CEE 5614: Analysis of Air Transportation Systems Spring 2020

Assignment 7: Runway Throughput and Capacity

Date Due: April 8, 2020 at 5 PM Instructor: Trani

Problem 1

Figure 1 shows the interface of the Webtrak system for Chicago Department of Aviation (CDA). The system is available on the internet at: https://webtrak.emsbk.com/cda. Figure 2 shows the configuration of the airport. Use the replay feature of the Web Tracker to study the operations at ORD on January 9, 2020. Consult the airport map provided in Figure 2.

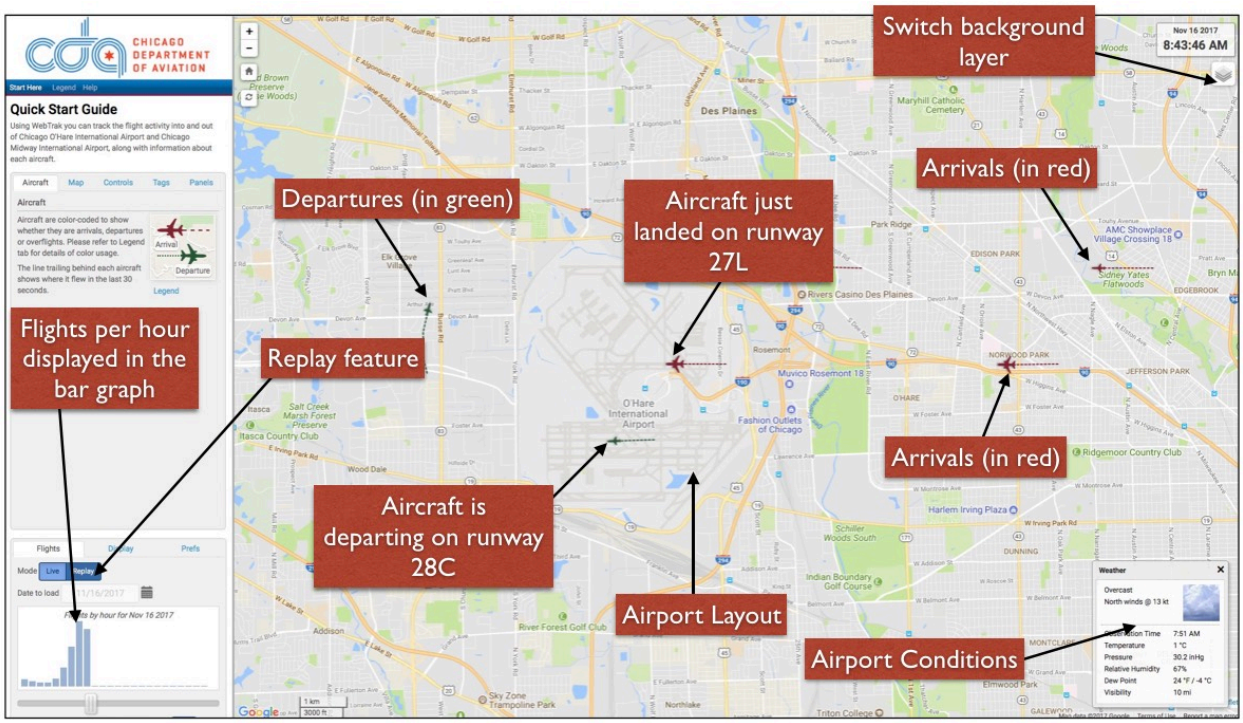

Figure 1. Webtrak system for Chicago Department of Aviation (CDA).

a) Use the replay feature in Webtrak5 to estimate the total number of hourly landing operations (i.e., throughput) at O'Hare runway 28C airport in the 3-4 PM period.

b) Use the replay feature in Webtrak5 to estimate the total number of hourly departure operations at O'Hare runway 28R airport during the period 3-4 PM.

c) Observe traffic departing on runway 22L and the arrivals on runway 28C. Explain what type of coordination is needed to operate these two runways during the peak morning period.

d) Using traffic during the period 3-4 PM, provide a first-order estimate of the closest distance between an arrival on runway 28C and a departure on runway 22. Use Google Earth to estimate distances shown in

the WebTrack system. For example, the Web Track system shows highway I-171, Route 43, etc. in the map. These distances can be used as reference in your estimate.

e) Explain the airspace organization to feed and meter arrival traffic to runways 27R, 27L and 28C. Are the arrivals independent of each other? Explain the FAA rule to operate triple independent arrivals.

f) If the hourly arrivals and departures estimated in parts (a) and (b) represent maximum runway throughput or capacities, estimate the runway capacity of the airport in West flow configuration with arrivals on runways 27R, 27L, 28C and departures on runways 28C and 22L.

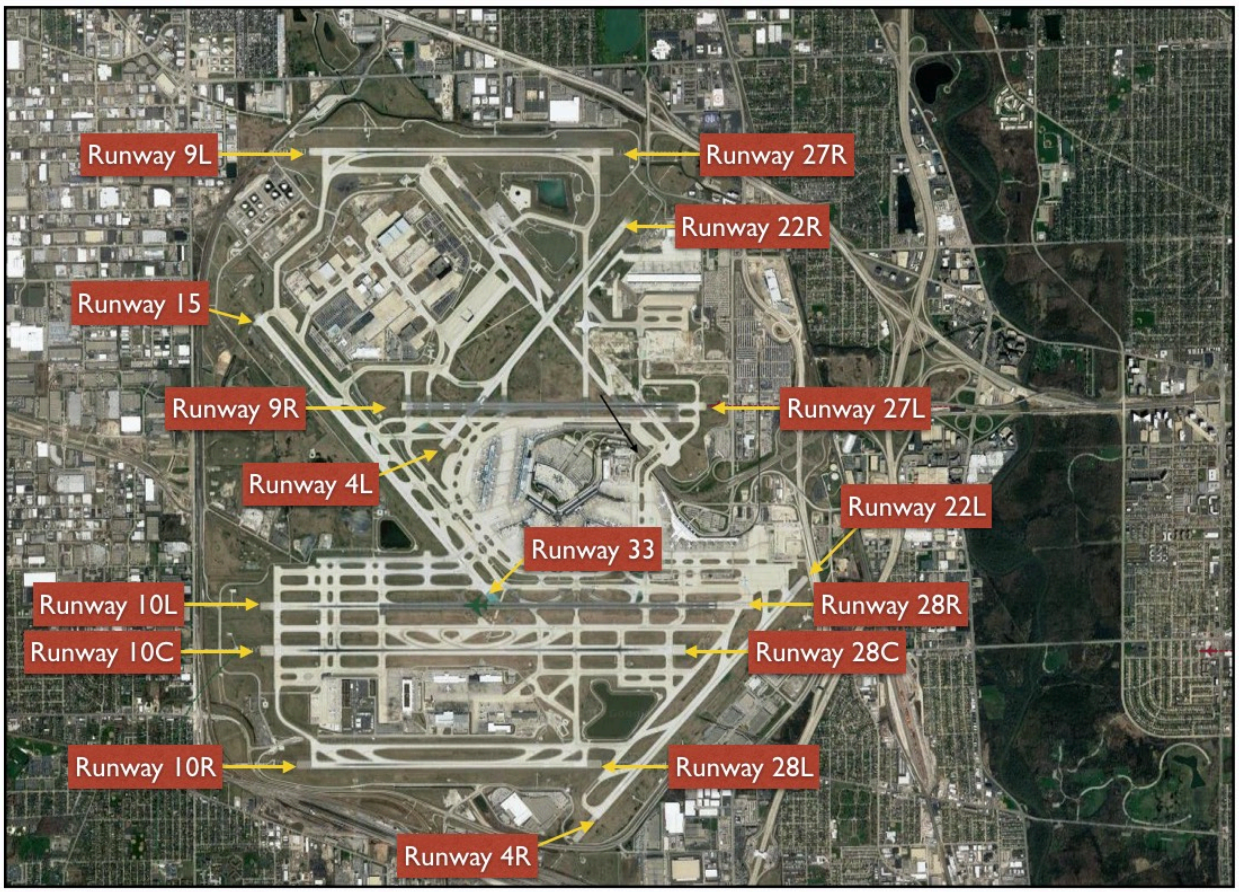

Figure 2. Chicago ORD Runway Configuration.

Problem 2

Review the runway configuration of México City airport (see Figure 3 and consult Google Earth if necessary). Runway 5L is normally used for departures. **Runway 5R is used for arrivals**. Because the close proximity of the runways, ATC controllers block **departures on runway 5L** when an arrival is inside the "reserved zone" in Figure 3 to reduce the risk of a simultaneous go-around on runway 5R and a departure on 5L. Aircraft in line and wait position are clear to depart once the arrival is outside the reserved zone. Table 1 shows the fleet mix for México City. Figure 4 shows the standard ICAO separations applicable to México City (IMC conditions). Table 2 shows the typical departure-departure separations used in México City. Mexico has standard airport surveillance radar. The common approach length is 10 nm. Use a probability of violation of 1%. The ATC controllers are conservative and use an in-trail position error of 22 seconds.

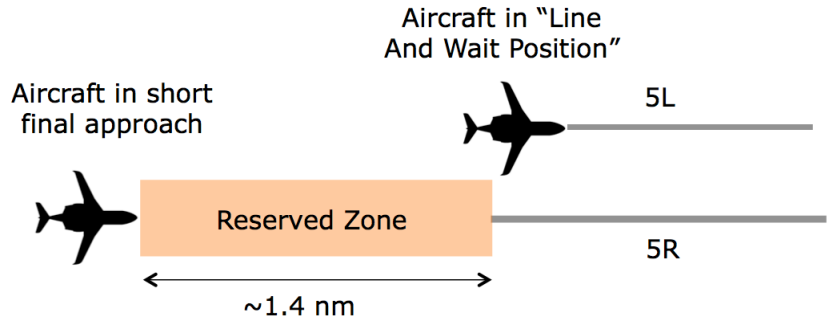

Figure 3. Close Parallel Configuration of Mexico City Airport.

Table 1. Runway Operational Parameters and Fleet Mix for México City Airport.

Aircraft	Percent Mix (%)	Runway Occupancy Time (s)	Typical Approach Speed (knots) from FAF
Small	4	50	126
Large	72	54	146
Heavy	22	61	161
Superheavy	2	76	158
Totals	100		

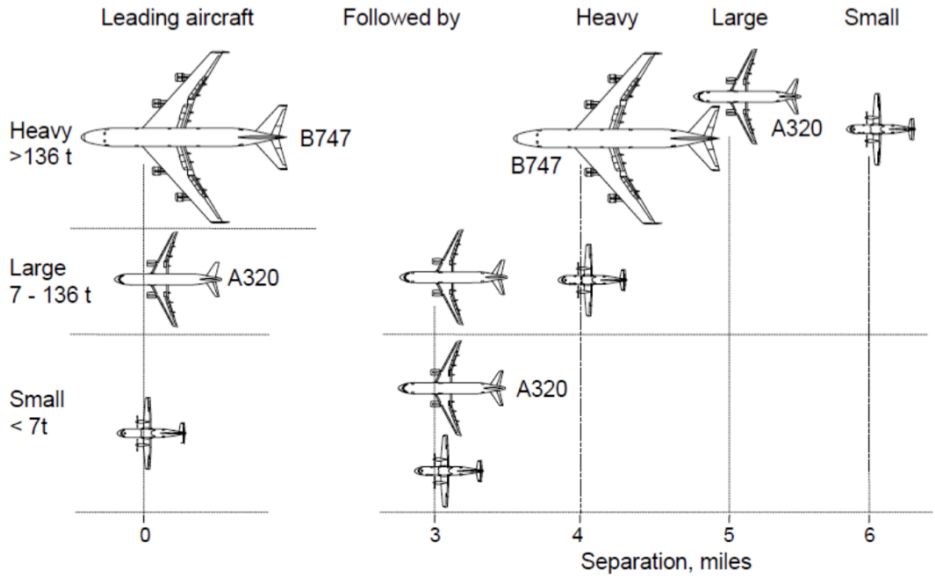

Figure 4. ICAO Recommended IMC Separations. Source: Lang et al., 2010. Arrival-Arrival Separations.

Table 2. Minimum Departure-Departure Separations. Columns are the Following Aircraft. Values in are seconds.

Aircraft	Small	Large	Heavy	Superheavy
Small	70	70	90	90
Large	70	70	70	70
Heavy	120	120	120	120
Superheavy	180	120	120	120

a) Find the IMC arrival capacity to the airport using runway 5R. Show sample calculations.
b) Find the IMC capacity diagram for this airport. Clearly explain how did you accounted for the dependency between arrivals and departures.
c) Plot the Pareto diagram for the two runways operated in IMC condition.

Problem 3

Review pages 28-31 of the handout on aircraft classifications. Review the runway configuration of Chicago O'Hare. 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. 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 18 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). Use the minimum arrival separation matrix under RECAT Phase conditions explained in class. ORD has good runway exits and hence minimum radar separation is 2.5 nm.

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
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

Aircraft	A	B	C	D	E	F
F	65	65	65	65	65	65

a) Estimate the arrival only capacity to runway 28C.
b) Estimate the departure only capacity for runway 28R.
c) Estimate the runway capacities (arrivals and departures) for ORD 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. Show the complete Pareto diagram (arrivals and departures) for two ORD configurations under IMC conditions.