

# Competition for air traffic management

## Lessons learned from the COMPAIR project

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**Abstract**—The growth in air travel demand observed in the European airspace has challenged the Air Traffic Management (ATM) system to adapt and respond to the new capacity and congestion issues. The introduction of competition in the ATM sector has been proposed as a means to incentivize the adoption of new technology and defragmentation of the system thus contributing to the achievement of the European high-level policy objectives for aviation. The overall goal of the COMPAIR project was to study the impact of various institutional and market design options ranging from changing governance, unbundling, tendering en route control at the Member State level to auctioning en route control for origin-destination pairs. The project results suggest that introducing some form of competitive elements would likely lead to increase in ANSP cost efficiency, lower charges up to half of the current levels, increases in technology uptake, and decreases in the fragmentation of the European skies.

*ATM, economics, competition, unbundling, tendering*

### I. INTRODUCTION

Air transport is facing many challenges such as increasing demand, larger airports, increased network congestion, etc. which also need to be reconciled with environmental issues. Hence there is a need for smarter solutions at service, operational and technical level. One of the important players within aviation is Air Traffic Management (ATM). Since 2004, the European Union gained competences in ATM. The EU wants to reform the European ATM system in order to cope with sustained air traffic growth under safe, cost-efficient and environmentally friendly conditions. The Single European Sky (SES) initiative aims to re-structure the European airspace as a function of air traffic flows, create additional capacity and increase the overall efficiency of the ATM system<sup>1</sup>. The European Commission has set ambitious goals for the SES in 2012 to be reached by 2020<sup>2</sup>, including a three-fold increase in

airspace capacity and a cost reduction of at least 50% for the provision of ATM services.

Today's progress towards SES objectives is perceived as slower than expected<sup>3</sup>: the steps taken towards enhanced collaboration between various air navigation service providers (ANSPs) are sometimes considered ineffective<sup>4</sup>, the implementation of functional airspace blocks (FABs) to defragment the European landscape of national ANSPs and enable economies of scale has had limited success, and the R&I cycle is still too long. The PRB (2016) also warns against the risk of SESAR Deployments working against the SES objectives. In this context, the question of how to provide the appropriate organizational structures, institutions and incentives for new operational concepts and technologies to yield the expected results stands high on the European policy agenda. The introduction of competition has been proposed as a means to provide the right incentives for the realization of the high-level objectives of the SES, through the speed up of the innovation cycle and the fostering of more efficient operations. On the other hand, competition does not prevent every market failure (e.g. negative externalities) and, depending on market conditions, liberalization can also have undesired outcomes, such as the emergence of oligopolies or monopolies. Besides, competition does not exist abstractly, but is influenced by the legal and regulatory framework. Hence, the successful introduction of competition requires a comprehensive impact analysis to evaluate different regulatory approaches along a variety of dimensions.

**The main research question of COMPAIR was “how to introduce competitive incentives in the ATM sector so as to best contribute to the achievement of the European high-level policy objectives for aviation.”** In reply to this, the project has pursued the following objectives [2]:

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<sup>1</sup>[http://ec.europa.eu/transport/modes/air/single\\_european\\_sky/index\\_en.htm](http://ec.europa.eu/transport/modes/air/single_european_sky/index_en.htm)

<sup>2</sup><http://www.sesarju.eu/discover-sesar/history/background-ses>

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<sup>3</sup>[http://europa.eu/rapid/press-release\\_SPEECH-13-703\\_en.htm](http://europa.eu/rapid/press-release_SPEECH-13-703_en.htm)

<sup>4</sup>E.g.: <http://aviationweek.com/aftermarket-solutions/has-single-european-sky-project-failed>

- Propose a set of **new institutional market designs** for the introduction of competition in the European ATM sector;
- Define a framework for **comprehensively assessing** the impact of different institutional market designs on ATM stakeholders and society at large;
- Develop a variety of **economic and network simulation models** in order to assess the proposed approaches;
- Assess the **feasibility and acceptability** of proposed institutional changes for various stakeholders;
- Propose a **vision for the implementation** of the most desirable institutional structures.

The rest of this document is organized as follows. Section II provides a brief overview of the scenarios and the methodology used. The focus of section II is on the main outcomes of the COMPAIR project. Section III presents the Conclusions and Recommendations

## II. SUMMARY OF THE ACTIVITIES OF THE COMPAIR PROJECT

### A. *Introducing the four COMPAIR scenarios*

COMPAIR focused on four potential ways to introduce competitive elements in the ATM sector. These options were based on the initial ideas at the outset of the project proposal, which have been further fine-tuned in a variety of ways: literature review & desk research, a workshop with the Advisory Board Members, face-to-face interviews with selected respondents and a survey which was sent out to a broader set of ATM stakeholders. This first assessment was made qualitatively [7]; first results were discussed during the first workshop [9].

#### 1) *Option 1 – Performance regulation with variations in ownership and governance models*

The ownership form of ANSPs varies over countries, from government agencies to government owned corporations to semi-public, semi-private firms (for profit and not-for-profit). There is also variation in the consultation processes by ANSPs of ATM stakeholders before making strategic decisions. In some countries, extensive consultation procedures are in place, whereas in others formal processes are currently under development or do not exist. The composition of an ANSP governance board may be designed to reflect the presence of specific skills or different opinions of ATM stakeholders. This variety may give rise to performance differences and the establishment of causal links between governance structures and performance.

While this option does not directly introduce competition, it does so indirectly via two ways. Firstly, by introducing some

form of vertical integration (market based or board based), competition is introduced in the DNA of the ANSPs as shareholders/board members do act in a competitive environment. Secondly, performance regulation in the form of yardstick competition could be introduced. With yardstick competition the regulatory framework would be based on a comparison of performance between ANSPs. Today, the SESAR performance scheme is not based on such a comparison.

#### 2) *Option 2 - Unbundling*

Unbundling is the process by which a large company with several different lines of business retains one or more core businesses and sells off the remaining assets, products, services, etc.

The provision of Air Traffic Management could be subdivided into the following components:

- Network management: currently EUROCONTROL is in charge and is supported by national ANSPs
- En-route air traffic service (ATS) provision
- Terminal air traffic service (ATS) provision (incl. approach and tower control)

The unbundling of ATM services could start with the separation of terminal air traffic services. This is the activity where most direct benefits can be realised and which also is the easiest to separate. Unbundling of terminal ATS happens already today at a number of airports in Sweden, UK, Spain and Germany, which have appointed their local tower ATC provider through a public tender process[3]. The evidence on the effect of these market tenders is limited up to now, but it seems that the experience has overall been positive [3]. The approach for unbundling terminal ATS provision would thus be competition for-the-market.

As a second step, a number of en-route air traffic services could also be unbundled. These are mainly ATM support services, not the core ATC activities. These services are not necessarily monopolistic in nature and could therefore be supplied by independent service providers. These providers can sell their services to ANSPs. Unbundling of these support activities could lead to a competition in-the-market for service provision. Support services that are typically cited as candidates for unbundling are:

- Meteorological services (MET)
- Aeronautical information services/management (AIS/AIM)
- Communication, navigation and surveillance services (CNS) – this is mainly an infrastructure maintenance and management function

Further outsourcing of ATM activities could involve more specialised ATM activities with closer links to core air traffic control service:

- Airspace organization and airspace management
- Provision of contingency services. Think for example of the recent events in Belgium where German ATCOs took over the tasks during a strike at Skeyes.

However, without a change in ownership form or the strengthening of the price cap approach, there is little interest in cost efficiency hence little interest in unbundling from the viewpoint of ANSPs.

### 3) Option 3 – Tender of licenses for en-route air traffic services

Option 3 concerns the tendering of a license to operate core en-route air traffic services, namely the provision of air traffic control, in a specific geographical area and for a certain period. The tender process is repeated after each fixed period, which could lead to contract renewal for the incumbent provider or to a new provider supplying the market. The form of competition under this institutional option is thus that ANSPs compete for-the-market, i.e. they compete for the right to provide ATM services in a certain geographical area for a certain period.

The geographical scope of the tender can correspond to the area of an air traffic control centre or even a national charging zone. This time-based tendering process could lead to consolidation among European ANSPs. Certain ATS providers will be successful and be able to further improve their service provision thanks to learning effects. They may take over other providers, which are less successful, thereby reducing fragmentation and enabling economies of scale through a market driven process.

Contract conditions should also include performance incentives with respect to capacity, environment/flight-efficiency and safety to ensure that selected ATM operators are responsive to various performance dimensions.

4) Option 4 – Flight centric, sector-less operations  
Sector-less operations in itself is not an “institutional design option”, but it will have institutional consequences. It can also increase the scope of competition in the ATM sectors, with ATM providers competing on a per-flight basis or per-airline, rather than per geographical zone. The sector-less scenario also acts in COMPAIR as an example of the effects of technology changes on the institutional structures.

### B. Methodologies for assessing the four scenarios

The four scenarios were first qualitatively assessed based on literature, a survey and interviews [7] and discussed during the first workshop [9]. These scenarios were then quantitatively assessed using different quantitative approaches based on

- Economic modelling (using mixed goal functions) [6],
- Econometric estimations (stochastic frontier analysis) [6],

- Game-theoretic concepts (game tree and two-stage network congestion game) [8], and
- Agent-based simulations (agent based auction model) [5].

The aim of these modelling approaches was to understand the potential impact of these four scenarios.

These assessments were then shared with stakeholders in a workshop ([10]) and in individual interviews to discuss the feasibility of the outcomes, possible hurdles for implementation etc.

### C. Key Project Results

This section describes the key modelling results and the feedback received from stakeholders.

#### 1) Modelling results

#### Option 1 – Performance regulation with variations in ownership and governance models & yardstick competition

This option focusses on the link between the performance of ANSPs and their ownership form. The theoretical economic model described in [6] suggests that the effort to achieve cost efficiency will be higher in the case of public companies with a board of stakeholders composed of airspace users and in the case of private companies in which stakeholders are also shareholders. The importance of strong national interests, on the other hand, encourages technology purchases from local suppliers or relatively powerful labour unions, which are likely to decrease efficiency. A stochastic frontier analysis estimation of the production and cost function of 37 European ANSPs over nine years suggests that the public-private ownership achieves statistically significant higher cost and production efficiency levels compared to either a government cooperation or state agency [6]. The coefficient estimates are significant and have the expected signs. Note that input prices for labour costs (wages) seem to carry a greater importance in comparison to capital costs. This observation may be explained by the higher share of labour costs at the ANSP total cost level currently. With respect to the cost function and economies of scale, [6] finds that a 10% increase in traffic, given the same airspace, corresponds to a cost decrease of around 10 to 15% on average. Structural differences in air traffic characteristics between ANSPs are important in explaining productivity and efficiency performance differences. Seasonality and traffic complexity seem to be particularly relevant. For en-route service, it was found that there are large differences across Europe based on a stochastic cost frontier analysis. The figure below shows the average production efficiency estimates across the ANSPs. When comparing average efficiency levels across ANSPs, we see that the efficiency levels of ten of the ANSPs lie above 0.7- with MUAC, NATS and SkyGuide at the top. Eighteen of the smallest ANSPs scores lead the bottom of the rank with efficiency estimates below 0.4. This indicates that there is room for substantial improvement.

With respect to terminal control we observe similar tendencies.

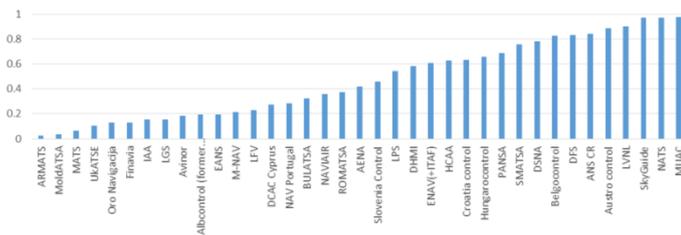


Figure 1 Average production efficiency Estimates per En-route ATC provider – source [6]

## Option 2 - Unbundling

Unbundling is done for a variety of reasons, but the goal is always to improve performance. In the case of a monopoly market, unbundling of non-core activities can introduce competition for part of the market. Within ATM, a key example is the unbundling of tower control.

The experience and analysis using a game-tree of introducing competition by outsourcing tower control services shows [6]:

1. Competition for tower control services is at present only introduced in a few European countries and in each of these countries only part of the market is opened for competition. There are two motivations for the opening of the market for airports. The first is a reduction of costs; factual information suggests that cost reductions of 40% or more could be possible. The second motivation is transparency in the subsidies given to regional airports in many countries. Regional airports do often not pay for tower control and this gives rise to inefficient operation of regional airport activity.
2. In those countries where the tower control activities were liberalized, there was important resistance and lobbying from the side of the incumbents and the unions. In some countries, the unions managed to protect the salaries and benefits of the existing local Air Traffic Controllers (ATCO's). The incumbents were able to renegotiate existing contracts and prolong their position for another term, avoiding competition for some years. At the same time, this threat of competition led to renegotiations for the benefit of the airports.
3. One of the major drivers of liberalization were the airports when they are private or when they face strong competition. For these airports to succeed in a successful renegotiation or successful tendering operation the national legal framework has to clearly allow the airports to choose their tower services provider.

4. As only some countries have a legal framework that allows organizing competition, one may call upon EU directives to help introducing effective competition. However, the example of electricity production liberalization where it took 5 to 10 years before EU directives were implemented shows the initiatives remain largely in the hands of the member states.

A similar analysis can be made for other services which can be outsourced such as MET, CNS, (AIS/AIM), etc. The main difference is that it will not be the airport that will outsource, but the ANSP itself. While airports are often privatized and/or face strong competition, this is less the case for ANSPs – reducing the drive for cost efficiency.

## Option 3 – Tender of licenses for en-route air traffic services

This option was assessed by two models: a game-theoretic network model [8] and an agent based model [5]. Both models showed that the creation of for-profit ANSP companies and the introduction of competitive tendering processes would

- Likely lead to the defragmentation of the skies because companies would bid for more than one airspace.
- Lead to lower charges than occurs today, in part due to the economies of scale achieved through defragmentation and in part due to the bidding process that creates a competitive environment at least once every five to ten years.
- Another advantage of this system would be the potential to remove the economic regulatory bodies currently involved in setting the price caps of the existing system.
- Based on the results of the multiple analyses, it would likewise appear that another aim of the Single European Sky initiative<sup>5</sup> could be facilitated, namely the adoption of new SESAR technologies.

There are however also some points of attention:

- According to the agent-based simulation [5], the results suggest, for Europe, that a maximum market share of 20% ensures sufficient competition.
- It would be important for Member States to set minimum capacity levels or maximum levels of delay in order to ensure sufficient service levels.

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[https://ec.europa.eu/transport/modes/air/single\\_european\\_sky/ses\\_2\\_en](https://ec.europa.eu/transport/modes/air/single_european_sky/ses_2_en)

- The order in which the Member States undertake the tendering has a strong impact on the local charges in each country, but the global network effect is not as important. Member States adopting the auctioning system earlier are at an advantage [5].
- Finally, the duration of licenses shows different outcomes, with the shorter, five-year periods leading to less efficiency gains in the short-term, but higher levels of competition in the longer term [5].
- The transport equilibria outcome appears to be closer to achieving the Single European Sky objectives under for-profit company competition than non-profit. In the case of non-profits, the charges decrease below the current price cap but to a lesser extent than the for-profit case. Moreover, it is less likely that all ANSPs will adopt the SESAR technologies as the current results suggest that only the larger ANSPs will choose to invest. However, without tendering, the non-profit result is superior to that of for-profits or the current system [8].

These conclusions are made on the base of two case studies, covering about half of the European airspace. Their geographical context is shown in the figures below.

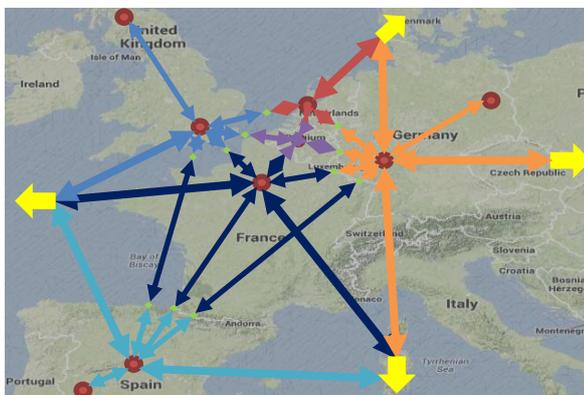


Figure 2: Geographical context case study 1 – source: [8]

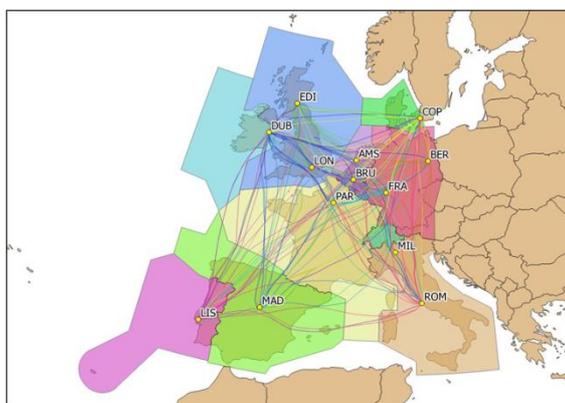


Figure 3: Geographical context case study 2 – source: [5]

#### Option 4 – Flight centric, sector-less operations

Using agent-based modelling, [5] simulated a futuristic sector-less scenario in which ANSPs provide air navigation services to flights from origin to destination (OD). ATCOs can work at any OD pair and ANSPs can provide air navigation services in all European regions. Hence, there is no preference to work on specific routes. To explore this idea in a simple manner, this was simulated using a market design similar to the electricity market, in which airlines submit their bids and ANSPs simultaneously submit their ask prices<sup>6</sup> of controlled flight-kilometres to the Regulator, which chooses some price  $p$  that clears the market. In this model, ANSPs have the incentive to invest in improving their efficiency and reduce their costs, otherwise their productivity relative to competitors will decrease and they may be out of the market.

In the case of the sector-less scenario, with air traffic services provided on an origin-destination pair basis, it is observed that the most efficient ANSPs control an increasing market share until they reach the maximum market share allowed by competition regulation. The results of the simulation suggest that, since the dominant ANSPs tend to increase their market share in each auctioning process, the maximum market share permitted is a necessary measure in order to avoid the emergence of a monopolistic ANSP serving the entire European market.

#### Overall results

The results show that governance/ownership matters and impacts performance. COMPAIR also finds that unbundling – or even only the threat of unbundling can lower costs substantially. However, as ANSPs do not face strong competition, the result might be less substantial for services which are to be outsourced by ANSPs (rather than by airports) [6].

The applied models ([8][5]) suggest that introducing competition for the market via outsourcing service provision may lead to a reduction in charges by up to half the current levels. It would also appear that auctioning the service is likely to lead to defragmentation of the European system as companies win more than one auction. According to the agent-based simulation, the results suggest that, for Europe, a maximum market share of 20% ensures sufficient competition. The companies will be large enough with sufficient financial backing that they will be in a position to invest in new SESAR technologies. Both modelling approaches derive results suggesting that for-profit companies are highly likely to invest in such technologies thus encouraging adoption faster than appears to be occurring today. Note that it is important to ensure a sufficient number of competitors for the auction

<sup>6</sup> The “ask price” is the minimum price a seller is willing to receive. A bid price on the other hand represents the maximum price that a buyer is willing to pay for the service.

process to be successful over time. Finally, according to the game-theoretic model, non-profit companies would be strictly preferable to both the current state agency and to a government corporation if auctions were not introduced.

### 2) Stakeholder feedbacks

Within COMPAIR, special emphasis was given to gather stakeholder feedback in different stages of the project. Two workshops [9][10], advisory board meetings, interviews, presentations at conferences and other workshops and a survey ensured the technical approach was balanced with the validation of the experts. The main stakeholder views collected by the project can be summarized as follows:

- There is general agreement that at least some competition is needed in order to increase the efficiency of the European air navigation service environment;
- Most stakeholders agree that the main obstacle in the way of achieving such an improved environment is the lack of sufficient political will to initiate and execute the necessary changes;
- There is a feeling that the current auctioning process for terminal control as a good basis for going forward.

## III. CONCLUSION AND LESSONS LEARNED

### A. Conclusions

The overall goal of COMPAIR was to study various institutional and market design approaches for introducing competition for en-route ATM services, in order to assess their potential contribution to the European Single European Sky objectives.

The table below summarizes the results.

TABLE I. SUMMARY COMPAIR RESULTS

It was established that Option 1 could be a candidate for

	<i>Responsible for air traffic safety</i>	<i>Provision of ATM services towards airlines</i>	<i>Form of competition</i>	<i>Timeframe</i>	<i>Assessment Tool</i>	<i>Potential</i>	<i>Feasibility</i>
Governance	National	Several providers, one for each charging zone	None	Short term	SFA analysis Economic model incentives Game network model	Large efficiency gains possible Differences efficiency	Political No impact fragmentation
Unbundling	National	Several providers for suppose services, one for each charging zone	Competition in the market possible for support service	Mid term	Example tower control Game tree	Tower control: large reduction in costs	Airports as drivers - > ANSP? Most acceptable
Tendering	National	Several providers, one for each charging zone	Competition for the market	Mid term	Game-theoretic network model Agent-Based modeling	Large reduction in costs Uptake technology Less fragmentation	Owenships plays a role Political will Legally feasible Min. market share
Sector less operations	EU	Singel ATM provider for a singles trajectory	Competition in the market	Long term	Agent –based modeling	Reduction in costs Uptake in technology Less fragmentations	Min. market share Political will Influence order

implementation in the short term, in view of the fact that there are already examples of this approach [6].

Option 2 would require substantial changes in the attitude of the ANSPs who appear to have little interest in unbundling in the current ownership structures. The project concluded that realistically, this option would only be a candidate for medium term implementation [6].

Option 3 could potentially lead to consolidation among the European ANSPs, eliminating some of the current fragmentation as well as a reduction of charges in the competitive environment. However, political and institutional constraints would appear to make this option also a candidate for the medium term only [4].

Option 4 was special in that it assumed an important change in the way the air traffic control service works, supported by further technology developments. Potentially able to reduce the charges to about half of their current level in real terms, this option can only be seen as a longer term solution as the required environment cannot be created sooner [5].

The COMPAIR project made extensive use of stakeholder feedback (including, but not only [7], [9] and [10]) to both develop and validate its work.

### B. Next steps

Before implementation, further benchmark studies could prove informative. These should assess the same industry in additional locations and assess other previously monopolistic industries in Europe that followed a similar path. An interesting example for the first case could be a more detailed (quantitative) assessment of NavCanada. For the second case, telecommunications and the railway industry may be valuable reference points.

The most important implementation step is to maintain an

institutional environment that can support competition. This environment ought to be created both at European and at Member State levels. “Environment” does not only include legal measures, but also the overall political, administrative and economic landscape that support investment in efficiency and competition in general.

The options mentioned in COMPAIR should be further assessed and should be updated if necessary. The models could be extended to include more countries and/or relax some conditions. Detailed implementation steps and guidelines should be prepared for each option and they should be promoted within the European aviation community. It is important that these discussions should not be at the level of air navigation service providers alone rather airlines, airports, passenger representatives and other aviation stakeholders such as the regulatory authorities, the states and unions should be duly involved.

Furthermore, when preparing for implementation, other factors should be taken into account such as the emergence of new, disruptive technologies in general with special emphasis on unmanned aircraft (UAS) as a game changer for air navigation, the airport capacity shortage in Europe and the need for an update of the European ATM Master Plan.

The COMPAIR consortium believes that following the steps mentioned above would likely encourage the **beginning of a process to create a more competitive European air navigation service sector, which would help to make the overall European aviation industry more efficient, profitable and user-friendly.**

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