# AGENDA

First Workshop  
COMPAIR Project

<table>
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<th>Grant:</th>
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| Location:    | Melior Business Centre  
47 Diego de León, Madrid, Spain |
| Consortium coordinator: | Eef Delhaye  
Transport & Mobility Leuven  
Eef.Delhaye@tmleuven.be |
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# 1 AGENDA

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<td>LUNCH &amp; REGISTRATION</td>
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<td>14:30-15:00</td>
<td>Welcome and introduction to the COMPAIR project</td>
<td>Eef Delhaye (TML)</td>
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<td>15:00-15:30</td>
<td>SESAR 2020 Economic Projects</td>
<td>Gerald Gurtner (University of Westminster), Frank Fichert (Hochschule Worms)</td>
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**Short Description**

The provision of air traffic management (ATM) services has for a long time been a national monopoly. In addition, it has traditionally been considered a natural monopoly due to the need for large infrastructure investments. Both of these elements are now changing. Air traffic management has been under increased scrutiny of the European Union since the start of the Single European Sky program. In addition, technological evolutions have reduced the need for large scale ground-based infrastructure and expensive equipment, questioning the natural monopoly character of the industry. So it is the right moment to study the liberalization and introduction of competition in the ATM sector. Competition can be introduced at various levels and in different ways. The overall goal of COMPAIR is 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.

Presentation of the two other economic projects within SESAR 2020 Exploratory Research VISTA (Market forces trade-offs impacting European ATM performance) will examine the effects of conflicting market forces on European performance in ATM, through the evaluation of impact metrics on four key stakeholders and the environment. COCTA (Coordinated capacity ordering and trajectory pricing for better-performing ATM) proposes coordinated economic measures aiming to pre-emptively reconcile air traffic demand and airspace capacity. The project primarily aims to reduce the cost arising from lack of coordination in the ATM system, stemming both from divorced planning horizons of ANSPs and aircraft operators (AOs), and from an inadequate pricing of navigation services.
### Short Description

Overall, we considered four options to introduce more competition into ATM. This session focuses on two of these options. Firstly, we present econometric estimates for the cost and production function in order to assess the influence of governance on performance. Secondly, we present an economic model discussing the auctioning of tower control as an example for unbundling part of the services.

### Network modelling

16:45-17:45  
Stef Proost (replacing Nicole Adler), Javier Torres (NOMMON)

This session focuses on the other two options considered in the project: auctioning and competition on a "origin-destination" trajectory base.

First, we will present the preliminary results of a network game in which tendering of ATC is introduced.

Secondly, Nommon is developing an agent-based model to simulate different mechanisms to auction Air Navigation Services within Europe. In this session, we will present the architecture of the model and will discuss with the audience the main modelling assumptions and data sources we plan to use.

### Closure, lessons

17:45-18:00  
Peter Vass (Slot Consulting)
2 The COMPAIR project

The provision of air traffic management (ATM) services has for a long time been a national monopoly. In addition, it has traditionally been considered a natural monopoly due to the need for large infrastructure investments. Both of these elements are now changing. Air traffic management has been under increased scrutiny of the European Union since the start of the Single European Sky program. In addition, technological evolutions have reduced the need for large scale ground-based infrastructure and expensive equipment, questioning the natural monopoly character of the industry. So it is the right moment to study the liberalization and introduction of competition in the ATM sector.

Competition can be introduced at various levels and in different ways. The overall goal of the COMPAIR project is 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.

There are different ways to increase the overall efficiency of ATM. The current EU approach is more focused on centrally steered regulation. COMPAIR focusses on the introduction of competition as a trigger for change. However, competition does not exist abstractly, but it is influenced by both legal and regulatory framework, and can be introduced at various levels and in different ways. At the start of the project some concepts to be further analysed have been indentified:

- Regulatory approach and governance.
- Unbundling of central infrastructure management tasks from service provision tasks.
- Auctioning approach using tenders to licence air navigation services within a certain charging zone.
- Sector-less based operations where trajectories are managed as origin-destination.

Within the Project Deliverable 2.2 “Report on Institutional Design Options” we qualitatively analysed these options. The result can be found here:

http://www.compair-project.eu/public-deliverables.html

The session on Economic modelling focusses on the regulatory approach and the unbundling option while the session on Network modelling focusses on the question of auctions and competition on Origin-Destination level.
3 Economic Modelling

3.1 Performance and ownership - Eef Delhaye

In this session we focus on the effect of ownership and ANSP performance. We first estimated econometrically the cost and production function of European ANSPs.

3.1.1 Cost function

The econometric estimation (using stochastic frontier analysis) of ATM performance data leads us to the formulation of following overall conclusions with respect to the cost function.

With respect to economies of scale for En-Route, we find a difference in whether we control for airspace size or not. A 10% increase in traffic corresponds, on average, to a cost increase of around 6% in costs, assuming that the traffic levels arise keeping the current airspace structure. If we let airspace size also increase with 10% (such as in a merger of two ANSP airspaces in a FAB) we find that costs arise by around 8%, indicating lower economies of scale. For terminal control activities, this effect seems to be even stronger: a 10% traffic increase is associated with a 5% increase in costs if we control for the number of TMA/APP areas (showing strong economies of scale). But if we let TMA/APP areas also increase proportionally (10%), then the expected cost increase also equals 10%. In this case, the economies of scale disappear entirely. Both results seem to indicate that simply joining airspaces or TMA/APP zones under a single ANSP is not likely to lead to significant cost reductions in itself. It is on the other hand the consolidation of centres (possibly enabled by virtualization technologies) that enables stronger economies of scale to kick in.

With respect to economies of scope, the Project achieved indicative results suggesting the presence of diseconomies of scope. ANSPs that have a proportional repartition of activities over En-Route and terminal control do not seem to have a cost advantage over ANSPs that rather focus on one type of activity. In fact, rather the contrary is the case; they have a cost disadvantage. This result suggests that unbundling both activities may lead to cost reductions. However, we want to stress that further research into this issue is needed to come to more conclusive results.

Institutional elements, such as ownership form, turns out to be less relevant than expected. Coefficients are mostly non-significant in almost all econometric models. Also, we have found less variation in ownership form than we anticipated. Most of the ANSPs are 100% state-owned corporations. There is a wider variation in names given to this institutional setting, than in the bottom line.

Based on a simple economic model, we did derive that effort will be higher in the case of public companies with a board of stakeholders and in the case of a private company where stakeholders are also shareholder.
3.1.2 Production function

The project did not use the same parameters in the estimation of the production function than for the cost function. For example, for labour, the number of ATCOs rather than the labour costs was used. As for the cost estimates a distinction between En-Route and Terminal ATM was made as well.

For En-Route, we did not find economies of scale. However, this could be linked to the fact that European ANSPs only governs relatively small airspaces. We also find that more labour leads to higher output. Providers handing more complex traffic are more efficient, while providers with a lot of seasonality are less efficient. This last aspect is probably linked to high fixed costs.

With respect to terminal control we observe the same tendencies. Overall, however, terminal ATC seems less efficient than En-Route. Over time, the efficiency of En-Route ATC improved, although there are large differences between countries. As with En-Route, terminal efficiency decreased in 2009, but – in contrast to En-Route – did not yet recover. The differences in terminal efficiency between countries are larger than for En-Route.

3.2 Unbundling – illustration of tower control - Stef Proost

The unbundling of ATM services should probably start with the separation of terminal air traffic services. This is the activity where most direct benefits can be realized and which also is the easiest to separate.

An important option to assess and decrease costs of terminal ANS costs is to check whether these services can be provided under market conditions. Some member states (UK, Spain, Germany, Sweden, and Norway) explored this option but some of them only a sub-set of their airports and some member states did not explore this option at all.

This brings us to the 3 research questions we explore in this session:

• Can a bidding process decrease costs of tower control? And what are the necessary conditions for this to materialize?
• How did the process develop – does it work in practice?
• Can we illustrate numerically the welfare effects of different institutional contexts?

We first explore briefly the potential benefits of market opening for tower control. Next, we describe briefly the current status of tower control market opening in the EU. We also discuss in abstract terms the theoretical conditions needed to make a market opening via auctions a success. Next, we present a simplified conceptual model of the market opening mechanism to tower control and confront this concept with the tower control liberalization up to now. The figure below summarizes the game.
We can summarize the main findings as follows:

- 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 smaller airports. The first is a reduction of costs, factual information suggests that cost reductions of 50% 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.

- 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 ATCO’s. The incumbents were able to renegotiate existing contracts and prolong their position for another term, avoiding competition for some years.

- 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.

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

A similar game can be set up for other services which can be outsources such as MET, CNS, (AIS/AIM), etc. The main difference is that it will not be the airport which 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 liberalization.
4 Network modelling

4.1 Tendering in ATC - Nicole Adler

The project analyses the potential for introducing competition in the air traffic control market by assuming that non-profit or private companies could compete through a system of auctions to provide service to a country for a limited period of time. We will compare the likely outcomes of such a system to business as usual in an attempt to determine the likelihood of SESAR technology adoption and pricing structures on the equilibria outcome in 2035 and 2050.

We create a two-stage network congestion game in which the air traffic control (ATC) service providers set their charges and capacities in stage one and airlines choose their flight paths in stage two. Prior to the game (stage 0), the Member State regulator will decide whether or not to set up an auction. If the auction is created, ATC providers will be required to offer a bid consisting of a peak and off-peak price and minimum level of service. If the provider offers a service level higher than the minimum required by the State, the charge per km increases (as occurs today in the UK). In order to ensure that the European Union is not served by a single provider which would create an undesirable monopoly, we assume that no company is permitted to participate in more than a maximum number of auctions. The winner will be chosen based on a lexicographic rule. The company offering the lowest peak price will win. If two or more companies propose the same peak price, then the lowest off-peak will determine the winner. If both prices are the same, then the company with headquarters in the Member State will be chosen, known in the academic literature as home bias. If two or more ‘home’ companies bid the same prices, then the company offering the highest capacity will win the auction. If all four criteria are the same, the winner will be chosen randomly with equal probability.

In order to compare the current situation with the suggested scenarios, we model the ATC providers as labour rent maximizers (current situation), private company profit maximizers (similar to NATS) or non-profit capacity maximizers (similar to NavCanada). Each service provider best responds to the choices of its competitors, taking as given the equilibrium airline flows that will be chosen in the second stage of the game, thus leading to a sub-game perfect Nash equilibrium.

The airlines choose their preferable flight paths in the second stage based on minimizing non-linear cost functions. The objective functions are composed of five categories, all of which are impacted to some degree by the ATC service providers. This quadratic objective function includes operating costs, cost from flying off-peak (equivalent to the loss of revenues from a reduced airfare in the off-peak), a congestion cost (which increases non-linearly in total traffic) and ATC service provider charges set in the first stage. Additionally, in order to account for elastic demand, there exists an outside option flow which represents the choice to reduce service were the total costs of being served are too high.
The preliminary results of the modelling approach suggest that without changing ownership form, it will be very difficult to encourage technology adoption. Without auctions but with privatized companies, it is likely that technology will be adopted and labour levels will be reduced creating similar capacity levels to those available currently. The profits are likely to rise to around 25% of revenues because the companies will continue to charge the current price caps. Non-profits are likely to offer higher capacity levels by utilizing both new technologies and current labour levels requiring similar charges to those currently capped.

When creating an auction, it would appear to be very important that there are a sufficient number of bidders in order to move from the current equilibrium outcome. Therefore, it would be imperative to ensure that no company could serve more than 20% of the traffic today, ensuring that at least five ATC operators have experience in the European market. Assuming that there are economies of scale, it is likely that companies will serve more than one airspace thus helping to reduce the current issue of fragmentation. If the companies are privatized, they are likely to bid varying prices in the different Member States (as a function of IFR kilometres controlled) and the model shows that these charges will drop by close to 50% compared to current price caps. However, to achieve greater cost efficiency, they are likely to offer slightly lower capacities with fewer controllers than serve today and their profits, though positive, would be relatively marginal at around 5 to 10%. It would therefore appear to be necessary to set minimum standards and closely monitor service levels over time should this avenue be pursued. The non-profit equilibrium outcome is also likely to invest in new technology and create similar capacity levels to that of the for-profit firm but at slightly lower cost to the airlines.

These very preliminary results will need to be tested across various parameter values and for increased demand as expected according to the demand forecasts for 2035 and 2050.

4.2 Agent Based modelling - Javier Torres

In order to evaluate different mechanisms to auction Air Navigation Services within Europe, Nommon is developing an agent-based modelling platform that will be used to simulate two institutional designs:

1. The tendering of licenses to operate En-Route air traffic services in specific geographical areas (ACCs),
2. A second, more futuristic sector-less scenario in which ANSPs provide air navigation services to flights from origin to destination and airlines are allowed to select different ANSPs for each OD pair or an ANSP which manages their whole network.

The simulation involves two main stages. The first stage simulates the auctioning process while the second one simulates how agents evolve between one auction and the next one. The evaluative process, where agents adapt their behaviour to reach their goals, will allow us to study the dynamics of the system, complementing the static, game-theoretical modelling approach being developed by HUJI.

In this session, the architecture of the agent-based model will be presented as well as a discussion with the audience about the main modelling assumptions and data sources planned to use, as well as the indicators we plan to monitor will take place.