

AIRFIELD CAPACITY & NEXTGEN

The Capacity of the National Airspace System (NAS) is determined by the capacity of:

1. Airfields
 - a. Runways
 - b. Gates
 - c. Taxiways
2. Airspace
 - a. Number of Sectors
 - b. Sector Capacities
 - c. Traffic Flow Management (for efficient use of sectors)

The NAS capacity bottleneck is Airfields, specifically Runways.

Using the Workbook and the SYST 660 spreadsheet (provided in the Syllabus) answer the following questions:

1. Which combinations of Lead-Trailing pairs on approach are Compression or Separation cases

		Trailing aircraft			
		1(H)	2(L)	3(M)	4(S)
leading aircraft	1(H)	~	S	S	S
	2(L)	C		S	S
	3(M)	C	C	~	S
	4(S)	C	C	C	~

2. Write down the equations for Inter-arrival Time (for both compression and separating cases)

Compression $t_{ij} = r / (v_j - v_i) = s_{ij} / v$

Separation $t_{ij} = (r + s_{ij}) / v_j - (r / v_i)$

3. Length of Approach Path
 - a. Which combinations of Lead-Trailing pairs on approach include Length of Approach Path

		Trailing aircraft			
		1(H)	2(L)	3(M)	4(S)
leading aircraft	1(H)	-	S	S	S
	2(L)			S	S
	3(M)				S
	4(S)				-

- b. What role does length of approach path have in determining Runway capacity. Explain (short sentence)

For the separation case, the length of the approach path affects the runway capacity as it determines how much time (or distance) the following aircraft has to start not to violate the separation distance with the lead aircraft. The longer the approach path, the lower the capacity

4. Write down the equations for the Probability of each class of Lead-Training Aircraft Pairs

$$P_{ij} = p_i * p_j$$

5. What is the Average Arrival Capacity (Ops/hr) for the following scenarios*:

- a. Fleet Mix = 100% Heavy 37. Arrivals per hour
- b. Fleet Mix = 100% Large – 52. Arrivals per hour
- c. Fleet Mix = 100% Medium – 44. Arrivals per hour
- d. Fleet Mix = 1005 Small – 36. Arrivals per hour

* use default values for probability of fleet mix, approach speed, runway occupancy time. Set ATC Buffer to 0. Set Length of Approach Path to 6nm.

Plot Average Arrival Capacity (Ops/hr) (y-axis) vs Fleet Mix (x-axis).

Does the Average Arrival Capacity change monotonically with decreasing aircraft? Explain why/why not?

Not monotonic. Capacity = $f(S_{ij}, v)$

6. Complete question #5, with ATC Buffer = 10 secs.

- a. Fleet Mix = 100% Heavy 34. Arrivals per hour
- b. Fleet Mix = 100% Large – 45. Arrivals per hour
- c. Fleet Mix = 100% Medium – 39. Arrivals per hour
- d. Fleet Mix = 100% Small – 33. Arrivals per hour

Plot Average Arrival Capacity (Ops/hr) (y-axis) vs Fleet Mix (x-axis).

What is impact of ATC Buffer?

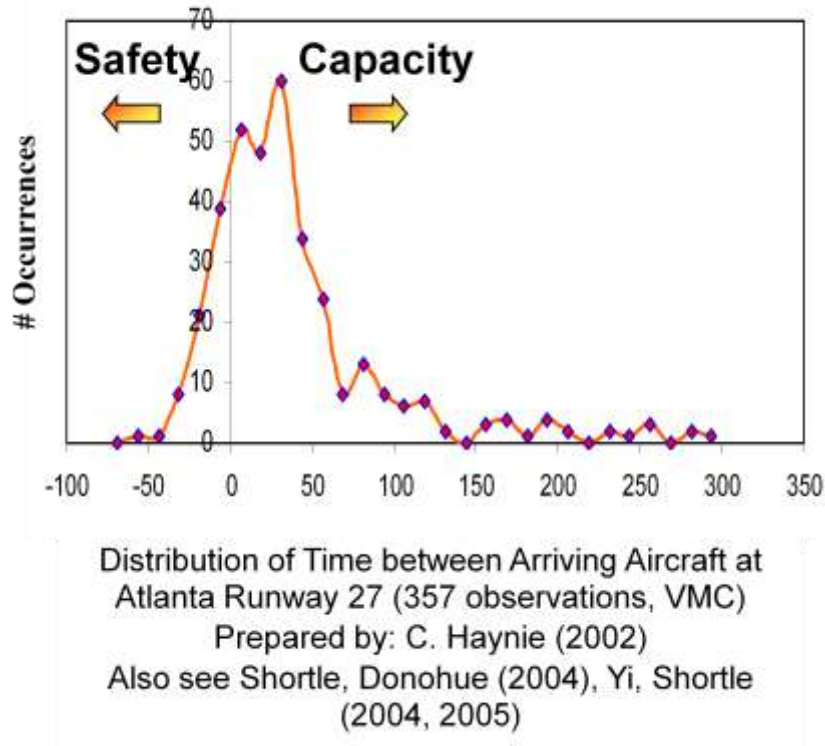
ATC Buffer increases $t_{ij} \rightarrow$ reduced capacity

7. NextGen and Airfield Capacity

- a. What parameters in the Runway Capacity model will be changed for each of the listed NextGen capabilities. Explain how each parameter is adjusted and whether the mean and/or variation is adjusted (short sentences).

NextGen Capability	ATC Buffer	Approach Path Length	Fleet Mix	Approach Speeds	Runway Occupancy Time
b. Digital Data Communications	<i>Faster response to ATC instructions</i>				
c. RNP	<i>More accuracy in separation distance</i>	<i>Shorter approach paths</i>			
d. ADS-B	<i>More accuracy in</i>				

	<i>separation distance</i>				
e. 4-D Trajectories	<i>Lines up sequence of aircraft with improved accuracy</i>				



b. Based on your analysis in 7 (a), will NextGen improve Airfield Capacity? Explain.

NextGen can improve the effective airfield capacity by eliminating gaps between arriving aircraft. Based on reduction in ATC Buffer, 10% (see #5 vs #6 above)

8. Mixed Arrivals and Departures

Assume the runway will be used alternately for arrivals and departures of Large Aircraft only (6nm Approach Path Length and ATC Buffer 10 secs). Assume each departure requires 60 secs. What is the Average Ops/Hr for the runway? Explain (short sentence).

Arrival + Departure pair $t_{ij} = 78.2 \text{ secs} + 60 \text{ secs} = 138 \text{ secs}$

3600 secs per hour / 138 secs = 26 pairs \rightarrow 52 operations/hour (alternating arrivals and departures)