Has blockchain cracked
the aviation
capacity code?

A new project that aims to make slot-swapping easier
for airlines could help cut delays and minimise losses

As passengers return to the air, the relief that aviation is recovering may soon be overshadowed. Concerns about capacity and flight delays existed before the pandemic, but these troubles now sit alongside mounting cost pressures for airlines.

The International Air Transport Association (IATA) estimated airline industry net losses of US$126.4bn in 2020 and expects that figure to be US$47.7bn in 2021. The last thing the industry needs as it tries to kickstart its revival is the fear of costly delays due to a congested airspace.

In Europe, air traffic flow management (ATFM) slots are issued by EUROCONTROL's network manager, regulating traffic to meet air space capacity or available air traffic control capability. Computer systems calculate the number of flights planned to arrive at an airport in a particular timeframe and gives them a take-off time slot that will allow them to reach their destination in time for their landing slot.

ATFM slots are allocated on the basis of a first-planned-first-served policy, which means that changes are generated that bear no relation to the impact that delays have on airline operations and costs. If a flight slot is missed, an airline could amass hefty charges.

The costs are generally indirect expenses the airline will incur; for example passenger compensation fees or staff overtime costs. To minimise charges for missing slots, airlines will often swap flight slots to prioritise the most expensive flights. This is also inefficient because currently the exchange of ATFM slots are only possible within the same airline, therefore limiting the options available for change.

For slots to be shared between airlines and for them to have the possibility of re-prioritising flights based on their actual cost structure, the exchange of airline data, passenger data and cost structures would also be required. However, airlines want to keep this information confidential for fear of a competitive disadvantage if disclosed. Flight cost structures may vary for many reasons, from the provisioning of connecting flights or work-time restrictions for crew members. This desire for confidentiality has therefore hampered slot-swapping between different airlines. But what if this crucial information could be shared anonymously?

Ensuring data privacy

Exchanges and auctions for flight slots have been suggested as the most appropriate mechanism for a slot management platform. However, this relies on the accurate reporting of the internal operational costs of a delay. Making sure that the privacy of this information is maintained is therefore an incentive to ensure airlines accurately report the data.

Swiss International Airlines and Frequentis are working with EUROCONTROL, the Austrian Institute of Technology (AIT) and the Austrian University of Linz on the European Union-funded SlotMachine project to foster the emergence of this new marketplace for airlines to exchange ATM slot priorities. The SlotMachine consortium is developing a platform that is expected to enable more flexible, faster, scalable and (semi-) automated processing of slot sequence transactions in a fair and trustworthy way. Built with a privacy first approach, the aim will be to protect sensitive airline data from competitors and airport operators and therefore fully unleash the potential of slot-swapping.

The objective is to optimise the allocation of flights according to the airline priorities and on the cost structure of different airlines. Prioritisation takes place through airlines submitting preferences for their flights – margins that define time-not-before/time-not-after – to SlotMachine. This information is directly linked to internal costs at airlines and must be considered sensitive information and therefore be protected.

Bring on blockchain

Blockchain and multi-party computation (MPC) are two emerging technologies that are relevant for the design of trustworthy and privacy-preserving slot-swapping systems.

Blockchain is a decentralised way of storing and accessing data, which makes it extremely secure as it has no single entry point for hackers. Secure MPC is a subfield of cryptography, which aims to allow the joint input of data while keeping all contributions private. This can be used to enable blind auctions, without the need for a trusted party, in a decentralised setting, where individual bids are completely hidden. Besides privacy, MPC also achieves accuracy for determining the best bidder, further increasing reliability. And, since any potentially damaging behaviour by a participant is excluded by design, the system is less attractive to attackers.

Although blockchain technology includes many interesting concepts that can significantly increase the transparency, and therefore the credibility, of trading platforms, it does not protect the privacy of data handled. Flight prioritisation based on the airlines' cost structures could potentially expose this sensitive information to competitors.

MPC and blockchain technology could serve to hide sensitive information while determining the optimal flight sequence without the need of a trusted negotiator. However, the challenge in the context of flight list prioritisation is in selecting a mechanism and designing a technical implementation that guards and secures this critical information. For this reason, it must be combined with additional cryptographic protections for data confidentiality to enable blind bids.

To achieve the highest security standards, SlotMachine protects the confidentiality of input data using cryptography to secure transactions between users. In fact, all sensitive data resides within the privacy

engine (PE), which is based on MPC and which guarantees that such information is never used in plain text within the system but only in encrypted form. The PE assists the optimisation process and assures that input data is well formed according to the rules of fairness and equality. This prevents the disclosure of a flight's cost

About...

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structure to any party, competitor or even the platform provider.

What's next for the project?

User-driven prioritisation of slots would improve the use of resources and mitigate the economic impact of disruptions. With blockchain technology and a secure MPC, the SlotMachine project aims to extend the existing user-driven prioritisation process (UDPP) solution currently in development by SESAR (Single European Sky ATM Research) 2020 to allow a more flexible prioritisation process that does not disclose any confidential information.

The SlotMachine platform intends to allow secure, auditable transactions without the need for a central broker so that stakeholders would enter transactions without disclosing information to other users. By demonstrating the feasibility of a privacy-preserving platform and proposing a new operational concept, the foundation can be laid for the development of a product that will be essential in the aviation industry. It is also expected to lead to better use of existing resources at airports, higher efficiency of airlines, lower emissions and shorter passengers delays.

To ensure the validity of the results, the project will convene an external advisory board to review requirements and design decisions and have a demonstrator in two or three iterations throughout the project duration. Representatives from airlines, airports, ANSPs and other interested stakeholders who want to review and validate the outcomes of this project can join the advisory board and participate in the upcoming workshops. **ATM**