Air Transportation Systems Field Exam: Airport Systems
January 2012

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. Part A focuses on airport systems (your main elective area) and Part B is a shorter question on the airline industry. Please plan your time accordingly.

Make any assumptions that you believe are reasonable, but be sure to state them while answering the questions.

GOOD LUCK!

Part A:

1. Consider a typical major airport in Asia and a typical major airport in the United States, serving some 30 million passengers per year – e.g., Tokyo Narita and Philadelphia. [*Note:* You need not know anything specific to these two airports – this is a question about "generic" airports.] Please describe in qualitative terms how these two airports will probably differ with respect to some set of **airside** characteristics. A list of characteristics you may wish to refer to would include, at a minimum (feel free to add some others):

   (a) Airport airside capacity, i.e., the number of aircraft movements that can be served per hour at the airport.

   (b) Aircraft mix.

   (c) Sensitivity of runway capacity and of air traffic delays to weather conditions.

   (d) Use of limits on the number of movements ("slots") that can be scheduled per hour at the airport.

2. Consider Airport A, located somewhere in the United States. Suppose A has two parallel and independent runways, one used for arrivals only and the other for departures only, due to noise limitations. We shall look **only** at the runway used for arrivals, assuming that aircraft land according to a first-come, first-served queuing discipline.

   A typical set of separation requirements (in nautical miles) between consecutive landing aircraft on final approach (that is, minimum airborne inter-arrival separations) is given in the Table below. These are indicative only, in case you wish to refer to some specific examples.

		Trailing Aircraft		
		H (heavy)	L (large)	S (small)
Leading Aircraft	H (heavy)	4	5	6
	L (large)	2.5	2.5	4
	S (small)	2.5	2.5	2.5

   (a) Please describe qualitatively how the **capacity** of the runway (that is, the expected number of landings per hour under continuous demand) **and** the **variance** of the capacity is affected by the aircraft mix. For example, discuss how the capacity and variance of the capacity of the following three types of mixes would compare: (i) a homogeneous mix consisting mostly of narrow-body commercial jets (e.g., B737 and A320); (ii) a

homogeneous mix consisting mostly of wide-body aircraft; and (iii) a "diverse" mix consisting in almost equal percentages of wide-body, narrow body and smaller general aviation aircraft.

(b) Why is "the variance of the capacity" an important metric?

(c) With reference to part (a) above, which of the three mixes – described by (i), (ii) and (iii) – might benefit the most from queuing disciplines other than first-come, first-served, if the objective were to increase, as much as possible, the expected number of aircraft that can land per hour? Please discuss briefly. Would there be any "winners" and "losers" under such alternative queuing disciplines?

(d) Let us go back again to the first-come, first-served queuing discipline. Suppose you were told that the capacity of this runway was found to be 40 landings per hour and that the demand is, on average, 36 arrivals per hour over a period of several consecutive hours of the day. Please discuss what this information alone would tell you about likely level of delay at this airport for arrivals, given what you know about the characteristics of demand and of service times at airports. Would aircraft using this runway be more likely to experience high delays (because "demand is close to capacity") or low delays (because "demand is lower than capacity")?

(e) For the situation described in (d) above, please provide a numerical estimate of the average delay that a random aircraft would experience until its turn to use the runway, using a simple queuing model and assuming steady-state conditions. Please explain your assumptions briefly.

Part B:

1. Mega Airlines is a large US network legacy carrier that operates a variety of aircraft types on a network of domestic and international routes. In response to increasing delays and congestion at a specific US airport, Mega Airlines is considering changes in its schedule of operations on a short-haul (500 miles) competitive non-stop route into that airport. Specifically, it plans to replace its existing schedule of 6 daily non-stop flights operated with 100-seat aircraft with 4 daily flights operated with 150-seat aircraft. Mega Airlines currently competes against one other non-stop competitor that offers 6 daily flights with 100-seat aircraft. Both airlines have been operating at an average load factor of 86% on this route, carrying exclusively local O-D passengers (i.e., no connecting passengers), consisting of approximately one-half business and one-half leisure passengers.

   In qualitative terms, what are your expectations with respect to changes in each of the following measures, if Mega implements its plan to fly fewer daily frequencies with larger aircraft in this non-stop O-D market given the competitive scenario presented? That is, for each measure listed, do you expect it to increase, decrease or is the outcome uncertain? Explain fully the rationale for your answer in each case.

   (a) Aircraft operating costs <u>for this route</u>, both total and unit costs (also known as "flight operating costs" or FOC).

   (b) Total passengers carried by Mega Airlines on this route.

   (c) Average fare (yield) per passenger carried.

   (d) Average daily aircraft utilization for Mega's fleet of 150-seat aircraft.