CEE 5614: Analysis of Air Transportation Systems Fall 2014

Assignment 6: Air Traffic, Operations and Capacity

Date Due: October 20, 2014 Instructor: Trani

Problem 1

Read the article on Required Navigation Requirements (http://en.wikipedia.org/wiki/Required_navigation_performance) and answer the following:

a) Name the first airline and first approach commercial RNP approach
b) What is the meaning of RNP 4? Briefly explain.
c) What is the typical RNP value for terminal area operations?
d) Explain why are low values of RNP desirable in air traffic and navigation?

Problem 2

Read the article (http://www.honeywell.com/sites/servlet/com.merx.npoint.servlets.DocumentServlet?docid=D60671A93-51BD-1C36-20CF-446F85B0FD6C) and answer the following:

a) Briefly explain what are the components of FANS.
b) How can FANS help airlines and air traffic?

Problem 3

The Organized North Atlantic Track System (OTS) is a system of tracks derived daily that optimize the routes to be flown every day between Europe and North America (Westbound) and from North America to Europe (Eastbound). The Eastbound tracks for October 10, 2014 are shown below. Each track is defined between flight levels 310 and 390 (inclusive). Core tracks (i.e., most heavily used are Tracks W and X that day). Note that the powerful jet stream moves from the West to the East providing with a substantial tailwind component to the Eastbound flights.

a) Estimate the hourly capacity of the OTS system in today's environment where most aircraft are separated 10 minutes longitudinally. The average speed Eastbound is estimated to be 500 knots ground speed. Find the average longitudinal separation (in nautical miles) between aircraft flying the OTS Eastbound. In your answer state the total hourly capacity and the single track (single flight level) capacity.
b) Estimate the hourly capacity Westbound if the average ground speed is 420 knots instead. Find the average longitudinal separation (in nautical miles) between aircraft flying the OTS Eastbound.
c) Since March 2012, new Air Traffic Rules allow suitably equipped aircraft (with datalink, FANS/1 and RNP 4 navigation equipment) to be separated by 5 minutes of headway if a successive pair of aircraft are equipped. Estimate the OTS system capacity if 75% of the aircraft flying today meet the navigation and avionics requirement.

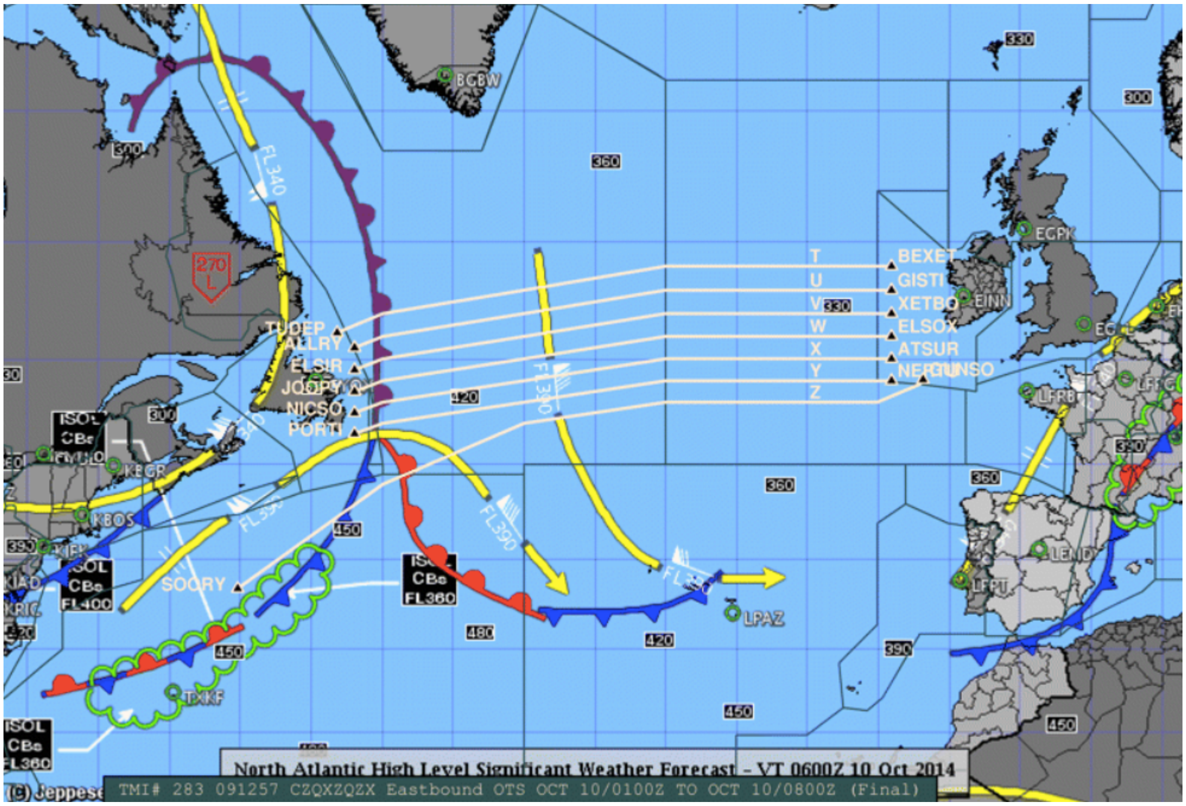

Figure 1. Organized Track System for October 10, 2014. Source: http://www.turbulenceforecast.com/atlantic_eastbound_tracks.php.

Problem 4

Perform a simple capacity analysis for the San Diego International Airport (SAN) considering real operational information. Consult Google and Airnav to understand the problem. The airport has a single runway oriented East-West . San Diego terminal area arrivals and departures are controlled by Southern California TRACON using standard airport surveillance radar with a scan rate of 5 seconds. Table 1 shows the approximate fleet mix operating at the airport. For this analysis we use the following technical parameters: a) in-trail delivery error of 16 seconds under both VMC and IMC conditions, b) departure-arrival separation for IMC conditions is 2.2 nautical miles (when mixed operations are conducted on the same runway), c) probability of violation is 5%. Arriving aircraft are “vectored” by ATC to the final approach fix located 10 miles from the runway threshold. The typical IMC separation values applied by ATC are shown in Figure 2 and Table 2.

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

Aircraft	Percent Mix (%)	Runway Occupancy Time (s)	Typical Approach Speed (knots) from Final Approach Fix
Small	5	45	127
Large	80	56	145
Heavy or B757	15	61	152

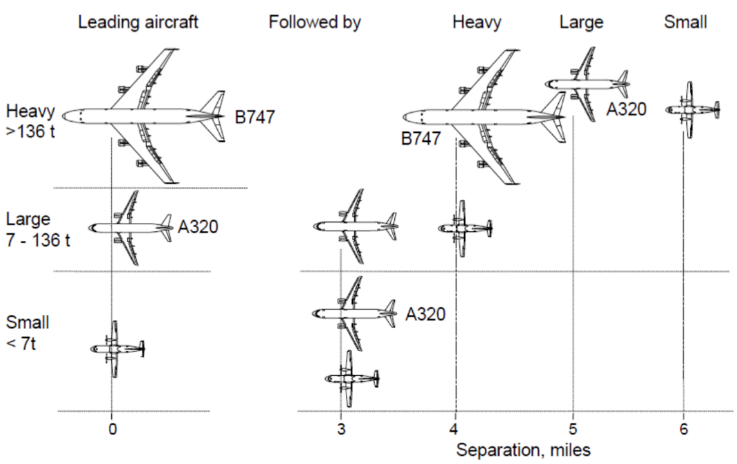

Figure 2. ICAO and FAA Recommended IMC Separations. Source: Lang et al., 2010. Arrival-Arrival Separations for all Groups Behind a Super-heavy add 2 nm over the Heavy Category.

Table 2. 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

Estimation of Runway Capacity Operations

a) Find the IMC arrival saturation capacity of the runway configuration at SAN.
b) Find the IMC saturation departure capacity with 100% arrival priority of the airport if we assume departures operations are dependent of the arrivals calculated in part (a)
c) Find the departure only saturation capacity in IMC conditions.
d) Plot the Pareto diagram (arrivals/departures diagram) for solutions obtained above.

Problem 5

Using the San Diego analysis perform the following sensitivity study:

a) Find the added arrival capacity in the NextGen era when ADS-B is in place and using in-trail delivery error of 5 seconds.

b) Find the added departure capacity in the NextGen era with RECAT Phase 2* in place that could reduce the average departure-departure separations by 10% and the average arrival-arrival separations by 5%.

c) Plot the new Pareto diagram and compare with that obtained in Problem 4. Comment on the results obtained.

RECAT Phase 2 (see article. w.wakenet.eu/fileadmin/user_upload/SpecificWorkshop_RECAT/FAA_Leader-Follower%20Static%20Pairwise%20(RECAT%20Phase%20II)%20ver4.pdf).