Rostering, Productivity and Cross-Border Opportunities in Area Control Centres

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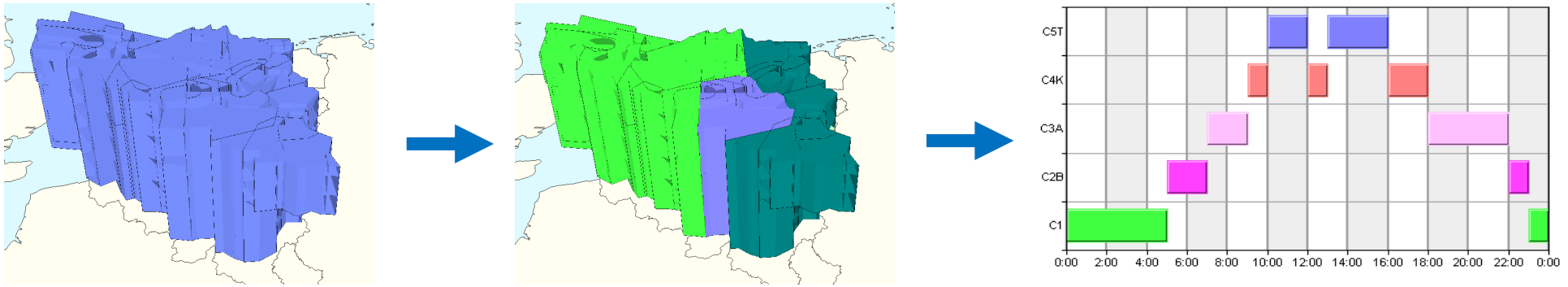
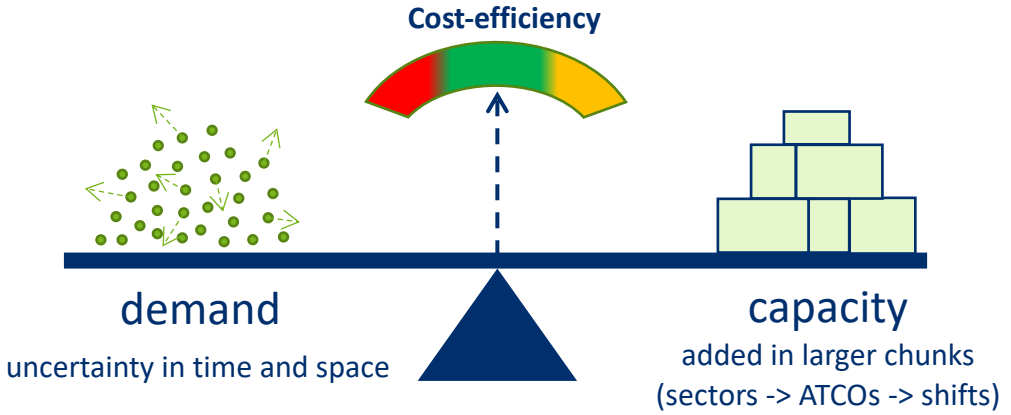
- Case study and assumptions
- Results and conclusions
- Further research

Introduction – delivering ATC capacity



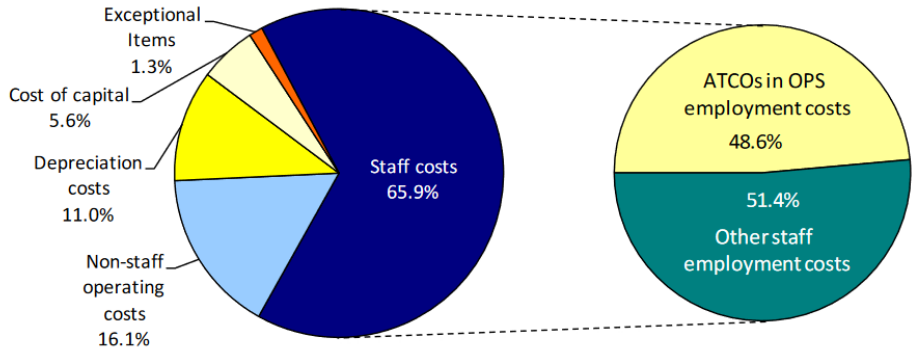
In order to accommodate traffic demand, airspace is divided into smaller segments - “sectors” (elementary and/or collapsed), each served by a pair of ATCOs – planner and executive.

ACC – Area Control Centre
ATCO – Air Traffic Control Officer



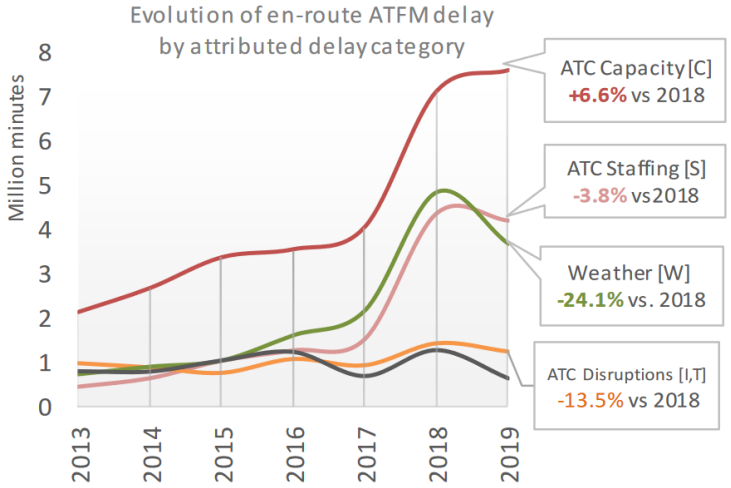
Motivation - why ATCO rostering matters?

- Staffing - **major cost component** in the total ATM/CNS costs (labour-intensive activity)
- At the same time one of the **main reasons for delay** in the European ATM network
- High **heterogeneity in rostering practices** applied across ANSPs/ACCs
- Evidence of **spare capacity** – but when/where?



Total ATM/CNS provision costs: **€ 8 711 M**

Source: ATM Cost-Effectiveness (ACE) Benchmarking report 2019



Source: Performance Review Report (PRR) 2019

Status quo and opportunities

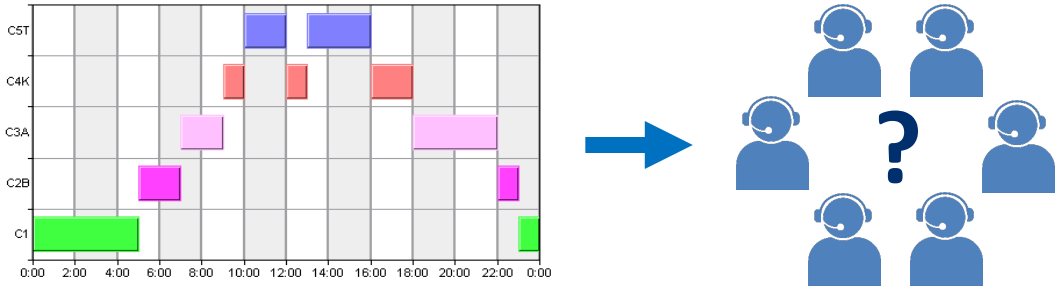
- Initial survey shows quite rigid rostering practices in some European ACCs
- No common requirements in Europe, largely managed at national level
- Spare capacity present in some parts of the network

- Need to increase **flexibility in capacity provision** (in time and in space)
- Virtualisation / capacity-on-demand concept?

"Since 2013, the delivered capacity increases have not been able to match the 3% average increase in traffic leading to increased delays. ***Strategic recruitment choices, unexpected shifts in demand and sub-optimal deployment of staff*** *in some ACCs has led to opening of fewer sectors than planned in the Network Operations Plan (NOP)".*

Key research goals

- to **establish a relationship** between taskload (demand/capacity profile), rostering flexibility in place and the number of ATCOs needed



- to explore how different rostering practices applied in ACCs affect **spare capacity** in the system

ATCO rostering model

Objective function:

(1) To minimize the number of ATCO pairs (**i**) engaged during one day of operations, represented by a given capacity profile.

Constraints:

(2) - link between variables x_{ist} and z_i, i.e. an ATCO pair is considered engaged (z_i = 1) only if it is assigned to a shift. The number of shifts assigned to an ATCO pair does not exceed 1.

(3) - the minimum number of available ATCO pairs at any time period is greater than the number of open sectors in the same period

(4) and (5) - limitations for decision variables (binary).

$$(\min) \quad f(x) = \sum_{i \in A} z_i \qquad (1)$$

s.t.

$$\sum_{s \in S} \sum_{t \in M} x_{ist} \leq z_i \qquad i \in A \qquad (2)$$

$$\sum_{i \in A} \sum_{s \in S} \sum_{\substack{k \in M: \\ \max\{1, t-ts+1\} \leq k \leq t}} wb_{s\,(t-k+1)} x_{isk} \geq ns_t \qquad t \in T \qquad (3)$$

$$x_{ist} \in \{0,1\} \qquad i \in A,\ s \in S,\ t \in T \qquad (4)$$

$$z_i \in \{0,1\} \qquad i \in A \qquad (5)$$

Template-based model

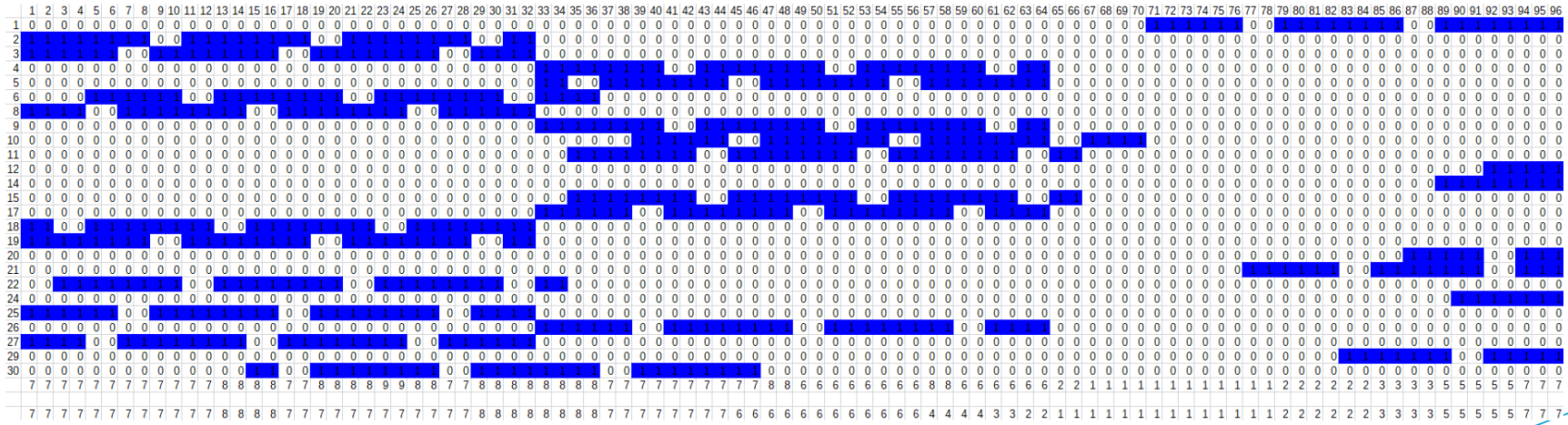
ATCO working templates - example

Possible work-break templates for one shift

Template 1	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1
Template 2	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1
Template 3	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1
Template 4	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1
Template 5	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1
Template 6	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1
Template 7	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1
Template 8	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1
Template 9	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0

1 – if an ATCO pair is at the operational position at a given time period
0 – otherwise

Example of model output for one full day of operations



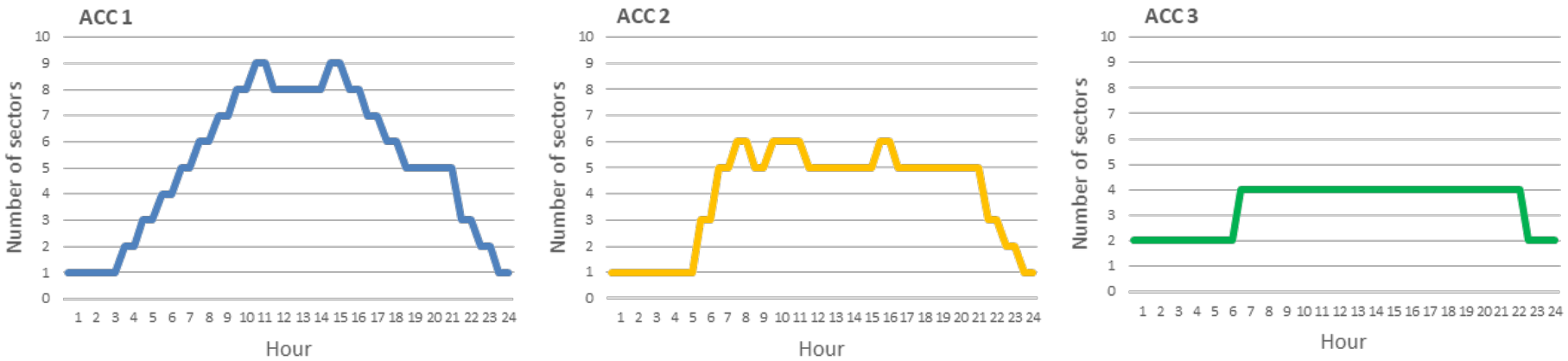
Case study and assumptions (1)

Key ideas:

- to capture different capacity profiles and levels of ATCO rostering flexibility
- to grasp key relationships, not to build an actual roster for an ACC!
- generic (common) assumptions - not to replicate any specific ACC and its local operational and/or social conditions:
  - maximum consecutive time at operational position **2 hours**
  - minimum duration of break away from the position **30 minutes**
  - maximum shift duration **8 hours**
  - time for briefings before taking up duty, as well as time needed for handovers at the operational position considered to be relatively short and therefore not taken into account

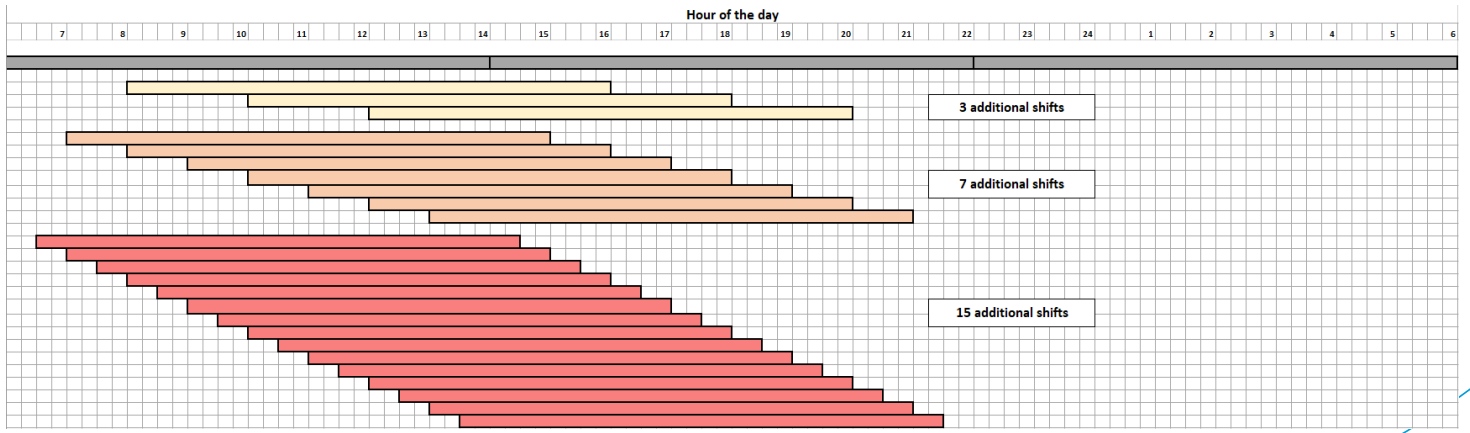
Case study and assumptions (2)

Three capacity profiles with different hourly variability:

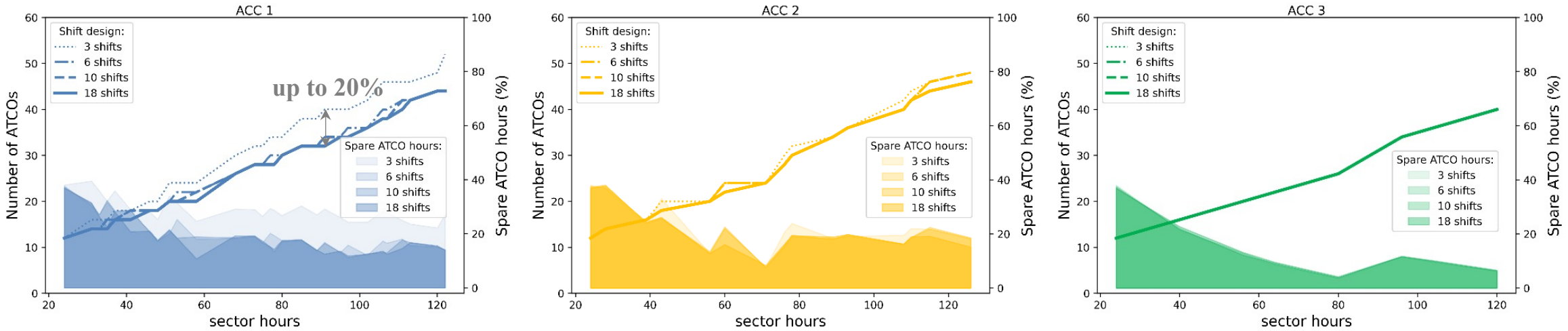


Different levels of rostering flexibility:

- Basic pattern with 3 shifts
- 6 shifts (basic + 3 staggered shifts in increments of 2 hours)
- 10 shifts (basic + 7 staggered shifts in increments of 1 hour)
- 18 shifts (basic + 15 staggered shifts in increments of 30 min)



Results and conclusions



Number of ATCOs:

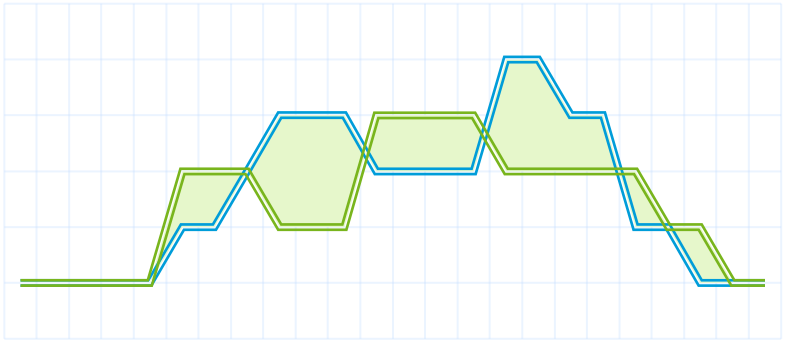
- increases linearly with sector-hours
- the increase is generally slower for smoother profiles
- savings reduce with the flattening of the demand profile

Spare ATCO-hours:

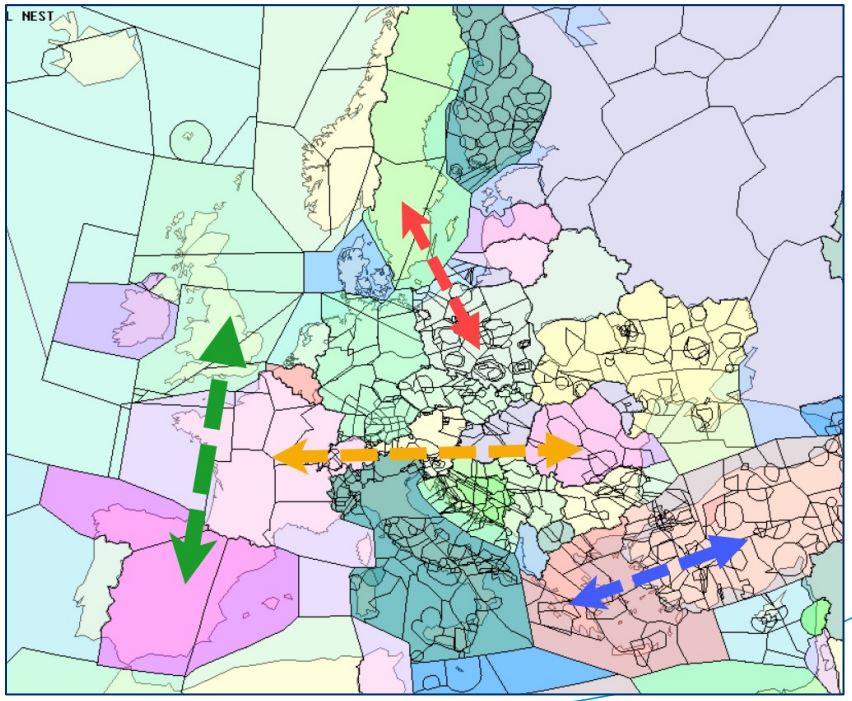
- largest capacity wastage occurs in low traffic conditions
- gradually decreases with more flexible shift designs and flatter demand/capacity profiles
- always present - inability to perfectly match supply with demand

Work in progress!

Spare capacity is there - how to make best use of it?



- dynamic cross-border operations
- ACCs with complementary demand profiles
- what is the optimum pairing/grouping of ACCs in Europe?
- what are the potential benefits within existing initiatives (e.g. FABs) and alliances (e.g. COOPANS)?



THANK YOU FOR YOUR ATTENTION!

Questions/comments/ideas?

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