COCTA: Coordinated capacity and demand management in a re-designed ATM value chain

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on behalf of the COCTA consortium:

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COCTA project – formal overview

• H2020-SESAR-2015-1 call – topic Economics and legal change in ATM;

• Exploratory research project; TRL1: “Basic principles observed and reported. Exploring the transition from scientific research to applied research by bringing together a wide range of stakeholders to investigate the essential characteristics and behaviours of applications, systems and architectures. Descriptive tools are mathematical formulations or algorithms.”

• Duration: April 2016 - September 2018;

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COCTA objective

Problem: substantial extra cost to users of the European airspace, arising from:

- divorced planning horizons of ANSPs and AOs - > mismatch between predictability for ANSPs and flexibility for AOs - > capacity buffers...
- inadequate capacity delivery (vs. demand profile); supply-driven
- an inadequate (average-cost) pricing of air navigation services.

COCTA Objective: Incentivize more cost-efficient outcomes!

In a re-designed ATM value-chain, propose and evaluate coordinated economic measures aiming to pre-emptively reconcile air traffic demand and capacity supply, by acting on both sides of the inequality.
**Current situation**

1. The Network Manager has **limited influence** on capacity and demand.

2. **Limited coordination** between ANSPs on capacity provision combined with decentralized average cost pricing.

3. ANSPs plan their capacity provision rather early, Aircraft Operators (AOs) prefer short-term decisions.

4. **No incentives** for AOs to deviate from their **individual optimum**, even if that would improve overall efficiency.

**Proposed changes**

1. **Strengthen the role** of the Network Manager.

2. **Network capacity coordination** between ANSPs and **overall trajectory pricing** to improve efficiency.

3. NM-ANSP **capacity provision contracts** to optimize **network performance** in line with **policy goals**.

4. **Incentives** tailored to AOs’ business needs/goals, aiming at **system optimum**.
COCTA institutional settings

The future Network Manager

Air Navigation Service Providers → Contracts! → Aircraft Operators

Capacity provision:
1) Long-term capacity requirement
2) Strategic capacity profile
3) Pre-tactical sector opening scheme

Demand management

Trajectory products:
1) Standard – ST
2) Discounted – DT
3) Premium – PT

Capacity management

Equity | Environment | Cost-efficiency | Delays | Re-routings
NM applies network-centric, demand-driven capacity management, coordinated with anticipated demand management measures:

1. Long-term capacity planning may bring major cost savings!
2. Strategic capacity planning and provision for a season – in line with anticipated seasonal demand variability.
3. Capacity delivery in the short term, adjusted as needed based on assumed flexibility level in capacity provision.
### Current charging scheme

1. **Airspace based**: charging zones and corresponding unit rates are determined.
2. In some cases, longer routes lead to cost reductions for AOs (airspace charges vs fuel cost trade-off).
3. Negative impact on the environment.

### Airport-pair charging

1. Charges are set on airport-pair basis: any route (2D) between the two airports has the same base charge.
2. By design, there is no need to plan longer routes.
3. Shorter-route planning incentives should help reducing emissions and improve predictability.
COCTA demand management (2/3): Trajectory products and pricing

• Differentiation of charges as an instrument for incentive-based demand management (when needed)!
• Different charges for different trajectory products:
  • *Ex ante discount* (compensation) for a potential delay or re-routing (DT);
  • *Standard* trajectory product (ST).
  • *Premium* trajectory product (PT) – AUs buying an option for last minute trajectory changes, in space or time, within agreed margins
• Incentivise utilisation of available airspace;
• Incentivise AOs to reveal their flight intentions earlier (as an option).
COCTA demand management (3/3): Trajectory products

**Standard (ST), example:**
- Up to 5’ concerning the time of departure or
- Up to 5nm deviation from shortest path in horizontal plane or/and
- Up to 2,000ft deviation from the preferred cruise flight level.

**Discounted (DT), example:**
- Up to 20’ concerning the time of departure or
- Up to 20nm deviation from shortest path in horizontal plane or
- Up to 4,000ft deviation from the preferred cruise flight level.
Large-scale case study

• **Eight ANSPs** (with 15 ACCs/sector groups) in central and western Europe, with 173 possible configurations enabled for en-route traffic. NEST/DDR data.

• Busiest day in 2016 with **11,211 flights** in the case study region.

Some of the assumptions for evaluation:

• Up to **15% of flights appear at relatively short notice**.

• Model uses ‘**sector hours**’ as measure of capacity.

• Only one demand management measure applied per flight (either delay **or** rerouting)
Selected COCTA model testing results

- **Sector half-hours**
  - COCTA: Green dots
  - Baseline: Blue dots

- **Displaced flights**
  - COCTA: Green squares
  - Baseline: Blue squares

**Graph Details**

- X-axis: Number of flights
- Y-axis: Sector half-hours

**Legend**

- Green dots: Sector half-hours - COCTA
- Blue dots: Sector half-hours - Baseline
- Green squares: Displaced flights - COCTA
- Blue squares: Displaced flights - Baseline

**Graph Description**

The graph compares the sector half-hours and displaced flights between COCTA and Baseline models. The data points are color-coded to distinguish between COCTA and Baseline, with COCTA represented in green and Baseline in blue. The graph shows a comparison of the number of sector half-hours and displaced flights over a range of flight numbers.
Results (low traffic variability, high demand): Capacity

Capacity activated (sector hours)

- 6% CAPACITY SPENDING

MODELLED BASELINE

COCTA
Results (low traffic variability, high demand): Delays

- 83% Delay Minutes
- 89% Long Delays

COCTA | Toulouse, 16/04/2019
Results (low traffic variability, high demand): CO₂

Current CO₂ emissions

Baseline: CO₂ emissions with shortest plannable route

Reduced CO₂ emissions due to city-pair charging

Net reductions of CO₂ emissions with COCTA

CO₂ emissions with COCTA

Additional CO₂ emission due to more re-routings in COCTA
Case study: + 1.2 kg/flight

*DRAWING NOT TO SCALE*
Stakeholder consultation and dissemination

- Four meetings with the COCTA AB
- Workshop with AO representatives, July 2017
- Stakeholder Workshop, Frankfurt, 27 September 2017
- Presentation to the NM Director, May 2018
- Meeting/presentation with Skyguide Capacity management team, July 2018
- Final project workshop, Brussels, 14 September 2018

Conference papers/presentations:
SIDs 2016, 2017, 2018
ATRS World Conference 2017, 2018
FABEC/Baltic-FAB workshop, 2018, Warsaw

Journal papers:
Transportation Research Part A, 2017
Journal of Air Transport Management, 2019
Transportation Science (under revision)

COCTA promotional video

Jane’s 2019 ATC Award – Innovation
Summary

COCTA strong points

• **Substantial cost-efficiency improvement** resulting from network-wide, contract-based coordinated capacity and demand management.

• Suitable model for **network performance optimisation under demand uncertainty**, at different time levels.

• **Model** able to tackle large-scale instances in acceptable time.
Possible next steps

• More detailed elaboration of selected elements of the COCTA concept
  • Negotiation process NM-ANSP, legal aspects, contracts, etc.

• Tactical phase and non-nominal conditions

• Integration of additional elements of the air transport system
  • Terminal airspace, airports, military

• Long-term investment
  • Analyze incentives of ANSPs for capacity-enhancing investment within the COCTA scheme

• Implications of technological progress
  • FRA, flexible capacity provision etc.
Thank you very much for your attention!