Airside Study of Charles de Gaulle Airport

Airside Organization

Traffic Growth and Risks of Congestion

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Introduction

Paris Charles de Gaulle Airport is the 3rd busiest airport in Europe behind London Heathrow and Frankfurt with 48.2 M passengers last year. It’s also the 6th busiest in the world in terms of operations with 505 000 movements last year.

How the air traffic is organized around this major airport? What are the stakes concerning its development?

The object of this study is to apply the concepts discussed in class to the Charles de Gaulle Airport in order to figure its expansion potential in the next years with the traffic increase.
I. Airside organization

I. 1. Traffic conditions

The Paris Charles de Gaulle is one of the major airports outside the US. It welcomed 505,000 Air Traffic Movements in 2003, and is the 6th world airport in this metric. The airport enjoy good weather conditions more than 95% of the time. It has a few snowy days in the year. It is the Air France hub, which perform about 60% of all ATM. This graphic below shows the recent evolution of the Air Traffic in the region of Paris. It includes the data of the second Parisian airport Orly.

Since 2001, the growth of the airport has been a little slow down. But with the year 2004, the statistics are back to the levels of 2000. The peak operation day has seen 1,689 ops. During the peak hour, the airport was able to perform 125 ops. Finally, the 1st of August of last summer, the airport has welcome 181,000 passengers in one day.

I. 2. Runway systems

Charles de Gaulle airport has 2 pairs of parallel runways. They already respect the requirements to welcome the A380.

<table>
<thead>
<tr>
<th>Number</th>
<th>Length</th>
<th>Width (code F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>08L/26R</td>
<td>13829 ft / 4215 m</td>
<td>197 ft / 60 m</td>
</tr>
<tr>
<td>08R/26L</td>
<td>8858 ft / 2700 m</td>
<td>197 ft / 60 m</td>
</tr>
<tr>
<td>09L/27R</td>
<td>8858 ft / 2700 m</td>
<td>197 ft / 60 m</td>
</tr>
<tr>
<td>09R/27L</td>
<td>13780 ft / 4200 m</td>
<td>197 ft / 60 m</td>
</tr>
</tbody>
</table>
The following map presents the organization of the field of Charles de Gaulle. The airport is spread on a significant area of 3200 Ha.

Concerning the airside facilities, the airport has already 2 Air Traffic Tower but another (last) one is supposed to be build next to the North parallel runways in the next years. The airport has also about 71 km of taxiways connecting the runways to the terminals.

Runway organization of the Airport

The airport has 2 configurations, depending on the wind directions. However, in both configurations Eastward and Westward of Charles de Gaulle:

- The Runways 08R/26L and 09L/27R (far from the terminal) are mainly used for landings.

- The Runways 08L/26R and 09R/27L (near the terminal) are mainly used for takeoffs.
I. 3. Calculation of the Capacity

To compute the total capacity of the Airport Charles de Gaulle, we first compute the capacity of a single runway.

We can classify aircraft into 3 types: heavy (H), large/medium (L) and small (S). I use the data given in the section 10-7 of the text book and assumed that the length of the final approach is 6Nm.

<table>
<thead>
<tr>
<th>Aircraft type</th>
<th>Approach speed (knots)</th>
<th>Runway occupancy time on landing (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>150</td>
<td>70</td>
</tr>
<tr>
<td>L</td>
<td>135</td>
<td>60</td>
</tr>
<tr>
<td>S</td>
<td>105</td>
<td>50</td>
</tr>
</tbody>
</table>

Then, I used the FAA separation requirements (in nautical miles) between successive landing aircraft on final approach given by the matrix below:

<table>
<thead>
<tr>
<th></th>
<th>S</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>L</td>
<td>4</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>H</td>
<td>6*</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

[⁎]This separation applies only when the leading aircraft is at the runway threshold; all the other separations apply throughout the final approach.

I added a buffer time of 15s (according to section 10.5 of the textbook). And, I finally got the matrix of average time separation.

<table>
<thead>
<tr>
<th></th>
<th>S</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>100.7</td>
<td>81.6</td>
<td>75</td>
</tr>
<tr>
<td>L</td>
<td>197.9</td>
<td>81.6</td>
<td>75</td>
</tr>
<tr>
<td>H</td>
<td>220.7</td>
<td>164.3</td>
<td>111</td>
</tr>
</tbody>
</table>


We assume that the air traffic controllers are not making any sequencing. Then, we can compute the matrix of pair probability.
Finally, I compute the average separation time between a pair of aircraft.

\[ E(t) = \sum_i \sum_j p_{ij} \cdot t_{ij} = 97.557 \text{ s} \]

Therefore the capacity of one runway is 37 movements per hours. Since Charles de Gaulle has 2 pairs of independent runways. Each time we have an arrival on a runway, we can make a departure on the runway just next to. Therefore, we get the capacity of the airport by multiplying this number by the number of runways.

We get the capacity of the airport: **148 movements per hours.**

**I. 4. Remarks**

This estimation of 148 movements per hours is based on the several assumptions presented above. Anyway, it gives a good estimate of the traffic potential of the airport, given the type of traffic that uses it. It can be considered as a maximum capacity of the airport. The real number may be a little less. Indeed, the Paris Air Traffic Controllers may decide to use more restrictive separation requirements than those demanded by the FAA. On the other hand, they could do some sequencing of the arrivals and departures which would increase this number. It’s is very striking to find that the number of available slots per hour (which means the number of operations per hour, the airport authorities allow the airlines to schedule an operation) is only 103 movements per hour, currently and will become 105 in July 2005. ([http://www.cohor.org](http://www.cohor.org)).

This number is given by the COHOR, an « independent » authority that co-ordinates flights in France. However, the independence of the organisation is not so obvious since the slot co-ordinator is a former Air France employee, and that his point of contact at the French civil aviation authority sits on the board of Air France. Easy jet accused Cohor of colluding with Air France to prevent competition; which The Cohor strongly denies. This fact points out that
the capacity of an airport not only depends on its own characteristics, but also of its history and of political issues.

I. 5. Comparison of the capacity with similar airports

Atlanta and Los Angeles are 2 international airports similar to Paris Charles de Gaulle. Indeed, they also have 2 pairs of independent parallel runways. However, according to the “2004 Airport Capacity Benchmark Report” by the FAA, they have better capacity than Paris Charles de Gaulle.

We found that Atlanta International Airport has a capacity of 180-188 movements per hour in good weather conditions and 158-162 in Instrument Flight Rules conditions. Whereas, Los Angeles can perform 137-148 operations in good weather conditions and 117-124 under instrument conditions.

Los Angeles International Airport

Atlanta International Airport

These figures given by this American airport could represent and potential capacity of the Charles de Gaulle airport.
II. Air Traffic Control

II. 1. Two Configurations of the Airport

The Charles de Gaulle airport is an easy case. Indeed, due to its geometry, it has only 2 configuration possible called:

- Eastward when the wind blows from the East
- Westward when the wind blows from the West.

The Westward configuration which minimizes the noise disturbance on the nearby communities is used 60% of the time and the Eastward (in which the landing approaches fly over a lot of communities) is used 40% of the time. However, this numbers can change a lot through the year, as we can see on the graphic below.

II. 2. Traffic in Paris region

Roissy Charles de Gaulle is not the only airport in the Paris region. Indeed, there are also 2 older airports:

- **Orly**, the first French international airport performs about 700 movements per day. It has no margin for expansion since it was limited by the government to perform at most 250,000 movements per year.

- **Le Bourget**. It’s an airport situated between Charles de Gaulle and Paris mainly used by private jets. It performs about 170 movements per day.
Westward configuration  

This picture gives an overall view of the flow of aircrafts under the two configurations. Each plane route is guided by the air traffic control whose purpose is to minimize the risk of aircraft collisions while maximizing the number of aircraft that can fly safely at the same time.

Concerning CDG, we can find 5 waiting zones. These zones are situated between 35 and 70 miles away from the airport. So that once you leave the zone, you still need between 15 and 30 minutes to reach the runway of the airport.

II. 3. Radar images of the traffic

I found the Radar images provided by Aéroport de Paris (AdP) that show the air traffic in Charles de Gaulle for one day. In the westward configuration, we have:
This radar image shows both the arriving and departing traffic for one day at Charles de Gaulle airport. We get an idea of the density of the traffic above the terminal area. We can also see the dispersion of the aircraft from their ideal route. This may be due to different performances from one aircraft to another, but also to separations requirement between them. We can see that the dispersion is more important concerning the arrival area than the departing area. Indeed, the air traffic controllers need to disperse the aircrafts in order to always keep satisfied the separation requirements.

Thanks to the color code, we get a better idea about the vertical reparation of the aircraft route. The colors indicate the altitude of the aircraft. We can see that the aircraft flow lower by landing than by taking-off. Indeed, for landing, the aircraft must have a small angle with the runway (usually about 3°) whereas, during taking-off, it can take a bigger angle.

As a consequence, the Eastward affects more the communities living at the north of Paris.

There is a big community at the north of Paris. In the west configuration, the airplane which takes off can takes altitude quickly. In the East configuration, the approaching aircrafts fly at a lower altitude, which bother much more the surrounding communities. This will become a main issue when we will discuss the expansion of the airport.
III. Risks of Congestion

III. 1. Determination of the traffic growth

Eurocontrol has published a forecast concerning the traffic growth in France. Since we learn in the course to be very careful with forecasting, it can be interesting to look at the assumptions made here and the method used.

The STATFOR Medium-Term Forecast uses three scenarios which differ in terms of the assumptions. The low-growth and high-growth scenarios capture the most-likely range of future growth in air traffic; the baseline scenario indicates a likely position within this range. The Forecast includes many variables:

- GDP growth forecasts in real prices in local currency (linked with economic growth)
- Changes in rail travel time on city pairs served by high-speed links, compared to the baseline year (to represent the high-speed train development).
- Low-Cost growth (which adds additional traffic)
- Load factors
- Demographic change

Preparation process of the Medium-Term STATFOR Forecast
At each stage of the Forecasting, different comparisons by using any available data, for example, with statistics published by similar growing airports, to check if the forecast gives sensible results. The first-year growth is compared with known airline plans; the first two years are compared to the short-term forecast. However, such comparisons remain more a matter of judgment than a precise numerical correlation.

Anyhow, the forecast predicts a strong augmentation of the air traffic: the baseline forecasts a 22% growth, the High Growth scenario, a 30% growth, and the low growth a 13% growth.

To get a forecast the air traffic growth in Charles de Gaulle, I assumed that this growth would be directly correlated to the traffic growth in France. For each year, I compute the traffic using the same rate than the France growth. I get the following forecast:
III. 2. Estimation of the annual capacity

The annual airside capacity is the number of aircraft movements that can be handled at a reasonable level of service during one year. This number, that will be important to evaluate the congestion risk based on the growth forecasting, is however difficult to estimate. Indeed, it depends from the runway capacities, but also the seasonal peaking or the airport use during in the day or political issues that may artificially limit the capacity.

We find a capacity of 148 movements per hours in good weather conditions. Since, bad weather condition occurs less than 5% in the year, we can assume that the hourly capacity is about 144 (= 148*95% + 74*5%) movements per hour.

The airport could then accommodate roughly 1.26 M (= 144*24*365) of movements per years. However, since it’s only used about 16 hours in the day, it could only accommodate 810,000 Air Traffic Movements (ATM) per year.

When the ratio of utilization of an airport is too closed to 1, it produces a lot of delays. Therefore, to guaranty a decent service, we take 85-90% of our former result. We get a capacity of 715,000-755,000 ATM per year.

However, the airport experiences a seasonal variation in demand with a 10% traffic increase during the summer as we can see on the graphic below:

<table>
<thead>
<tr>
<th>Number of Flights</th>
</tr>
</thead>
<tbody>
<tr>
<td>56000</td>
</tr>
<tr>
<td>54000</td>
</tr>
<tr>
<td>52000</td>
</tr>
<tr>
<td>50000</td>
</tr>
<tr>
<td>48000</td>
</tr>
</tbody>
</table>

Therefore, the service ratio is only valid for the summer period (April-October).

Finally, we get the annual capacity of the airport: 682,000 – 722,000 ATM per year.
III. 3. Peak hours

We compute an estimation of the traffic during a summer day as follow:

\[ = \frac{\text{Annual capacity}}{12} \times 1.05 \]

Then, we take 8% of the daily traffic, since it represents an estimate of the peak hour demand. Under the 3 different scenarios, we get:

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Moves per day</th>
<th>Peak hour (max moves)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>1741</td>
<td>139</td>
</tr>
<tr>
<td>High Growth</td>
<td>1852</td>
<td>148</td>
</tr>
<tr>
<td>Low Growth</td>
<td>1611</td>
<td>128</td>
</tr>
</tbody>
</table>


Number of ATM forecasted during the summer of 2010

III. 4. Conclusion

This evaluation shows that the maximum capacity would be reach under the assumption of the High Growth scenario. However, the baseline scenario doesn’t forecast such a big increase in the traffic.

Finally, the Airport potential growth seems to be able to absorb any increase in the traffic during the 6 next years to 2010. That’s why the decision of the government to postpone the decision about the construction of a 3rd airport in Paris region can be justified.

However, the current debate is not only about the capacity of Charles de Gaulle to absorb the increasing traffic, but also about the complaints from the communities next to the airport which refuses an increase of the Air traffic more than 600,000 ATM per year...
IV. Limitation to expansion

IV. 1. Noise disturbance

Since the creation of the airport, a lot of communities have developed at the north of Paris. The map below shows the communities mainly touch by the aircraft landing to or departing from Charles de Gaulle.

Map of the noise disturbances

These map shows the regions were a signification increase in the noise is noted due to the activities of the airport. A few years ago, the Concorde was particularly known to produce a lot of noise by taking off or landing. Also, the communities’ complaints about the night traffic at the airport, which represent a little more than 10% of the overall traffic. Some local community leader would even like to forbid this night traffic.
IV. 2. Consequences

According to our forecast, the airport will not reach its saturation level by 2010, but the communities around my reach their saturation level. The government has already made some concession on this topic. For instance, Charles de Gaulle is a very wide-spread airport, and there is definitely available space to build new runway in the future to respond to a traffic increase. However, the government decided some years ago to satisfy the communities not to build another runway in Roissy.

So, what is the most likely solution at the moment is no decision is taken during the newt year. A first site, Chaulnes, 80 north of Paris, had been designated by the former the government to be the third Paris international airport. But the project has been stopped due to political pressure and uncertainty about the traffic growth. Moreover, airlines were not in favor of this project, saying that the site was too far from Paris center.

If congestion appears in the next years, a feasible solution would be to use a little existing airport, Vatry, 80 miles East from Paris, and to transform it into an International airport. The big advantage of the airport is that the region around the airport is much less crowded than around Roissy.

Site of Vatry, possible 3rd airport
Conclusion

The potential capacity of Charles de Gaulle airport (148 ops per hour) is much bigger than the number of slots offered to the airlines (103 currently) by the COHOR. This can be related to a very conservative way to deal with the problem.

The air traffic growth in France will affect Charles de Gaulle and it may lead to some congestion problems in 2010 or in the following years. This issue mustn’t be forgotten since the expansion or the development of an airport takes several years.

Finally, this study has show that even if Charles de Gaulle’s Airport is able to welcome the traffic growth in the next years and that the airport has the potential to develop, its expansion is related with political issues.
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Reports:


