



Dynamic TMA:

Adapting to arrival traffic variations

SESAR 2020 PJ01

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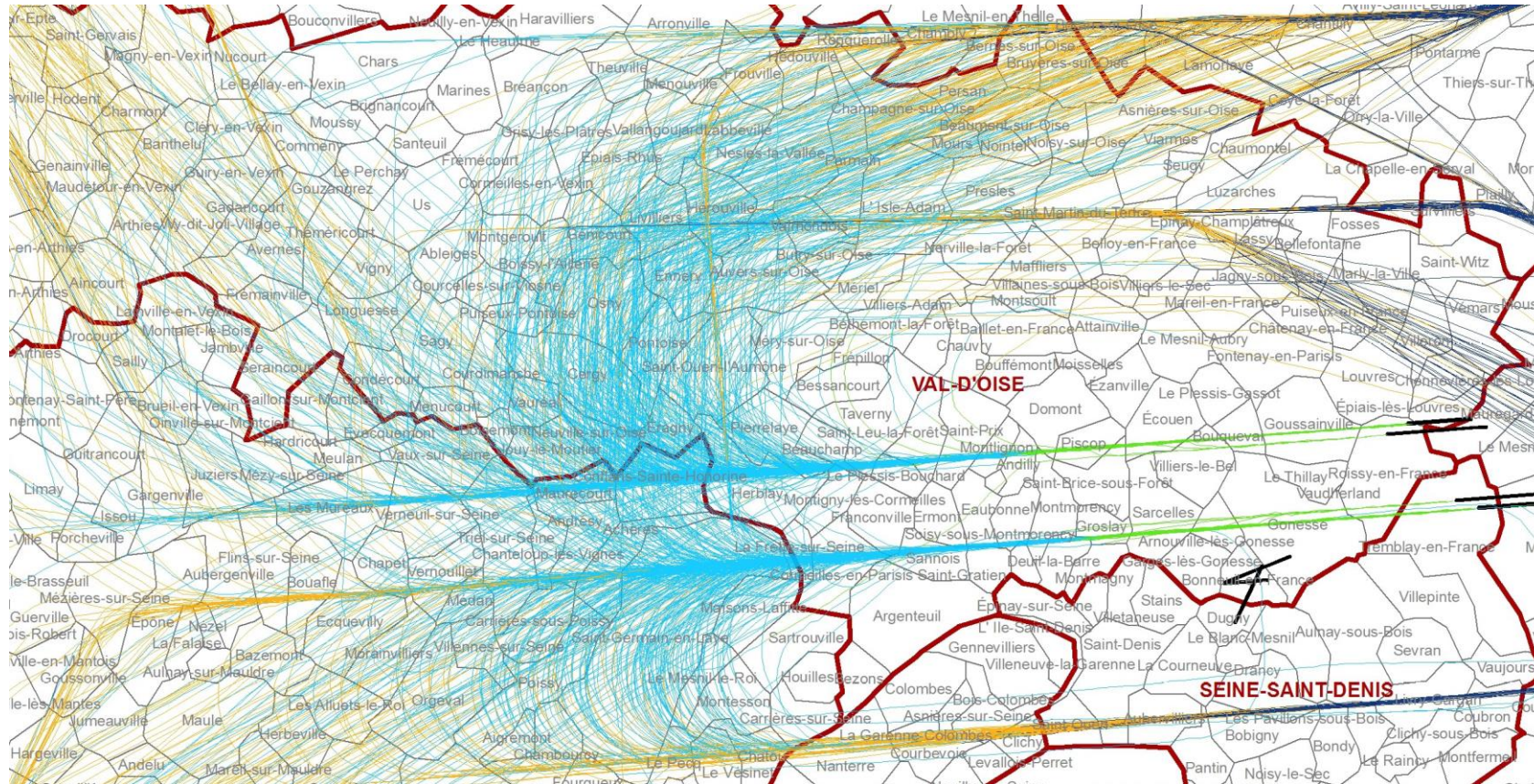


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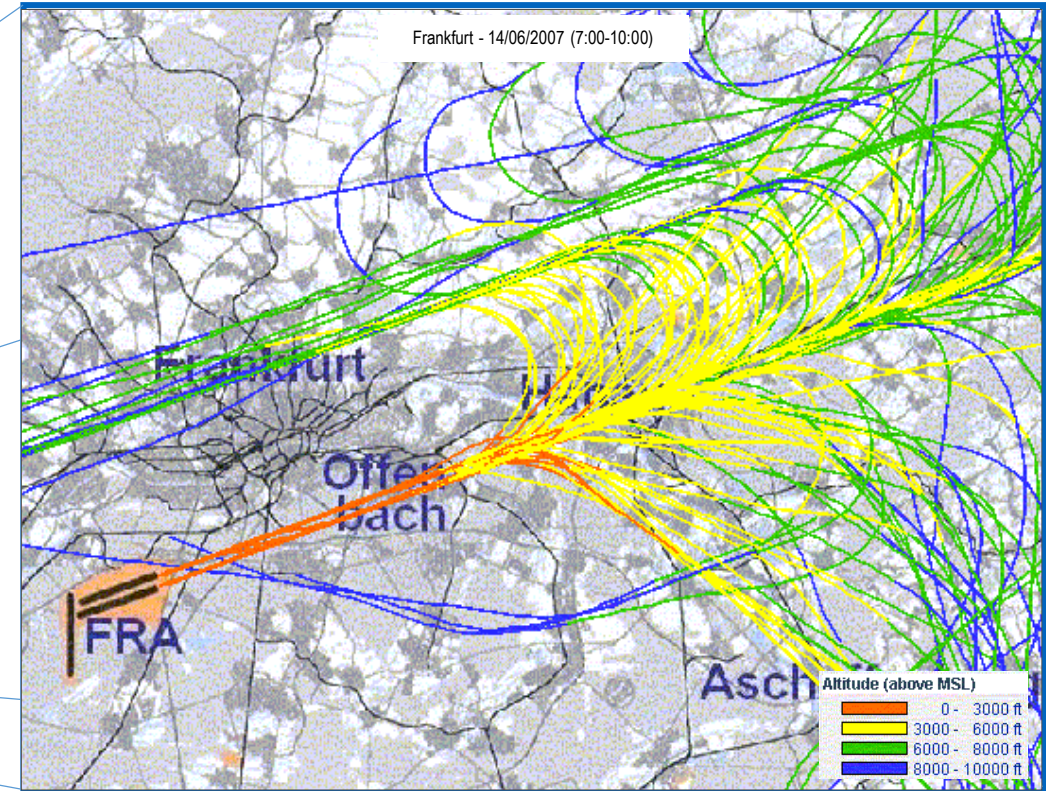
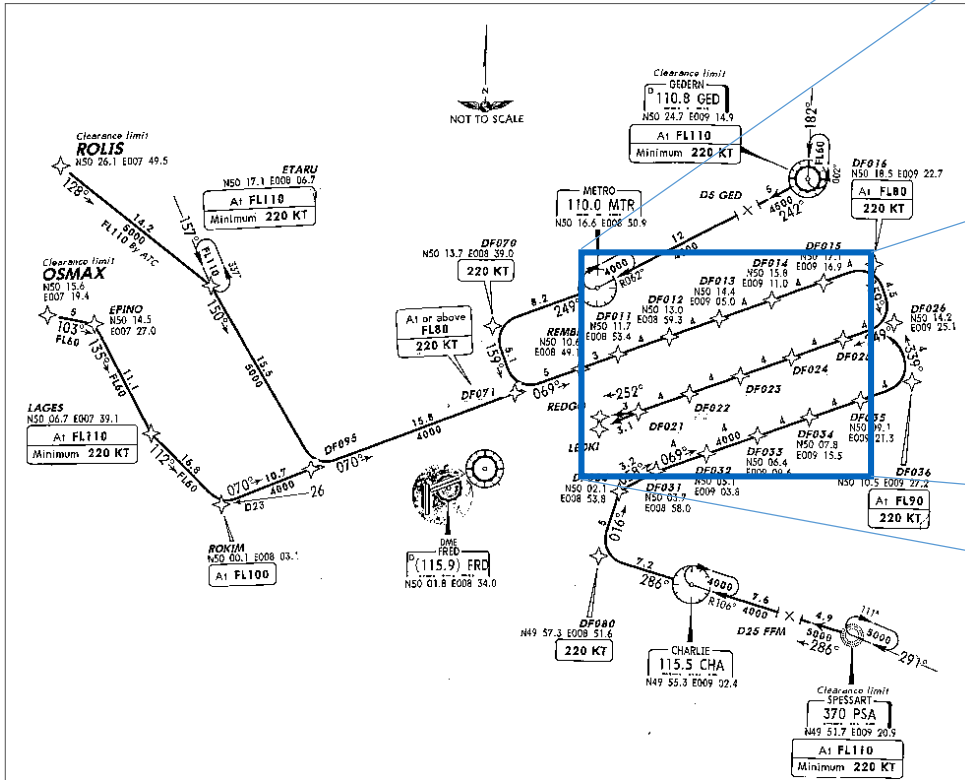


From vectoring ...



Credit DGAC

...to Performance Based Navigation



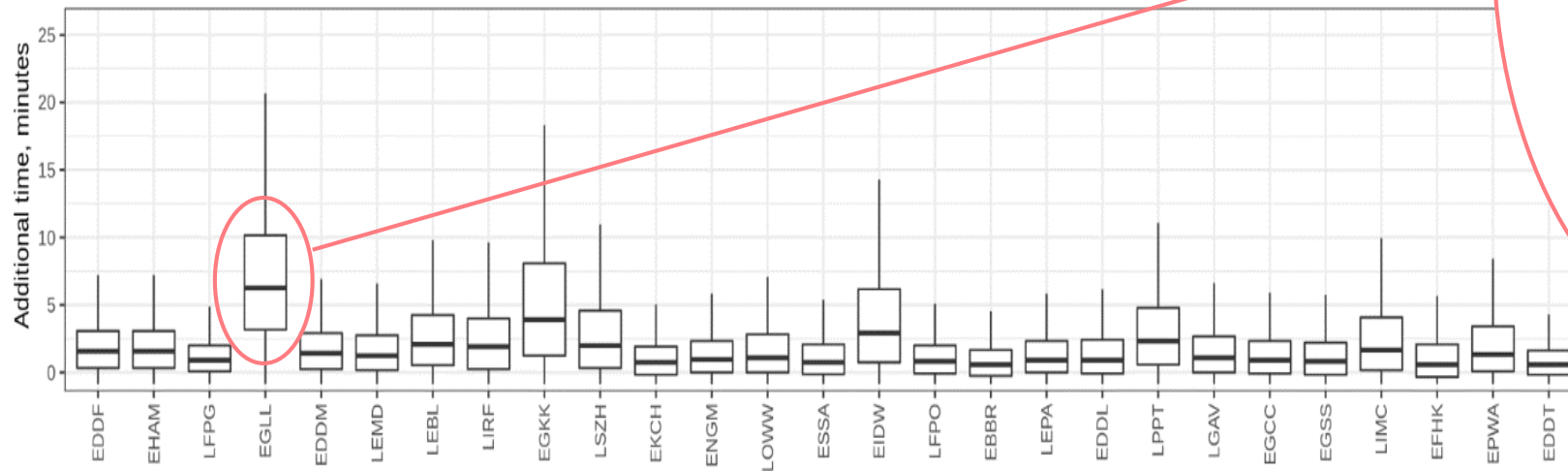
Where can we go from here?

- Historically vectoring provided flexibility, and some agility to sequence and merge arrivals
- Introducing systemized TMAs with fixed PBN structures for arrivals aimed at safety, capacity, efficiency and environmental benefits but also has significant implications:
 - **traffic needs to be properly streamed into these route structures, inducing specific constraints**
 - **these constraints are the same for all traffic conditions, with a fixed trade-off between performance areas**

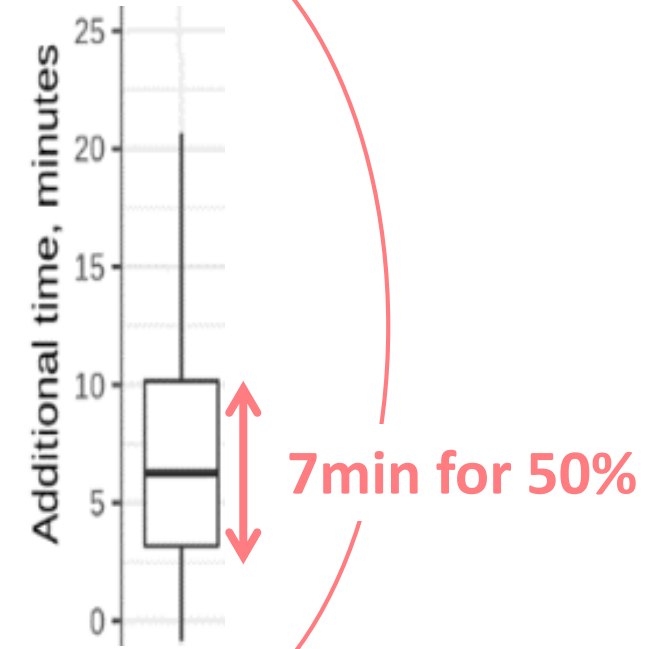
→ How and where to introduce dynamicity ?

Is there room for dynamicity?

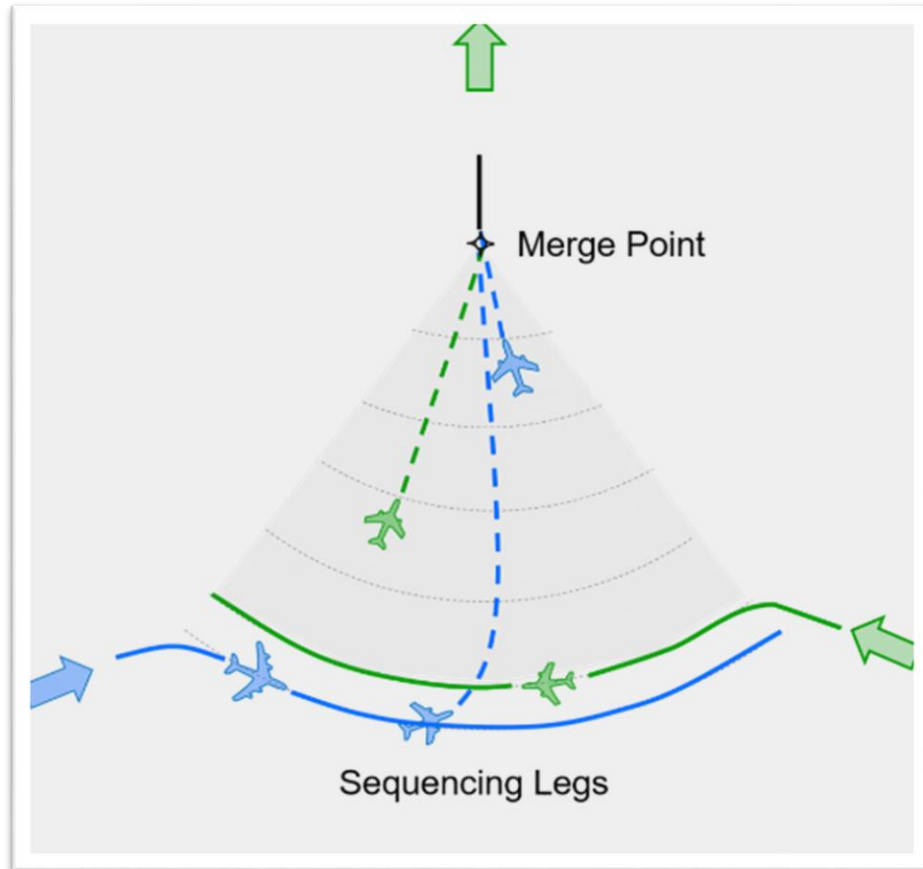
Arrival traffic variability: high at some airports



Additional times at 50NM for 27 European airports (ordered by number of movements)

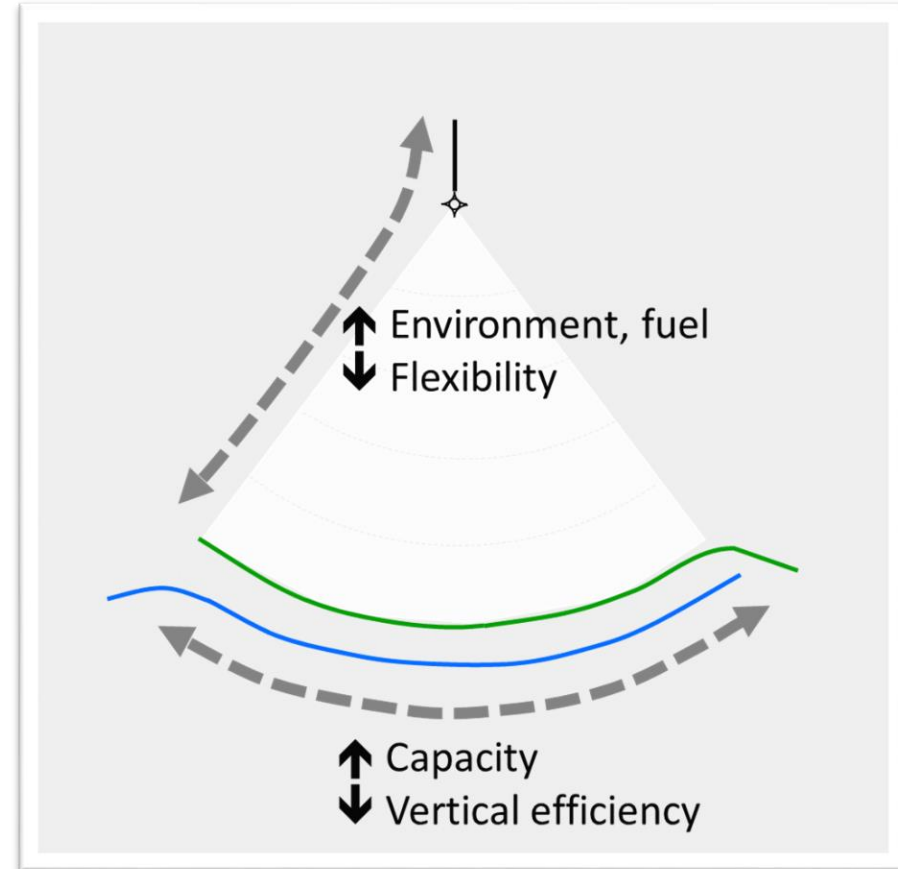


The Point Merge example (*)



Principle

(*) See last slide for more details



Trade-offs

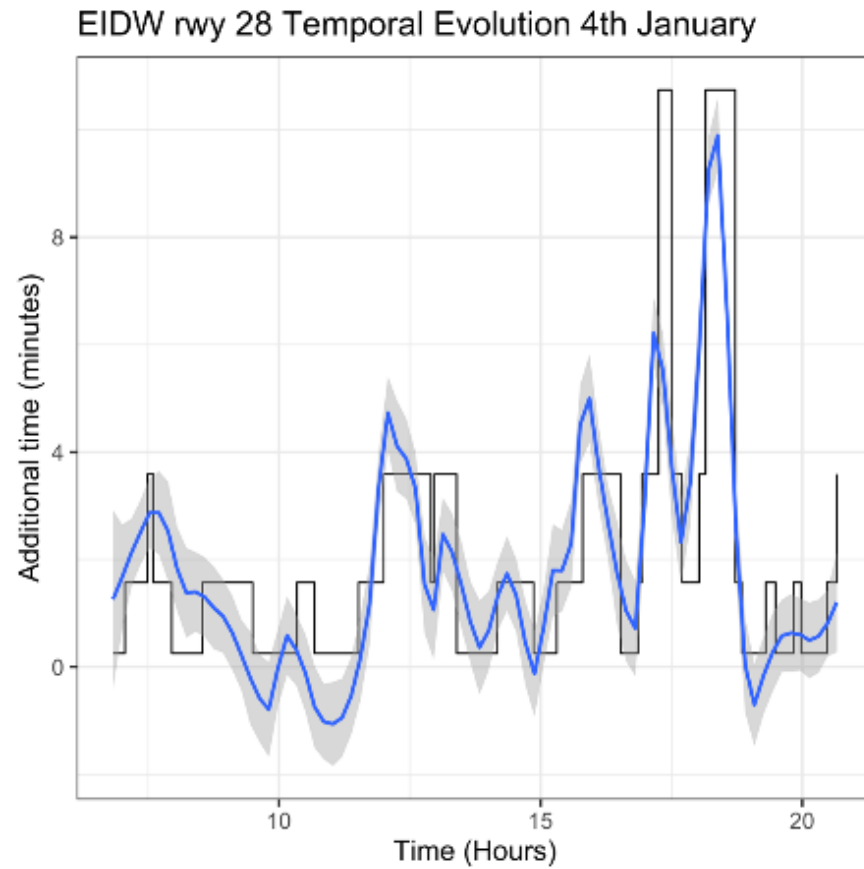
A scalable structure: towards dynamic trade-offs



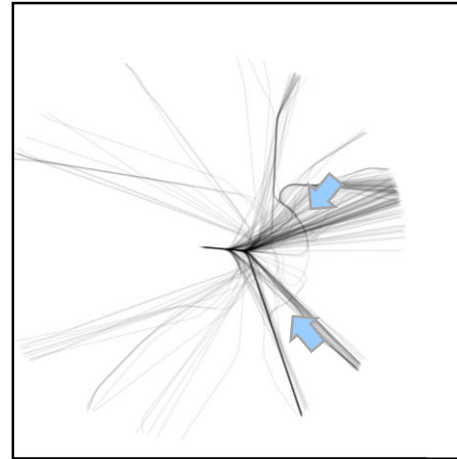
Motivations

- Depart from fixed PBN arrival routes $\leftrightarrow$ fixed trade-offs between KPAs
→ **Enable agile responses to arrival traffic variations in terminal areas**
- Dynamic deployment of route structures to provide an adequate trade-off between e.g. capacity and flight efficiency / environmental impact:
 - **Capacity during peak periods**
 - **More predictable and more fuel- and environmental-efficient operations during periods of lower traffic demand**

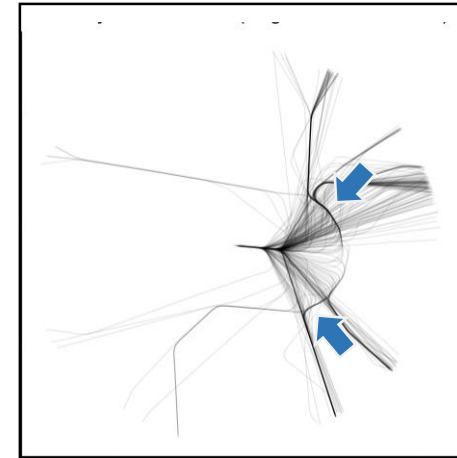
Clustering – high variability of additional times (1/2)



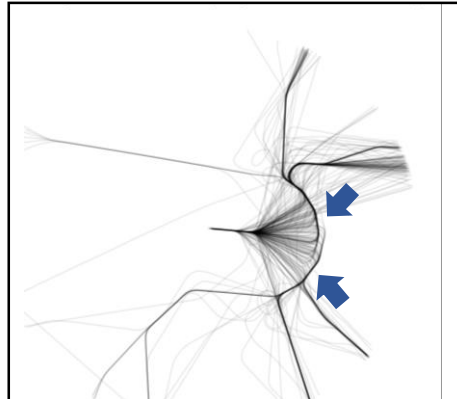
Cluster 1 – avg. 0.25mn / 95% 2.2mn



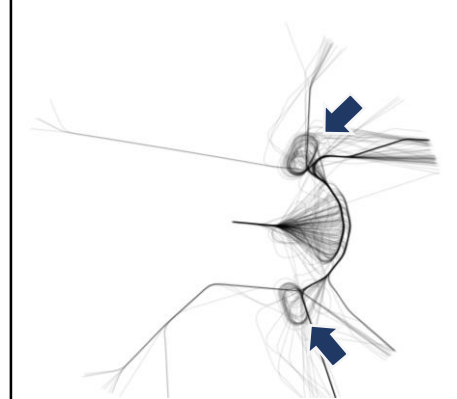
Cluster 2 – avg. 1.57mn / 95% 4.6mn



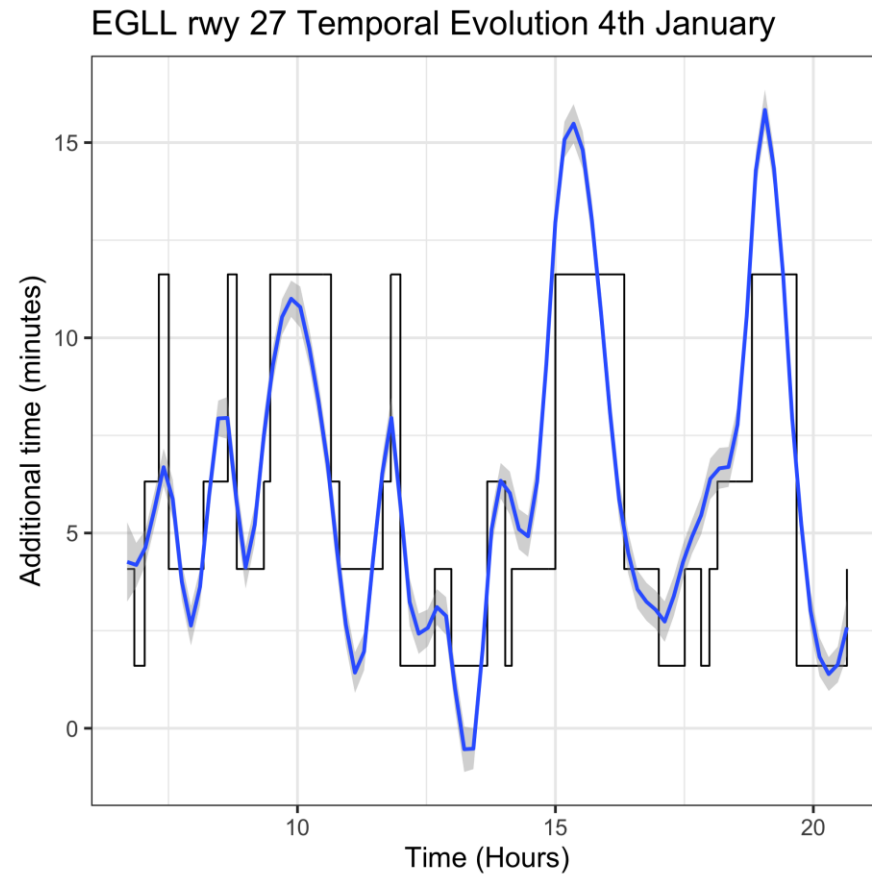
Cluster 3 – avg. 3.59mn / 95% 6.5mn



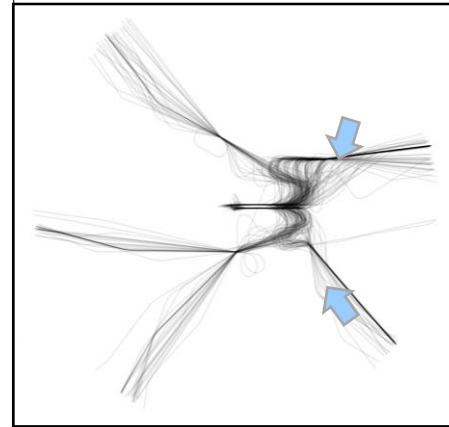
Cluster 4 – avg. 10.74mn / 95% 17.8mn



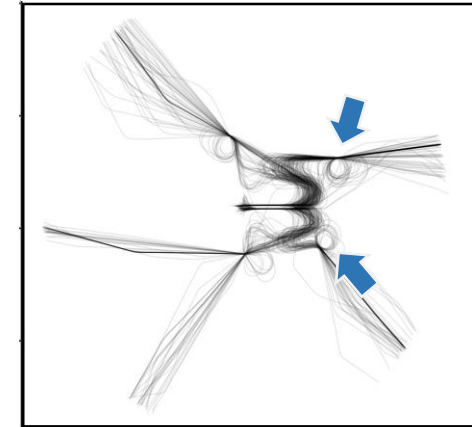
Clustering – high variability of additional times (2/2)



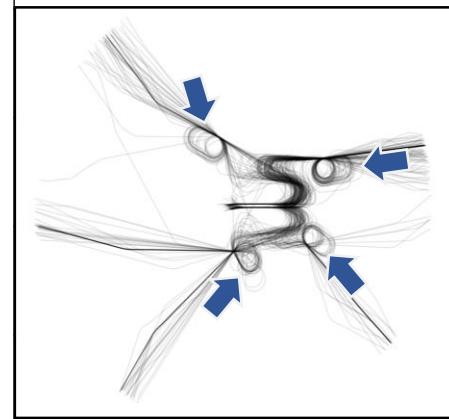
Cluster 1 – avg. 1.6mn / 95% 4.7mn



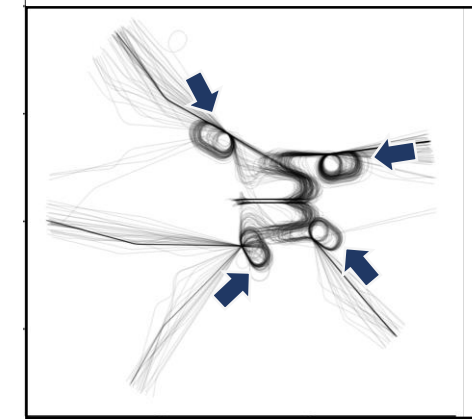
Cluster 2 – avg. 4.08mn / 95% 7.4mn



Cluster 3 – avg. 6.32mn / 95% 10.5mn

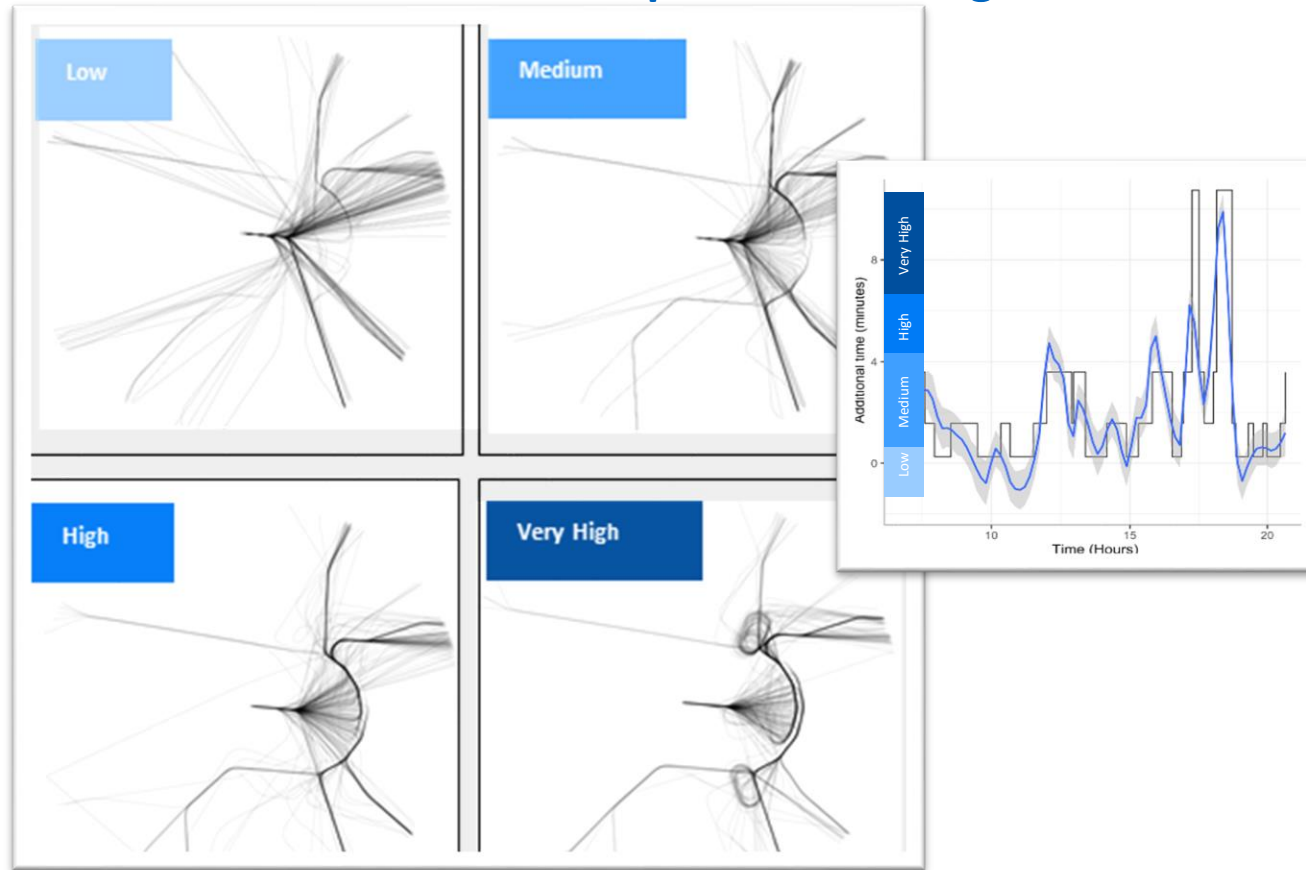


Cluster 4 – avg. 11.62mn / 95% 17.8mn

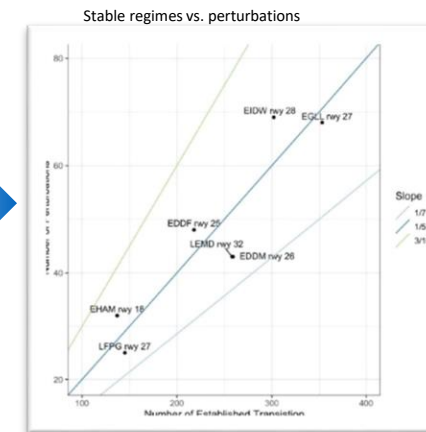


Operating regimes

Statistical temporal Clustering



Stability



Operating regimes



- Temporal k-means clustering, 50k flights, 4 major European airports: operating regimes with moderate to high variability of arrival traffic demand
- Use of three or four regimes balance discrimination vs. acceptability

In perspective

Fixed route structures → Dynamic route structures → Tailored arrivals ?

- Revisiting of, and clearer mapping with arrival management:
 - TMA dynamic route structure supporting sequencing and merging to final
 - E-TMA dynamic structure, absorbing variability and streaming into a fixed downstream structure
- Enablers
 - Initially existing ATFCM tools
- Still open
 - Acceptability & feasibility (publication, FMS capability..)
 - Link with TTA
 - Better predictions including weather impact

More details on Point Merge

- For more details on Point Merge state of the art and implementation status please refer to: <https://www.eurocontrol.int/concept/point-merge>
- Note: a EUROCONTROL Point Merge Webinar is expected to be scheduled soon, with a focus on lessons learnt from implementation. Check www.eurocontrol.int for the official announcement, to be published shortly.