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Determining Sector Capacity

For: ICAO Workshop in Abuja, Nigeria

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Introduction to determining sector capacity

Introduction

Sector Capacity:

The number of aircraft
- ✓ in a given sector

- ✓ for a specified period of time

- ✓ that can be managed safely and efficiently

Introduction

Optimum sector capacity value

+ / -   Adjustment factors

Sector capacity

Introduction

Table method for determining the Optimum Sector Capacity Value (Doc 9971)

Table II-App C-1.   Simplified method

| Average sector flight time (in minutes)	Optimum sector capacity value (aircraft count)
3	5
4	7
5	8
6	10
7	12
8	13
9	15
10	17
11	18
12 or more	18

The process

Sector Capacity

The number of aircraft
- ✓ in a given sector
- ✓ for a specified period of time
- ✓ that can be managed safely and efficiently

Factors that affect sector capacity:

- Airway structure in the sector

- Airspace volume of the sector
  - ✓ Vertically and horizontally

- Complexity of operations in the sector
  - ✓ Number of adjoining sectors
  - ✓ Amount of climbing/descending traffic
  - ✓ Terrain
  - ✓ Military operations and special use airspace
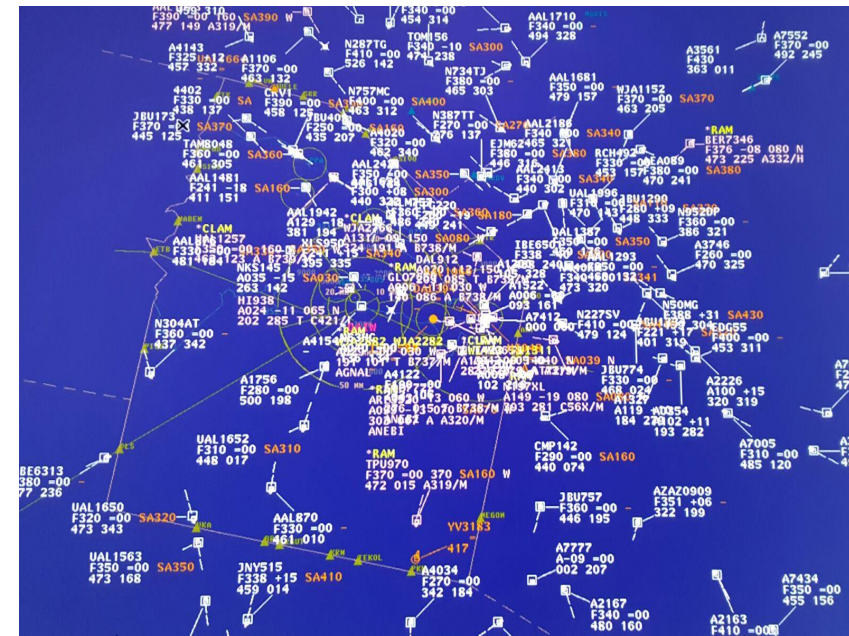
Simple mathematical method

For each 15-minute time period:
- Determine the average time, in minutes, that an aircraft spends in a sector

In most cases, this will be measured:
- from 7am to 7pm
- Monday through Friday

Simple mathematical method

You need to obtain **three** parameters!

1. The **total number of aircraft** observed in a sector during a 15-minute period

2. The **total minutes of flight time** generated by those aircraft in the 15-minute period

3. Adjustment factor (± number of flights)

Observations

Example:

1. **15 flights** are observed in a sector in a 15-minute period as shown in the table.

2. **120 minutes** is the **Total minutes of flight time** in this sector in a 15-minute period

2 of 3 parameters obtained!

AIRCRAFT ID	MINUTES IN SECTOR
UAL1039	9
CGBEP	10
DAL1822	7
FFT98	10
JBU1058	9
WJA2766	10
JB1869	9
SWG439	9
UAL1664	10
JBU174	9
AZV778	5
SWA812	10
JBU2537	4
N322EC	3
VQTGG	6
TOTAL MINUTES	**120**

11

Simple mathematical method

In this example example:

- You observe 15 flights in the sector in a 15 minute period
- Add their individual sector times together
  - ✓ 120 minutes, in this example
- Divide by 15 (flights)
  - ✓ To obtain the average
- The quotient is the average sector flight time, in minutes
  - ✓ 8 minutes, in this example

Simple mathematical method

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120

120 / 15 =

8

120: Total minutes of flight time recorded in a 15-minute period

15: Number of flights observed in 15-minute period

8: Average sector flight time in minutes

Simple mathematical method

Multiply the average sector flight time in minutes by 60 seconds

In this example:
- The average sector flight time is 8 minutes
- Multiply 8 minutes by 60 seconds (8 x 60)
- The quotient, 480 seconds, is the average sector flight time -- in seconds

Simple mathematical method

8 x 60 =

480

> 8:   Average sector flight time in minutes
>
> 60:   (Fixed) Minute to seconds conversion
>
> 480: Average sector flight time in seconds

Simple mathematical method

- Divide the average sector flight time in seconds by 36 seconds
  - 36 seconds is a value established for use in the United States by human factor experts
  - It represents the average time a controller interacts with a flight while in a sector

- In this example:
  - The average sector flight time is 480 seconds
  - Divide 480 seconds by 36 seconds (480 / 36)
  - The quotient, 13.33 (round down to 13)
  - 13 is the optimum sector capacity value for 15 minutes

Simple mathematical method

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480 / 36 =

13.33

13

480: Average sector flight time in seconds

36: (Fixed) Average time in seconds that an ATCO works each aircraft (as established by FAA Human Factor Experts)

13: Optimum sector capacity (round down from 13.33)

Simple mathematical method

120 minutes (total of the observed minutes)

120 minutes/ 15 flights = 8 minutes per aircraft

8 = average sector flight time in minutes

8 minutes x 60 seconds/minute = 480 seconds per aircraft

480 = average sector flight time in seconds

480 seconds / 36 seconds per aircraft = 13.33 aircraft

Round down to 13

13 aircraft = optimum sector capacity value

Even easier:

Table method

Table method for determining the Optimum Sector Capacity Value (Doc 9971)

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Almost done:

Adjust the optimum sector capacity value
- May be adjusted up or down

- Take into consideration the factors that affect the sector
    - Airway structure in the sector
    - Airspace volume of the sector
        - Vertically and horizontally

    - Complexity of operations in the sector
        - Number of adjoining sectors
        - Amount of climbing/descending traffic
        - Terrain
        - Military operations and special use airspace

Adjust the optimum sector capacity value

After taking into consideration the factors that affect the sector:

- Apply local, professional judgment and adjust the optimum sector capacity value **up or down**, as necessary

Final product: Sector Capacity

> 3 of 3
> All parameters obtained!

	Optimum sector capacity value	13
+ / -	Adjustment factors	**-1**
	--	-----
	Sector capacity	**12**

Background Information

Determining Sector Capacity

Doc 9971:

3.1.4 Airspace capacities

3.1.4.1 The capacity for an airspace sector (terminal or en-route) is defined either as

an entry count (maximum number of aircraft entering an airspace sector in a given period of time)

or

a maximum occupancy count over a specific time period (e.g., 15 minutes).

Airspace capacity represents the total number of flights that a controller can handle within a sector.

Determining Sector Capacity

Doc 9971:

3.1.4 Airspace capacities

3.1.4.2 In some cases, instantaneous or short duration occupancy counts (e.g., one minute) can be used to complement entry counts and allow higher values for such entry counts.

Such occupancy count capacities require accurate and frequent live ATC message and surveillance data updates to the ATFM system.

Occupancy counts should be available in advance of the flight entry into the given airspace and on a frequent basis.

Determining Sector Capacity

Doc 9971:

3.1.6 Operational capacity

In addition to the declared capacities for airports and airspaces (and the capacity associated with the strategic airport slot process), ATFM services require knowledge of the operational capacity.

Operational capacity is the expected capacity associated with the tactical situation at the airport or airspace.

Dynamic factors, including meteorological conditions, CNS status, fleet mix and staffing may result in an operational capacity inferior to the declared capacity. ATFM solutions (see Part II, Chapter 4) are based on the expected dynamic operational capacity.

Determining Sector Capacity

Doc 9971:

3.1.7 Capacity determining methods

3.1.7.1 It would be extremely complex to establish a universal rule to calculate capacity.

Capacity can be affected by so many variables and external considerations that standardization is simply not possible.

It is therefore up to each ANSP to decide how to determine its capacity by choosing from either ==basic methods== based on observation or highly sophisticated mathematical models.

Determining Sector Capacity

Doc 9971:

3.1.7 Capacity determining methods

3.1.7.2 In any case, capacity limits may be assessed using feedback from control staff, incident reports where heavy workload is a factor and real-time observations.

Post-operations analysis and monitoring provide essential feedback and can be of great use to refine capacity determination.

Determining Sector Capacity

Doc 9971:

3.1.7 Capacity determining methods

3.1.7.3 Operational capacities are not static values, as they vary with traffic complexity and other factors.

In general, sustained levels of demand superior to capacity warrant some form of ATFM intervention, whereas short demand spikes moderately above capacity may be managed through attentive oversight, without intervention.

Tolerance thresholds may be defined to frame those possible variations of the capacity and to ensure that variations remain within a defined range.

Determining Sector Capacity

Doc 9971:

3.1.7 Capacity determining methods

3.1.7.6 There are two schools of thought on how to assess and establish ATC sector capacity:

<mark>mathematical occupancy and complexity models</mark>, and

<mark>controller workload assessment models</mark>.

In both cases it is essential that the capacity calculated using these models be validated by other means (e.g., real-time observations, real-time simulations).

Determining Sector Capacity

Doc 9971:

3.1.7 Capacity determining methods

3.1.7.7 Mathematical occupancy and complexity models take account of:
a) traffic profile: cruise, climb, descent;
b) traffic mix: light, heavy, speed mix;
c) number and types of typical ATC interventions;
d) sector flight times; and
e) default workload per flight

Determining Sector Capacity

Doc 9971:

3.1.7 Capacity determining methods

3.1.7.8 Controller workload assessment models break down the controller workload into a set of definable and measurable tasks for which average execution times are defined.

These tasks include coordination, handling flight data, radio frequency, communications and conflict management.

Since the amount of mental reasoning a controller uses cannot be measured, an acceptable workload threshold is normally established and capacity is assessed to be at the point where this threshold is reached. Such models require intensive participation by the control staff in establishing task execution workload metrics.

Determining Sector Capacity

Doc 9971:

3.1.7 Capacity determining methods

3.1.7.9 Regardless of the method chosen to establish capacities, it is strongly recommended that any major calculated increase in capacity be implemented in an incremental way.

This will allow real-time experience to be fed back into the models used and will also foster air traffic controller acceptance of the calculated capacity increase.

Thank you!