CEE 5614: Analysis of Air Transportation Systems Fall 2018

Assignment 6: Runway Capacity

Date Due: November 9, 2018 Instructor: Trani

Problem 1

Perform a runway capacity analysis for the San Diego International Airport (SAN) considering the following operational information. Consult Google and Airnav to understand the problem as necessary. The airport has a single runway oriented East-West . San Diego terminal area arrivals and departures are controlled by Southern California TRACON using standard airport surveillance radar with a scan rate of 5 seconds. Table 1 shows the approximate fleet mix operating at the airport. For this analysis we use the following technical parameters: a) in-trail delivery error of 16 seconds under both VMC and IMC conditions, b) departure-arrival separation for IMC conditions is 2.5 nautical miles (since mixed operations are conducted on the same runway), c) probability of violation is 5%. Arriving aircraft are “vectored” by ATC to the final approach fix located 9 miles from the runway threshold. The typical IMC separation values applied by ATC are shown in Figure 1 and Table 1. The departure-departure separations are shown in Table 2.

Table 1. Runway Operational Parameters and Fleet Mix for Problem 1.

Aircraft	Percent Mix (%)	Runway Occupancy Time (s)	Typical Approach Speed (knots) from Final Approach Fix
Small	3	44	127
Large	82	53	148
Heavy or B757	15	64	155

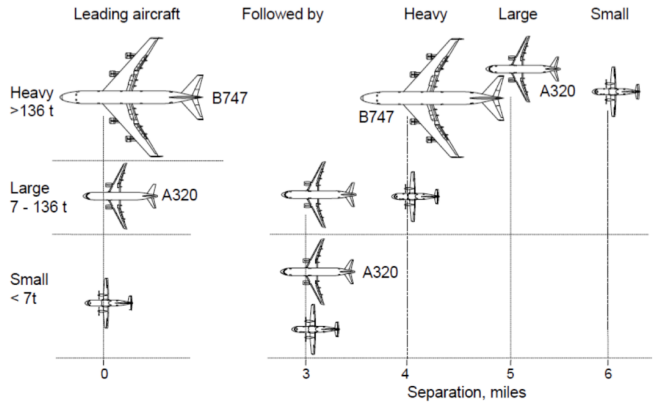

Figure 1. ICAO and FAA Recommended IMC Separations. Source: Lang et al., 2010. Arrival-Arrival Separations for all Groups Behind a Super-heavy add 2 nm over the Heavy Category.

Table 2. Minimum Departure-Departure Separations under IMC conditions. Values in are seconds.

Departure-Departure Separation Matrix (seconds)					
	Trailing Aircraft (Header Columns)				
Lead (column 1)	Small	Large	B757	Heavy	Superheavy
Small	60	60	60	60	60
Large	90	60	60	60	60
B757	120	120	60	60	60
Heavy	120	120	120	120	90
Superheavy	150	120	120	120	120

a) Find the IMC arrival saturation capacity of the runway configuration at SAN.
b) Find the IMC saturation departure capacity with 100% arrival priority of the airport if we assume departures operations are dependent of the arrivals calculated in part (a)
c) Find the departure only saturation capacity in IMC conditions.
d) Plot the Pareto diagram (arrivals/departures diagram) for the solutions obtained above.

Problem 2

Review pages 28-31 of the handout on aircraft classifications. Review the runway configuration of Chicago O'Hare (see Figure 2). Assume IMC conditions, with **arrivals to runways 27R, 27L, 28C** and **departures from runways 28R and 22L**. The airport fleet mix is shown in Table 3. Assume the departing aircraft acceleration is 2.1 m/s^2. Consider the interactions between arrivals on runway 28C and departures on runway 22L (see Figure 2). **ATC controllers hold departures on runway 22L if an arriving aircraft on runway 28C is 2.5 nm or less from the runway 28C threshold**. Once the arrival to runway 28C has reached the threshold, departures on runway 22L can be executed. The airport has a PRM radar at the facility. In the analysis consider the ATC human factor time lag and engine spool-up time (8 seconds).

For this analysis we use the following technical parameters: a) in-trail delivery error of 16 seconds under IMC conditions, b) probability of violation is 5%. Arriving aircraft are "vectored" by ATC to the final approach fix located 8.5 miles from the runway threshold. Assume the fleet mix for all the runways is the same (to simplify the problem). The minimum separation matrix for ORD is shown on page 43 of the Aircraft Classification handout (http://128.173.204.63/courses/cee4674/cee4674_pub/Aircraft%20Classifications_rfs.pdf). ORD has good runway exits and hence minimum radar separation is 2.5 nm (empty cells on page 43 of the handout).

Table 3. Runway Operational Parameters and Fleet Mix for ORD Airport. RECAT Groups.

Aircraft RECAT Group	Percent Mix (%)	Runway Occupancy Time (s)	Typical Approach Speed (knots) from FAF
A	0	N/A	N/A
B	12	61	153

Aircraft RECAT Group	Percent Mix (%)	Runway Occupancy Time (s)	Typical Approach Speed (knots) from FAF
C	10	57	146
D	37	58	142
E	36	54	138
F	5	51	127
Totals	100		

Table 4. Departure-Departure Separations with Buffers Included. Columns 2-7 are the Following Aircraft. First Column Presents the Lead Aircraft. Values in are seconds (include departure buffers).

Aircraft	A	B	C	D	E	F
A	125	125	130	130	130	180
B	75	130	130	130	130	130
C	65	65	90	120	120	120
D	65	65	65	65	65	65
E	65	65	65	65	65	65
F	65	65	65	65	65	65

a) Estimate the IMC runway capacity for ORD airport today. **Shown in detail your analysis to account for the dependency between operations on runways 22L and 28C for today's configuration and for the future configuration**.

b) Estimate the IMC runway capacity for ORD airport in the year 2022 with a new 11,250-foot runway 9C-27C located 1600 feet to the North of runway 9R/27L. Show the complete Pareto diagram (arrivals and departures) for two ORD configurations under IMC conditions.

c) How does the new runway benefits the airport? Explain.

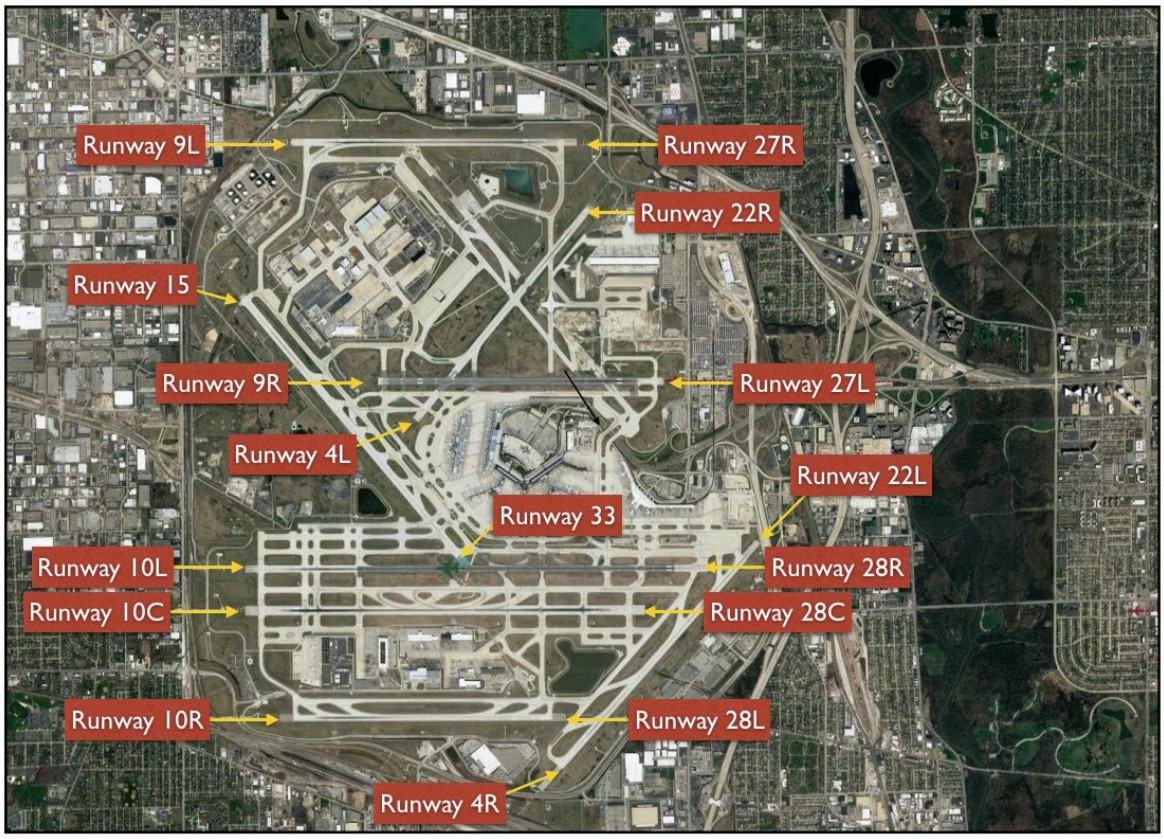

Figure 2. Chicago ORD Airport Today.