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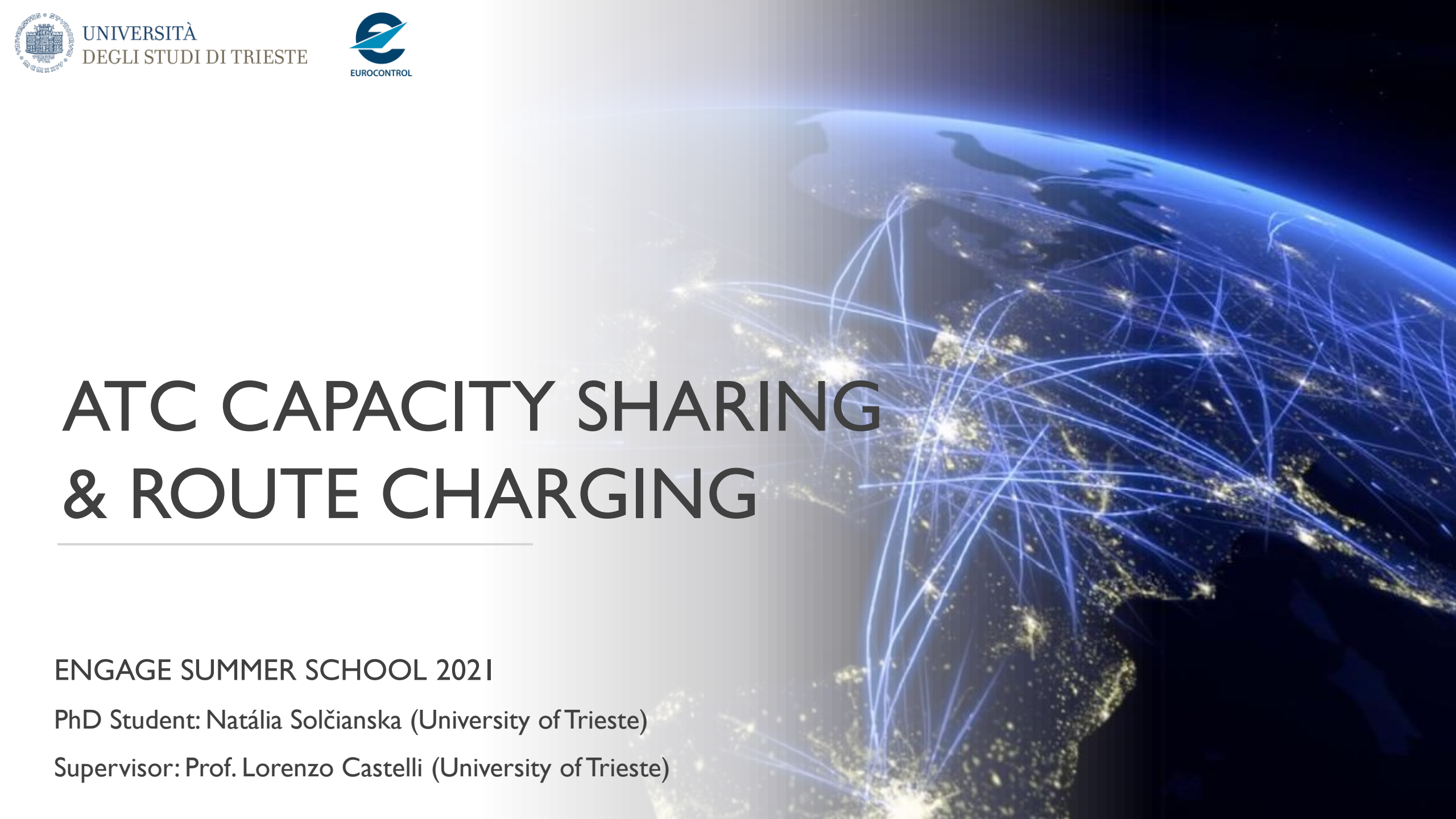

ATC CAPACITY SHARING & ROUTE CHARGING

ENGAGE SUMMER SCHOOL 2021

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Supervisor: Prof. Lorenzo Castelli (University of Trieste)

Presentation Outlook

Introduction & motivation for the research

Capacity Sharing

Linear programming to determine Virtual Centres

Future work

1. **Airspace Architecture Study (SJU)**

   - ✓ A proposal for the future architecture of the European airspace

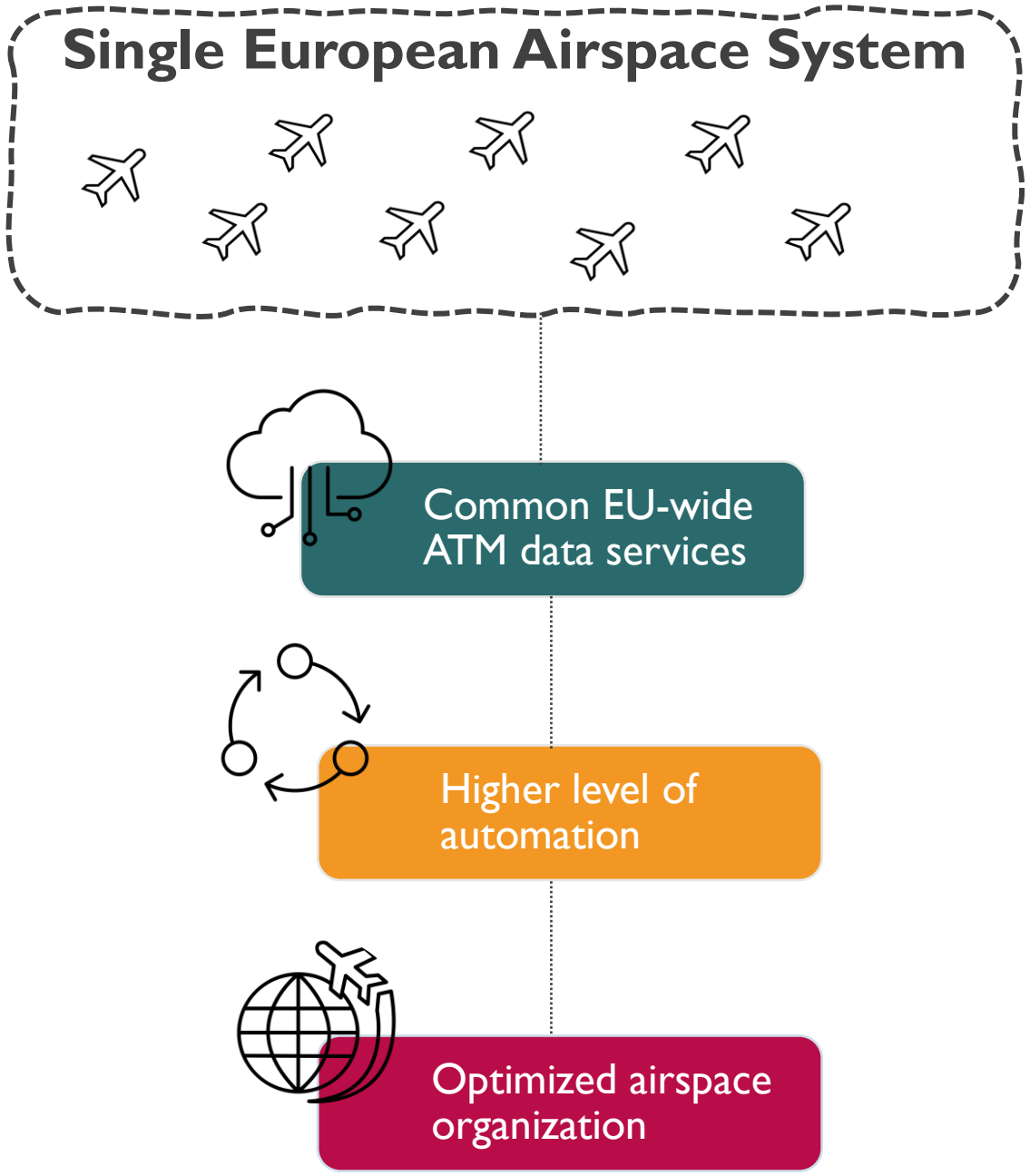
2. **Legal and economic aspects of ATM data service provision (Helios, Integra)**

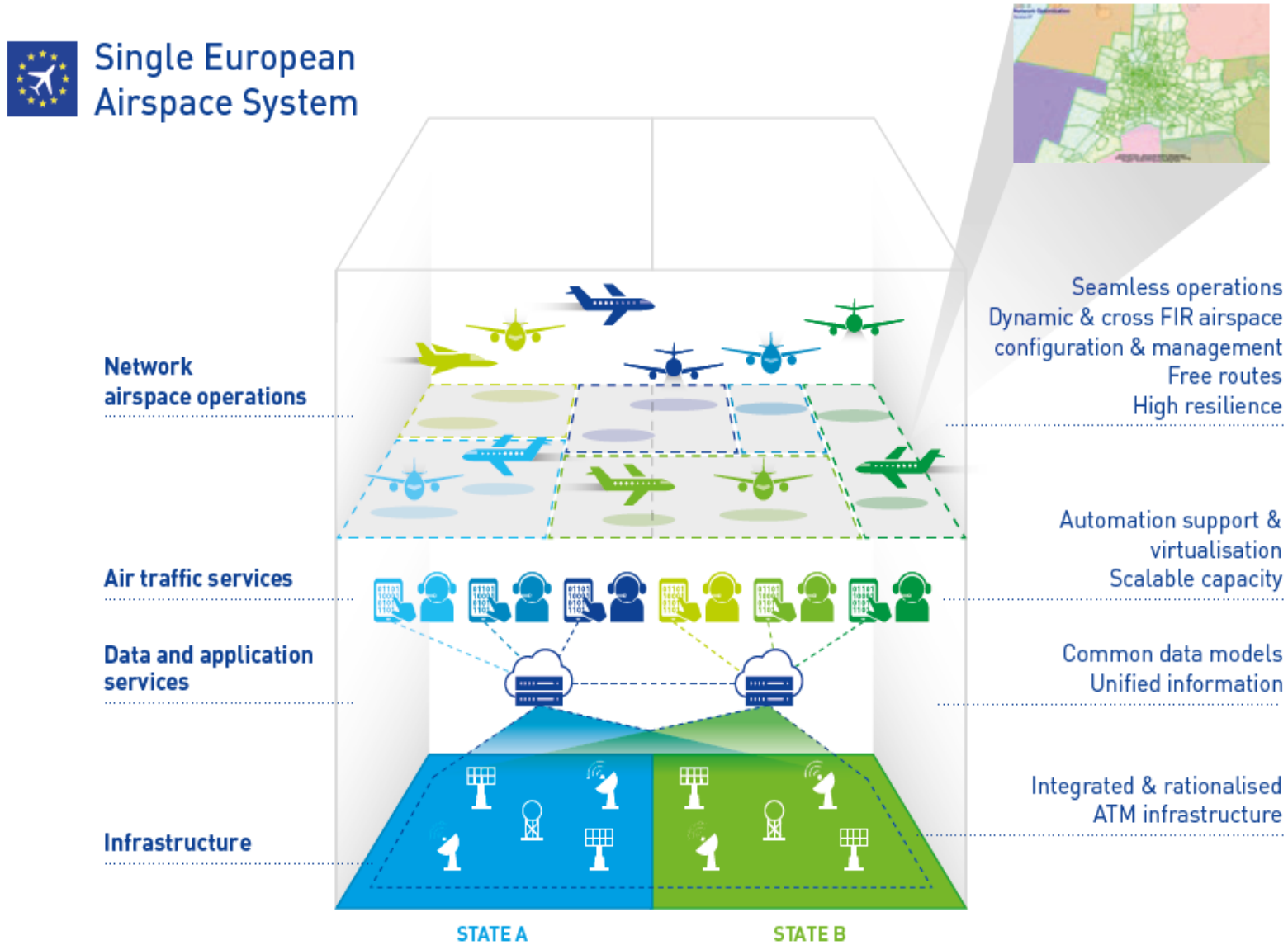
   - ✓ Policy options to deliver a defragmentation of European skies through virtualization and the free flow of data among trusted users across borders

3. **RoMiAD - Role of Markets in AAS Deployment (Think Research) - Engage KTN Catalyst project**

   - ✓ Financial benefits of ATM modernization as proposed in AAS and the market mechanisms that would best enable the necessary transformations

   - ✓ *Theoretical background and motivation for our research*





Source: SESAR JU:Airspace Architecture Study 2019

FOCUS areas & SOLUTIONS to deploy AAS

Airspace & Capacity

- Optimised airspace organisation
- Operational harmonisation
- Automation and productivity tools

Scalability & Resilience

- Virtualisation and ATM data as services
- Dynamic management of airspace
- Flight-centric operations where applicable
- Sector-independent ATS operations
- CNS enhancements

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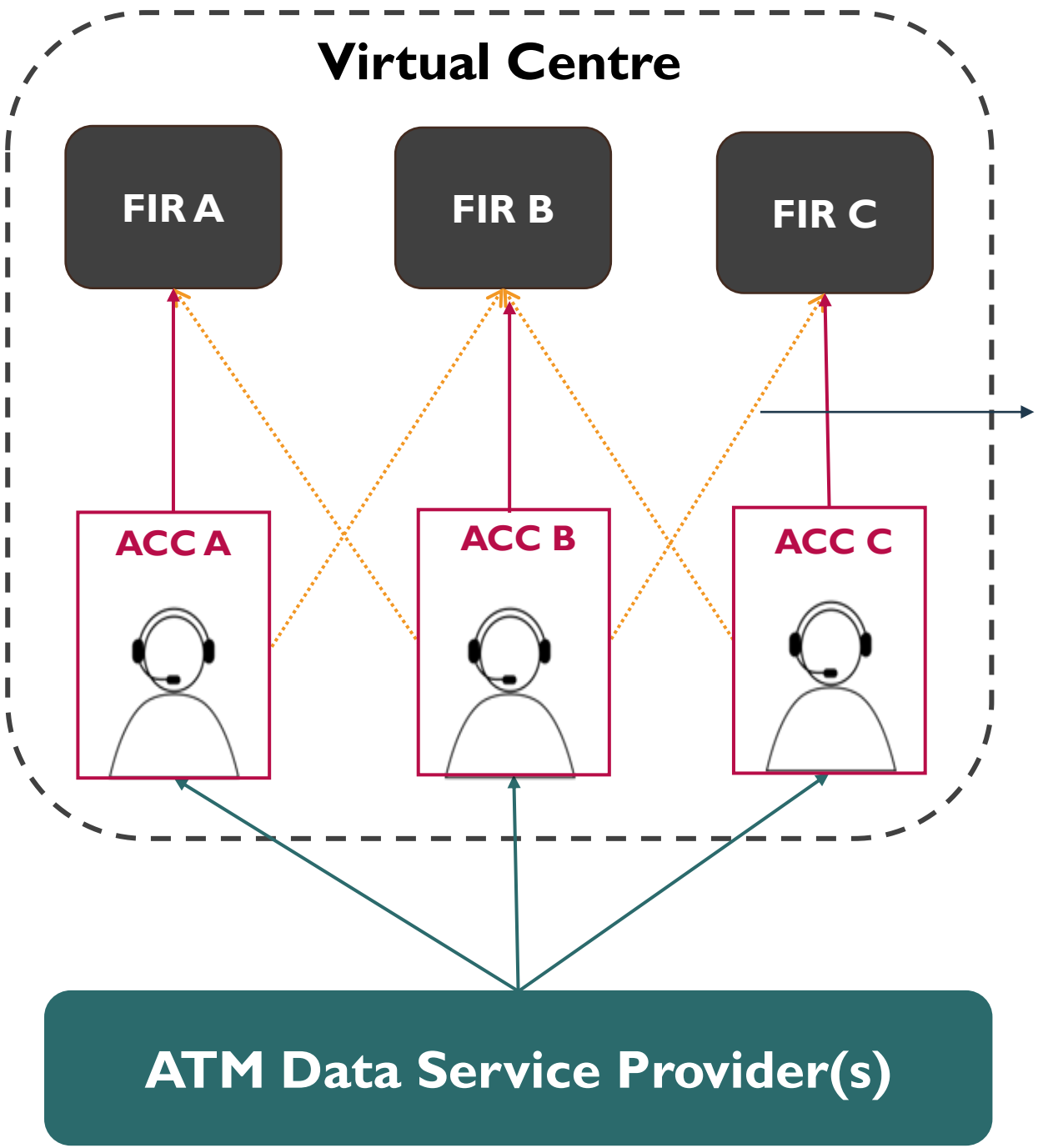


Capacity sharing
cross-border
provision of ATS

Capacity Sharing

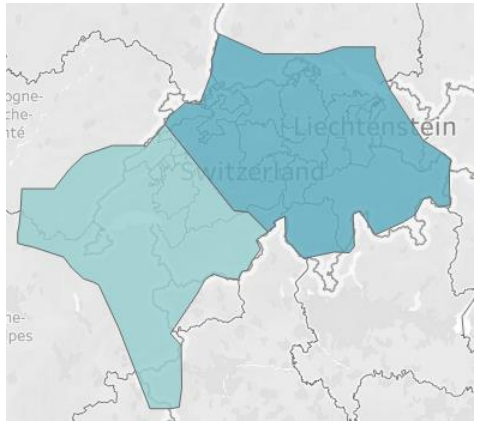
PRE-DEFINED
(current airspace design)

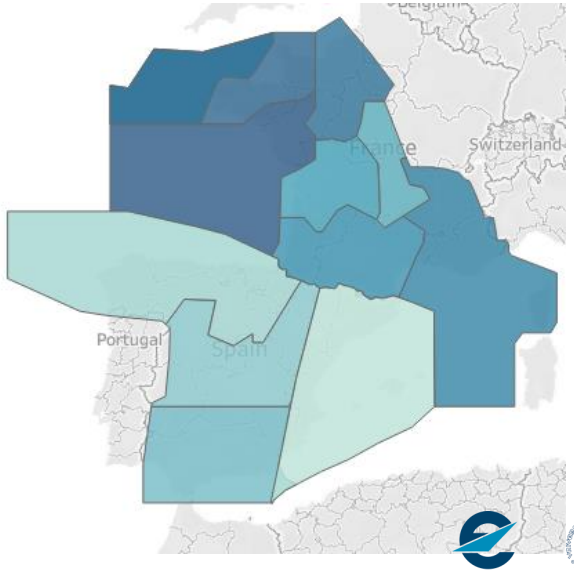
DYNAMIC
(complete airspace re-design)

within an ANSP

between neighbouring ANSPs

Capacity-on-demand





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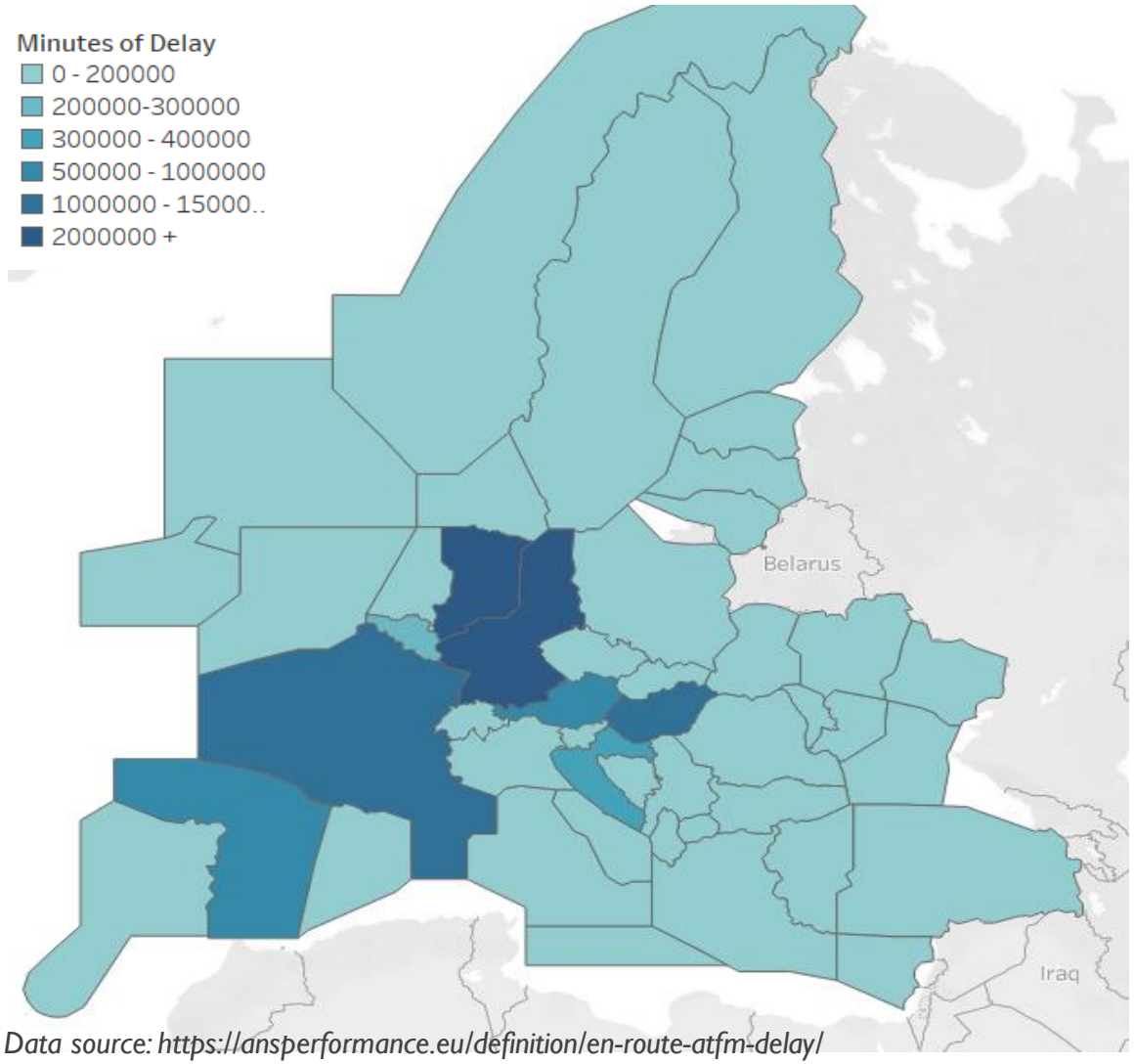
Delays, delays & delays….

En-route ATFM ATC C & ATC S delays (2019)



Data source: https://ansperformance.eu/definition/en-route-atfm-delay/

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Virtual Centre designation

Which ACCs are the best to form VC(s)?

1. Where are the capacity issues ?
   - *Which of these are recurring ?*
2. Where are the spare capacities ?
3. How these capacities can be balanced ? – linear programming to determine the collaborations
4. What kind of capacity sharing, where ?
5. Where are the delegation models actually beneficial?

Assumptions per ACC and per each time interval:

Overload (number of sectors)

Additional sectors nee to be open to accommodate delayed flights

$$\frac{\sum delayed\ flights}{avg\ sector\ capacity}$$

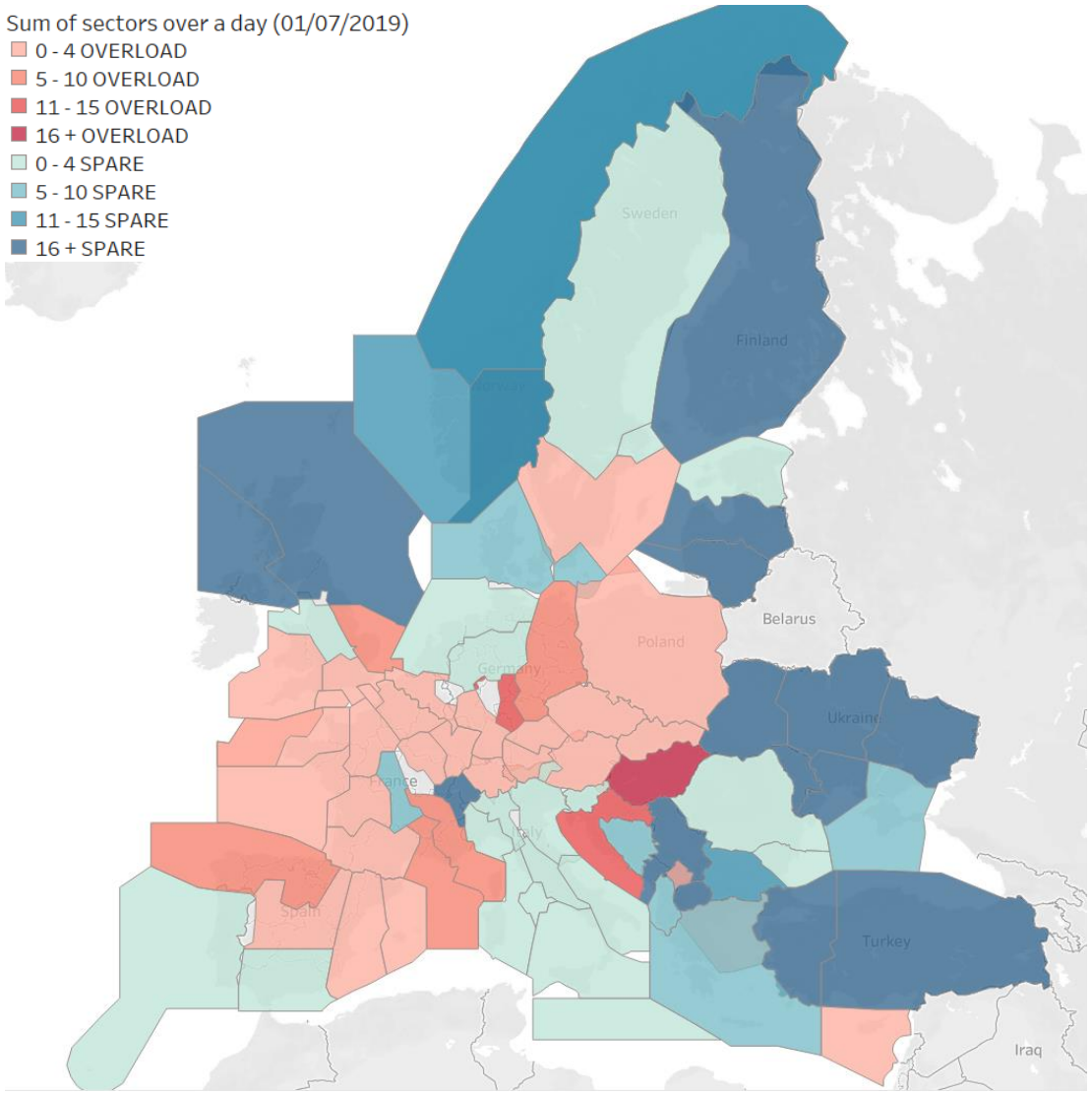
Spare capacity (number of sectors)

ACC with additional capacity (low sectors utilization) and/or less sectors opened than *actually a*vailable

$$\sum_{c<40\%} S + (\mathrm{NOP} - \mathrm{OS})$$

NOP – opening schemes declared in Network Operations Plan (EUROCONTROL, 2019)
OS – Actual Opening Scheme (R-NEST)

Overloaded and spare capacities in terms of sectors



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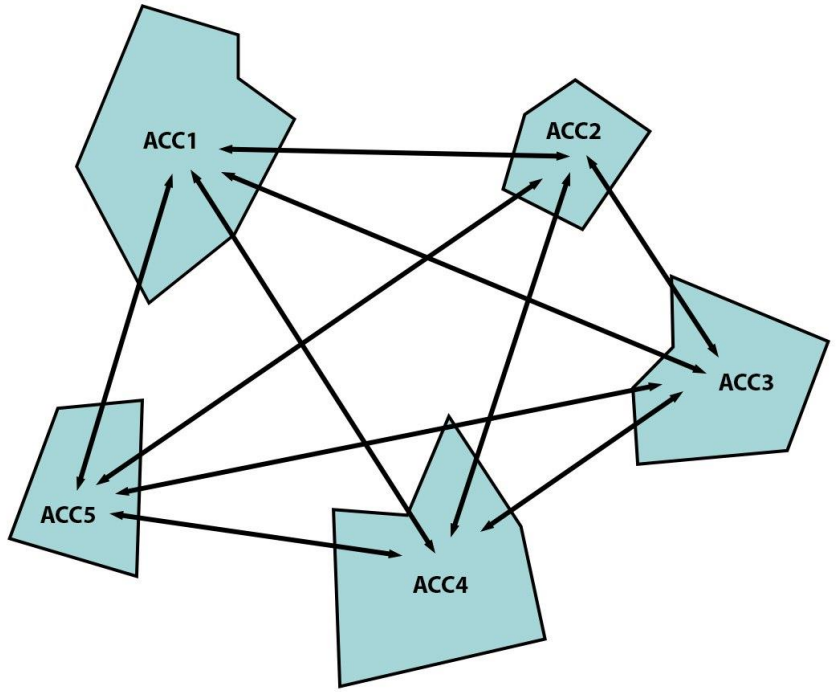
Linear programming model to designate & evaluate Virtual Centres

- Determine *collaborations* between pairs of ACCs to improve *efficiency*

- *Collaboration* – two ACCs form a Virtual Centre, providing ATC services to each other when needed

- *Efficiency* – reducing delays per ACC, while the cost of the solution does not exceed the cost of the delay



Model flow

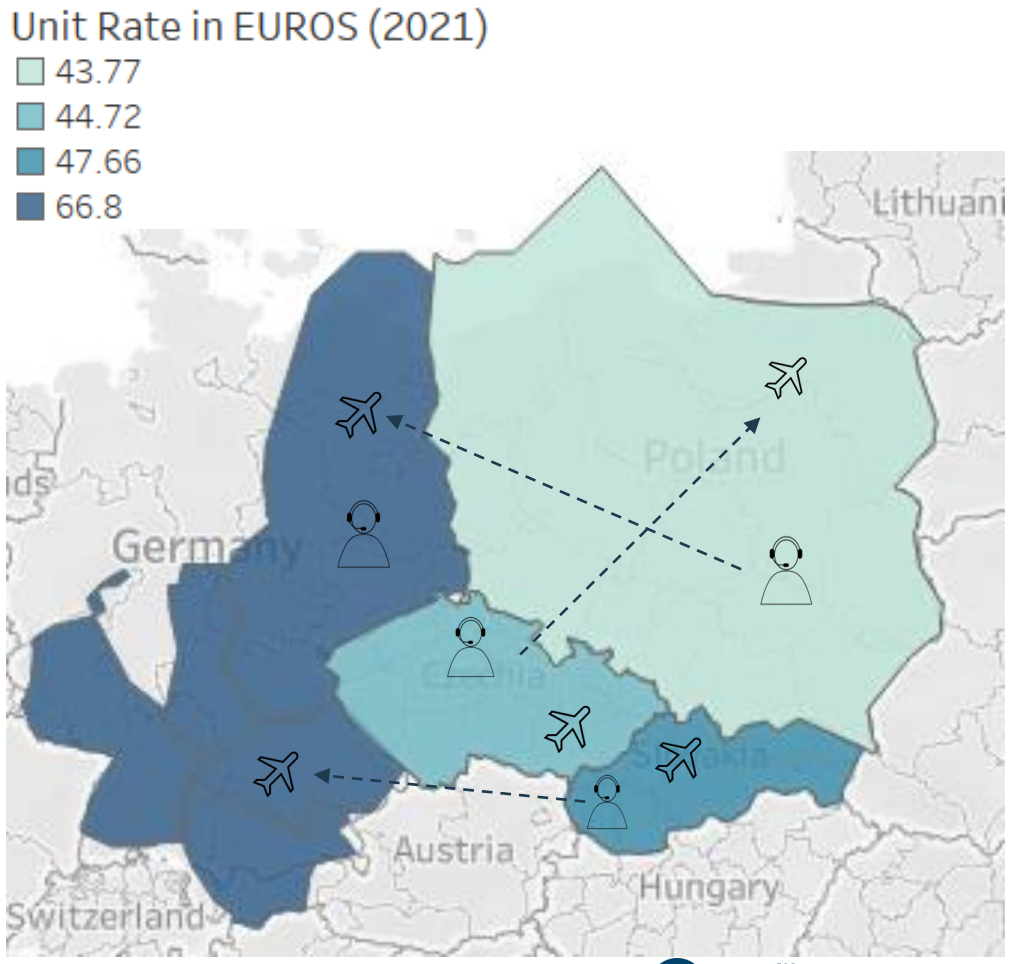
For each ACC and each time interval, we identify:

- capacity shortage / spare capacity
- the number of delayed flights and their delay value
- number of currently opened sectors
- actual maximum capacity
- number of sectors in max configuration (airspace capacity)
- capacity of sector(s)

The optimisation part of the model, determines the set of collaborations which minimise the delay.

Route charging & Virtual Centre

- Each State in given Virtual Centre has own Charging Zone & UR
  - Which UR is AU charged?
  - Cross-ANSPs compensation
- Single Charging Zone / Single UR per Virtual Center
  - Supported by regulation proposal (SES 2+)
  - Not acceptable by ANSPs / FABs
  - Revenue distribution mechanism
  - Find an optimal UR value



Current work

For limited group of ACCs:

- Which pre-defined capacity sharing is beneficial where ?
- How much collaboration is needed to resolve capacity issues?
- To what extend we can improve the efficiency using pre-determined capacity sharing arrangement?

Initial results to be submitted to SIDs 2021

Future work

Capacity-on-Demand

- Implementing the cost of capacity provision and the cost of delay in the model
- Expanding geographical are of interest
- *How much can be dynamic capacity sharing beneficial ?*

Route charging

- Does the current Charging Methodology enable complex cross- border on-demand ATC?
- Is the single Unit Rate easier to reach if collaborations are in place?

Thank you for your attention

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