as their ability to ensure equity and their resilience and robustness in the presence of irrational or strategic behaviour of AUs;
2. perform a detailed **review of the tactical slot and trajectory allocation mechanisms proposed in the literature** and identify the most promising to improve UDPP;
3. develop an **agent-based model allowing the evaluation of different UDPP mechanisms** according to the proposed assessment framework;
4. run a set of **simulation experiments**, considering different AUs' behavioural assumptions, in order to conduct a systematic assessment and comparison of the identified UDPP mechanisms and derive **conclusions on the advantages and disadvantages of each of the proposed mechanisms**.

Industry representatives (including AUs, ANSPs, the Network Manager and the UDPP development team) are involved throughout the project by means of several consultation mechanisms, in order to ensure that the assessment and modelling framework developed by the project takes into account the expectations and constraints of all concerned stakeholders.

The project is expected to advance the state of the art in the **design, modelling and validation of flight prioritisation mechanisms**. This will facilitate the development and implementation of advanced UDPP concepts, which will ultimately contribute to enhance the **flexibility**, **cost-efficiency** and **resilience** of the ATM system, while preserving **equity**.

This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 783287.