

# Crew Management Study Group

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Marc Paelinck

KLM cabin crew  
on-call stand-by duty optimisation

# Cabin crew management at KLM

8000 CAs



Internet-based flight request system



Part time

100%  
67%  
80%  
50%



5 ranks

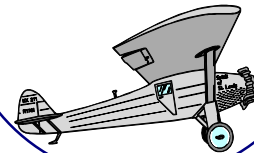
long haul purser  
short haul purser  
assistant purser  
business class CA  
tourist class CA



6000 weekly trip assignments

3000 short haul (Europe)

3000 long haul



grouped in divisions according to aircraft types

# Assignment of flight duties

- long haul: assignment by cycle

cycle = one flight "out and back" + leave

|            |  |            |       |       |                    |                    |
|------------|--|------------|-------|-------|--------------------|--------------------|
| KL0641 JFK |  | KL0642 AMS | leave | leave | part-time<br>leave | part-time<br>leave |
|------------|--|------------|-------|-------|--------------------|--------------------|

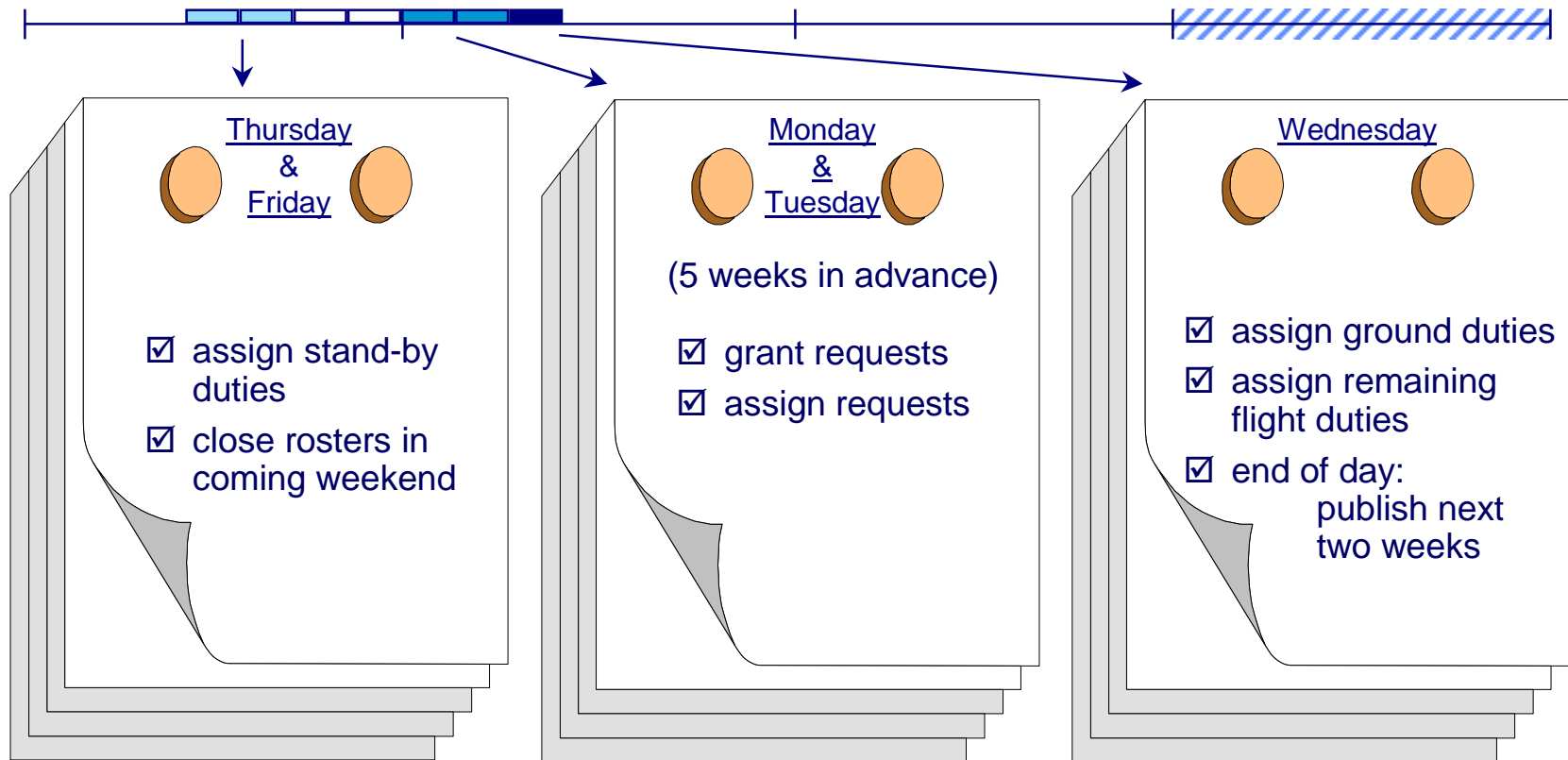
- short haul (Europe): assignment by pattern

pattern = several flights + leave

|            |  |            |            |                          |       |       |                    |                    |
|------------|--|------------|------------|--------------------------|-------|-------|--------------------|--------------------|
| KL1151 OSL | KL1144 AMS<br>KL1021 LHR<br>KL1022 AMS | KL1613 IST | KL1610 AMS | KL1699 MAD<br>KL1600 AMS | leave | leave | part-time<br>leave | part-time<br>leave |
|------------|--|------------|------------|--------------------------|-------|-------|--------------------|--------------------|

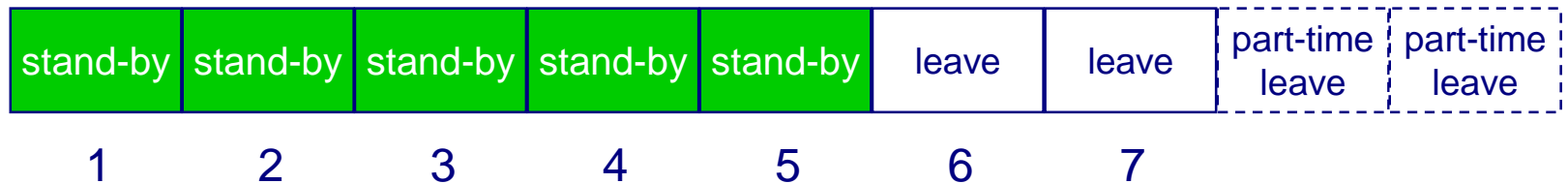
# Weekly scheduling routine

Scheduling of one week, 2 weeks in advance

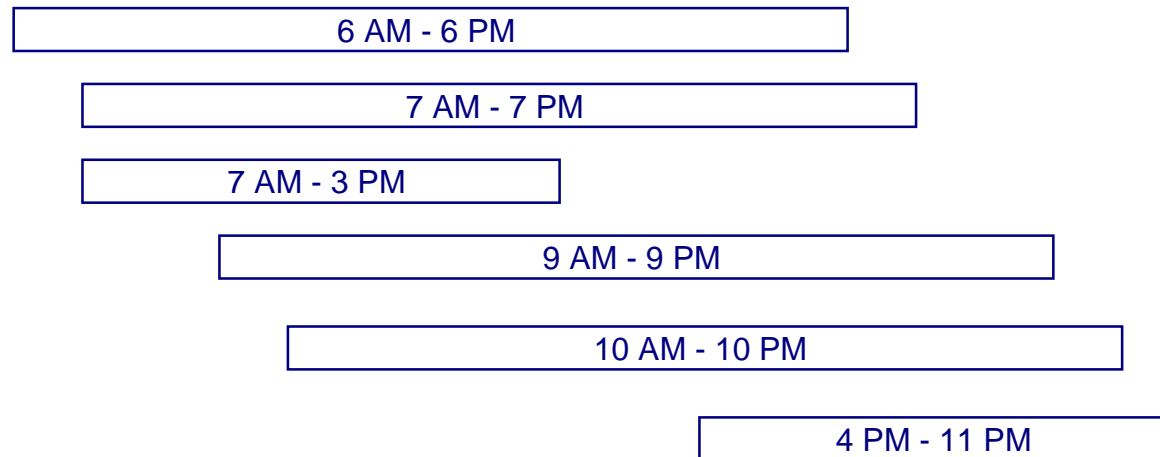


# Current stand-by duty policy

- stand-by duties are part of a roster
- they are assigned as a 7-day “block”

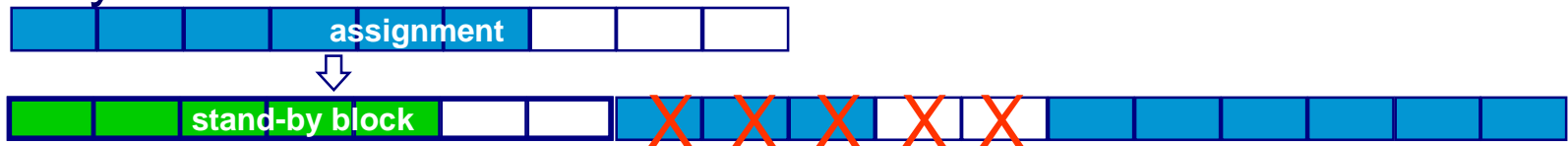


- There are various duty times



# Problems

- Duty times are no longer adequate
  - stand-bys are not always on duty when they are needed
- The relation between daily number of blocks and service level is unknown
- The follow-up roster is often disturbed when assigning a duty



- extra maintenance costs
- CA is uncertain about follow-up roster
- not in line with policy of request system

# Questions

How many stand-by duties are needed for a given service level?

Which duty times should we use?

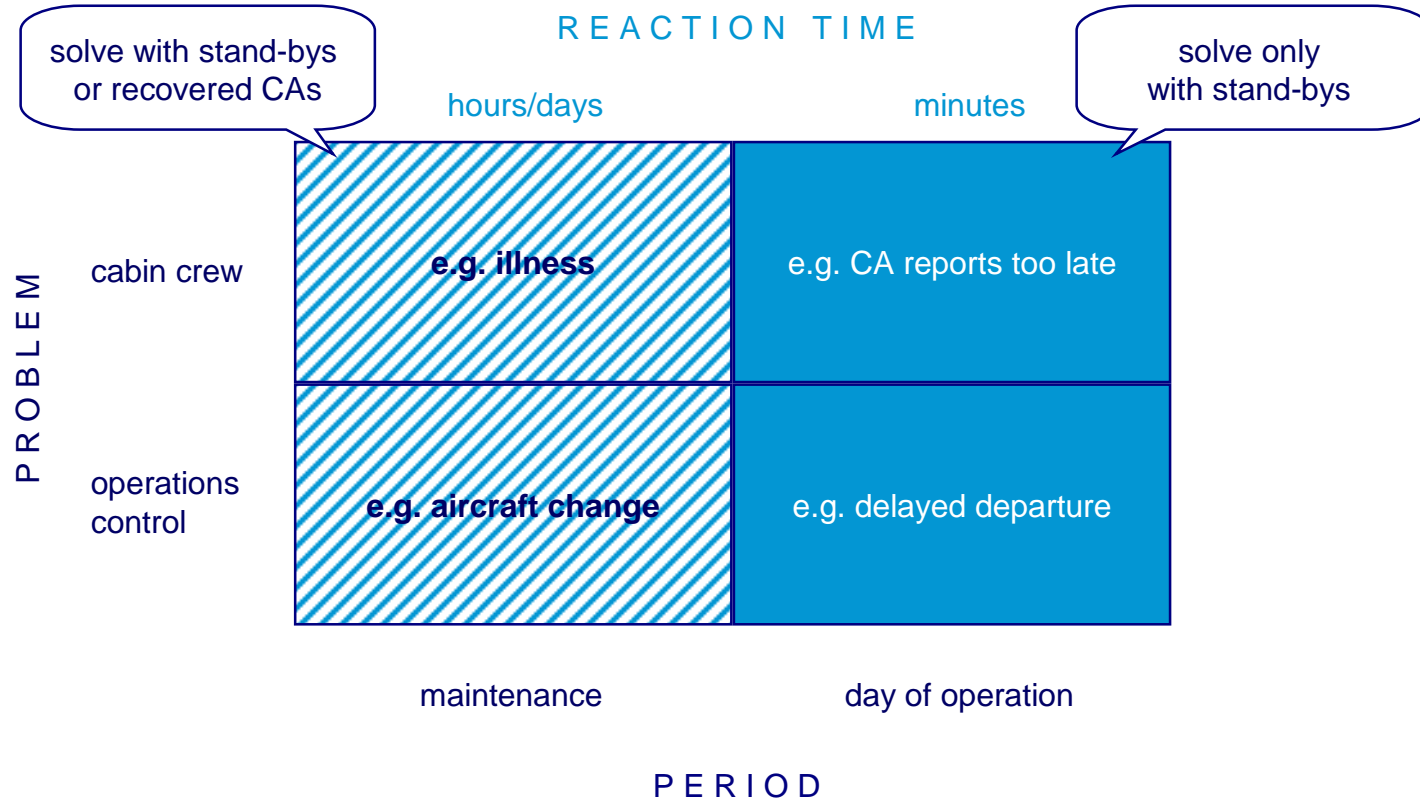
What is the effect of blocks on the actual # of stand-bys on duty?



What should be the length of a stand-by block?

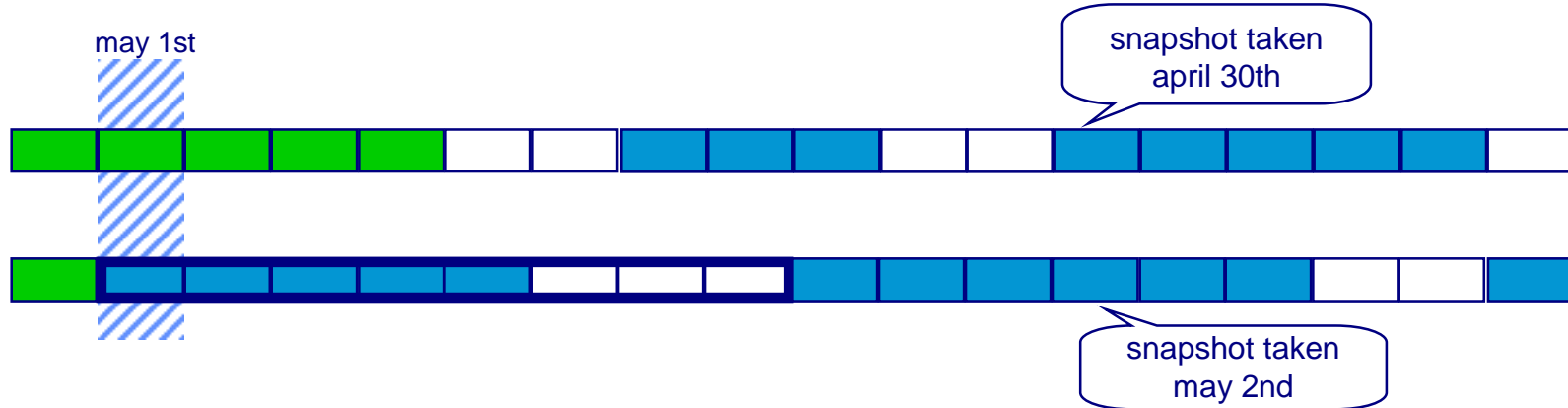
How much do stand-by duties cost?

# When do we need on-call stand-bys?



# How to quantify the daily demand

- Compare two snapshots of a roster



- Keep the following data about the assignment
  - kind of assignment
  - start date & time
  - end date
  - aircraft type
  - rank

**NOTE**  
In this way, we can only deduce the "constrained demand"!

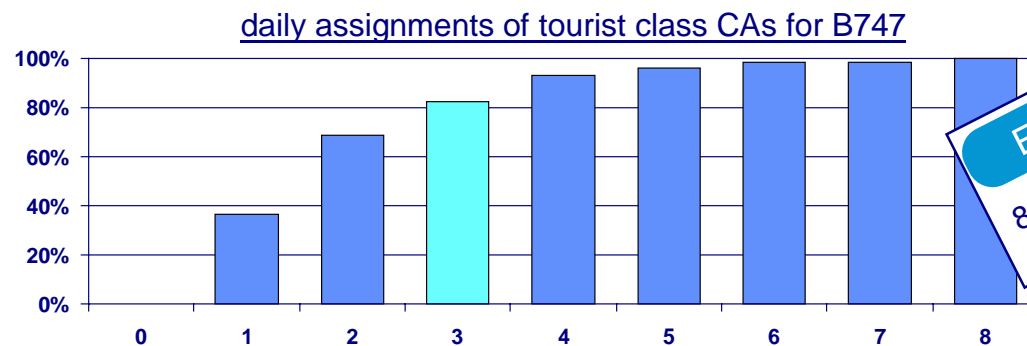
# How to quantify the daily demand

- Next, determine the frequency of assignments
  - per day (per hour)
  - per aircraft type
  - per rank

daily assignments of tourist class CAs for B747

| Time of day  | 1 jan    | 2 jan    | 3 jan    | 4 jan    | 5 jan    | 6 jan    | 7 jan    | 8 jan    |
|--------------|----------|----------|----------|----------|----------|----------|----------|----------|
| 6:00 AM      |          |          |          |          |          |          |          | 1        |
| 7:00 AM      |          |          |          |          |          |          |          |          |
| 8:00 AM      |          | 1        |          |          |          | 1        | 1        |          |
| 9:00 AM      |          |          |          |          | 1        |          | 1        |          |
| 10:00 AM     |          |          |          |          |          |          |          |          |
| 11:00 AM     |          |          |          |          | 1        |          |          |          |
| 12:00 AM     |          |          |          |          |          |          |          | 1        |
| 1:00 PM      | 1        | 2        | 1        |          |          |          |          |          |
| 2:00 PM      |          |          | 1        |          |          |          | 1        |          |
| 3:00 PM      |          |          |          |          |          |          |          |          |
| 4:00 PM      |          | 2        |          |          | 1        |          |          |          |
| 5:00 PM      |          | 2        |          | 1        |          | 1        | 1        | 1        |
| 6:00 PM      |          |          |          | 1        |          |          |          |          |
| 7:00 PM      |          |          |          |          |          |          |          |          |
| <b>Total</b> | <b>1</b> | <b>7</b> | <b>2</b> | <b>2</b> | <b>3</b> | <b>2</b> | <b>4</b> | <b>3</b> |

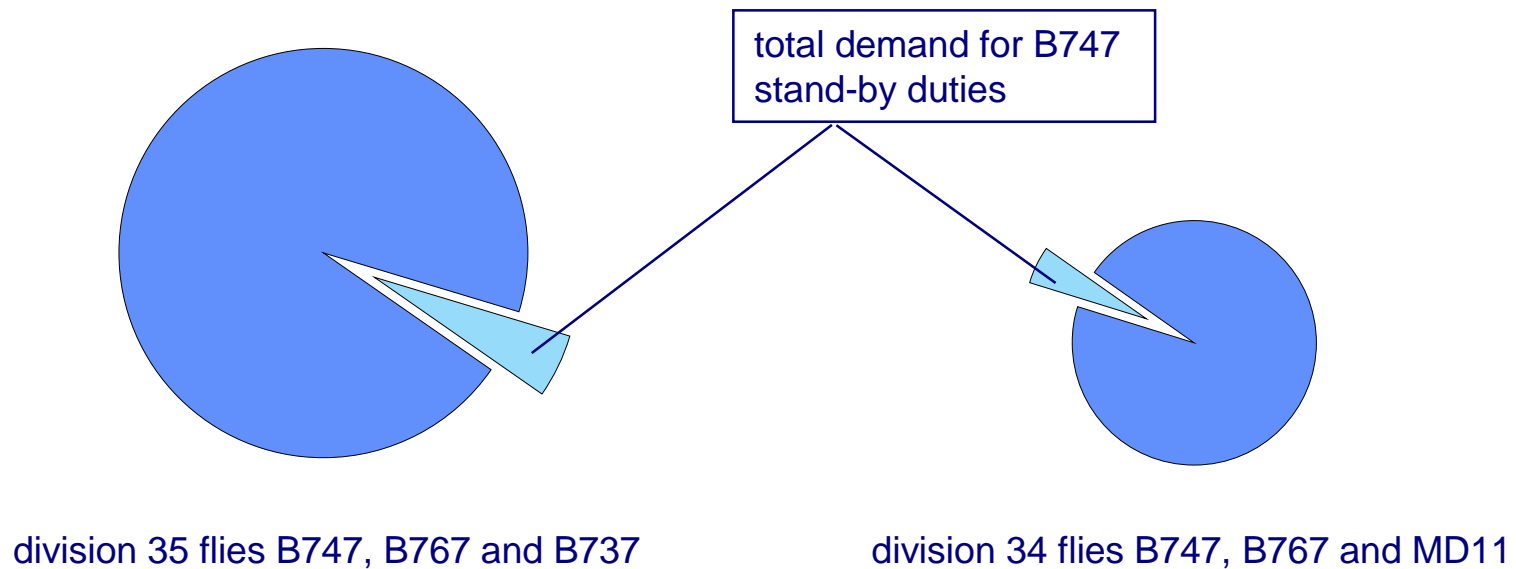
- Then, determine the  $x^{\text{th}}$  percentile of the daily demand



Example  
80th percentile  
equals 3


# How to quantify the daily demand

- Finally, convert the results to the demand of stand-bys per division
  - remember that the division determines which aircraft types the CA is allowed to fly
  - we aim at a proportionate distribution over the various divisions




# Questions

Now we have the daily demand of stand-bys.



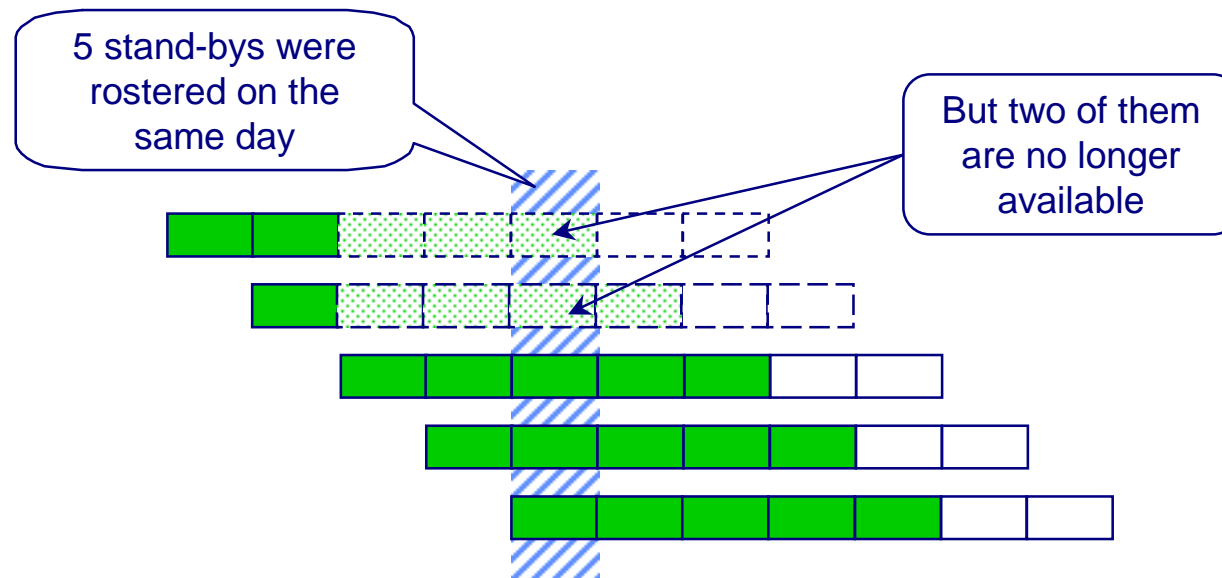
But is that also the number of 7-day blocks we need?



And what about the start and end times of stand by duties?

# Block stacking

- How many stand-bys can we expect on a given day using stand-by blocks?
  - The number of (potentially) available stand-bys accumulate
  - But stand-bys also can get an assignment before the end of their block



## Expected number of stand-bys

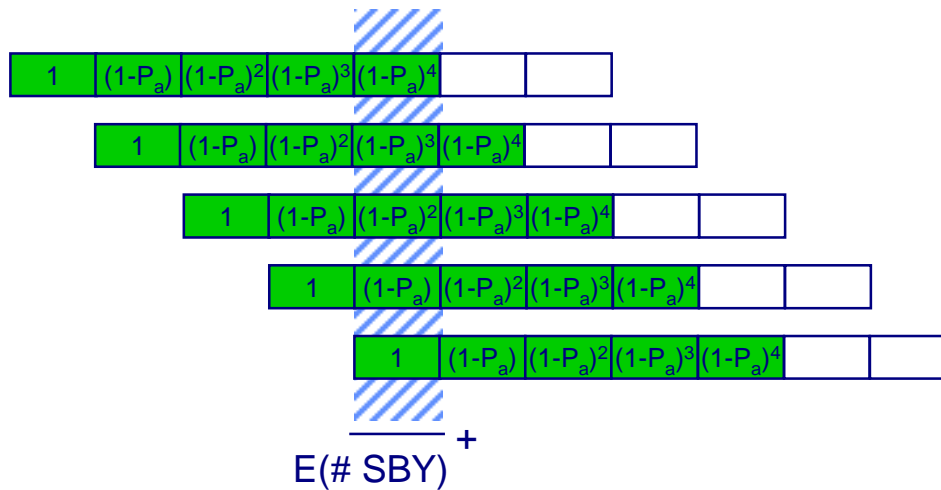
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- Determine the probability of assigning a stand-by on a given day:

$$P_a = P(\text{assignment}) = \frac{\text{average \# of stand-bys assigned daily}}{\text{\# of daily stand-by duties}}$$

# Expected number of stand-bys

- Next, determine the expected number of remaining stand-bys per day



**NOTE**  
 Instead of the average ( $P_a$ ) we could also use a higher percentile

- Finally, matching  $E(\# \text{ SBY})$  with the daily demand is mostly a question of trial and error

# Duty times

- A similar method can be used to determine duty times
- But first, we must determine the demand of stand-bys per hour
  - remember, as of yet we have only determined the “daily demand”

## PROBLEM

If we simply took the  $x^{\text{th}}$  (e.g. 80<sup>th</sup>) percentile for each hour, the daily total would come out wrong!

daily assignments of tourist class CAs for B747

|          | 11 jan | 12 jan | 13 jan | 14 jan | 15 jan | 16 jan | 17 jan | 18 jan | P80 |
|----------|--------|--------|--------|--------|--------|--------|--------|--------|-----|
| 8:00 AM  | 1      |        |        | 1      |        |        |        | 1      | 1   |
| 9:00 AM  |        |        | 1      | 1      |        |        | 1      |        | 1   |
| 10:00 AM | 4      | 1      | 1      | 1      | 4      | 2      |        | 2      | 4   |
| 11:00 AM |        |        | 2      |        |        |        |        |        | 0   |
| 12:00 AM |        |        |        |        |        |        |        |        | 0   |
| 1:00 AM  |        |        |        |        | 1      | 1      |        |        | 1   |
| 2:00 AM  | 1      | 1      |        |        |        |        |        |        | 1   |
| 3:00 AM  |        | 4      |        |        |        |        |        |        | 0   |
| 4:00 AM  |        |        | 1      | 1      |        |        |        |        | 1   |
| 5:00 AM  | 1      |        |        |        | 1      |        |        |        | 1   |
| 6:00 AM  |        | 1      | 2      |        |        |        |        |        | 1   |
| 7:00 AM  | 2      |        | 4      |        | 2      |        | 1      | 1      | 2   |
| 8:00 AM  | 1      |        | 4      | 1      |        |        |        | 1      | 1   |
| Total    | 10     | 7      | 15     | 5      | 8      | 3      | 2      | 5      | 14  |

P80 on a daily basis

sum of P80's on an hourly basis

# Duty times

Instead, choose a different percentile rank for each hour of the day

linear decrease

| Time of day  | perc. rank              | percentile         |
|--------------|-------------------------|--------------------|
| 6:00 AM      | 1                       | P <sub>6:00</sub>  |
| 7:00 AM      | $1 - (1 - \alpha)/16$   | P <sub>7:00</sub>  |
| 8:00 AM      | $1 - 2(1 - \alpha)/16$  | P <sub>8:00</sub>  |
| 9:00 AM      | $1 - 3(1 - \alpha)/16$  | P <sub>9:00</sub>  |
| 10:00 AM     | $1 - 4(1 - \alpha)/16$  | P <sub>10:00</sub> |
| 11:00 AM     | $1 - 5(1 - \alpha)/16$  | P <sub>11:00</sub> |
| 12:00 AM     | $1 - 6(1 - \alpha)/16$  | P <sub>12:00</sub> |
| 1:00 PM      | $1 - 7(1 - \alpha)/16$  | P <sub>13:00</sub> |
| 2:00 PM      | $1 - 8(1 - \alpha)/16$  | P <sub>14:00</sub> |
| 3:00 PM      | $1 - 9(1 - \alpha)/16$  | P <sub>15:00</sub> |
| 4:00 PM      | $1 - 10(1 - \alpha)/16$ | P <sub>16:00</sub> |
| 5:00 PM      | $1 - 11(1 - \alpha)/16$ | P <sub>17:00</sub> |
| 6:00 PM      | $1 - 12(1 - \alpha)/16$ | P <sub>18:00</sub> |
| 7:00 PM      | $1 - 13(1 - \alpha)/16$ | P <sub>19:00</sub> |
| 8:00 PM      | $1 - 14(1 - \alpha)/16$ | P <sub>20:00</sub> |
| 9:00 PM      | $1 - 15(1 - \alpha)/16$ | P <sub>21:00</sub> |
| 10:00 PM     | $\alpha$                | P <sub>22:00</sub> |
| <b>Total</b> |                         | <b>D</b>           |

this can be done with a spreadsheet solver

By changing  $\alpha$  we can achieve that the sum of all the percentiles amounts to **D**.

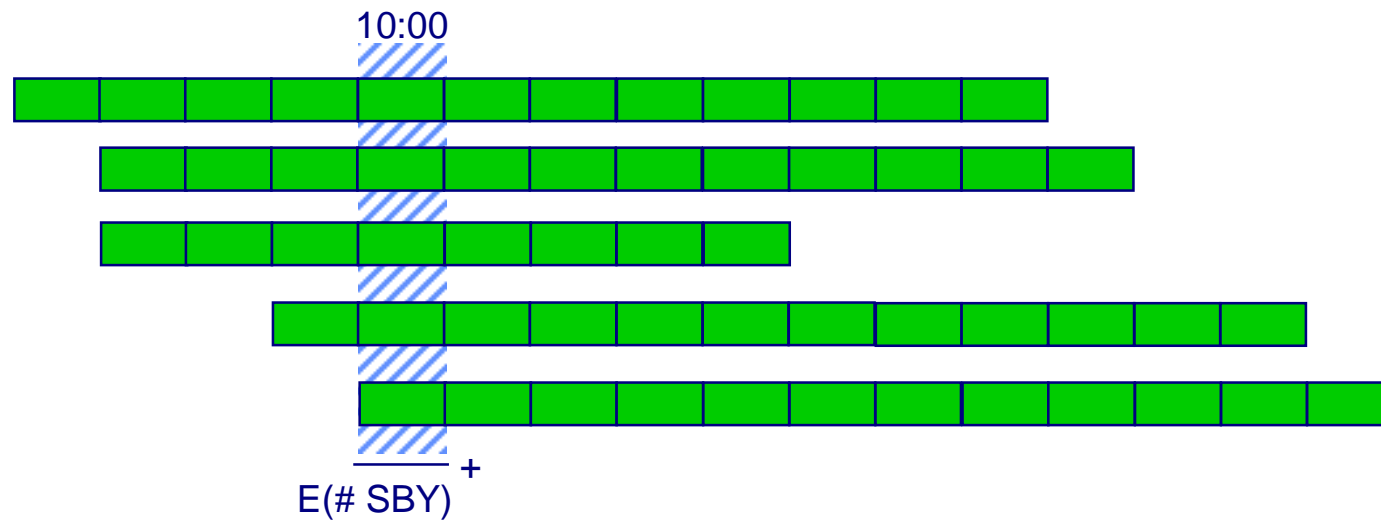
P<sub>10:00</sub> is the " $1 - 4(1 - \alpha)/16$ "-th percentile of the number of assigned stand-bys between 10 AM and 11 AM.

D is the daily demand for stand-bys as determined earlier.

# Duty times

Now we can determine the duty times and the number of stand bys per duty

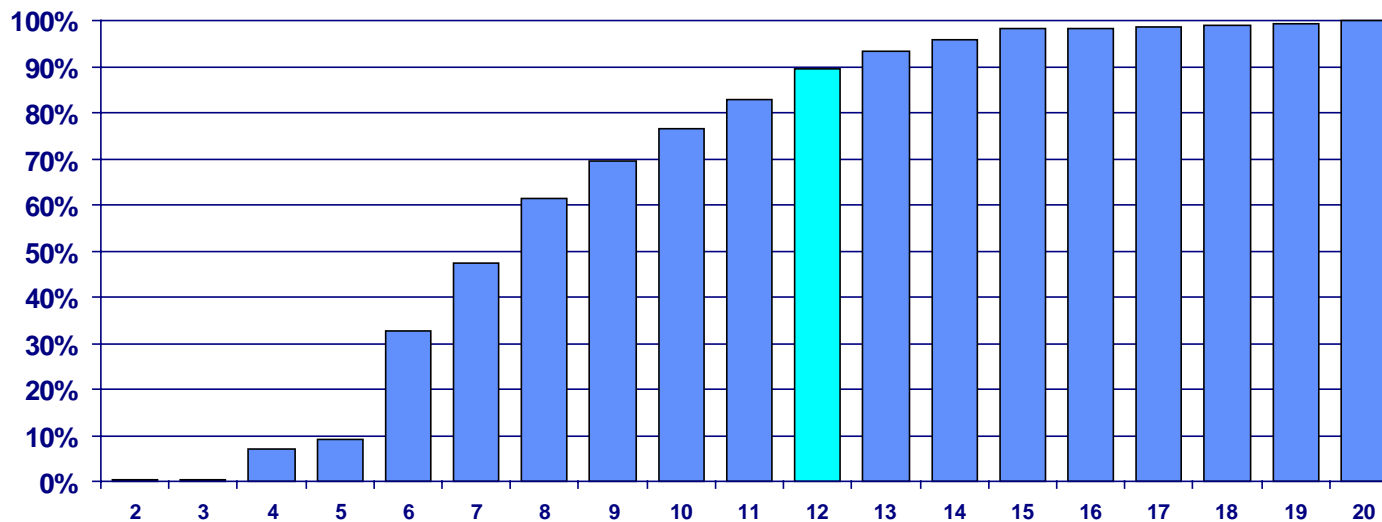
- in a similar way as for the blocks
- using information about the schedule
- and a lot of “common sense”



# Determining the block length

- Determine the distribution of the cycle length of all stand-by assignments

cycle lengths of long haul flights (as assigned to stand-bys)

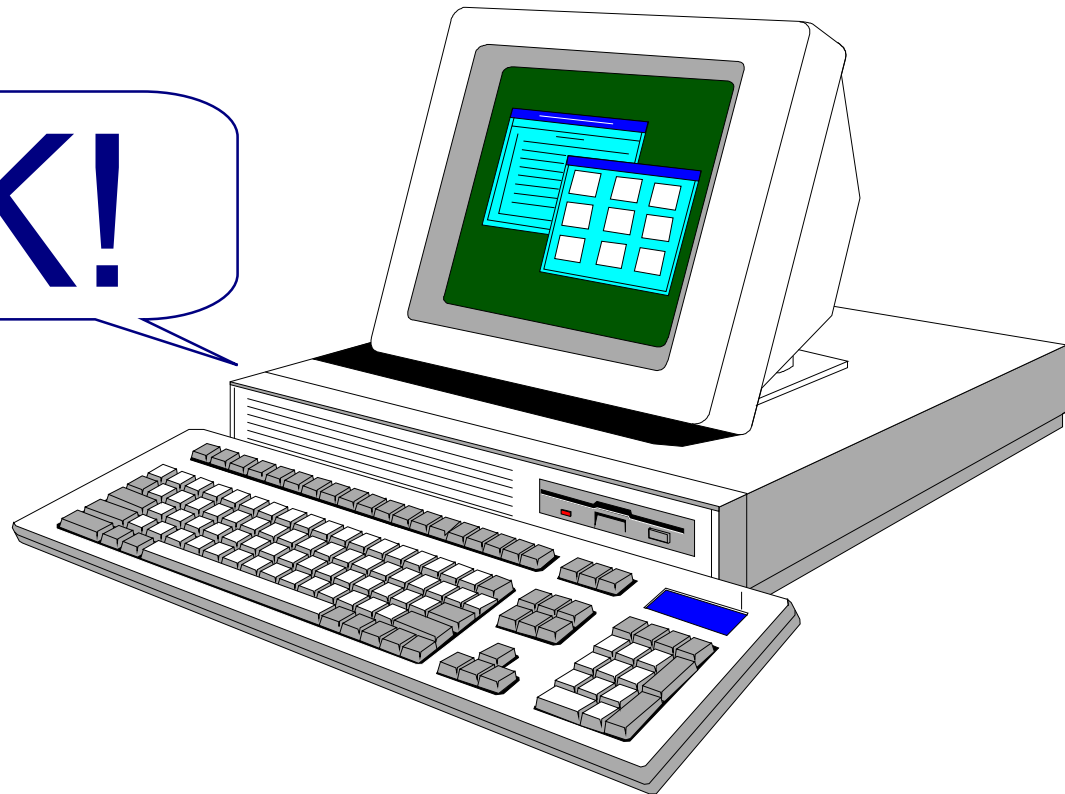


- Make a choice for the confidence level

# Computer simulation

With a spreadsheet simulation using VBA, we have enacted the daily assignment of CA's using the calculated norms.

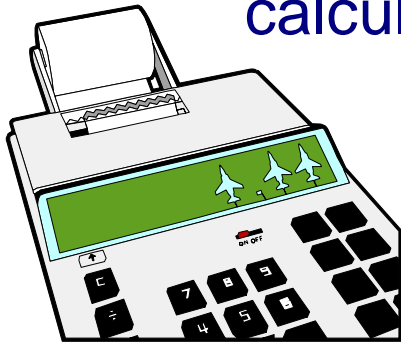
OK!



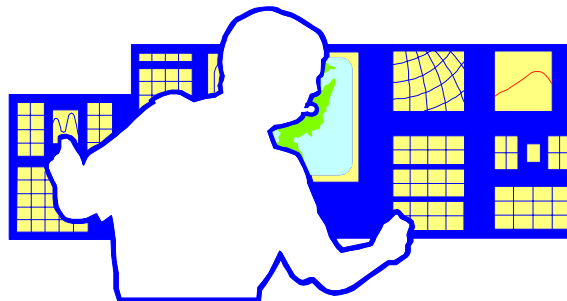
# The proof of the pudding...

We have introduced the new stand-by norm,  
based on a combination of

calculation...



...simulation...



...and experience

# And next...

There are still unanswered questions

