Assignment 7: Runway Throughput and Capacity

Date Due: November 8, 2021
Instructor: Trani

Problem 1

An internet application to show communities around airports the extend of their operations is shown in Figure 1. The application is called Webtrak (https://webtrak.emsbk.com/lax4). This application shows flight operations to an airport. Study the airport configuration for Los Angeles International airport (https://www.faa.gov/airports/runway_safety/diagrams/). Normally, arrivals are conducted on runways 24R (Northern runway) and runway 25L (Southern runway). Departures on runways 24L and runway 25R.

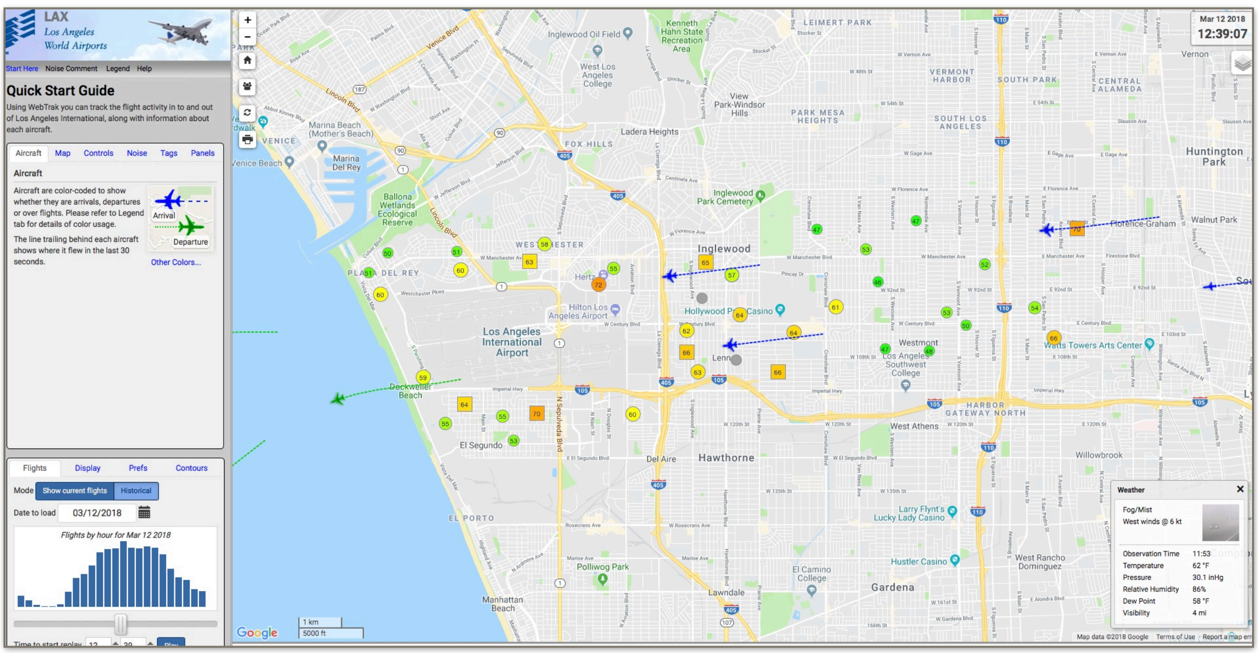

Figure 1. Webtrak system for Los Angeles International Airport. Departures are shown in Green. Arrivals in Blue. Airport Weather Conditions Panel Shown at the Lower Right Viewport. Replay Panel on the Lower Left.

a) Use the replay feature in Webtrak5 to estimate the number of landing operations between 11:00-11:30 hrs (i.e., called runway throughput) at LAX runway 24R airport on September 30, 2021.

b) Use the replay feature in Webtrak5 to estimate the number of departure operations at LAX during the period 11:00-11:30 hrs.

c) Find the runway hourly throughput of the airport in West flow configuration with arrivals on runways 24R, 25L and departures on runways 24L and 25R. Since you collected data for a 30-minute period, assume the period 11:30-12:00 would have similar number of operations.

Problem 2

The objective of the problem is to find the capacity of San Diego International Airport. San Diego is a single runway airport.The airport has an airport surveillance radar (ASR) which tracks aircraft up to 50 nautical miles form the airport site. The radar has a scan rate of 4 seconds. Tables 1 through 3 show technical parameters and the typical ATC separations at the airport under Instrument Meteorological Conditions (IMC). Assume the minimum separations under VMC conditions are reduced by 10% from those observed under IMC conditions. Four aircraft groups operate at the airport. The airport has the following technical parameters: a) in-trail delivery error of 16 seconds, b) departure-arrival separation for both VMC and IMC conditions is 2 nautical miles, c) probability of violation is 5%. Arriving aircraft are "vectored" by ATC to the final approach fix located 11 miles from the runway threshold as the aircraft overfly the Sweetwater Reservoir (see Figure 2). Arrivals follow in-trail after crossing the final approach fix. The airport aircraft mix, runway occupancy times and approach speeds are shown in Table 1.

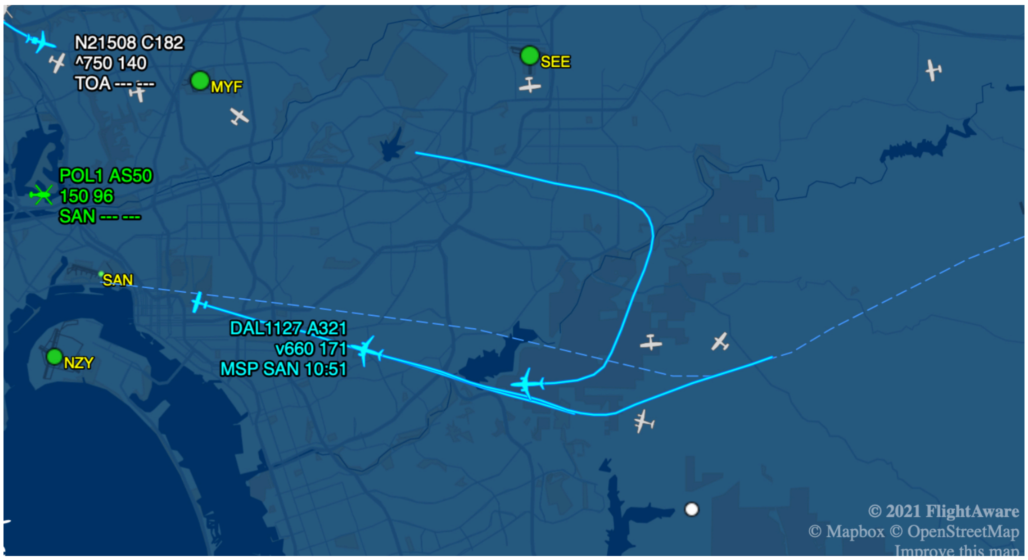

Figure 2. San Diego International Airport Final Approach Segment Configuration. Source: Flightaware.

You are allowed to modify the spreadsheet provided in class to solve the problem. Show me sample calculations for both opening and closing cases so that I know that you can do such calculations by hand.

a) Calculate the arrivals-only saturation capacity under IMC conditions.

b) Calculate the departures-only saturation capacity under IMC conditions.

c) Calculate the arrival-departure saturation capacity diagram (Pareto diagram) under IMC conditions. In your diagram, include at least one point to estimate the departure capacity with 100% arrival priority under mixed runway operations. Show me sample calculations of Tij and Bij so that I can judge your analysis.

d) Repeat part (a) for VMC conditions. Comment on the differences observed. Specifically, comment on the number of departure values obtained with 100% arrivals. Show me sample calculations of Tij and Bij so that I can judge your analysis.

e) Compare the solution obtained in part (c) with the FAA runway capacity diagram (https://www.faa.gov/airports/planning_capacity/profiles/media/SAN-Airport-Capacity-Profile-2014.pdf). Comment on the possible sources of error.

Table 1. Runway Occupancy Times and Fleet Mix for San Diego International Airport (Source: FAA/Virginia Tech Landing Database).

Aircraft RECAT Group	Percent Mix (%)	Runway Occupancy Time (s)	Typical Approach Speed (knots) from FAF
E	18.2	47	126
D	75.3	51	137
C	3.5	62	147
B	3.0	64	151
Totals	100		

Table 2. Minimum arrival-arrival separations under IMC conditions. Values in are nautical miles. ***Values Shown Do Not Include Buffers.***

Minimum Separation Matrix (nm)			Arrivals-Arrivals	
		Trailing Aircraft (Header Columns)		
Lead (column 1)	E	D	C	B
E	2.5	2.5	2.5	2.5
D	3	2.5	2.5	2.5
C	3	3	3	3
B	5	5	4	3

Table 3. Minimum departure-departure separations under IMC conditions. Values in are seconds. ***Buffers are Included.***

Departure-Departure Separation Matrix (seconds)				
		Trailing Aircraft (Header Columns)		
Lead (column 1)	E	D	C	B
E	70	70	70	70
D	70	70	70	70
C	120	120	120	120
B	120	120	120	120

Problem 3 (Bonus Problem 5 Additional Points)

Evaluate the performance of a 3000-meter runway configuration shown in Figure 3. Use the FAA/Virginia Tech Runway Exit Design Model (REDIM) demonstrated in class. The runway has all right-angle exits at locations shown.

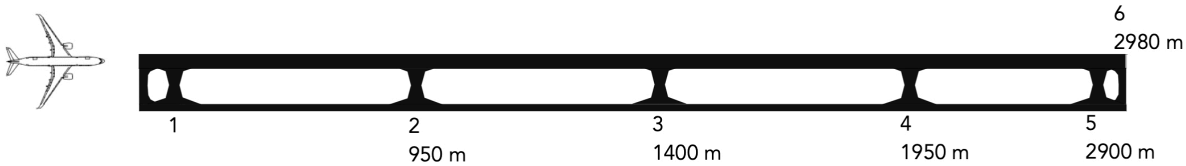

Figure 3. Runway Exit Configuration for Problem 3 (Bonus Problem).

Table 2. Aircraft Mix for Problem 3.

Aircraft	Percent Mix (%)
Pilatus PC-12	5.0
Embraer Phenom 300	3.8
Aerospatiale ATR 42	11.2
Boeing 737-800	25.6
Airbus A320	23.6
Boeing 757-200	12.5
Airbus A321	11.8
Airbus A330	6.5
Totals	100

a) Calculate the runway occupancy times for each aircraft using the REDIM model.

b) Improve the ROT of the runway by replacing runway exits 3 and 4 with two high-speed exits located at 1300 and 1700 meters.

c) With the improvement made, does the runway meet the 50 second ROT criteria to allow reduced in-trail separations?