Air Transportation Systems Field Exam
January 2010

Note: You have 60 minutes to prepare for this examination. The preparation is closed book, but you can bring any notes that you generate during the preparation period to use in the oral exam. The oral examination will be 45 minutes long.

GOOD LUCK!

As you know, airports are among the most capacity-constrained resources in the National Airspace System. Today, we are going to discuss airport capacity, and some related issues.

1. Briefly discuss the concept of airport capacity.

2. What are some of the factors that affect runway capacity?

3. Let us suppose we knew what the required inter-aircraft separation times were for different weight classes (for arrivals on a single runway under IFR). How would one typically estimate the capacity of an airport with only one runway under IFR? What other data would we need and assumptions would we need to make?

4. Let us now consider an airport with two runways, each with a landing capacity of 30 aircraft/hour. Suppose the total arrival demand at the airport is 30 aircraft/hour. A schematic of the airport is shown in Figure 1, with two arrival queues, one for each runway. Assume that the runways are used exclusively for arrivals.

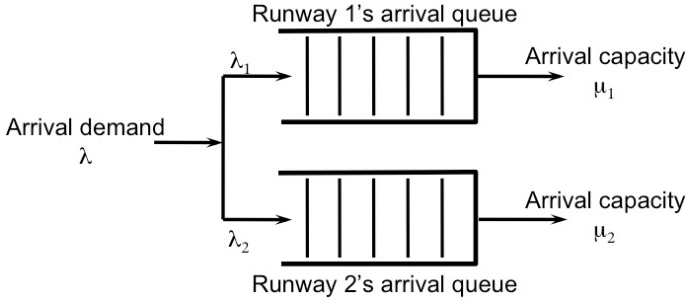

Figure 1. Schematic of arrival process for two arrival runways.

   a. Qualitatively describe how you would expect the average delay in each arrival queue to behave as the arrival demand assigned to it changes (for example, if the fraction of arrivals assigned to that runway varies from 0-100%.)

   b. What will be the optimal way to split the arriving flights between the two runways, if we would like to minimize the expected delays?

5. What schedule planning strategies might an airline implement in an effort to reduce the impacts on its operations of persistent flight delays due to congestion at a particular airport? What are the trade-offs involved in implementing such strategies?

6. Consider the simple network shown in Figure 2, with four airports denoted A, B, C and D. Each airport *i* (*i* = A, B, C, D) has a departure demand λ_i, a departure capacity (service rate) of α_i and an arrival capacity of β_i. (Please note that the λ_i shown in Figure 2 represent demands for departures.) Aircraft depart from their gates and join the departure queue, which is serviced at rate α_i. Aircraft at airport *i* leave the departure queue and head for destination airport *j* with probability π_{ij}. Once in the terminal-area of airport *j*, they join the arrival queue, which is serviced at the rate β_i. Aircraft can be assumed to leave the system when they land. Assume that there are only four airports in the entire system.

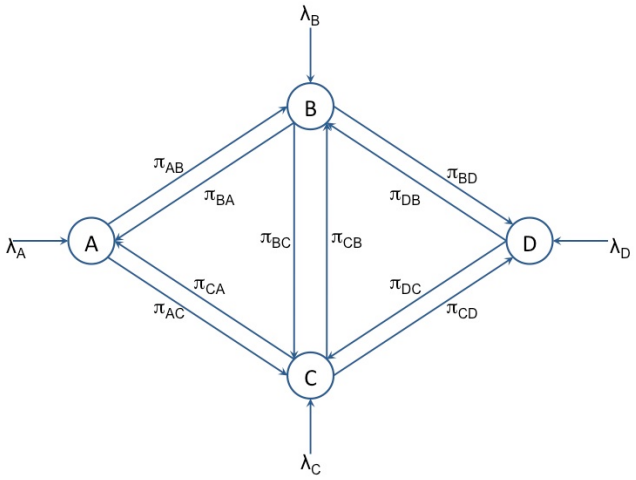

Figure 2. Four airport network, for Problem 6.

a. Under what conditions will the system reach steady state?

b. Suppose the system is in steady state. If the average flight time (elapsed time between pushback and landing, including any delays suffered on departure or arrival) is *T*, what is the average number of aircraft operational at any time?

c. How would you analyze the arrival process at airport D? Describe any modeling assumptions you might make that would be helpful in simplifying the nature of the arrival process, and thus also simplifying the analysis of the queuing network.