De-peaking Lufthansa Hub Operations at Frankfurt Airport

General Context

Frankfurt Airport is one of the major airports in Europe with a traffic volume of approximately 480.000 flights each year. Lufthansa uses Frankfurt as its main intercontinental airport in a Hub-and-Spoke System that connects a large number of European destinations to the intercontinental flights. As a result of this Lufthansa holds around 60% of the traffic share at Frankfurt and is highly dependent on a reliable and punctual operation to satisfy the connecting passenger flows.

The particular Infrastructure Problems at Frankfurt

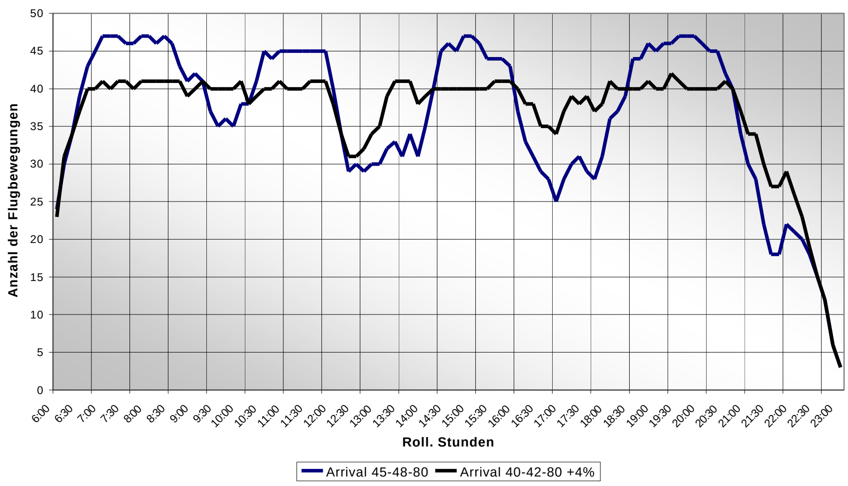
One of the biggest problems Lufthansa is encountering at Frankfurt is that of limited runway capacity. The airport has a runway system consisting of 3 runways, all of which can be used as departure runways while only two of these are usable for arrivals. The result consecutively is an arrival capacity deficiency. In previous years this generated a significant Air Traffic Control Delay, generated through a Ground Delay Program (GDP) at departure stations for flights inbound Frankfurt, as well as an additional holding of aircraft in the Frankfurt Area. In comparison with other major hubs in Europe FRA accumulated the largest portion of ATC-Delay with up to 950.000 minutes per year (in 2002), which is the equivalent of the production of 5 medium-haul aircraft on European routes.

As a part of the delay is airborne holding the scheduling department tries to account for this proactively, such as to provide customers with feasible and reliable connections through the hub-airport. The ‘blocktime’ specifies the time that an aircraft is in motion from the moment it leaves the gate at the origin until it arrives at the gate at its destination. In the light of the aforementioned, airlines have taken on the approach to calculate scheduled blocktimes in terms of quantiles of actual blocktimes flown in the previous period. Thus they are accounting for a constant and structural airborne delay with prolonged blocktimes.

However, if actual blocktimes show a significant spread then the mode of the flighttime is somewhat left of the quantile used for the blocktime calculation. This can consecutively result in overdeliveries, i.e. the number of flights filed to the ATC provider seems higher than the number of flights scheduled in the same period of time (due to the fact that aircraft tend to arrive somewhat ahead of schedule). If this difference becomes too large, ATC is forced to protect sectors/airports from overloads by the means of a ground delay program (GDP). As this GDP is a very imprecise and crude tool for dealing with overloads the interference may still lead to airborne holding at the destination station which then in the long run then causes yet another increase in blocktime.

The Idea of Depeaking

When looking at how the airport/airspace infrastructure is being used in several banks of arrivals and departures in a hub-system it becomes obvious that while at times the scarce capacities are used above their limits, at other times these capacities are slack. Thus the idea was to balance the use of the capacities better over the entire day. While in previous years the maximum number of scheduled arrivals peaked at 45 per hour this number was reduced in the depeaking process to 42 arrivals per hour, the excess movements where then used filling up the trough between two peaks.



With this the load on the scarce resource 'arrival runway' could be reduced thus leading to less airborne holding. As described above, in the long run this would mean a decrease in blocktime. Yet as this was to be expected, the intention was to already anticipate the magnitude of delay reduction and decrease the blocktimes by this amount proactively, thus breaking the vicious circle of blocktimes and ATC interference described above.

In order to evaluate this right amount of blocktime reduction, a highly flexible simulation tool was necessary that enabled modeling of complex, interdependent queues as well as large numbers of multiple runs and needed the flexibility in using various statistical distributions for the different processes involved. In this context *Arena®* provided by *SAT Simulations- und Automa-*

tions-Technologie AG (Freiburg, Germany) could satisfy all the requirements above and hence was chosen by Lufthansa as tool for this simulation.

Iterative simulation was used as a new approach to overcome the task at hand. Here the result in terms of delay *reduction that was the outcome of a set of multiple runs was used as an input for* the next set of runs such as the schedule was adjusted to accommodate for the reduced blocktime. After several iterations this converged to a result that was then taken as achievable delay reduction for the scheduling process.

Benefits achieved

As a result of the entire process in summer 2004 Lufthansa could on the one hand reduce the blocktimes inbound Frankfurt by around 5 Minutes per flight inbound; on the other hand it was possible to increase the overall traffic into FRA by approximately 5% while maintaining the same level of punctuality. Overall the magnitude of delay was reduced by approx. 5 Minutes per flight accumulating in more than 10.000 delay-hours per year. In addition, 50.000 tons of Kerosin were saved per year. Overall this means total savings in the range of 20 to 30 Million Euro per year for Lufthansa operations.