Assignment 8: Airport Capacity and Airport Demand

Date Due: April 12, 2016
Instructor: Trani

Problem 1

The Punta Cana International Airport has the configuration shown in Figure 1.

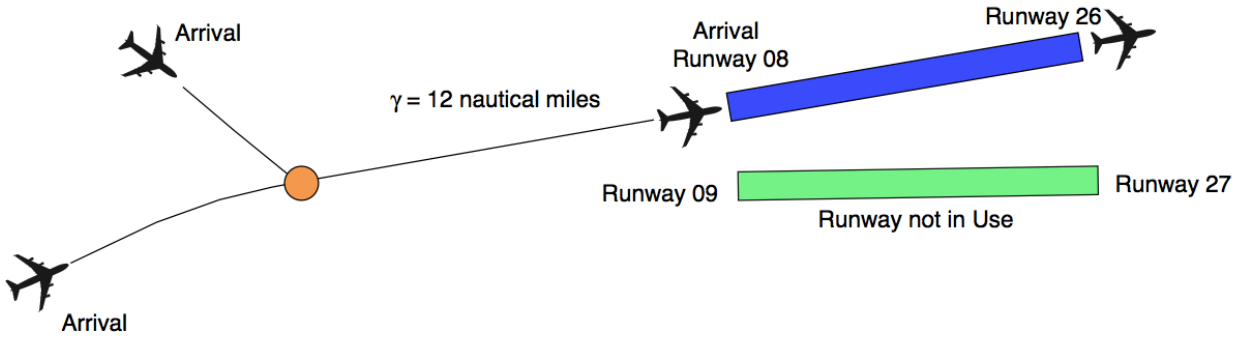

Figure 1. Configuration of Punta Cana Airport. Runway 08 Used for Arrivals and Departures.

The operating runway is 08-26 for both arrivals and departures. The airport has a standard airport surveillance radar (ASR) which tracks aircraft up to 50 nautical miles form the airport site. The radar has a scan rate of 4.5 seconds. Table 1 shows some of the technical parameters of the airport. Tables 2 and 3 show the estimated ATC separations at the airport under VMC conditions. Four aircraft groups operate at the airport as shown in Table 1. The airport has the following technical parameters: a) in-trail delivery error of 20 seconds (because there is a radar at the site), b) departure-arrival separation for both VMC and IMC conditions is **4 nautical miles**, c) probability of violation is 5%. Arriving aircraft are "vectored" by ATC to the final approach fix located 12 miles from the runway threshold (see Figure 1). 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.

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

b) Repeat the analysis when the airport operates arrivals and departures on runway 26 instead (around 20 days of the year). In this runway configuration, we have been told by ATC that arrivals are spaced 9 nm from each other (irrespective of the wake vortex group) for arrivals only capacity. Note that runway occupancy times are large (hence the 9 nm separation on final) when runway 26 is used because aircraft have to land and roll to the end of runway 26 and use taxiway Echo to taxi to the terminal (see Figure 4). For departures to be processed on runway 26, consider the taxi time required to reach the takeoff position (called line up and wait) on runway 26. This is shown in Figure 2. In your solution assume all aircraft are required to use the full length of the runway as shown in Figure 2.

Table 1. Airport Arrival Occupancy Times and Fleet Mix for Problem 1.

	Small	Large	B757	Heavy	Superheavy
ROT (s)	60	57	59	62	70
Percent Mix (%)	23	55	3	19	0
Vapproach (knots)	115	142	145	150	150

Table 2. Estimated minimum arrival-arrival separations under VMC conditions at Punta Cana International Airport. Values in are nautical miles. Values Shown Do Not Include Buffers.

Minimum Separation Matrix (nm)			Arrivals-Arrivals		
		Trailing Aircraft (Header Columns)			
Lead (column 1)	Small	Large	B757	Heavy	Superheavy
Small	4	4	4	4	4
Large	5	5	5	5	5
B757	6	5	5	5	5
Heavy	6	5	5	5	5
Superheavy	10	10	10	10	10

Table 3. Estimated minimum departure-departure separations under VMC conditions at Punta Cana International Airport. Values in are seconds.

Departure-Departure Separation Matrix (seconds)					
		Trailing Aircraft (Header Columns)			
Lead (column 1)	Small	Large	B757	Heavy	Superheavy
Small	75	75	75	75	75
Large	75	75	75	75	75
B757	120	120	120	120	120
Heavy	120	120	120	120	90
Superheavy	180	180	180	180	180

Figure 2. Punta Cana Airport Configuration for West Flow (Takeoffs and Landings on Runway 26).

Problem 2

Suppose the Punta Cana International Airport re-paves runway 09-27 to process arrivals only on runway 09. Runway 08 is used for departures only. The new airport configuration of the airport is shown in Figure 3. The figure shows segregated operations on two runways (one for arrivals and one for departures). In VMC conditions, the runways are operated independently.

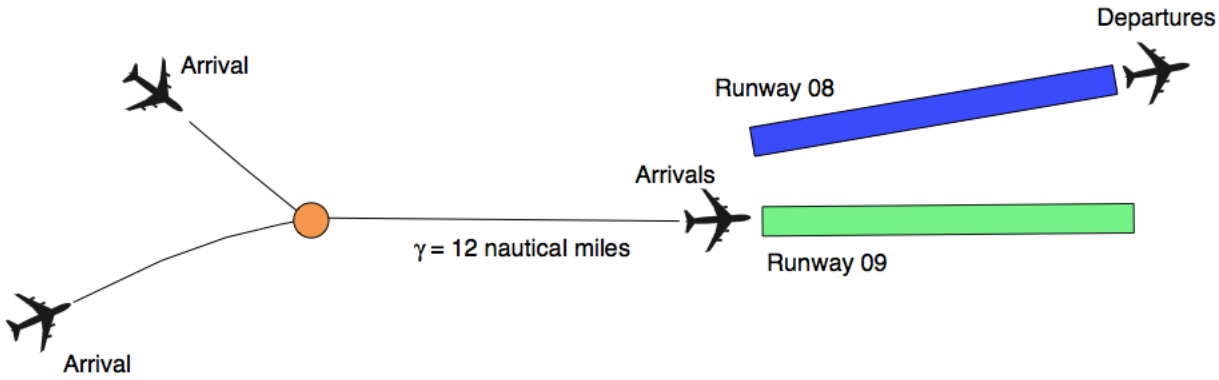

Figure 3. Configuration of Punta Cana Airport.

a) Calculate the arrival-departure saturation capacity diagram (Pareto diagram) under VMC conditions for the new configuration (show all your work). In your diagram, include at least one point to estimate the departure capacity with

100% arrival priority under mixed runway operations. Show me two sample calculations to obtain the values of Tij and Bij so that I can judge your analysis.

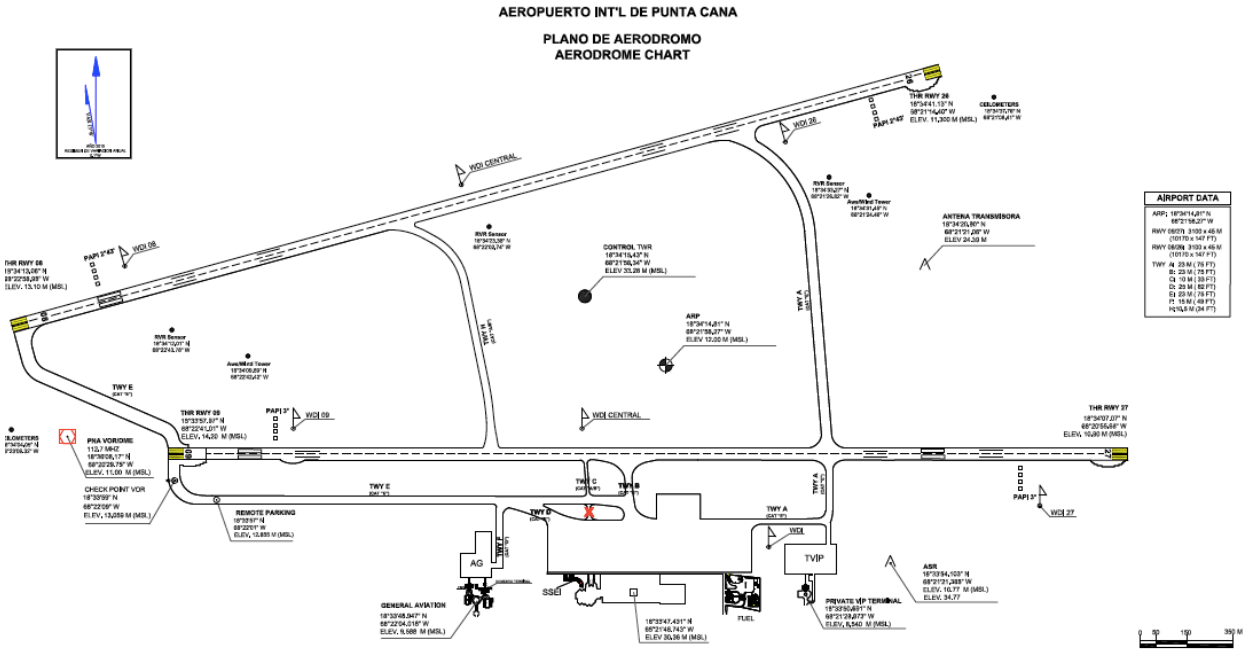

Figure 4. Punta Cana International Airport Configuration.

Problem 3

A Caribbean airport has recorded the following passenger enplanements over time shown in Table 5.

a. Plot the historical number of total passenger enplanements as a function of time.

b. Calculate the values of coefficients **a** and **b** in the logistic model. The airport has enough terminal infrastructure to support up to 4.1 million passenger enplanements (i.e., boardings) per year in the future.

c. Comment on the goodness of the logistic model vs. the data. Plot the historical data vs. the logistic curve obtained in step (b) to make meaningful comparisons.

d. Using this model predict when would the airport reach a point of 90% capacity?

Table 5. Caribbean Airport Demand

Year	Normalized Year	Passengers Boarding
1984	1	2,976
1985	2	6,951
1986	3	9,438
1987	4	11,925
1988	5	30,236
1989	6	50,733
1990	7	71,231
1991	8	69,924
1992	9	108,538
1993	10	164,717
1994	11	226,716
1995	12	343,135
1996	13	388,781
1997	14	448,583
1998	15	515,727
1999	16	651,564
2000	17	878,686
2001	18	927,385
2002	19	949,825
2003	20	1,286,103
2004	21	1,352,917

2005	22	1,470,152
2006	23	1,711,671
2007	24	1,785,447
2008	25	1,851,854
2009	26	1,894,292
2010	27	1,997,707
2011	28	2,225,657
2012	29	2,403,181
2013	30	2,597,086
2014	31	2,784,000
2015	32	3,178,000