Contact:

Xavier Prats (UPC - APACHE)
xavier.prats@upc.edu

Pablo Sánchez (CRIDA - AURORA)
psescalonilla@e-crida.enaire.es

Rodrigo Marcos (Nommon - INTUIT)
rodrigo.marcos@nommon.es

Ongoing ATM modernisation programmes, including SESAR, are **performance oriented**. This implies **informed decision making** driven by the desired results and reliant on **facts and data**. A performance framework sets a series of indicators and metrics that are the basis for any performance assessment.

ATM performance results from a complex interaction of policies and regulations, stakeholders, technologies and market conditions. There is a need for new approaches able to **translate local improvements into overall performance impact**, as well as for **performance indicators providing new angles of analysis**, including the users' view.

APACHE (www.apache-sesar.barcelonatech-upc.eu)

APACHE proposes a new framework to assess European ATM performance, capturing the interdependencies and trade-offs between KPAs.

The system allows the **simulation** of different operational concepts corresponding to the **current ATM system** or **future SESAR 2020 solutions**.

AURORA (www.aurora-er.eu)

AURORA proposes **new efficiency metrics**, encapsulating **airspace users' operational objectives** regarding fuel consumption or costs, and **equity metrics,** measuring how fairly inefficiencies are distributed among the airspace users. The project also explores how to set a framework for **real-time monitoring** of ATM efficiency indicators.

INTUIT (www.intuit-sesar.eu)

INTUIT explores the potential of **visual analytics and machine learning** techniques to understand **trade-offs** between ATM KPAs.

The project consists of a series of performance modelling case studies that will be integrated into a **decision support tool** for **ATM performance monitoring and management**.

Performance Management

Performance Monitoring

Cost-efficiency/environment

Route choice modelling (INTUIT)

Airline route choices are modelled with machine learning techniques to predict routes used between two airports as a function of the characteristics of each route: flight length, charges and congestion. The proposed model allows the improvement of pre-tactical traffic forecasting and the evaluation of the trade-offs between cost-efficiency, environment and capacity.

	Length	Regulations	Time	Charges
Current unit rates	1628	0.18	236	1395
Constant unit rate	-0.60%	-0.009	-0.40%	-14%
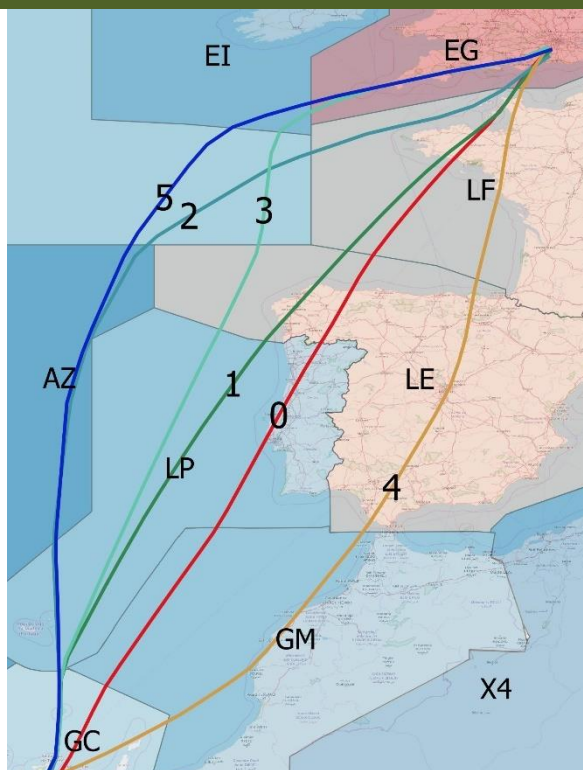
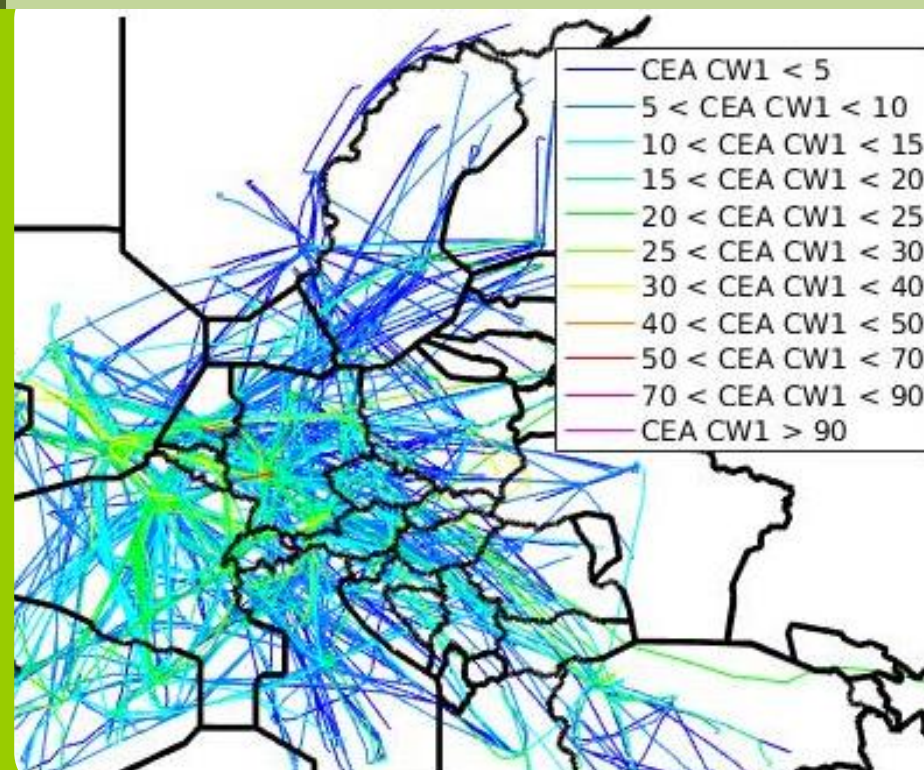### Advanced User-centric efficiency indicators (AURORA)

User-preferred trajectories are reconstructed as reference for the development of efficiency indicators based on surveillance ADS-B data, considering weather conditions and without using sensitive information from the airlines.

Figure: CEA_CW1 compares actual versus optimal cost-based trajectory in a free route scenario.

CEA CW1 < 5
5 < CEA CW1 < 10
10 < CEA CW1 < 15
15 < CEA CW1 < 20
20 < CEA CW1 < 25
25 < CEA CW1 < 30
30 < CEA CW1 < 40
40 < CEA CW1 < 50
50 < CEA CW1 < 70
70 < CEA CW1 < 90
CEA CW1 > 90

Generation of optimal trajectories considering realistic weather scenarios (APACHE)

Optimal trajectories are calculated by means of different optimisation criteria:

- user-preferred (considering cost of fuel, time and route charges);
- minimum environmental impact;
- minimum network delays (considering ATFM re-routings or level capping).
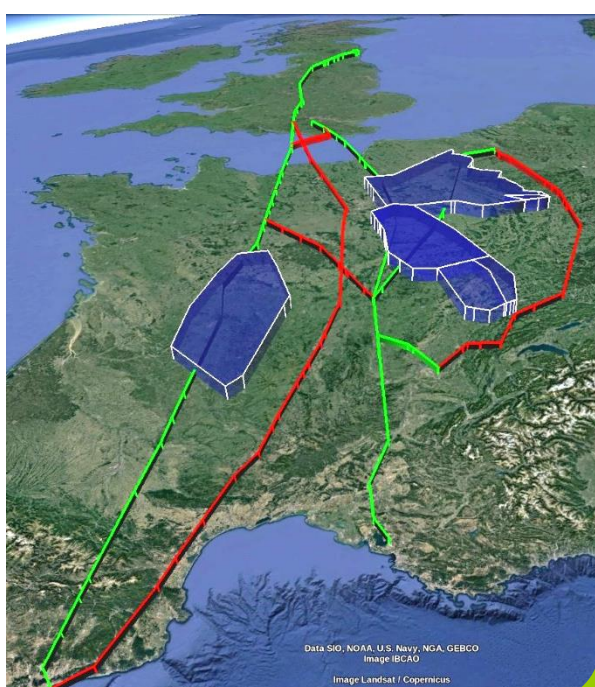
### Drivers of en-route efficiency (INTUIT)

Aggregated environmental KPIs fail to capture the dependencies between local and network impact. There is a need to monitor local performance whilst maintaining the network perspective.

In INTUIT we use machine learning to model flight efficiency as a function of flight properties, such as heading or route length. Efficiency drivers are studied to identify causes and effects of inefficiencies.
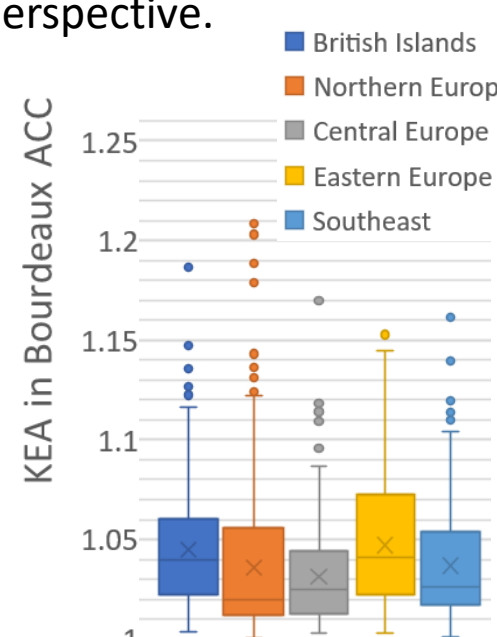
Efficiency PIs online calculation (AURORA)

AURORA is testing an online computation of user-centric air traffic efficiency indicators. Results highlight that these indicators can be successfully processed over a flight's duration by leveraging state-of-the-art big data technologies and distributed system design.

Capacity
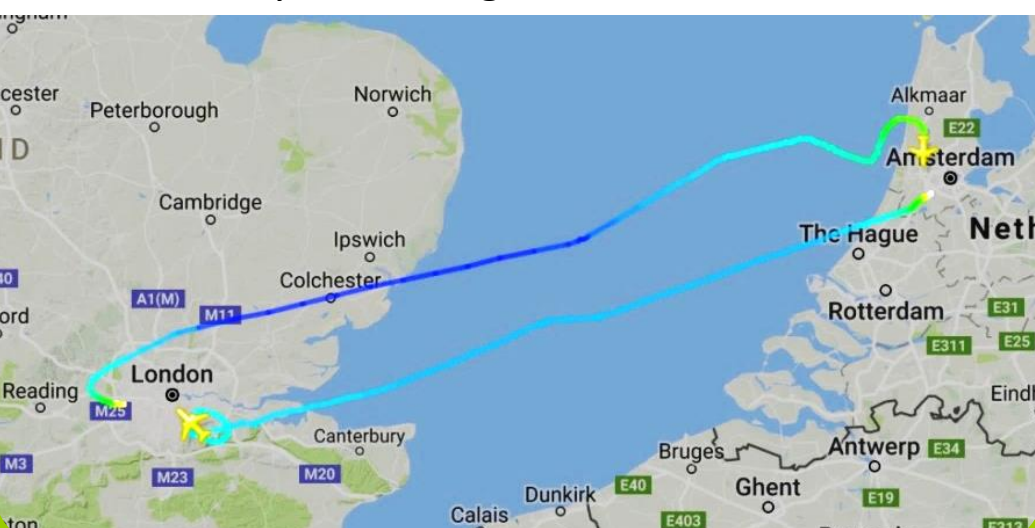
Simulation of SESAR 2020 Solutions (APACHE)

The APACHE ATM simulator is capable to synthesise scenarios representative of current or future concepts of operations, allowing performance monitoring (post-operations analyses) and performance management (what-if scenarios) assessment.

An Initial impact assessment of three SESAR 2020 solutions will be carried out: PJ06 (trajectory based free routing) , PJ08 (advanced airspace management) and PJ09 (advanced demand-capacity balance).

Figure: example of optimal sectorisations using dynamic airspace configurations.
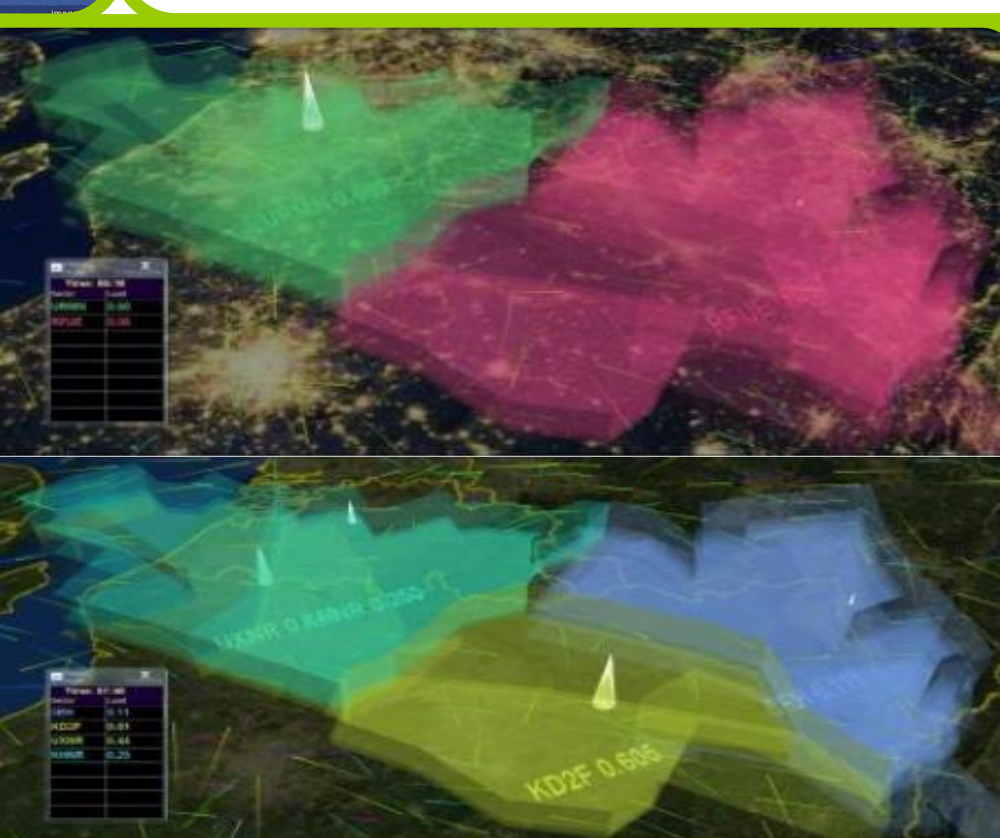
### Multiscale analysis of performance data (INTUIT)

Sector configuration is a key tactical decision for ANSPs influencing performance. There is a need to understand the influence of sector configuration on the achieved performance.

Increased granularity (temporal and spatial) on KPIs data allows the identification of network bottlenecks and/or inefficiencies at ACCs/sector configuration level.

Visual analytics is used to represent and get insights on the influence of sector configuration on several KPIs.

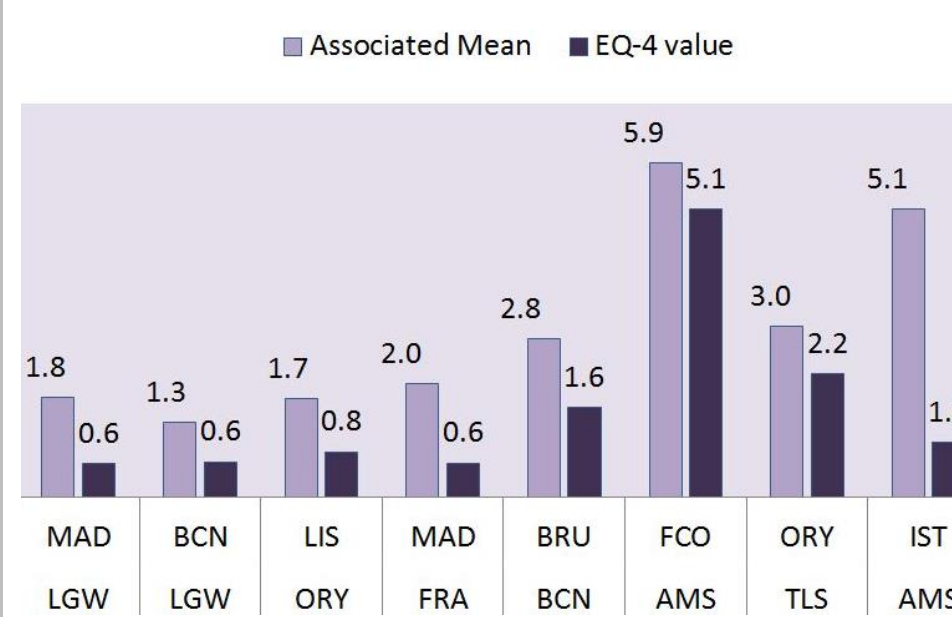## Trade-offs

Performance analyser (APACHE)

The APACHE performance framework implements 42 new (or enhanced) performance indicators along 7 different key performance areas (KPAs), with the objective to assess pre-ops, but also post-ops scenarios (historical realised data).
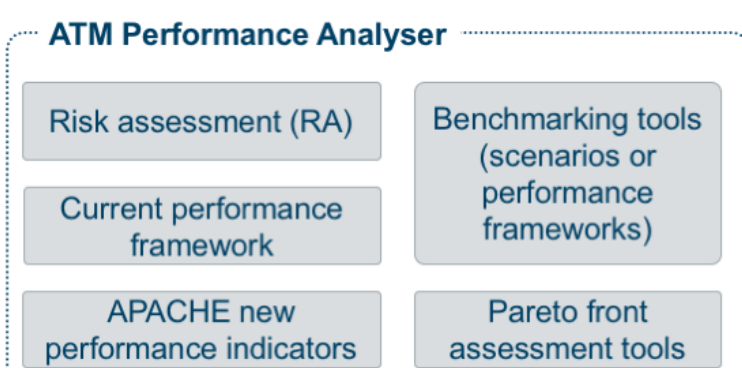
User-centric equity indicators (AURORA)

Equity indicators allow measuring inequities per city-pair, and identifying those airlines which are more penalized in terms of flight level inefficiencies, extra fuel consumption or extra costs.

EQ-4 quantifies cost inequalities of actual versus planned trajectories per airline.

Outcomes

- The APACHE simulation tool will enable the synthesis of realistic traffic and airspace scenarios and the calculation of advanced performance indicators. It will allow us to assess both pre-ops and what-if scenarios and calculate the Pareto frontier of ATM performance among various KPAs.
- AURORA will provide a new set of advanced efficiency indicators based on Airspace Users' operational view, including equity metrics. A new designed platform will offer the possibility of computing and displaying these efficiency metrics in real-time.
- INTUIT will integrate several case studies into a performance monitoring and optimisation dashboard, enabling different types of ATM performance analyses, such as unit-rate modulation for traffic optimisation or assessment of en-route efficiency.