CEE 5614: Analysis of Air Transportation Systems Fall 2012

Assignment 7: CDA and Dependent Runway Analysis

Date Due: November 9, 2012 Instructor: Trani

Problem 1

You are expected to perform a capacity analysis for the airport shown in Figure 1. The airport has a standard airport surveillance radar (ASR) which tracks aircraft up to 60 miles form the airport site. The radar has a scan rate of 4 seconds. Tables 1 and 2 show the typical ATC separations at the airport under IMC conditions. The airport has the following technical parameters: a) in-trail delivery error of 18 seconds (because there is a radar at the site), b) departure-arrival separation for IMC conditions is 2 nautical miles, c) probability of violation is 5%. Arriving aircraft are “vectored” by ATC to the final approach fix located 10 miles from the runway threshold. 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. The IMC separation matrices are shown in Tables 2 and 3.

The operational concept for the medium spaced runways is as follows: The primary landing runway is runway 09L-27R. If the natural gaps left between successive arrivals on runway 09L-27R satisfy the condition that an approaching aircraft to runway 09R-27L (aircraft 3 in Figure 1) is separated by 1.5 nm or more in diagonal distance from the two approaching aircraft on 09L-27R (labeled as aircraft 1 and 2), the surrogate operation on runway 09R-27L can occur. If the diagonal separation is not feasible, then the surrogate operation of aircraft 3 cannot happen and the gap between aircraft 1 and 2 on 09L-27R is not used.

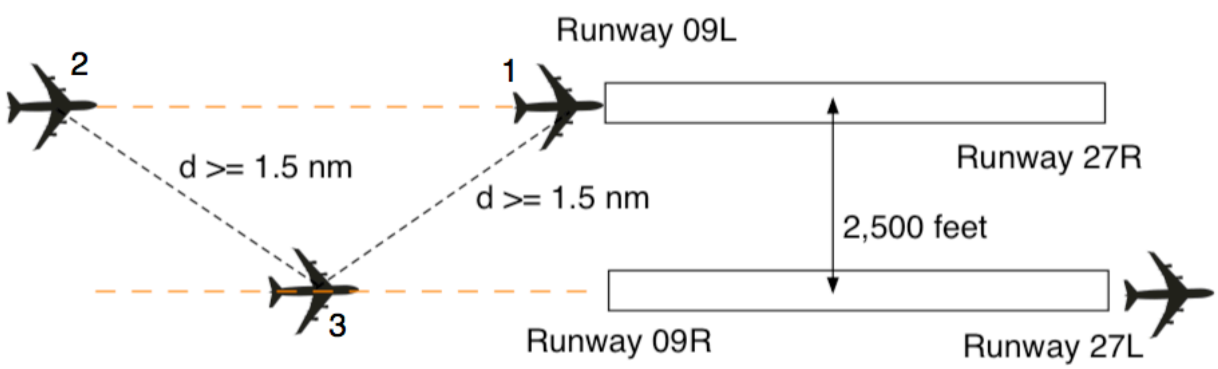

Figure 1. Runway Configuration for Problem 1. Dependent Approach Procedure.

a) Find the IFR arrival saturation capacity of the runway configuration shown in Figure 1. The runways are located 2,500 feet apart. Dependent instrument approaches are conducted to both runways as shown in the figure. Runway 09L is the primary arrival runway. In your analysis make sure there is enough in-trail separation between successive arrivals to the same runway.

b) Estimate the departure saturation capacity and the complete Pareto diagram for IFR conditions if takeoffs are allowed on runway 09R with100% arrival priority on 09L.

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

Aircraft	Percent Mix (%)	Runway Occupancy Time (s)	Approach Speed (knots)
Small	5	45	125
Large	70	55	140
Heavy	25	65	150

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)	Small	Large	B757	Heavy	Superheavy
Small	2.5	2.5	2.5	2.5	2.5
Large	4	3	2.5	2.5	2.5
B757	5	4	3	3	2.5
Heavy	6	5	4	4	4
Superheavy	10	10	10	10	10

Table 3. 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

Problem 2

One of the fuel savings initiatives under NextGen is to conduct Continuous Descent Approaches (CDA) to busy airports. A sample CDA approach is shown in Figure 2. The CDA approach starts 3 minutes later than the normal approach for our analysis. The aircraft initially is straight and level at 37,000 feet and flying at Mach 0.8. A typical approach to LAX involves one or more step down segments as shown in Figure 2. Figure 3 shows actual flight paths extracted from radar data provided by the FAA for a terminal design study. The data applies to large twin-engine transport aircraft. Note that according to Figure 2, below 17,000 feet both profiles will follow the same trajectory.

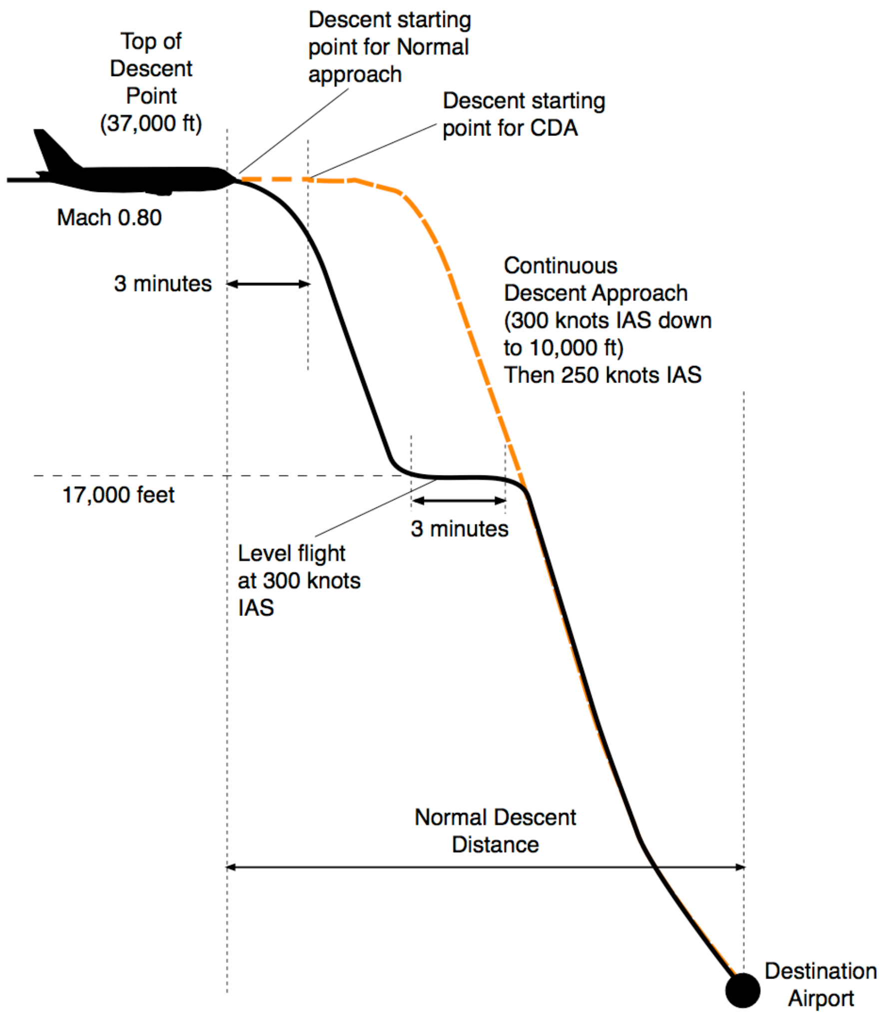

Figure 2. CDA Approach Compared to Typical Approach to LAX Airport.

a) Using the large twin-engine transport aircraft in our course material, estimate the fuel savings for a single flight to LAX using the CDA technique. Assume the mass at the TOD point is 200,000 kg. The speed parameters of the approach are provided in Figure 2. Assume the idle thrust is constant at 1/12 of the maximum generated at altitude. In your calculations consider the normal approach having a 3 minute step at 17,000 feet. During the step segment, the aircraft flies straight and level and thus the aircraft engines generate thrust to overcome drag.

b) Read the paper about CDA approaches by Richard Coppenbarger et al. (Journal of Aircraft, Volume 46, 2009) (http://www.aviationsystemsdivision.arc.nasa.gov/publications/2009/AIAA-39795-675.pdf) and comment on the possible fuel savings reported in the literature. Compare to your calculation.

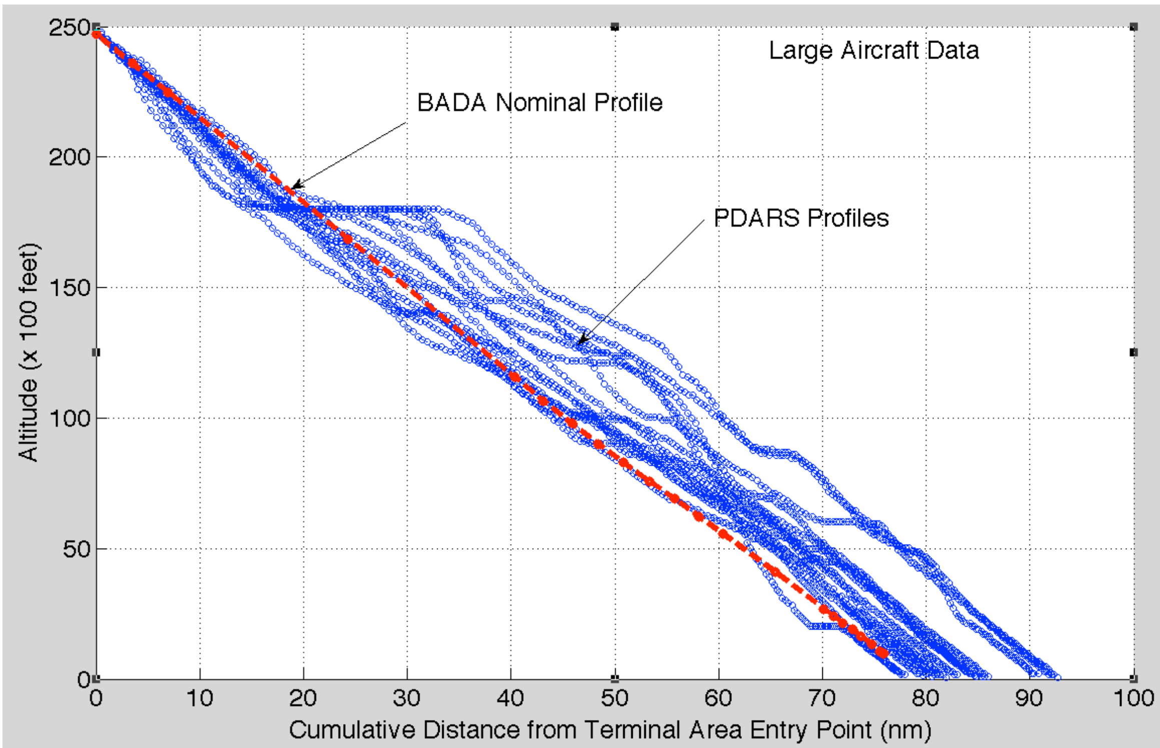

Figure 3. Nominal and Observed Descent Profiles at LAX Airport. Large Twin Engine Aircraft.