

# Benchmarking Airport Airside Performance: FRA vs. EWR

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**Abstract**—A benchmarking study of the Newark International (EWR) and Frankfurt/Main International (FRA) airports has been carried out, focusing on 2007, a year when airport congestion reached a peak. This paper summarizes some of its main findings. The two airports were selected because of the similarities in their runway layouts, regional importance, and air traffic characteristics. The analysis relied on the ASPM database of the FAA and on internal and METAR data of DFS. The maximum throughput capacities of the two airports, under a full range of weather conditions, were estimated from empirical data. They vary significantly with weather conditions at both airports, with FRA achieving higher throughput values, largely because of how the third runway there can be utilized. The two airports display different demand-to-capacity relationships. This is due to the fact that FRA is a “coordinated” airport where EU airport scheduling regulations are applied strictly. The result is a “flat” daily demand profile whose peak values do not exceed the capacity of the airport, even in Instrument Meteorological Conditions (IMC). In contrast, no scheduling limits were in effect at EWR in 2007, with peak-period demand often exceeding the capacity of the airport, even in Visual Meteorological Conditions (VMC). Consequently, delays, airline punctuality, and schedule reliability at the two airports were also vastly different, with arrival and departure delays at FRA significantly lower and punctuality higher. Moreover, punctuality and schedule reliability deteriorated sharply at EWR in the afternoon and evening, suggesting over-scheduling. A detailed analysis of gate delays versus taxi-out delays on departure also demonstrated the effect of differences in the way the two airports are operated. In summary, the study highlights the impact of different operational regimes and of demand management policies on the performance of congested airports.

*Keywords*—airports, capacity, delay, schedule reliability, schedule predictability

## I. INTRODUCTION

The Federal Aviation Administration (FAA) and EUROCONTROL have long held a strong interest in obtaining a better understanding of how ATM and airport operations in their respective domains compare with those elsewhere – see, e.g., the continuing series of regular and occasional reports, such as [1], issued by EUROCONTROL’s Performance Review Commission. In 2008, these two organizations initiated an extensive collaborative effort aimed at

understanding the differences and similarities between the ATM and airport systems in the US and in Europe and at identifying, when possible, best practices. A joint report was issued [2] [3] that presented an early set of interesting findings, comparing the practices and performance of the two systems with respect to air traffic flow management, as well as en route, terminal area, and taxiway operations. This first study also motivated a number of follow-up investigations of more specific issues. One of these, conducted at MIT in the US, concentrated on comparisons between the airside performance characteristics of the 34 busiest airports in Europe and the 34 busiest in the US. This research [4] [5] pointed to the existence of very significant differences between the two groups of airports with respect to runway system capacities, delays, and flight schedule reliability. The work reported in the present paper summarizes a subsequent effort, undertaken in 2010, to supplement and refine the findings of the broad-based comparisons between these two large groups of airports through a detailed benchmarking of performance at two specific major commercial airports, Frankfurt am Main (FRA) in Germany and Newark Liberty International (EWR) in the US. The content of this paper will be confined to the specific questions of how (i) airside airport capacities, (ii) airport scheduling practices, (iii) airport air traffic delays and (iv) schedule reliability compare at the two airports. It will also relate these comparisons between FRA and EWR to the findings of the more general study of the two groups of 34 airports in Europe and the US. Some of the principal contributions of the present study include: (a) a comparison of performance at a European and a US airport at similar levels of detail – a difficult task due to the unavailability of a comprehensive, publicly available European database analogous to the ASPM database in the US; (b) several novel ways of analyzing and comparing airport airside performance with respect to a broad range of measures; and (c) a set of observations of a general or specific nature that have important policy implications. As will be seen, very significant differences in the performance of the two airports do exist. Probably the most important among these is that divergent practices vis-à-vis flight scheduling had striking consequences for each of the two airports when it came to flight delays and schedule punctuality in 2007, the year for which the detailed comparisons were made.

Section II provides background information through short descriptions of the main characteristics of the two airports and the data sources used for this project. Section III compares the demand-to-capacity relationships that existed at the two airports in 2007, as a result of the different scheduling practices. Section IV presents air traffic delay and punctuality comparisons for the two airports and generalizes these to the larger groups of 34 airports on each side. Finally, Section V summarizes the principal conclusions, describes some developments on the US side since 2007, and identifies ongoing areas of research in connection with the described project.

## II. BACKGROUND

### A. Airport Operations

EWR and FRA are airports of major importance to their regional aviation systems. The two were selected for this in-depth benchmarking study because (i) they are considered to be among the most congested airports in their respective continents, (ii) their runway systems have quite similar geometric layouts (see below) with two close parallel runways and a third intersecting (or nearly-intersecting, in the case of FRA) runway and (iii) they handle comparable numbers of annual movements (Table I). Furthermore, both airports qualify as good examples of American and European airport ATM operating practices and schedule-setting practices. FRA is a fully coordinated airport where the EU slot coordination regulations are applied with diligence. EWR was not subject to scheduling constraints in 2007, the year studied here – although this changed in 2008, as described in Section V.

Each airport has two close-spaced parallel runways that do not allow independent parallel operations under Instrument Flight Rules (IFR), and a third runway at an almost right angle with the parallel runways. At FRA, this third runway, Runway 18, does not intersect the parallel runways and is used as a unidirectional runway for departures only, due to noise restrictions. Runway 18 serves approximately 60% of all departures from FRA. The two parallel runways, 07L/25R and 07R/25L, serve all arrivals and the remaining 40% of departures, often necessitating mixed operations on each runway in any given hour. Due to prevailing winds, the parallel runways are operated to the Northeast (07L and 07R) about 70% of the time.

TABLE I. COMPARATIVE OVERVIEW OF THE TWO AIRPORTS IN 2007

	FRA	EWR
No. of passengers <sup>a</sup>	54.2 million	36.4 million
No. of movements	479,874	443,952
Passengers per movement	113	82
No. of runways	3	3
Cargo volume (tons)	2.2 million	0.9 million
International passengers	85%	29%
Dominant carrier	Lufthansa	Continental

a. source: ACI world traffic report 2007

Currently, FRA is upgrading its runway system with a fourth runway located to the Northeast of the existing runway system. This new runway, scheduled to open in 2011, will serve arrivals only and will operate independently of the three existing ones. It is also noted that air traffic operations at FRA are largely independent of operations at the two small general aviation airports in the general vicinity.

By contrast, EWR is part of the world’s busiest multi-airport system, due to its proximity to the airports of LaGuardia (LGA), Kennedy (JFK) and Teterboro (TEB) and must be operated in a coordinated fashion with them. Moreover, EWR’s third runway, 11/29, physically intersects the close parallels. Its use is severely constrained by New York terminal airspace limitations, noise abatement regulations, and the runway’s length, which limits its use to Boeing 737-700 and smaller aircraft. The runway is mainly utilized during afternoon hours in the 29 direction and very seldom during the morning hours. When in use in the afternoon, the third runway is operated in tandem with runway 22L and 22R and handles about 50% of all arrivals. In the rare instances when the runway is utilized in the morning, it handles a few departures and no arrivals<sup>1</sup>.

### B. Data Sources

The analysis required data for all airport movements in 2007. For FRA, this information was obtained from COPPER, an integrated information platform designed by DFS, Fraport AG and Deutsche Lufthansa AG to monitor punctuality, delays and other performance indicators at FRA. For each movement, the provided datasets contained attributes such as the flight date and time, DEP/ARR airport, scheduled time of arrival/departure, estimated time of arrival, actual time of arrival, taxi-time in, runway used, actual in-block time, actual time of arrival, scheduled in-block time and actual taxi-time in. For EWR, the FAA’s well-known Aviation System Performance Metric (ASPM<sup>2</sup>) database was used. To a great extent, the COPPER records parallel the ASPM records, thus permitting direct comparisons, even though ASPM’s functionality is of considerably broader scope than COPPER’s.

Weather data were retrieved from RAW Aviation Routine Weather Report<sup>3</sup> (METAR) messages for FRA and from processed METAR data extracted from the ASPM database for EWR. The METAR messages contain descriptive data about wind speed and direction, precipitation, cloud cover and cloud height, as well as runway visual range.

Flight schedule data from OAG<sup>4</sup> Back Solutions were also used in order to obtain information about the scheduled aircraft mix, e.g. percentage of heavy aircraft, at each airport.

<sup>1</sup> FRA is subject to night curfew regulations between 1 and 4 a.m., whereas EWR is not.

<sup>2</sup> <http://ASPM.arc.nasa.gov/> (13th of Nov 2010)

<sup>3</sup> FEDERAL METEOROLOGICAL HANDBOOK No. 1, Surface Weather Observations and Reports FCM-H1-2005; September 2005

<sup>4</sup> <http://www.oagaviation.com/>

### III. DEMAND-TO-CAPACITY RELATIONSHIPS

#### A. Maximum Throughput Capacities

A fundamental performance measure for any airport is its maximum throughput capacity, defined as the expected number of aircraft movements (landings and takeoffs) that can be performed on the airport’s runway system in the presence of continuous demand [6]. The maximum throughput capacity (CAPA henceforth) is generally a function of several variables, including, for example, weather conditions, runway configuration in use, aircraft mix, and operations mix (arrivals vs. departures).

CAPA can be determined from empirical data or can be estimated by using an analytical or simulation “capacity model”. The former method is more reliable when plentiful data of good quality are available, since the models cannot capture all the details of local operating conditions, especially for airports that, like FRA and EWR, utilize complex configurations with interdependent movements on different runways. However, there is no alternative to utilizing the theoretical estimation approach when assessing the impact of future operating conditions or of potential modifications to existing airport configurations, ATM technologies and procedures, etc.

Since the focus of the study was on the empirical performance of FRA and EWR, an extensive data analysis was carried out, concentrating on estimating CAPA under various types of weather conditions at times when all three runways were in use at each airport. Weather conditions were classified into four categories – VFR, MVFR (for “Marginal” VFR), IFR, and LIFR (for “Low” IFR) – depending on ceiling and visibility, as shown in Table II.

It should be emphasized that the term “VFR” does not necessarily imply that ATM authorized operations under Visual Flight Rules during the corresponding periods of time. It only ascertains the presence of visual meteorological conditions (VMC) that might allow the use of visual separations at the discretion of the ATM system’s operator. Unfortunately, no data are available, either at FRA or at EWR, to indicate whether, in fact, visual separation procedures were used for some (or all) movements during such periods.

The frequency of occurrence of the four categories of weather conditions was reasonably similar at the two airports in 2007, as suggested by Table III. However, the percentages shown for EWR in the table are based on only 57% of all 15-minute intervals of the year. For the remaining 43%, weather data were not sufficiently fine-grained to permit distinction between VFR and MVFR or between IFR and LIFR.

TABLE II. CLASSIFICATION OF WEATHER CONDITIONS

Category	Ceiling (feet AGL)		Visibility (miles)
VFR	greater than 3000	and	greater than 5
MVFR	1000 to 3000	and/or	3 to 5
IFR	500 to 1000	and/or	1 to 3
LIFR	less than 500	and/or	less than 1

TABLE III. OCCURRENCE OF DIFFERENT CATEGORIES OF WEATHER CONDITIONS AT EWR AND FRA; FOR EWR BREAKDOWN BETWEEN VFR AND MVFR AND BETWEEN IFR AND LIFR IS BASED ON 57% OF ALL OBSERVATIONS (SEE TEXT)

Airport	VFR	MVFR	IFR	LIFR
EWR	70%	16%	10%	4%
FRA	52%	34%	7%	7%

The value of CAPA for each of the four categories of weather conditions was determined from the records of the actual throughputs (i.e., number of movements performed) at the two airports in a 15-minute interval. All the available observations of throughput for 2007 were assigned to one of four groups according to prevailing weather at the time of each observation. The CAPA values were then estimated as the 95-th percentile highest value of observed throughput. Stated differently, only 5% of observations in each weather category showed a throughput equal to or greater than the estimated value of CAPA. For all the values of CAPA that were obtained in this way, the data were reviewed carefully to make sure that the associated throughput was achieved under “saturated” conditions, i.e., there was a continuous presence of a queue during the respective time intervals, so that the runway system was operating at its full capacity.

The principal results of this analysis are summarized in Fig. 1 and Fig. 2 for FRA and EWR, respectively, which clearly indicate that the CAPA at each airport is highly sensitive to weather conditions. On an hourly basis, the maximum throughput capacity of FRA ranges from roughly 96 (=4x24) movements per hour under VFR weather conditions to about 84 per hour under IFR and LIFR, a loss of about 13% in capacity. Similarly, for EWR, CAPA declines from roughly 84 under VFR to 72-76 in IFR and LIFR conditions, a loss of 10-14% in capacity. The values of CAPA at FRA are consistently 10-12 movements per hour higher than the values observed at EWR for the same weather conditions. This difference may be largely due to the fact that the third runway in FRA is operated independently of the two close parallel runways (and used only for departures) while the third runway at EWR intersects with the two close parallel runways. FRA achieves its high throughputs despite handling a significantly higher percentage of wide-body aircraft than EWR.

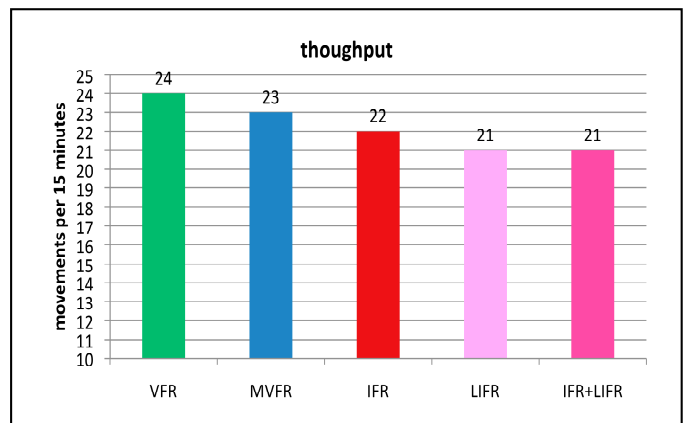


Figure 1. Throughput at FRA as a function of weather conditions

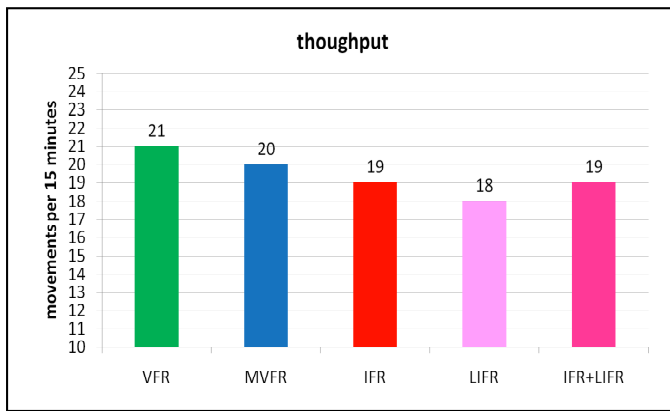


Figure 2. Throughput at EWR as a function of weather conditions

It has also been ascertained that the highest observations of hourly throughput are consistent with the values suggested by the 15-minute CAPA values shown in Fig. 1 and Fig. 2. For example, 2% of the throughputs observed during peak hours at FRA during 2007 showed 96 (=4x24) or more actual movements processed per hour.

Finally, it is noted that the estimates of CAP in Fig. 1 and Fig. 2 are quite insensitive to changes in the percentile value selected. If instead of the 95-th percentile, one chooses the 98-th or the 90-th percentile, the estimates of CAPA either remain the same or change by at most one movement (higher for the 98-th percentile and lower for the 90-th percentile) per 15-minute period. The highest observed hourly values of CAPA in 2007 were 100 movements at FRA and 92 movements at EWR and occurred on three occasions at each airport in VFR weather, probably under highly favorable conditions, such as a homogeneous mix of mostly narrow-body aircraft.

### B. Daily Traffic and Relationship of Demand to Capacity

A detailed examination of the daily traffic patterns at the two airports in 2007 provides a textbook illustration of the fundamentally different philosophies that prevail in Europe and the US when scheduling aircraft movements at congested airports.

FRA is a “coordinated” airport<sup>5</sup> where, in order to land or take off, it is necessary for an air carrier or any other aircraft operator to have been allocated a slot<sup>6</sup> by the German Airport Coordinator (GAC). The total number of slots available per hour at FRA in 2007 varied between 81 and 83 operations per hour, depending on the mix of arrivals and departures in each hour, with arrivals limited to a maximum of 44 per hour and departures to a maximum of 52. (In 2011, the limit on total operations per hour is essentially the same, varying between 81 and 84.) In order to keep the demand profile uniformly distributed, even within one-hour intervals, there are also limits on the number of arrivals, departures, and total operations that can be scheduled within a 30-minute interval and within a 10-minute interval (for details, see [6].)

<sup>5</sup> There were 73 coordinated airports in Europe in 2010.

<sup>6</sup> A detailed description of the slot coordination process is outside the scope of this paper.

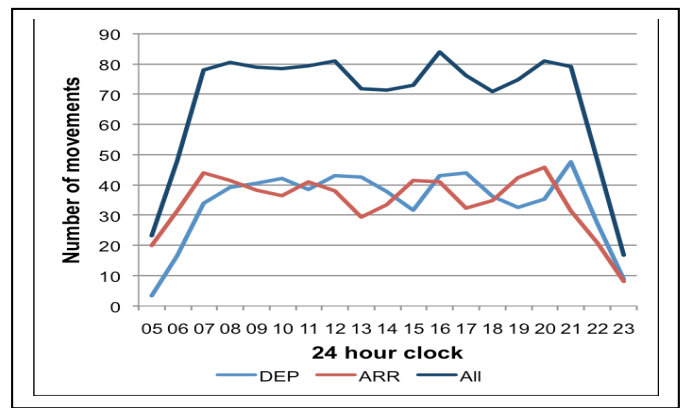


Figure 3. Demand at FRA as a function of the time of the day

In view of these limits and the strong airline demand for access to FRA, it is not surprising that the overall daily traffic profile is even throughout the day (Fig. 3). Total movements scheduled during peak times are close to the coordinated threshold value of 81 – 83 movements per hour. Note that the arrival and departure profiles (bottom of Fig. 3) also exhibit limited variability with small peaks in departures alternating with small peaks in arrivals. Overall, the daily demand profile of FRA is essentially “capacity constrained” and does not fully capture the true demand for airport access.

It is important to note that the limit of 81-83 operations per hour in effect in 2007 is almost identical to the IFR hourly maximum throughput capacity of FRA. As shown in Section 3.A, this IFR capacity is 21 operations per 15 minutes or approximately 84 per hour. In summary, the demand management system (i.e., the slot coordination process of the GAC) prevents airside demand at FRA from exceeding the capacity of the airfield under less-than-good (IFR/LIFR) weather. This also means the availability of considerable excess capacity in good weather (VFR and MVFR).

Absent scheduling constraints, the 2007 daily demand profile at EWR was, by contrast, very uneven and asymmetrical (Fig. 4). A short and sharp peak is present at 8 a.m., followed by a steady increase in traffic volume starting at 10 a.m. that reaches a maximum at about 4 p.m. and persists at a high level until 8 p.m., after which it declines rapidly. The critical point to note is that the peak demand of 82 per hour is at a level comparable to EWR’s VFR capacity of 84 movements per hour (Section 3.A). In 2007, demand exceeded EWR’s IFR capacity of 72-76 movements for many hours during an average day. One would therefore expect large air traffic delays whenever weather conditions were less than ideal during the busiest parts of the day.

The situation shown in Fig. 4 actually understates the potential for congestion at EWR, because the demand profile shows the average demand per hour for the *entire* year 2007. This masks the fact that on weekdays (Monday – Friday) and in certain months of the year (e.g., August) demand at EWR is significantly higher than the averages shown. This is illustrated by Fig. 5, which shows the demand profiles for weekdays by month of the year. Note that, in several months, peak demand exceeds by a considerable margin even the VFR capacity of 84.

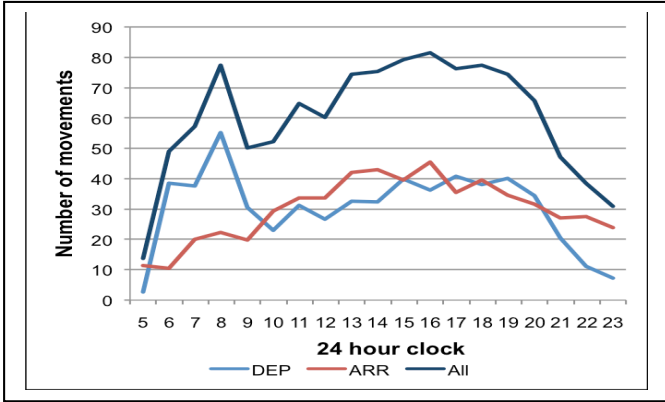


Figure 4. Demand at EWR as a function of the time of the day

These observations strongly confirm the conclusions of the less detailed study of 34 US and 34 European airports in [3]: at the busiest airports in the US, airlines schedule movements with reference to the optimal (VFR) capacity; at European airports, the number of movements scheduled is limited by the number of slots available (“declared capacity”); this number, in turn, is generally set at or below the airport’s IFR capacity.

#### IV. DELAYS, PUNCTUALITY AND SCHEDULE RELIABILITY

We turn next to the implications of the above demand-to-capacity relationships for delay-related performance at FRA and EWR.

As might be inferred from Section 3.B, delays at FRA are much lower than at EWR. Fig. 6 and Fig. 7 show the averages of scheduled movements, arrival delays, departure delays and actual movements at FRA and EWR for 2007. “Scheduled movements” indicates the number of movements scheduled to take place during a particular hour and “actual movements” the number that were actually performed during that hour. Delays are computed relative to schedule: a flight that was scheduled to arrive at 10:15 and actually arrives at 10:34 incurs 19 minutes of average delay. An early arrival (“negative delay” relative to schedule) is counted as having incurred zero delay.

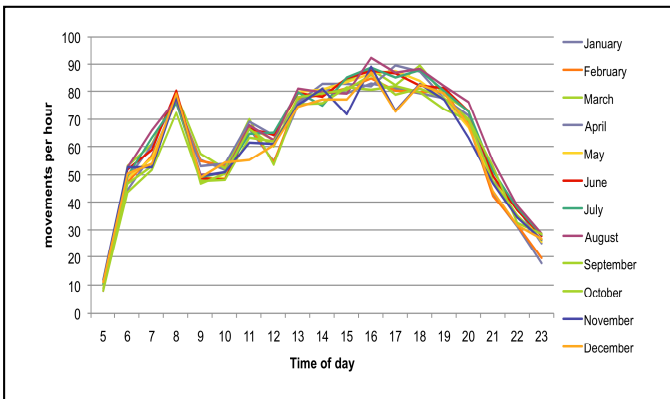


Figure 5. EWR – Weekday demand profile by month of the year

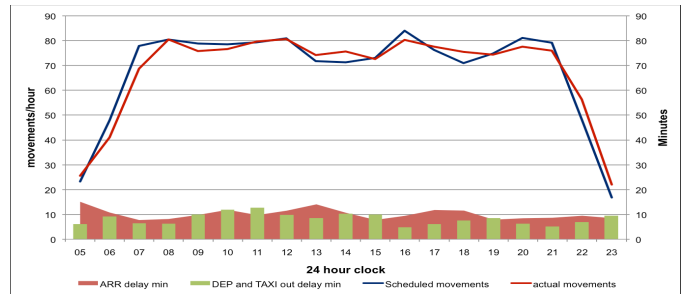


Figure 6. FRA: schedule (left scale) and delays (right scale)

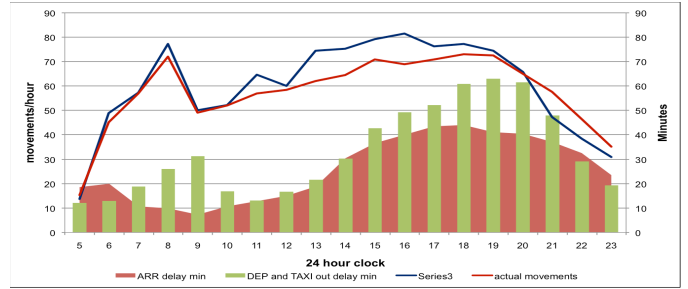


Figure 7. EWR: schedule (left scale) and delays (right scale)

Note that delays for both arrivals and departures at FRA remain stable throughout the day, averaging around 10 and 8 minutes, respectively (Fig. 6). The picture for EWR is entirely different. The arrival and departure delays are much larger, averaging around 30 and 20 minutes, respectively; moreover, the temporal distribution is very uneven, with peak average delay in the evening exceeding 60 minutes for arrivals and 40 minutes for departures (Fig. 7). Another noteworthy aspect of EWR’s performance is that the number of actual movements during the peak period from 12 noon to 8 p.m. is significantly lower than the scheduled number of movements, suggesting an inability of the airport to keep up with demand (top of Fig. 7). This inability results in flight cancellations and long delays. Due to the latter, many flights are “pushed” toward the end of the day. This is reflected in the fact that, after 9 p.m., the number of actual movements is significantly higher than the number of scheduled movements, as delayed flights from earlier in the day finally arrive or depart at these later hours.

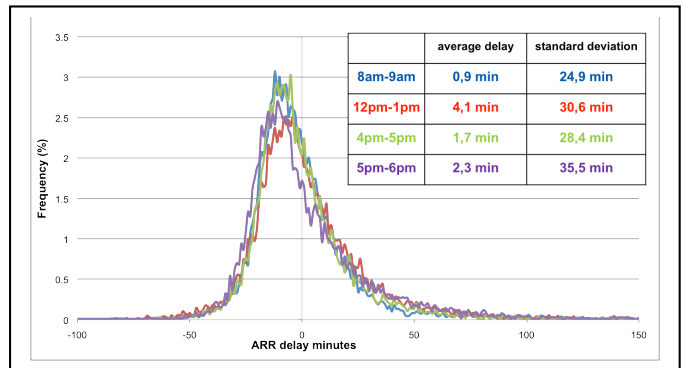


Figure 8. FRA - delays do not worsen over the course of the day; roughly constant schedule reliability

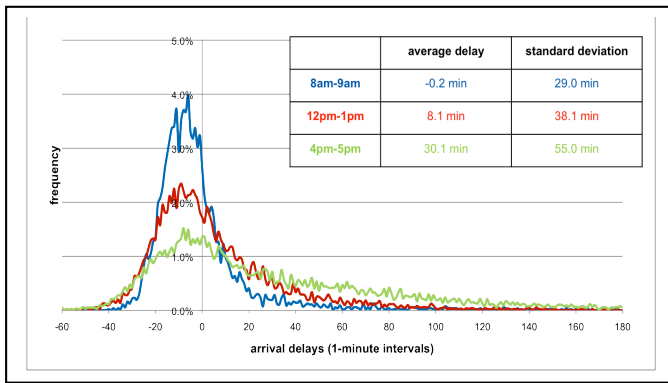


Figure 9. EWR - delays worsen during the course of the day; schedule reliability declines

Airport schedule reliability is defined here as the level of conformance between a planned schedule and the corresponding realized schedule. Conformance refers to both flight punctuality (i.e., the deviation of the time when a movement actually takes place from when it was scheduled to occur) and the amount of uncertainty associated with this deviation. Fig. 8 and Fig. 9 provide further insight into the differences between the two airports in this respect. Fig. 8 shows the distributions of “arrival delay relative to schedule” for all flights scheduled to land at FRA during 2007 at four different hours of the day: 8 – 9 a.m., 12 – 1 p.m., 4 – 5 p.m., and 5 – 6 p.m. Negative delays are also displayed and (unlike Fig. 6 and Fig. 7) taken into account in computing the average delay and standard deviation of delay shown in the Figure’s inset. Note that the four distributions are remarkably similar, a point confirmed by the roughly equal values of their respective averages and standard deviations. Clearly, this is not the case for EWR (Fig. 9): the average value and the standard deviation of the delay increase dramatically later in the day. This means that the distribution of delays at EWR becomes “flatter” as the day gets older, meaning not only longer delays on average, but also more uncertainty about their size. We conclude that flight punctuality and airport schedule reliability remain essentially constant at FRA throughout a typical day, but deteriorate sharply at EWR as the day gets older.

Taxi-out delays at the two airports also differ considerably. At FRA the actual taxi-time out (ATTO) had a mean value of approximately 13 minutes in 2007, comparable to the standard “unimpeded” taxi times that range from 8 to 16 minutes at the airport, depending on the specific gate of departure and the runway used. Thus, FRA has essentially insignificant taxi-out delays. This can be attributed in large part to the operating policies of DFS and of EUROCONTROL’s CFMU, which call for keeping aircraft at the gate, to the extent possible, if a large departure delay is expected, instead of having them queue on the taxiways.

EWR in 2007 had a daily mean ATTO of approximately 30 minutes, but with values as high as 35-40 minutes for many hours (8 – 10 a.m.) and 5 – 8 p.m.). These ATTO values mean substantial taxi-out delays with peaks of approximately 25 minutes in VMC and approximately 34 minutes in IMC. EWR does not have a strategy comparable to the one used at FRA for absorbing large departure delays mostly at the gates.

Fig. 10 and Fig. 11 provide additional perspective on the allocation of departure delays between the gates and the taxiway system. They show scatter diagrams of ATTO vs. gate delay for all departures at FRA and EWR in 2007. Note that FRA relies primarily on gate delays to absorb departure delays (Fig. 10), while very large ATTOs may be incurred at EWR, no matter how much gate delay occurs (Fig. 11).

## V. CONCLUSIONS AND CURRENT DEVELOPMENTS

The benchmarking of the two airports was highly successful, leading to improved insights on airport performance with respect to a broad range of measures, as well as to general and specific conclusions that have important policy implications. Ongoing work, as of this writing, is seeking to refine some of these findings, by examining additional issues such as: the relative importance of “local” vs. “upstream delays at FRA and EWR; the role that the limited number of gates at EWR plays in how departure delays are managed there; and the role of the various stakeholders (airports, airlines, ANSP) in determining slot limits at European airports.

In broad terms, one concludes that FRA is an airport where demand management policies play a major role in maintaining a reasonably stable airside operating environment, with seemingly acceptable levels of delay and quite reliable execution of the airport’s daily schedule. If anything, and despite occasional complaints by some incumbent airlines about congestion at FRA, our analysis suggests that current scheduling caps, as set by the airport coordinator, may be set too low. The economic benefits of modest increases (of the order of a few movements per hour) in these caps may well outweigh any resulting increases in delays.

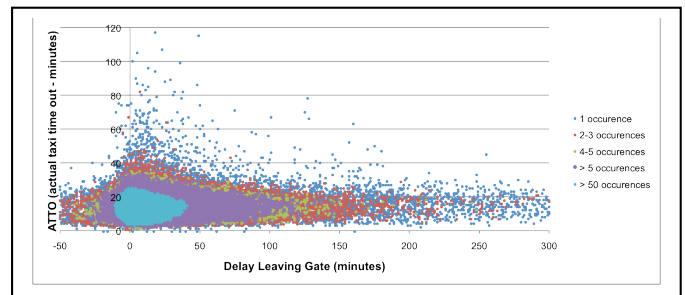


Figure 10. FRA – Actual taxi-out time vs. gate delays on departure

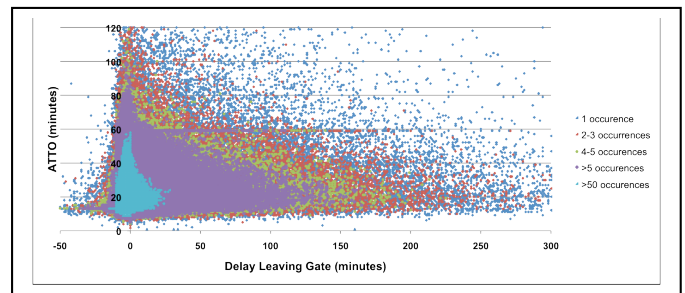


Figure 11. EWR – Actual taxi-out time vs. gate delays on departure

In the case of EWR, we provide clear evidence that, in the absence of any constraints on scheduling, airside demand in 2007 was excessive, leading to poor operating conditions, high delay costs, and low schedule reliability. Our careful analysis of EWR capacity, clearly demonstrates that demand in 2007, especially during the weekdays of the busiest months, exceeded what the airport could handle, even when weather conditions were nearly ideal.

Reacting to this situation, the FAA did impose in 2008 a scheduling cap of 83 movements per hour (81 scheduled plus 2 unscheduled) at EWR. This limit has been in effect ever since and is scheduled to expire in late 2011. As shown in Section 3.A, this limit is essentially equal to the VFR capacity of the airport. A report recently issued by the Office of the Inspector General of the US Department of Transportation [7] questioned the hands-off approach of 2007 and suggested that the limit of 83 be subjected to further study.

In the meanwhile, demand at EWR has declined due to the general economic conditions in 2009 and 2010. In January through September 2010, the number of movements at EWR was 8% lower than in the corresponding period of 2007, while average departure delay was 35% lower [8]. This points to the well-known fact that the relationship between demand and delay at highly utilized queuing systems is very nonlinear: in this case an 8% reduction in demand is largely responsible for a 35% reduction in delay.

As a final comment, this study underlines the importance of setting carefully scheduling limits, when these are necessary, at congested airports. The current approach to schedule coordination in Europe – a somewhat “liberalized” version of the widely adopted IATA guidelines [9] – seems to be weighted too heavily (especially, as actually practiced at many European airports) toward the objective of preventing delays. The economic benefits of accommodating additional runway movements (even at the risk of some additional delay cost) may not be recognized sufficiently by this approach. At the opposite extreme, the typically laissez-faire approach at US airports may lead to situations of obvious over-scheduling – as was clearly the case of EWR in 2007 according to our study.

#### ACKNOWLEDGMENT

The authors gratefully acknowledge the numerous comments and suggestions received from John Gulding (ATO FAA) and David Knorr (ATO FAA) in the course of their work. This research was supported by the Federal Aviation Administration under Delivery Order DTFWA-08-F-MIT25. The authors are solely responsible for any views expressed herein and for any errors in the paper.

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