Young Scientist Award winners presentations
David Bowen, Chief ATM, SESAR Joint Undertaking
Three shortlisted candidates...

Leonid Sedov

Javier Alberto Perez Castan

Junzi Sun
Unmanned Traffic Management

Leonid Sedov

https://undefined.github.io/
Unmanned Traffic Management
Unmanned Traffic Management
Hop topic

- Worldwide
  *Axiom*: UAV operations
  *Empirical proof*: Look around

  *Theorem*: UTM research
  *Proof*: Academia trims sails to the wind

- Main theme of conferences (DASC’16, I-CNS’17, et al), UTM tracks
- Amazon, Google, NASA
Uniform distribution?

Population density

Expected traffic density
How likely it is to see a drone?
Conflict rates
Noise footprint
5000 flights, h = 50m
Noise = 60dB under drone

Data rate capacity
5 Mbps/drone (720p video)
Decentralized GDP
Decentralized GDP, static vs dynamic geofences
## Conflict resolution algorithms

<table>
<thead>
<tr>
<th></th>
<th>Single-layer</th>
<th>Multi-layer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Centralized</strong></td>
<td>Ground delay</td>
<td>Layer assignment</td>
</tr>
<tr>
<td><strong>Distributed</strong></td>
<td>Hovering</td>
<td>On-demand descending</td>
</tr>
</tbody>
</table>
ICRAT’18 => 12 layers over a city (too many)

Why the same layers everywhere?
Adaptive # of layers = PBN for UTM
Also BBTM for UTM
And ATM sectorization
And design of arrival routes
Impact of Continuous Climb Operations in a high traffic density TMA

PhD Javier Alberto Pérez Castán

Thesis supervisor: PhD V. Fernando Gómez Comendador

December, 5 2019
Athens

Universidad Politécnica de Madrid
INTRODUCTION

• Justification
• Motivation
ICAO defines a CCO as “an aircraft operating technique enabled by *airspace design*, *procedure design* and *facilitation by ATC*, allowing for the execution of a flight profile optimised to the performance of the aircraft...”.

**Operational goal**

CCO is free of ATC actions from the departure to the cruise level.
Environmenta\nal benefits

Fuel burn

Noise levels

Emissions

Airspace design

Capacity reduction

Drawbacks

ATC workload

Expected results
Motivation

Is it feasible to integrate CCOs in a high-density scenario?

What is their impact on safety and capacity?

Is current airspace design acceptable?

Which modifications and improvements are required?
CCO modelling to obtain fuel-burn optimised trajectories
<table>
<thead>
<tr>
<th>Aircraft type</th>
<th>MC simulation s</th>
<th>Mass</th>
<th>Speed</th>
<th>Positioning errors</th>
<th>Wind</th>
<th>Bumpers</th>
<th>Pathology</th>
</tr>
</thead>
</table>

CCO MC Simulations for B738

- Height (m)
- Time (s)
Quantification of new separation minima
### CCO

<table>
<thead>
<tr>
<th></th>
<th>Initial separation minima</th>
<th>Proposed separation minima</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Leading</td>
<td>Trailing</td>
</tr>
<tr>
<td>Light</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>Medium</td>
<td>71</td>
<td>60</td>
</tr>
<tr>
<td>Heavy</td>
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<tr>
<td>Light</td>
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<td>202</td>
<td>368</td>
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<td></td>
<td>Leading Light</td>
<td>Medium</td>
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Development of a conflict-risk methodology to assess airspace design
<table>
<thead>
<tr>
<th>Conflict point $r$</th>
<th>$P_r^p$</th>
<th>$P_r^q$</th>
<th>$P_r^c$</th>
<th>$CR_r$</th>
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<tbody>
<tr>
<td>1</td>
<td>0.418</td>
<td>0.3523</td>
<td>3.3E-3</td>
<td>4.9E-4</td>
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<tr>
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<td>0.0134</td>
<td>4.5E-3</td>
<td>1.9E-6</td>
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<tr>
<td>7</td>
<td>0.086</td>
<td>0.0134</td>
<td>3.9E-4</td>
<td>4.5E-7</td>
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CCO impact on capacity
10 experiments

CCO Rate varies from 0% to 100%

Each experiment is repeated 10 times

Variables:
• Arrival and departure schedules,
• Routing distribution,
• CCOs and arrivals trajectories.

- CCO rate ↑ → Capacity ↓
- Optimisation scheduling process → Capacity ↑
CONCLUSIONS & FUTURE WORKS
This dissertation provides a methodology to evaluate the integration of CCOs considering safety and capacity.

New CCO separation minima are larger than standard separation minima.

A new conflict-risk model is laid out to assess the conflict probability between CCOs and arrivals based on altitude distributions.
Conflict-risk model allows to assess whether current airspace design is valid or not.

Capacity assessment is carried out by the development of a scheduling algorithm, a CD&I algorithm, and MC simulations to statistically analyse the CCO impact on the theoretical capacity.

CCO integration is feasible in Palma although it requires airspace-design modifications and optimisation scheduling process.
Further work

**Improvements** in path predictability and uncertainty modelling as well as to consider more aircraft models and optimised trajectories.

To design an **ATC-tool** to dynamically calculate an ad-hoc runway separation minima for each CCO pair.

These results must be corroborated under real **operational conditions**.


Thank you for your attention. Any questions?

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Open Aircraft Performance Modeling: Based on an Analysis of Aircraft Surveillance Data

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Delft University of Technology
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Introduction

TU Delft, CNS/ATM, and Open Science
In reality

In simulation

Starting Point: Air Traffic Simulation

9th SESAR Innovation Days
2 – 6 December 2019, Athens, Greece
The Research Project

Open Aircraft Performance Modeling: Based on an Analysis of Aircraft Surveillance Data
Open Aircraft Performance **Modeling**: Based on an Analysis of Aircraft Surveillance Data

- Data
- Truth
- Models

Revised Seminar on Open Aircraft Performance Modeling: Based on an Analysis of Aircraft Surveillance Data
Open Aircraft Performance Modeling: Based on an Analysis of Aircraft Surveillance Data
Open Aircraft Performance Modeling: Based on an Analysis of Aircraft Surveillance Data

Mode S

ADS-B
Open Aircraft Performance Modeling: Based on an Analysis of Aircraft Surveillance Data

TU Delft Receiver  FlightRadar24  OpenSky
Open Aircraft Performance Modeling: Based on an Analysis of Aircraft Surveillance Data
Analysis - Surveillance Data

ADS-B

Mode S (EHS)

Position, Altitude Speed, Vertical rate

Air Speeds, Intents

Surveillance data


Analysis - Kinematic Model


Open Aircraft Performance Modeling: Based on an Analysis of Aircraft Surveillance Data

- **OpenAP**: A complete set of aircraft performance model and toolkit
- **WRAP**: An open aircraft kinematic performance model
- **pyModes**: An open-source ADS-B and Mode-S decoder
- **Meteo-Particle-Model**: A weather reconstruction model using ADS-B and Mode-S data
- **BlueSky**: A large-scale fast-time open air traffic simulator
Now

Future A
Feasible

Future B
Feasible

Future C
Feasible

Future D
Feasible

Future E
Feasible

Future F
Feasible

Best
Thank you!

Junzi Sun, Ph.D., M.Sc.

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Delft University of Technology
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9th SESAR INNOVATION DAYS

And now the podium...
In third place...

Leonid Sedov
In second place...

Javier Alberto Perez Castan
And the Winner is...

Junzi Sun