The APACHE project
Assessing ATM Performance with simulation and optimisation tools

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Introduction

At present, the European Air Traffic Management (ATM) is evolving in a coordinated manner aiming at improving the overall efficiency of air navigation services across several **key performance areas (KPAs).**

Main Research questions

- **Flight efficiency:** how much fuel and emission reductions can be achieved by enabling user-preferred free routes at EU-wide level?
- What is the expected **impact in safety and capacity** if free routing and/or continuous cruise climbs are implemented?
- **ATM cost-effectiveness**: what is (approximately) the minimum number of sectors needed to support the current operations and traffic demand to minimize ATFM delays?
- With regards of ATM KPAs, can we estimate the **Pareto-front**?
- **Flight uncertainties**: which might be the expected impact in **predictability and robustness** of the planning?

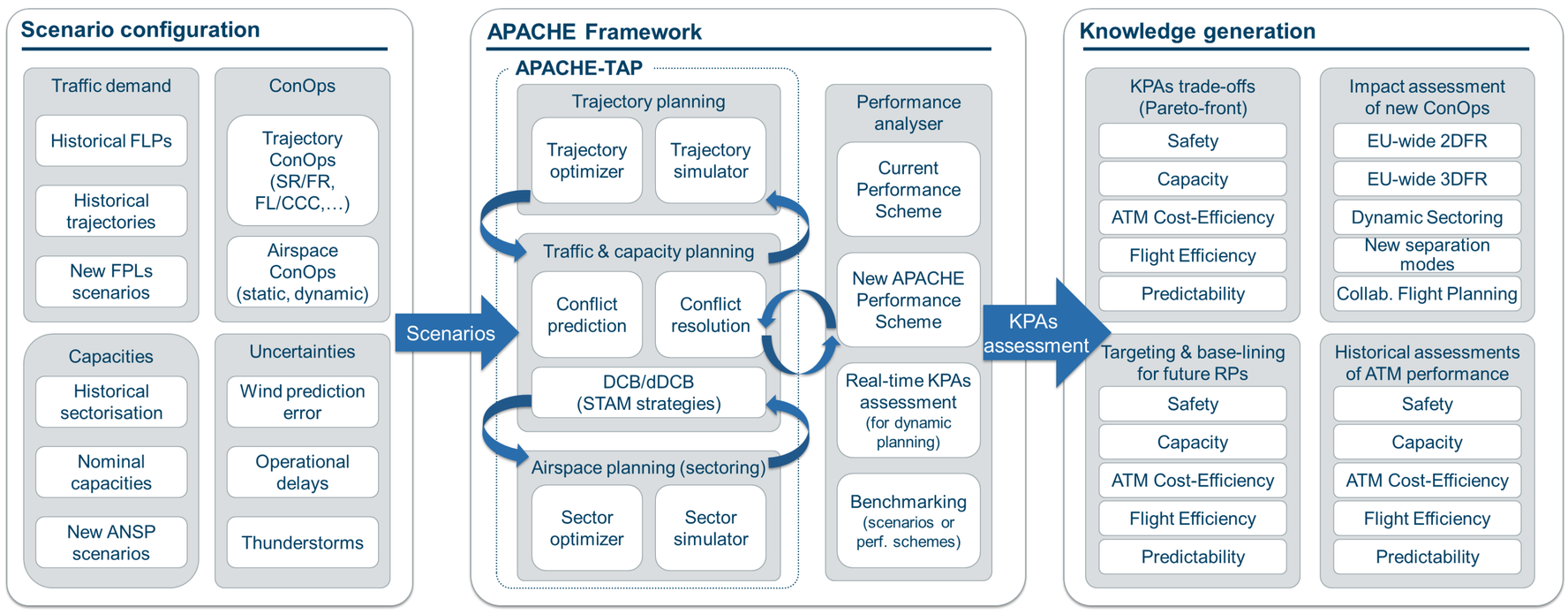
Objectives of the APACHE project

The APACHE project proposes a new framework to assess European ATM performance based on **simulation, optimization and performance assessment tools** that will be able **to capture complex interdependencies between KPAs at different modelling scales** (micro, meso and macro).

Specific objectives are:

- **Evolve the Performance Scheme** to foster a progressive performance-driven introduction of new operational and technical ATM concepts in line with SESAR.
- Make an (initial) impact assessment of **long-term ATM concepts** with the new APACHE Performance Scheme.
- Analyse the **interdependencies** between the different KPAs at the **Pareto frontier of the ATM performance**.

Novel APACHE Performance Framework



- **Optimal trajectories**
- **Traffic flow management with strategic de-confliction**
- **Optimal dynamic airspace airspace sectorisation**

The APACHE-TAP provides a set of realistic optimal trajectories and sectorisations wich will be used as **baseline for new key performance indicators (KPI)** covering several KPAs.

- The APACHE framework can be **configured** to represent **current** or different **future** (or hypothetical) **scenarios** and operational capabilities or contexts.
- **Historical scenarios** can also be reproduced (i.e., recorded flight trajectories and sector configurations) for **a posteriori analysis**.
- **Existing Performance Scheme** KPIs can be **benchmarked** against new proposed KPIs using the APACHE framework.
- The APACHE framework could be also set up to as a **real-time prototype** for monitoring and targeting ATM performance contributing to the effective implementation of **Performance Based Operations (PBO).**

New KPIs proposed (initial draft)

Capacity KPA
Robust maximum **ATFM delay** and average **arrival** ATFM delay
Percentage of "**changed" flights** for busiest sectors (as system wide KPI)/ for all sectors (FABs) during busiest hour
Maximum **throughput capacity** per sector/FAB
Airspace **recovery** period (**resilience** indicator)

Flexibility KPA
Percentage of RBTs **equal** to SBTs
Reserve capacity (1 - [(capacity utilized)/(capacity available)])
Number of **sector changes** per flight
Number of flight handled **over** declared capacity
Number of **alternatives** to solve demand/capacity imbalances

Participation KPA
Ratio between total number of **queries** in the negotiation process of the SBTs and number of RBTs different than SBTs

Cost effectiveness KPA
En-route ATM or unit **economic costs** for the AU
Sectorisation costs (number of active sectors relative to the optimal sectoriastion)

Efficiency KPA
Difference **between estimated actual trip cost** and **optimal trip cost (**identifying different ATM inefficiency layers)
Average (maximum) excess travel time per **passenger** or fight city pairs

Safety KPA
Number of STCA warnings, or Traffic Alerts, or Resolutions Advisories or Near Mid Air Collisions or Separation violations (per flight hour/number of operations)
Severity and duration of separation violations
Risk of conflict

Access and Equity KPA
Percentage variance of **RBTs equal to SBTs** per AU
Difference between **maximum penalty costs** (due to RBT differences from SBT) and average penalty costs per AU

Environment KPA
Difference **between estimated actual trip fuel** and **weather optimal trip fuel** (identifying different ATM inefficiency layers)
Absolute value of the difference between the actual horizontal trip distance and **weather optimal horizontal trip distance**
Similar metrics with **emissions** or **contrail** formation

Predictability KPA
Compliance with the RBT
Adherence with RBT/CTA **tolerance** window
Number of **slots left over**
Difference between **actual** delay and **estimated** delay

RBT: reference business trajectory; SBT: shared business trajectory

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