Assignment 6: Air Traffic, and Runway Operations

Date Due: March 25, 2024 Instructor: Trani

Problem 1 Basic ATC and Runway Separations

Answer briefly the following ATC-related questions.

a) An Airbus A330-300 cruises at Mach 0.82 at FL 370 and 150 miles East of Labrador enroute to Europe. Name the ATC service that oversees the flight.

Gander Oceanic control center.

b) Over the ocean, explain how pilots communicate with Air Traffic Control. Describe the time lag in communications for oceanic flights and ATC.

Typically a two-minute time lag for messages to travel back and forth. Use of datalink systems via satellite.

c) State the minimum separation between two parallel runways to serve operations shown in Figure 1. State the surveillance equipment needed to make the operations shown possible.

2,000 feet minimum due to stagger. Rule: 100 feet reduction for each 500 feet of stagger.

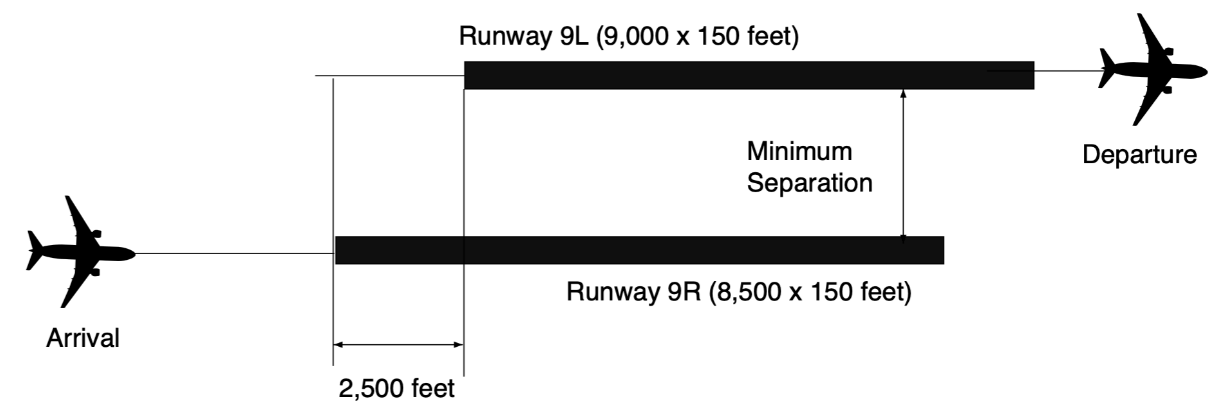


Figure 1. Runway Configuration.

d) Use Google Earth and the FAA airport diagram to familiarize yourself with the runway configuration at Los Angeles International airport. Can runways 24R and 25L be operated independently for simultaneous instrument arrivals? Comment on the rule used.

Yes, at LAX, runways 24R and 25L can be operated independently for arrivals.

e) Can the Denver airport operate three simultaneous arrivals in West flow (flying to the West) in instrument conditions? Name the runways selected in such operations.

Only two arrivals in west flow configuration.

Problem 2 Runway Capacity

Figure 2 illustrates the configuration of the runways at the airport. Runways 9L and 9R serve different aircraft fleet mix.

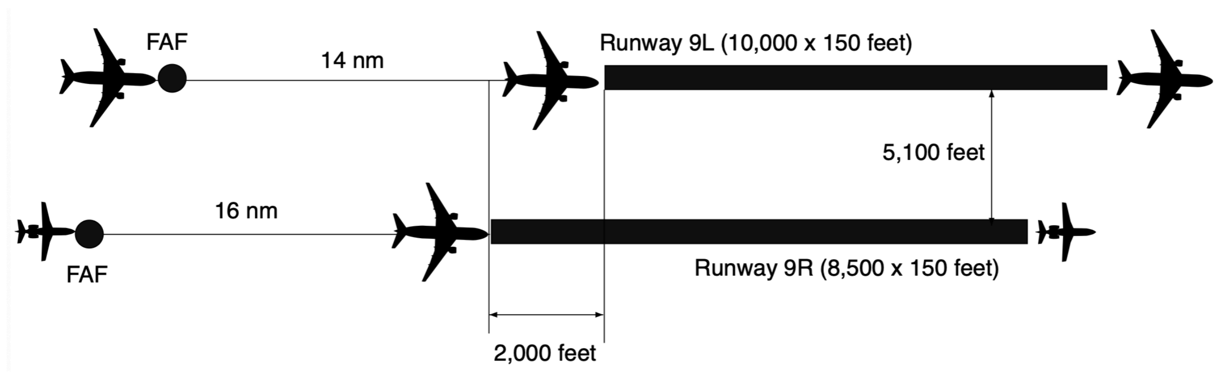


Figure 2. Runway Configuration for Problem 2.

Assume IMC conditions in the solution to the problem. The airport operates an East flow configuration with arrivals and departures using both runways. Tables 1 and 2 show the airport fleet mix for runways 9L and 9R, respectively. For this analysis we use the following technical parameters: a) in-trail delivery error of 17 seconds under IMC conditions, b) probability of violation is 5%. Arriving aircraft are “vectored” by ATC to the Final Approach Fix (FAF) for each runway, and c) 2.5 nautical miles minimum separation between an arrival and a departure. The 2.5 nm arrival-departure separation includes a small 0.5 nm buffer over the minimum value used in the US. Use the arrival-arrival separations for on-approach operations described in the consolidated wake vortex separation document (or notes). Table 3 shows the departure-departure separation matrix employed.

Table 1. Runway 9L Operational Parameters and Fleet Mix. CWT Groups.

Aircraft CWT Group	Percent Mix (%)	Runway Occupancy Time (s)	Average Approach Speed (knots) from FAF
B	6	61	150
E	18	59	145
F	76	55	138
Totals	100		

Table 2. Runway 9R Operational Parameters and Fleet Mix . CWT Groups.

Aircraft CWT Group	Percent Mix (%)	Runway Occupancy Time (s)	Average Approach Speed (knots) from FAF
F	48	55	138
H	26	49	126
I	26	45	118
Totals	100		

Table 3. Departure-Departure Separations with Buffers Included. Columns 2-6 are the Following Aircraft. First Column Presents the Lead Aircraft. Values in are seconds (includes 10-second departure buffers).

	Following Aircraft				
Lead Aircraft (Below)	**B**	**E**	**F**	**H**	**I**
B	130	130	130	140	140
E	95	120	130	130	130
F	70	70	70	70	90
H	70	70	70	70	70
I	70	70	70	70	70

a) Estimate the IMC arrivals-only capacities for runways 9L and 9R at the airport.

Runway 9L arrival capacity is 30.6 operations/hour

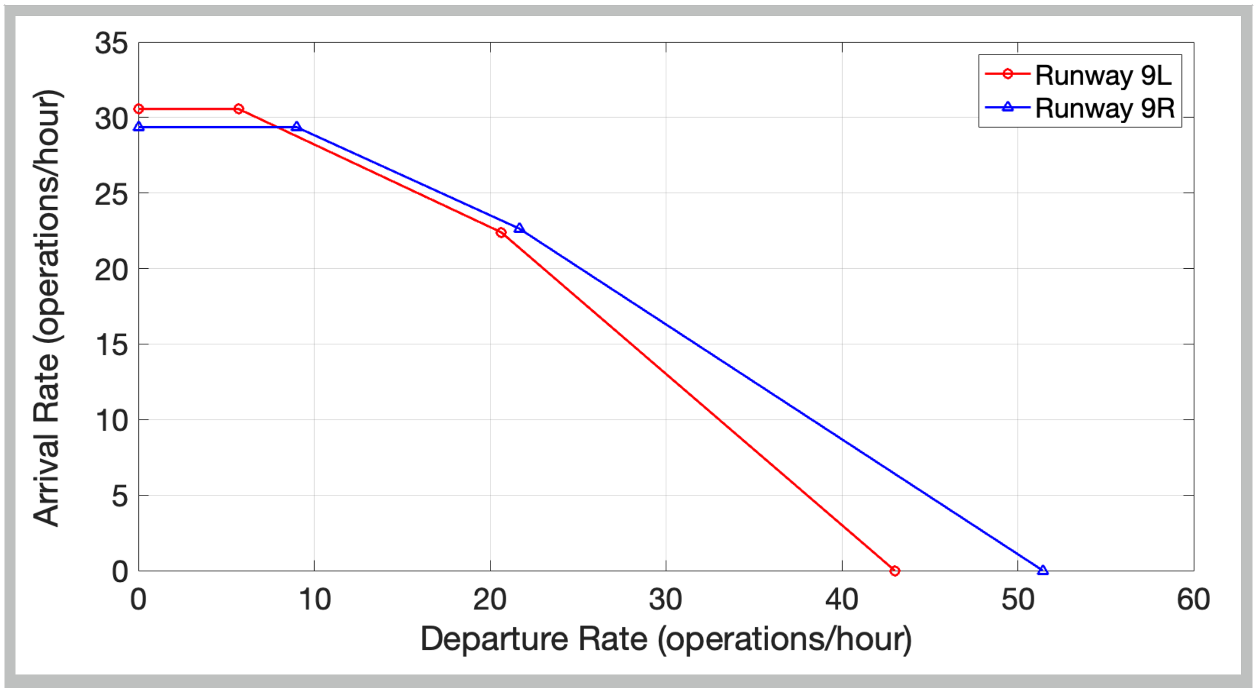
Runway 9R arrival capacity is 29.4 operations/hour

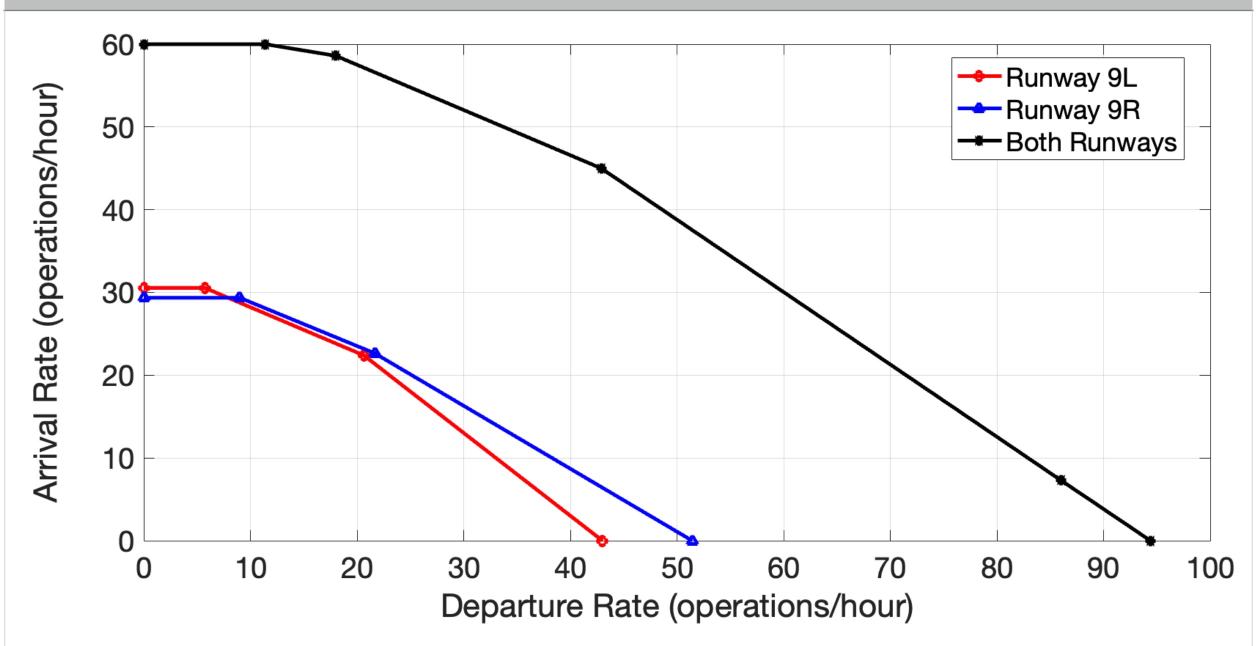
b) Estimate the IMC departures-only capacities for the airport

Runway 9L departure capacity is 43.0 operations/hour

Runway 9R departure capacity is 51.4 operations/hour

d) Show the complete Pareto diagram (arrivals and departures on both runways) for the airport under IMC conditions.





Arrivals-Departure Rate Diagram for Runways 9L and 9R.

e) Comment on the differences in runway capacity between runways 9L and 9R.

The departure capacity is significantly different. Flying behind CWT class B requires larger separations. Hence lower departure capacity. A small reduction in arrival capacity due to slower speeds on final approach.

Note: You can employ the Excel spreadsheet provided. However, you must show me some sample calculations.

Problem 3 Runway Capacity

Figure 3 shows the runway configuration for Problem 3. Use the technical separation parameters similar to those of Problem 2. Table 4 shows the fleet mix and ROT parameters of the airport. Use the departure-departure separations of Table 3 which include the departure-departure buffers.

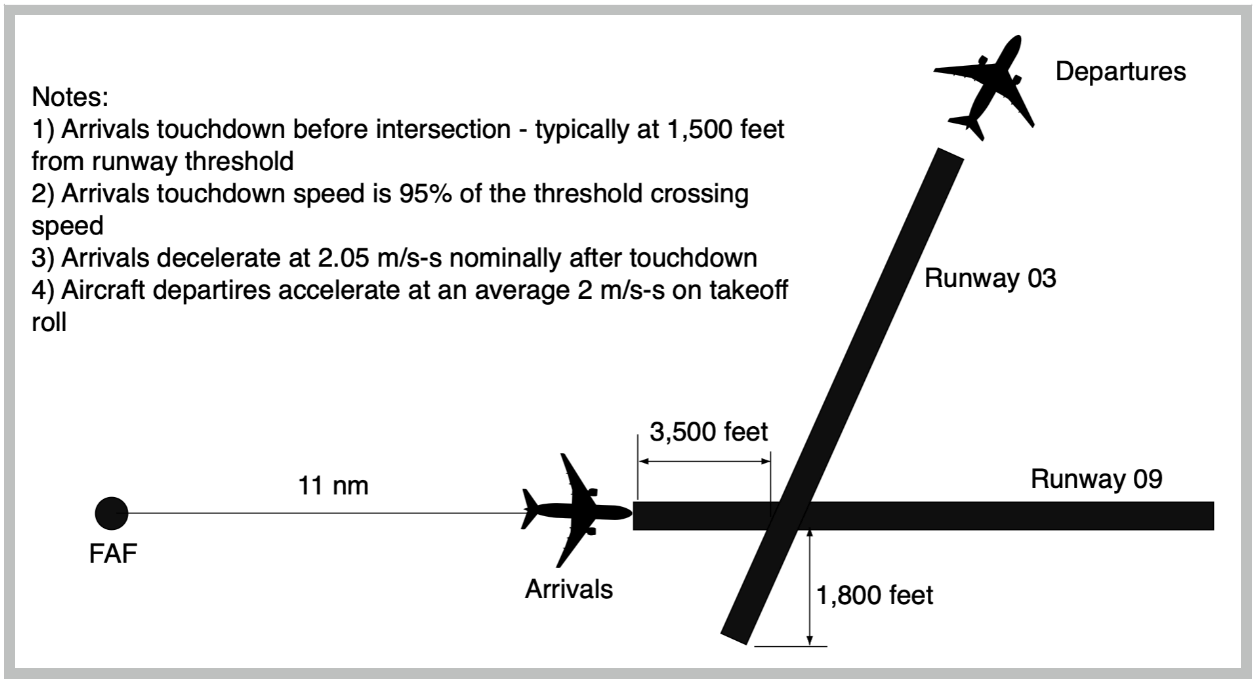


Figure 3. Runway Configuration for Problem 3.

Table 4. Operational Parameters and Fleet Mix for Problem 3.

Aircraft CWT Group	Percent Mix (%)	Runway Occupancy Time (s)	Average Approach Speed (knots) from FAF to Runway Threshold
F	69	62	139
G	13	60	134
H	18	54	125
Totals	100		

a) Estimate the IMC arrival and departure capacities for the two-runway system. Show me the procedure to estimate departures on runway 03.

Runway 9 arrival capacity is 32.1 operations/hour with 100% arrivals

Runway 3 departure capacity is 51.4 operations per hour with 100% departure priority

Aircraft CWT Group	Time to Cross Intersection after Landing (s)	Time to Cross Intersection when Departing Runway 3
F	18.5	23.4
G	18.8	23.4
H	18.5	23.4

Assume the minimum distance between an arrival on runway 9 and a departure that crossed the intersection of runway 3 is 2 nm.

Time from arrival crossing arrival threshold 9 to departure on runway 3 crossing the runway intersection is estimated to be 52.7 seconds. The time includes 10 seconds of time lag for the departure accounting for mechanical and human factors time lags.

Augmented Matrix (Tij + Bij) (seconds) - time to cross departure runway			
	Trailing		
Lead	H	G	F
H	61.7	55.9	53.0
G	83.0	55.9	53.0
F	93.7	66.6	53.0

Distance to go= (Augmented Matrix (Tij + Bij) - time to cross departure runway)/ speed following aircraft			
	Trailing		
Lead	H	G	F
H	2.1	2.1	2.0
G	2.9	2.1	2.0
F	3.3	2.5	2.0

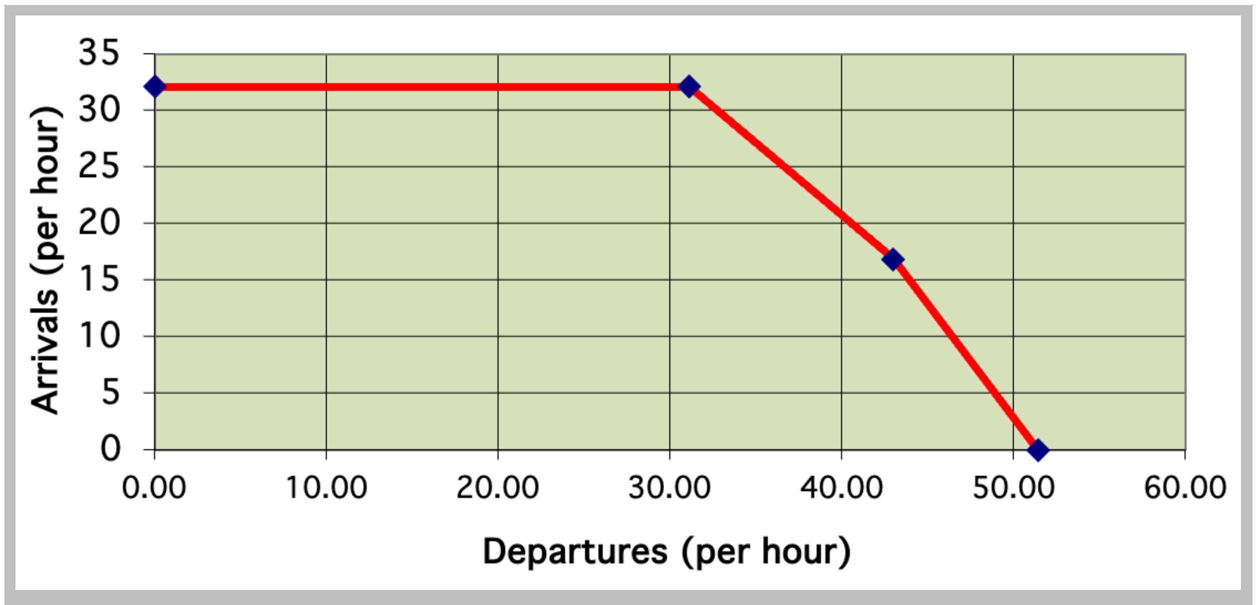
Departures per gap if delta <		2	
	Trailing		
Lead	H	G	F
H	1.0	1.0	1.0
G	1.0	1.0	1.0
F	1.0	1.0	1.0

Expected departures per gap if delta <			
	Trailing		
Lead	H	G	F
H	0.53	0.73	2.79
G	0.73	1.01	3.87
F	2.79	3.87	14.82

Total departures	31.12

Analysis of Departures on Runway 3 if Departures are Released with Between Arrival and Departure at Intersection. 2 nm of Separation

b) Draw the IMC Arrival-Departure diagram for the configuration shown in Figure 3.



Arrival-Departure Rate Diagram for Intersecting Runway Configuration.

c) If the airport ATC decided to operate additional departures on runway 09, estimate the new departure capacity with 100% arrival priority on runway 09 and 100% departures on runway 03.

The gaps left by successive arrivals are too small to allow additional operations on runway 9.