Integrated Airport/Airside Operations APT

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Papers & Analysis

This year's ATM 2009 airport sessions dealt with progress made in the field of more efficient airport airside operations, in the well know chain from approach via taxi-in, turnaround, taxi-out to departure. Airport people think in en-route-to-en-route instead of gate-to-gate process chains. Inline with the message from Jean-Marc Garot's plenary key-note speech, the airport R&D scene already thinks mainly in terms of time, when looking for improvements to airside operations, what can be observed already from the titles – the titles indicate subjects like scheduling, delays etc. Airports are considered as production plants which work efficiently and effectively when everything is properly scheduled and processes are well managed. Punctuality and predictability – that is even more important – seem to be the most important parameters. No other key performance parameters of airport operations were discussed, e.g. no papers on airport operations safety.

A further observable trend is that the consideration was extended to more holistic views on airport processes. First the scope was increased to more in-depths looks to turnaround processes as these are known to be a common source of uncertainty to the departure readiness. Further more emphasis was put on the options to integrate the well studied process management approaches like Arrival-Surface-Departure. This trend in the ATM seminar is of course dependent on the call for papers, this year calling explicitly more for this integration focus. But nevertheless all turnaround considerations came from EU papers, there were unfortunately no contributions from the US to this subject, what would have been nice as here some fundamental differences between US and EU airports exist. Further no papers on landside issues nor integration of airside and landside have been submitted. As landside congestion has certainly an impact on airside operations (and as a knock-on effect to the network) it would be wise to extend the scope in the coming conferences a bit.

It is commonly agreed that airports are the main bottlenecks of the Air Transport System and that they introduce a lot of stochastic effects to the network. The lack of predictability could emerge into a show-stopper of the entire 4D-concepts of SESAR and NextGen as accurate take-off times are key to catch the planned 4D trajectory. Despite this basically known insight, no really substantial results were submitted to the ATM seminar how to fundamentally overcome this issue.

Paper 81, Airport surface management and runways scheduling, presented by Jean-Baptiste Gotteland, DSNA.

This first paper studied the integration of AMAN-DMAN-SMAN. The XMAN approach is dealing with tactical decision support tools for the different involved humans in area control, approach control, tower and apron control. This approach to optimize the individual parts of the enroute-to-enroute chain was intensively researched, developed as commercial products and partly already implemented in Europe and beyond. Now in Europe there is the need to integrate these building blocks to make full use of the XMANs capabilities. In the US considerable work was done on the AMAN side (work of Heinz Erzberger and others), but for the other parts of the chain the approach is either lacking or different. Paper 81 was using Paris Charles-de-Gaulle airport as a simulation example how to gain more benefits from the integration of AMAN-DMAN-SMAN compared to today's solution. It was demonstrated in a short replay how taxing conflicts are solved by clustering potentially interfering taxi operations and by solving these conflicts in support of maintaining the planned overall airport process chain. It was pointed out that the stability of the planned arrival-departure sequence is substantially higher when making use of such an SMAN. The work is a consequent extension of previous work published e.g. in earlier ATM seminars. In the Q&A section the operational concept of an SMAN was discussed, e.g. the options to give speed advisories to taxiing aircraft vs. give only clearances and hold short instructions and the general difficulties to implement optimized scheduling solutions by the involved humans.

Paper 116, Scheduling Aircraft Landings to Closely Spaced Parallel Runways, presented by Michael Kupfer, University of California.

This paper dealt with possible enhancements of the currently already implemented SOIA concept at SFO airport. In comparison to the European XMAN-approach this could be considered as a AMAN for the specific

SOIA case. SOIA has the proven capability to increase the capacity (usage) for arrivals dramatically and is maybe as well applicable to European airports with closely parallels. During adverse conditions, the closely spaced parallels would be considered as one runway again. The optimization model was evaluated in simulation with the SFO sample. Different approaches have been tested, including genetic algorithms and linear programming to solve the optimization problem, taking into account temporal, sequencing, pairing, separation, grouping and precedence constraints. The result was an improvement of the throughput by 5-6%. In the Q&A section the simulation assumptions were discussed like starting with a random arrival sequence. As well the necessary decision support to the humans to implement such optimized solutions in reality was presented.

Paper 79, Application of Reinforcement Learning Algorithms for Predicting Taxi-out Times, presented by Poornima Balakrishna, George Mason University.

The 3rd paper discussed an approach to estimate the duration from off-block to the take-off event. A model free approach learning from data was used, what is quite innovative in the airport operations research domain. The work is based on the analysis of a good amount of real data (DFW, TPA and JFK). The data analysis showed that taxi out times are in the order of 30 min mean values (sometimes this is half of the airborne duration) and even worse with a standard deviation of 15 to 20 mins. Having in mind a more 4D-trajectory-based system in the future this is a significant issue. The training of the model took data from approx. 50 days per airport. Prediction accuracy was than computed against measured results from randomly selected new days. With the proposed algorithms a taxi-out prediction of 5 min in 60-90% of the cases is achieved. It turned out that the asymmetry of the airport has a certain influence, what could influence the accuracy due to the varying taxi-distances. During the Q&A section the approach was discussed concerning the sophistication of it vs. alternative approaches and the questions on the operational usage of such models. Is it better to predict the situation or should we directly aim to control it?

Paper 145, Linking Traffic Management to the Airport Surface: Departure Flow Management and Beyond, presentd by Nathan Doble, Metron Aviation.

This paper discussed the link between the airport operations control and the network on the departure process. How should we merge the departure stream from an airport optimally into the en-route traffic and how this should be supported by decision support systems. The presented results were obtained in field trials at several locations (SAN, LAS, LAX, …). It was shown that the DFM approach is better than current APREQ procedures, as it especially improves common situation awareness between human operators in the different centers and at the airport. The Q&A section said that this partly comparable to what the CFMU in Europe is doing. Maybe there are as well some similarities between activities in Europe on departure management and these activities.

Paper 153, Delay Impacts onto Turnaround Performance, presented by Hartmut Fricke, TU Dresden.

This first paper on turnaround process management' analyzed a huge amount of data from different airlines (Lufthansa main data source), at different sites (Frankfurt, Munich, Dubai, …) and as well took into account new aircraft types like the A380. It was analyzed how much buffer time could be released in certain conditions from the turnarounds. It was proposed to maybe use a dynamic buffer assignment strategy instead of today's fixed one. In the Q&A section it was discussed whether the buffer reduction would be recommendable in general, because small reductions would decrease the robustness of the airlines network without allowing e.g. a further leg to be flown. Further it was discussed when such a dynamic buffer assignment should take place, already in the airport seasonal scheduling or much later at the day-of-ops. The data analysis was considered to be very useful.

Paper 7, Airport Service Vehicle Scheduling, presented by Kenneth Kuhn, NASA Ames.

This joint paper (NASA/DLR) discussed the travel distances and necessary fleet sizes to service a given set of aircrafts in the turnaround phase. Assuming one would have position and identification information from the individual service vehicle, it was asked what we would gain from a more sophisticated vehicle scheduling. Different assignment strategies were realized and tested making use of some real data from Hamburg and DFW. It was pointed out that in cases of large airports the vehicle travel distances could be reduced significantly and that reductions of fleet sizes would be possible. In the Q&A section it was discussed whether the certain type of service vehicle has more importance than other types. We have not conducted the analysis to answer this question with confidence, but answer is probably no.

Paper 44, Integrating optimization and simulation to gain more efficient airport logistics, presented by Tobias Andersson Granberg, Linköping University.

The last paper was as well looking at turnaround processes. Starting with a detailed turnaround modeling approach it focused especially on de-icing, what is in the nordic European regions a common issue and as well source of delays. Like paper #7 different approaches how to better schedule de-icing trucks were analyzed. The optimization took into account to avoid delays caused by the de-icing trucks as well as their travel distance.

General Aspects

This years ATM seminar had in the airport session 7 presented papers, 3 from the US, 3 from Europe and one joint US-EU-(New-Zealand)-paper. The papers have been selected from 12 submitted airport papers, all with a relatively high ranking – what was a difficult decision making process for the program committee. Some of the 12 papers were rejected because of the overall limitation of presentation slots, though they would have been mature enough. This was discussed with the authors of the rejected papers, and recommendations were given to submit the results in other conferences or journals. The quality of the presentations was in general very good. It was observable that in addition to authors, who are already well known in the airport ATM scene, some new researchers showed up, what is promising.

The overall impression of the presented topics – which were selected by a pure bottom-up-approach - was that sometimes niches are (successfully) investigated and that no substantial progress is made anymore on the core issues. On the other hand the scope of the airport topic is becoming wider, what is good because the integration of all different results from the previous research have to be tied together. Maybe the next seminar should give a technical airport R&D architecture overview in the call for papers and ask for results concerning a set of most wanted topics. On the other hand free innovative research seems to be lacking, neither in the airport track nor in the innovation track there were any breakthrough results presented.

The attendance of the airport sessions was very good, up to 45 people attended the presentations though this was one of the last topics of the whole seminar.

A breakout session was held on airport R&D on the last day of the seminar, where approx. 30 attendees in a moderated brainstorming collected a considerable list of research questions. The list will be published on the internet.

High-level Recommendations

- Discuss with SESAR and NextGen the potential show-stoppers of their concepts (e.g. lack of take-off-time accuracy to catch the 4D trajectories) and re-think whether enough R&D is done on these most important topics. SESAR and NextGen should give an introductory, technical overview presentation of what was achieved in the recent two years concerning airports. Further these programs should point out from their overall perspective what are the most wanted topics for the future.
- The next call for paper should ask for more specific hot topics in order to encourage people to give answers to the main questions instead of doing too much work on niches. The criterion relevance for SESAR / NextGen maybe introduced in the paper evaluation. As well the relevance to the questions found in the airport breakout session should be taken into account in the next call for paper.
- Some core operational airport problems should be ‘standardized’ and benchmarking data sets should be provided by FAA and EUROCONTROL, such that more researchers try to solve the same core problems and that results become more comparable (maybe an award would encourage people even further…).
- We should consider that airports do not only deal with aircraft but with passengers, baggage, cargo etc. A deeper understanding of the coupling of airside and landside processes would be beneficial
- We have to encourage people to do out of-the-box-thinking and developing innovative ideas how to increase throughput, efficiency, safety and environmental compatibility by significant numbers instead of small margins.