Assignment 9: APM and Queueing Analysis

Date Due: April 28, 2014 in class
Instructor: Trani

Problem 1

a) An international airport has two parallel runways separated 800 meters away form each other. The following parameters are known for this airport. The technical parameters are given in Figure 1. The airport operates segregated operations where one runway is used for arrivals and the second one for departures. The airport does not operate simultaneous departures today.

Technical Parameters (inputs)	Parameter	Values
Dep-Arrival Separation (nm)	δ	2
Common Approach Length (nm)	γ	8
Standard deviation of Position Delivery Error (s)	σ	20
Probability of Violation	Pv	5

Figure 1. Technical parameters

The airport operates under IFR conditions with the separation matrices shown in Figure 2 and 3.

Departure-Departure Separation Matrix (seconds)			
		Trailing	
	Small	Large	Heavy
Small	60	60	60
Large	90	90	90
Heavy	120	120	120

Figure 2. Minimum Arrival-Arrival Separation Matrix

	Small	Large	Heavy
ROT (s)	46	52	60
Percent Mix	30	40	30
Vapproach (knots)	100	140	150

Figure 3. Minimum Departure-Departure Separation Matrix (seconds).

	Small	Large	Heavy
ROT (s)	46	52	60
Percent Mix	30	40	30
Vapproach (knots)	100	140	150

Figure 4. Runway Occupancy Times and Baseline Aircraft Mix.

a) Estimate the IMC conditions Arrival-Dearture Capacity diagram when the airport operates in segregated mode.

b) During a busy period in a typical day of the airport has a surge of 60 aircraft departures are scheduled in a 60-minute period. The demand decreases to 35 /hr after the surge. During the same 60 minute period, 40 arrivals are scheduled by the airlines.

a) Calculate the resulting departure delays during the surge of traffic. How many aircraft are affected?

b) Average passenger values time at $20.00/hr. Airlines value their operating cost at $2,800/hr per aircraft. Find the cost of the lack of departure capacity per day.

Problem 2

A TSA security area at a small airport receives passengers in a random fashion at a rate of 120 passengers per hour during the busy period of time in the morning. The security area has 2 x-ray stations to check carry-on luggage. The x-ray procedure can handle 63 passengers per hour.

a) Estimate the average delay expected per passenger for this setup.

b) Find the number of passengers that would queue on the typical busy period at the TSA station.

c) Find the probability that exactly 10 passengers wait for service at the TSA security station.

d) Find the probability that more than 20 passengers queue at the TSA security area.

Problem 3

During the busy morning periods, Atlanta International Airport has a peak demand flow of 9,500 passengers per hour (one-way) traveling from various concourses to the main terminal (see Figure 2). The Bombardier Innovia APM 100 system consists of Transit Units (TU) with 4 cars holding up to 70 passengers each (at maximum capacity).

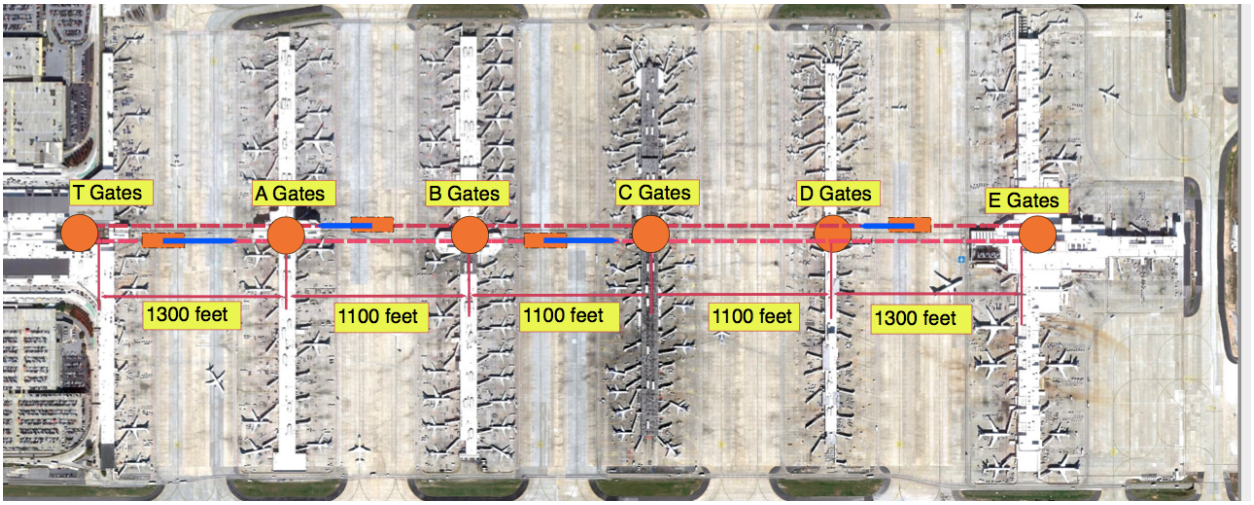

Figure 2. Atlanta APM System Layout.

a) Estimate the capacity of system if the minimum headway os 1.5 minutes. Is the system able to handle the peak load?

b) Plot the APM system capacity as a function of headway. Use a range of headways from 5 minutes down to 1 minute (the minimum safe headway).

c) If the airport demand increases by 50% in the next 20 years, make recommendations.

d) If the APM fails, estimate the width of the underground corridor needed to move all passengers without APM. In this solution assume the traffic flows are symmetrical with 9500 passengers traveling each directions between the two busiest satellite terminals. Show your work.