Departure Management

Controller HMI with Departure Sequence (blue labels) in mixed mode operations

Introduction

Departure Management has become an important topic in research, due to increasing growth of traffic, and airports becoming more and more the bottleneck. New concepts are discovered to avoid runway queues or taxiway congestion. NLR participates in this field of R&D, and has developed an advanced CDM-approach on Departure Management.

In three recent projects Departure Management as a Concept was validated. These projects were AFAS, LEONARDO, and Gate to Gate. They all used a planning tool for preparation of a departure sequence, with the purpose to give ATC more guidance in the departure traffic, and reduce congestion of the taxiways, and runway threshold.

Different human machine interfacing (HMI) and several algorithms were developed by NLR in order to build up knowledge in this field. This has lead to a sequence algorithm, which has evolved from an ATC planning tool to a complete CDM algorithm. The result is a scheduled runway sequence optimised for multiple stakeholders, where focus is put on Outbound Punctuality Sequencing (OPS).

Outbound Punctuality Sequencing

Departure Management focuses more and more on the punctual departure of flights. Punctuality leads to increased predictability of flight time, enhanced efficiency of the Airline, and therefore to improved reliability towards passengers.

All of the stakeholders have their own preferences concerning the departure planning; the Airline requires more punctuality for network purposes; the Airport wishes to improve ground service and gate assignment. CFMU desires refined regulation of the departure time, with priority for flights to congested Airports, and the pilot cannot go off-block until he has finished all pre-departure procedures, but prefers to go immediately when ready.

All these constraints and preferences of the stakeholders can be included into the Collaborative Decision Making process, enabled by an automated support tool. It must not only compute the optimum for all stakeholders, it must also consider the limitations of the resources, such as active runways and its capacity. In the Outbound Punctuality Sequencing vision of NLR, punctuality and efficiency will automatically lead to optimised capacity.

Benefits

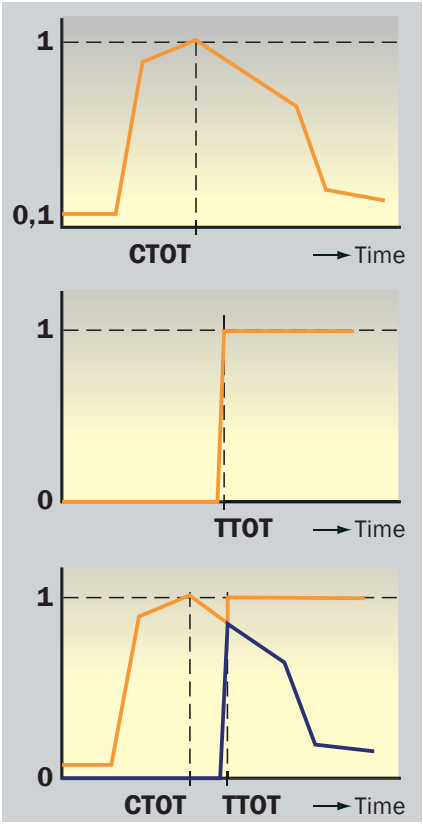
Summarised, benefits are to be expected for all ATM stakeholders:

- Improved punctuality and predictability for Airlines and Airport will contribute to their network and airfield gate planning
- Refined Traffic Flow regulation will contribute to CFMU achievements to increase arrival flow and en-route capacity
- Enhanced Efficiency will benefit Airline, ATC, and Airport in their financial performances
- Increased Capacity for Airport (gates) and ATC (runways) will allow for sustainable growth on current day infrastructure.

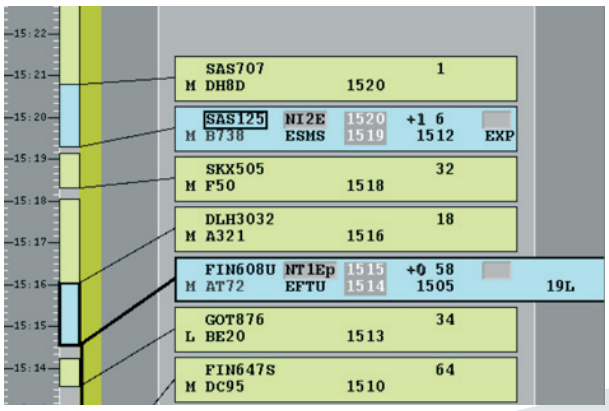
Methodology

The derived methodology is to transform constraints into preference functions. These normalised weight functions represent the preferred departure time characteristics for each individual flight, whereas 1 represents the optimal value, and 0 represents a hard constraint.

By taking multiple individual flight functions into account, and retrieve wake vortex separation from a database, the optimal sequence can be derived. A rapid algorithm developed by NLR finds this optimum in real time, after which the sequence is presented to the controller.



Combined Preference function
in blue for Calculated (CFMU)
and Target (Airline) Take-off Time



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As the preference functions and wake vortex are configurable, modifications can have large impact on the capacity of the runway, and the punctuality that can be achieved.

Planning quality can be determined by verification of the sequence and each of the individual flight plans. Overall delay is distributed based on priority, and saturation will affect the least prioritised the most. In a saturated situation, separation values are automatically reduced by optimising the sequence to the highest throughput possible, which ensures minimal overall loss of punctuality.

Future Developments

Departure Management can be integrated into the Airport CDM concept, as it interrelates with flow, arrival, TMA, and airport planning processes. OPS as a Departure Management concept is based on CDM, and hence depends on input from Airport stakeholders.

NLR is the first ATM R&D organisation that has validated the OPS concept in a large experiment with multiple airport stakeholders, and is ready to deliver knowledge and software prototype for industrial productizing.

NLR provides Industry and Air Navigation Service Providers the opportunity to validate and implement this concept, and optimise OPS for the special airport conditions of interest.

AT-One combines the strength of NLR and DLR in ATM Research

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