

Introducing More Competition into ATM: Possible Institutional Designs

Qualitative Assessment

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Abstract—In this work we develop a list of new institutional approaches for air traffic control. The idea being that performance of ATM could be improved if more competitive elements are brought into the system. These concepts are fine-tuned and qualitatively assessed based on a literature review, discussions with stakeholders, interviews and an online survey.

Keywords: *ATM, economics, competition, qualitative assessment*

I. INTRODUCTION

The provision of air traffic management (ATM) services has for a long time been a national monopoly. In Europe, this has led to a very fragmented market in which each country has, at least, its own civil and military air traffic control provision. In order to prevent excessive pricing, the service charges are regulated. Fragmentation, price regulation and the network character of most ATM technologies has led to problems of coordination, slow changes, inefficiencies and under-investments within ATM¹. Hence there is room for improvement.

There are different ways to increase the overall efficiency of ATM. The current approach is more focused on centrally steered regulation. We focus on the introduction of competition as a trigger for change. However, competition does not exist abstractly but is influenced by legal and regulatory framework, and can be introduced in different ways. The goal of this article is to qualitatively assess a range of options which might introduce more competition within ATM. Hence the next section introduces four possible options. In section III we discuss the literature review while section IV deals with the stakeholder input. This leads to the qualitative assessment within Section V.

II. FOUR OPTIONS

Overall, the idea is that some competition may give the right incentives to assist the ATM sector in its transformation

from national monopoly providers to a modern and integrated European system.

We focus on four options to be further analyzed:

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

This provided a starting base, but in the analysis we left open the possibility of adding another option.

A. Ownership models and yardstick competition

The ownership form of Air Navigation Service Providers (ANSPs) varies over countries, from government agencies to government-own cooperations to semi-public, semi-private firms (for-profit or not-for-profit). It can be expected that increased involvement of ATM customers in the board of ATM providers should lead to a higher customer focus and more incentives to invest.

In this model, there is no real competition in the market. It also does not address the issue of fragmentation. But its desired effect, the customer-orientation, is built in through the composition of the board. If for-profit or governmental entity, some form of economic regulation is probably still needed. This could take the form of a yardstick competition regulatory model. Yardstick competition is a mechanism in which the price of the regulated firm depends on the costs of similar firms. Under this approach, performance regulation of national ANSPs remains the cornerstone of the economic and performance incentive tools. So there is no real competition for ATM services, but performance regulation aims to provide incentives as if there were real competition.

B. Unbundling

¹ Based on assessment made in [9]

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 is also the easiest to separate. In a second step, a number of en-route air traffic services, such as meteorological services, information services and communication, navigation and surveillance services, could also be unbundled. These services are not monopolistic in nature and could therefore be supplied by independent service providers. This is already happening in e.g. Germany, Spain, UK, etc. Further outsourcing of ATM activities could involve more specialized ATM services with closer links to core air traffic control services such as the provision of contingency services.

In general, the main effects to be expected from the unbundling of en-route support services are realization of cost savings, increased strategic focus of ANSPs on core activities and possible improvements in interoperability.

C. Tendering of ATC licenses

This concept concerns the tendering of a license to operate core en-route air traffic services, namely the provision of ATC, in a specific geographical area and for a certain time period. The tender process is repeated after each fixed time period. The geographical scope of the tender can correspond to the area of an air traffic control center or even a national charging source. However, to mitigate political and national sovereignty tensions, it is probably most realistic to organize the tender at the level of an air traffic control center (ACC). This time-based tendering process can over time also lead to consolidation among European ANSPs.

D. Sector less ATM operations

Sector less operations is a concept that is currently still in the R&D stage. It envisions en-route ATC without conventional sectors. One controller will be assigned several aircraft regardless of their location and will guide these aircraft during their entire flight in upper airspace. This concept has the potential to increase the scope of competition in the ATM sectors, with ATM providers competing on a per-flight basis rather than per geographical zone. An airline could then choose one specific air navigation service provider to manage his/her entire network in a sector less airspace. And there could be various providers for different airlines. At least, ATM provision is no longer tied to specific geographical boundaries, but an airline could choose between various ATM providers or dispatchers for a specific flight.

III. LITERATURE REVIEW

In this literature review we discuss relevant literature for the four options – both theoretical as well as literature linked to air navigation services or experiences in other sectors.

A. Ownership models and yardstick competition

As said, the **ownership form** of ANSPs varies over countries. [1] provides a general overview of selected global

corporate ANSPs. They conclude that there is no conclusive evidence that any of these models is either superior or inferior to others with respect to productivity, cost-effectiveness, service quality, safety and security. They did see improvements in cost-effectiveness and performance and a faster implementation of technologies as a result of access to financial markets.

On the other hand, it can be expected that increased involvement of ATM customers (such as airports and airlines) in the board of ATM providers should lead to a higher customer focus. NavCanada is an example of an ATM provider that is governed by a user-dominated stakeholder board². [21] makes a distinction between three ownership and governance forms for ANSPs: a government corporation such as Germany's DFS, a for-profit corporation subject to rate-of-return regulation and a non-profit corporation that is governed by a user-dominated stakeholder board, such as NavCanada. It is argued that the user cooperative approach, such as the NavCanada case, has shown to be superior, in theory and in practice. A stakeholder board that is dominated by users creates an incentive for efficient performance in the absence of competition. It also eliminates the incentive for monopoly abuse. This was also echoed in [1] which further corroborates the point that the NavCanada governance and ownership model has had a significant and positive track record.

The comparative overview of ownership models provided by [6] shows that there is no evidence of safety standards being affected by commercialization, as long as appropriate structures for ensuring safety are kept in place. Commercialization allows for increased flexibility as new sources of funding (next to government budgets) become available. But efficient allocation requires that commercial risks are built into the system. So they conclude that there is no evidence that commercialization in itself has led to any deterioration and in some respects we have seen clear improvements in the overall portfolio of services that are provided. The challenge is then to find a regulatory regime to limit excess monopoly power that may be associated with ANSP activities without hindering incentive and innovation.

In this model, there is no real competition in the market and some form of economic regulation is probably still needed. This could take the form of a **yardstick competition regulatory model** [22]. Yardstick competition starts from the idea that franchised monopolies have little incentives to reduce costs. Yardstick competition is a mechanism in which the price of the regulated firm depends on the costs of comparable firms. This form of regulation implies that the regulator is "placing similar firms in competition with each other with respect to their cost levels" [3]. It can then be shown that in equilibrium, each firm chooses a socially efficient level of cost reduction. The mechanism generalizes to cover heterogeneous firms with observable differences. However, problems exist due to the potential for manipulative collusion by the ATC providers to raise average prices, as described by [22]. In addition,

²<http://www.navcanada.ca/EN/about-us/Pages/governance.aspx>

transparency is important in order to calculate the average price accordingly [24]. Due to the current charging regime undertaken by EUROCONTROL, the current cost and pricing mechanism is relatively transparent to all actors.

Yardstick competition has been applied in the regulation of various utilities (hospitals, water utilities, Norwegian busses, etc.). [5] discuss these examples in more detail. They show that yardstick competition is very flexible, in the sense that it can be used in multiple cases, given various constraints and objectives. They conclude that yardstick competition is particularly interesting for some kind of transport service regulation. [16] analyze the effectiveness of yardstick regulation on the Japanese rail industry and find that it led to a decrease in variable costs of the rail transport provider, with an overall cost reduction of 11.5% over the period 1995-2000. [20] evaluated yardstick regulation for European airports. The paper focusses on the difficulties arising from airport benchmarking as well as on the possible benefits. While not implemented in practice, there are examples in the European airport industry where yardstick competition was used as an input. The authors give the example of the Dublin Airport Authority plc where a form of yardstick competition was used to determine the prices that the airport could charge. It was not implemented as the airport never agreed to a list of potential comparators³. In the UK, the Civil Aviation Authority also considered a form of benchmarking analysis, but this was not used in the end within the regulatory framework.

An important question is how this would generalize to ANSPs with possible non-observable differences. Several attempts have been taken at understanding causes of ANSP efficiency differences using econometric techniques, but results have been inconclusive up to now. Finally, an open issue in this form is the question of how to effectively enforce the economic regulation.

B. Bidding processes

In the US most cities had contractual franchise for most utilities, starting with the introduction of gas in New York in the 1820. These contracts typically provided for access to public rights of way and a franchise monopoly in return for restraints on prices and concessional terms for supplying the municipality. The contracts were typically for 20-30 years, long enough to repay the large capital investments. Over time, more and more regulation and monitoring came in place which led to improvements in the system of regulation rather than to public ownership. Only 8% of the electrical utilities and less than 1% of trams were publicly owned by 1902 and 50% of water companies [17].

[14] explains the features of bidding markets, to be found in auctions and bidding processes. The article addresses why these features are often perceived as leading automatically to efficient outcomes and needing no antitrust or regulatory intervention. Then, he explains how most of the bidding market

characteristics are usually not fulfilled and often even mutually inconsistent. Therefore there is a clear need for regulatory/antitrust monitoring of bidding processes to ensure that their outcomes are efficiency enhancing.

[13] addresses the auction “Revenue Equivalence Theorem” which states that all the standard auction mechanisms are equally profitable for the seller and that buyers are therefore also indifferent among them. This theorem holds under a set of reasonable-sounding conditions, which are however often violated in practice. In particular, the assumption that bidders have independent private information about the value of the good being auctioned seems unrealistic. When this assumption is relaxed, the simple ascending auction⁴ becomes the most efficient auctioning procedure. The quantitative importance of this effect, however, turns out to be relatively small, as demonstrated by numerical simulations.

In practice, other potential pitfalls are often more important. What really matters in auction design is robustness against collusion and attractiveness to entry, just as in ordinary industrial markets. Ascending auctions may be more efficient but are more vulnerable to strategic colluding behavior by auction participants [12]. The reason for this is that bidders may use the repeated interaction to signal information to each other strategically. In addition, ascending price auctions often also lead to increased entry barriers for potential new entrants. The winner’s curse makes relatively small, “weaker” entrants particularly hesitant to enter an ascending auction. If they would outbid stronger actors, they are almost certain that they have overvalued the uncertain common value of the good.

Standard first-price, sealed-bid auctions in principle give less rise to collusion and low entry. Due to the one-off nature of the award procedure, with no possibility to change bids subsequently, even weaker players have a possibility to win the contract and are therefore more inclined to take a chance. Incentives may change again in case of repeated first-price, sealed-bid auctions, as actors are allowed to learn from previous procedures. There are a number of ways to deal with these issues, and to reduce possibilities for gaming within auction contexts. Examples of these are the obligation to bid round numbers, the prescription of increments for subsequent higher bids and the anonymization of bids received. The Anglo-Dutch auction⁵ is a hybrid auction type incorporating

⁴ In an ascending auction, price and allocation are determined in open competition among bidders. The bidders willing to pay the most win and pay prices that no other bidders are willing to top. A simple ascending auction may stimulate competition by creating a reliable process of price discovery, by reducing the winner’s curse and by allowing efficient aggregations of items. However, the information may also be used by the bidders to establish and enforce collusive outcomes. [8]

⁵ An Anglo-Dutch auction is a two-stage auction, which begins with an “English” phase during which the price is increased until all but a predetermined number of bidders drop out. At this moment (and price), the auction switches to a second “Dutch” phase. In this stage, only the remaining bidders can submit (simultaneous, sealed) bids and only bids above the price at which the English phase stopped are allowed. The Anglo-Dutch auction fosters entry and increases the revenues of the seller. [2]

³ Based on personal communication with Dr. Cathal Guiomard.

elements of ascending-price and sealed-bid auctions that should allow capturing benefits of both approaches.

On the other hand, it is also important to understand the political situation and the wider sector context of the auction taking place. No single auction design that was successful in a certain context can simply be transposed to another context. Sequence of auctioning processes may for instance be important, as bidders can learn from previous procedures. In the case of radio spectrum auctioning, the number of bidders reduced over time, as bidders learned that large players were better positioned to win the contracts, and were therefore no longer willing to invest. Therefore, the recommendation of [13] is to start from economic theory on auction, but to invest significant time and effort in understanding the political, regulatory and economic sector context. This is necessary to design a successful auctioning approach.

Within ATC there are two examples of bidding processes: the bidding for centralised services and the bidding for tower control in the UK.

EUROCONTROL has developed the concept of centralised support services in 2012. These are services with strong network character/economies of scale and hence benefit from being exercised at a central European/network level. Nine centralised services were identified and broken down in 18 contracts. Some of these services may and are currently tendered to the market through a public tender process. The tenders included safeguards and contractual provisions to have a good representation of ANSPs (EU and non-EU) in the consortium. This concept might pave the way towards opening up the European ATM market. Eurocontrol estimated that the centralised services could lead to savings of 200 million euro/year. As the process has just started, no results are available.

Tower control is a monopolistic activity considering the fact that one tower controls the traffic around one airport. However, over the past years, a number of airports in Spain, UK, Germany, etc. have appointed the management of their tower control and terminal activities through a public tender process, or have in-sourced them to self-supply. Evaluating this process, airports have cited that tendering led to the realization of cost savings and increased the strategic focus of ATM operations.

C. *Unbundling*

The idea would be to unbundle support ATM activities from core ATM services with a strong network component. There are different, not- exclusive, options to unbundle. There is the option to centralize support services to reduce fragmentation and enable economies of scale. Over time the right to provide these services could be awarded by public tender (similar to option 2). This means that at a certain point of time, there is only one provider (or provider group) of the specific service for a specific period. It is also the option to certify support service providers and to let the market determine who should provide them. In this option different

providers exist next to each other, offering their services for relatively shorter time periods.

[4] also see unbundling of ATM support services as a potential approach to move out of the SES gridlock. They see the centralization of these services at a higher level (for instance Eurocontrol) as a desirable step. However, there is a risk that an even larger operational monopoly is being created which is not in line with the EU liberalization agenda. Another approach would therefore be to unbundle the services, open their provision for competition and let the market determine who provides them.

In the field of simulation and training, some form of unbundling and competition is already present. Another example, within Aeronautical Information, is Jeppesen, SITA and ARINC who are providing consolidated information for airliner and airspace users. Unbundling has also taken place in similar industries such as rail and energy. The electricity sector and rail moved from one vertically integrated monopoly to a system with one “infrastructure manager” and several service providers. These sectors have similar characteristics as the ATM industry in the sense that their activities often require large investments and therefore naturally give rise to the emergence of a natural monopoly. In addition, they are also going through a structural market reform process from national provision by national (monopoly) firms towards a more integrated European market.

The experience of electricity liberalization in Britain has been well documented. [19] states that the British reform demonstrated the importance of ownership unbundling and a workable competition in generation in supply. The standard model of electricity supply in almost every country before liberalization was an effectively vertically integrated franchise monopoly under either public ownership or cost-of-service regulation. Before the reform of the electricity supply industry, pricing may have been sophisticated, investment planning, and in particular investment delivery was poor, slow and costly, and there were few incentives to deliver cost efficiency. Liberalization and restructuring was intended to replace the existing command and control structure with its regulated charges by a decentralized market-driven system that would nevertheless deliver secure, reliable electricity efficiently and at competitive prices. He concludes that, in the UK, privatization of electricity in 1990, combined with unbundling and a transparent wholesale market provided incentives for considerable efficiency improvements. Labor productivity doubled, real fuel costs per unit generated fell dramatically⁶, and substantial new investment occurred at considerably lower unit costs than before the privatization. However, the concentrated market structure also enabled incumbents to retain those cost reductions initially. Hence, initially the prices did not drop. This was due to the fact that only two generators were created, which could have been avoided by creating five generators [17]. Moreover, unbundling and liberalization does

⁶ After the first five years, costs were permanently 6% lower than under the counterfactual continued public ownership.

increase the risk for generators and encourages them to seek vertical integration with suppliers. This offers the opportunity for the regulator to trade horizontal for vertical integration and to reduce concentration – but at the costs of increased entry barriers. [19] argues that it would have been a better alternative to start from a more fragmented structure. In Scotland, where a different system was set up, negligible efficiency improvements were found. One reason was for this difference was that the two Scottish companies were not restructured and remained vertically integrated, making it more difficult for competitors to gain access to their home market.

In rail [23], different approaches (from full separation to partial integration to staying fully integrated) to vertical separation have produced different results, with different impacts on competition. In the UK competitive franchise bidding helped to stimulate market growth and this also encouraged service innovation. However, costs increased substantially since 2000. In Sweden both performance and reduction in delays improved and costs (excluding investments) decreased. Other countries also saw an improvement in service levels and no evidence of an increase in costs.

D. Sector less operations

[11] describes the automated airspace concept for air traffic control, which is one of the building blocks for shifting towards trajectory-based operations. The concept enables significant increases in both terminal area and en-route capacity, while at the same time enhancing safety and flight-efficiency. The key to this concept is automated separation assurance, to relieve controller workload associated with tactical separation monitoring. This will allow them to shift attention to more strategic control of traffic flow, handling of exceptional traffic situations, reroutes due to weather as well as manual separation monitoring and control of unequipped aircraft. The automation of separation assurance removes several operational constraints that limit the capacity and efficiency of today's system. With the reduction of controller workload achieved in this environment, controllers can accept more aircraft in their airspace, along more flexible flight trajectories. The relevant ATM capacity constraint then becomes the physical availability of airspace, rather than the availability of human controllers.

The automated airspace concept requires new components on the ground and in the cockpit as well as a reliable two-way data link for exchanging information between ground and airborne systems. Primary ground-based component is an automated airspace computer system (AACS) that generates efficient and conflict free traffic control advisories, and associated trajectories. The most important technical and operational challenge in designing this system is providing a safety net to ensure the safety of operations in the event of failures of primary system components such as computers, software and data link systems. This includes defining procedures for reverting to safe, though less efficient, back-up systems. The controller will play an indispensable role in this,

by assuming separation assurance responsibility. A Tactical Separation Assisted Flight Environment is a new ground-based system that may assist for protection against near term loss of separation in case of failure of the AACS.

IV. STAKEHOLDER INPUT

The stakeholder input consisted of a workshop with the COMPAIR Advisory Board, face-to-face interviews with selected stakeholders and a survey which was sent out to a broader set of ATM actors.

A. Advisory board⁷

Going over the options for introducing competition, the experts prefer unbundling as they believe it is the most feasible option (technically, economically and politically) to introduce competition in the sector. The idea is that ANSPs focus on core activities (core ATC and Air Traffic Flow Management (ATFM) and delegate provision of ATM support services towards other actors. These support services include elements such as: CNS (Communication, navigation, surveillance), ATM data management and provision, provision of meteorological information, management of infrastructure, management of common network resources, training services, etc. These services could be provided through public tenders (competition-for-the-market) or by letting service providers compete in-the-market. The best option probably depends on the type of service discussed. In addition, it should be noticed that ANSPs may still provide some of these support services themselves if they happen to be the most efficient actor. However, there should be some type of wall within the organization to prevent activities and interests to interfere with each other.

The second option on bidding services may also be relevant in combination with the unbundling of services, but experts do not propose to go for this option as the main one given the fact that is probably very difficult to implement from a political perspective. To be promising, experts propose to disentangle ATM technology/infrastructure provision (ATM capabilities) from the ATM operations/service provision. The first option on changing ANSP governance structure and regulation can give some complementary ideas as well, but is to a certain extent already there today and we should not expect any radical sector impacts from it. The fourth option on flight centric operations is rather different in nature, as it is rather an operational concept that could be a potential competition enabler, rather than a regulatory/policy instrument. In addition, the basic trajectory based operations (TBO) option will probably not be the enabler of radical change and this is the only “uncontroversial” concept. The more advanced option where there are different controllers managing different flights is much more controversial and experts consider it too far-fetched to be considered seriously at the current moment.

⁷ The COMPAIR advisory board consists of representatives from Eurocontrol, two ANSPs, one regulator, one industry association and two academics

B. Interviews

Six face-to-face interviews were made⁸, where each interview focused on a different subject. The goal of these interviews was to get a better insight into a specific subject.

In general, it was stated that it is important to consider the distributional effects of the solutions as an outcome might be beneficial in total, but will not be implemented if there are clear winners and losers. Moreover, one of the obstacles to change is that ANSPs have invested a lot of money in their current systems and will want to use them until the end of their lifecycle. The interviewees did agree that air navigation service provision will face competition in the long term. Small and medium ANSPs should amend their core businesses with additional services like simulation, training capabilities, etc.

With respect to governance the key issue for ANSPs is seen as governance rather than ownership. Whether public or private, ANSPs operating as monopoly service providers must be subject to independent and neutral economic and performance regulation to facilitate cost-efficiency.

With respect to tendering, one should think careful about the advised length of the license. This is linked to the issue of assets and ensured investments. This issue can be resolved via licence conditions that include performance incentives in the regulation. These should take into account that there has to be some return on investment. A “regulated asset base” can protect the investment, subject to a certain traffic risk. The question remains how long of a period you need for the return of investment and if this should be linked to the license period. It was also noted that this option would increase competition not only between ANSPs, but between the states too (which want to keep control over own airspace and jobs). Finally, the tendering process should not limit this to geographical control. It is perfectly possible to control the airspace from a different geographical location, although there is no evidence that a business case would be positive.

With respect to unbundling, it was agreed that there are indeed services within ATM which can be unbundled (CNS, MET, AIS). The question is whether cost savings realised through synergies (by having one provider of each service for various ANSPs) are large enough to outweigh additional coordination costs from separating these services. It was also suggested to link the steps within the unbundling process to the three stages in ATM activities (network management, en-route service provision, terminal service provision).

The flight centric option is seen as an option which is technically feasible and as an option which would decrease the fragmentation of the airspace due to the need for increased information sharing. It may therefore also be more difficult to introduce.

C. Surveys

A short survey was conducted in the period May 2016-July 2016. We have sent out the survey to our direct contacts, including a message that forwarding would be appreciated. The goal of the survey was to collect opinions from a variety of ATM actors and sector stakeholders. We developed a survey that was relatively short and to the point, to maximize the response rate and the collection of information. We worked with scales on which respondents had to indicate their level of agreement with feasibility, (political) acceptability and economic potential of the proposed options. We added open ended questions accompanying the scales, in which respondents could further refine and justify their responses. The complex nature of the topic makes an open survey format more appropriate.

We did not set a specific target in terms of number of responses or response rate. Our focus was rather on collecting in-depth insights from a variety of actors with different backgrounds. In total, we collected 21 replies. 15% of the respondents could be directly linked to European ANSPs. 30% of the replies came from actors in the research and consultancy domain, 15% from airports (including the reply from ACI), 10% from airlines, 10% from industry associations and 20% from a regulatory/government agency.

In general, most of the concepts proposed are considered as technically feasible to implement. Although sector less operations concept raised concerns in terms of safety and performance under various traffic regimes. Political acceptability on the other hand probably depends from country to country and region to region. One policy may be acceptable in one country but not in another. This of course makes it more difficult to come up with solutions which would work at European level. On the other hand, it could give opportunities for more local collaborations and initiatives. But these then have to converge in certain aspects if one wants to end up with an interoperable and integrated European ATM framework. It was stated that many of the options could have positive impacts, but on the other hand also may entail additional costs. So for many options it is not clear what the cost-benefit balance would be and there is a need for a thorough assessment.

With respect to the unbundling of terminal air navigation services it was stated that the political feasibility will be different in different EU Member States. The feasibility and potentially positive economic impact will depend on the specific terminal control area (TMA) and how clear the separation is between tower control (TWR) and approach control (APP). If both activities are integrated, it is probably more costly and more complex to separate tower control and tender it to the market. In addition, it also depends on how both activities are financed. Approach is usually part of the en-route charges, whereas tower control may be recovered through airport charges, may be subsidised by the government or may be recovered through an airport pool (covering several airports: major hub and small regional/local). So separation probably requires a clear distinction in charges for TMA activities. Moreover, unbundling tower and approach services is complex

⁸ Mainly with people from the same associations represented in the AB.

task from an operational and oversight perspective – although feasible. Therefore a well-planned process needs to be put in place for it. In the absence of such a process there is a risk of long drawn-out transitions due to operational, oversight, or other complications. Under an unbundled and tender-based system, technological acceleration in Terminal ANS could deliver major operational and economic benefits to aviation via higher airport performance and runway capacity, SESAR integration, resilience as well as overall contractual performance guarantees. The example of the UK is given for which it is argued that competition has delivered the most efficient runway utilization in the world. In all, unbundling of terminal air navigation services is considered as feasible and will probably have positive economic and performance effects.

With respect to the unbundling of contingency services most actors indicate that this would be feasible, only some ANSPs are more reluctant due to additional layer of complexity and coordination. Moreover, costs should not be underestimated as it may require hiring and training additional ATCO staff, develop appropriate communication, navigation and surveillance systems, etc. So question is on whether positive effects would outweigh the additional costs. The size of the benefits probably depends on the scale of operations of the ANSP. The benefits are probably more important for smaller ANSPs, as they have less possibility to organize contingency internally. For larger ANSPs, on the other hand, it is easier to organize contingency internally and more costly to align systems with those of an external provider. Moreover, this option also faces legal issues, linked to airspace legal liability and international security concerns. Finally, this option could also lead to social tensions as it may be perceived as a first step towards centre consolidation.

With respect to the potential of unbundling ATM en-route support services, survey respondents estimate the share of support services costs at about 20% - 40% of ATM costs en-route (rather 20% than 40%). Most respondents see the highest potential in unbundling of MET. But there are respondents who disagree; some respondents think that there is more potential in the unbundling of CNS (infrastructure management) activities or in the unbundling of AIS. In general, there is agreement on the fact that MET, CNS and AIS should have higher priority for unbundling than more strategic activities such as airspace organization and airspace management. In the end, this should boil down to a strategic choice made by the air navigation service provider, unless it is mandated in some way by a regulatory/governance body. If the service has the appropriate incentives, he will probably make the correct choice himself.

With respect to the tendering and organization of bidding processes for awarding en-route ATC operating licenses one respondent mentions that states have already the freedom to tender ATS services today, but they do not use this possibility in practice. Hence there should be an obstacle explaining why states do not implement it and we should propose a way to overcome this barrier. The fact that this option does not necessarily affect the number of air traffic control areas is seen as a problem because fragmentation is one of the underlying

causes for inefficiency. On the other hand, some respondents also argue that this approach may over time lead to an oligopoly of providers and leave us even worse off than we are now. Another criticism on this option is the fact that long-term incentives may be jeopardized as ANSPs will be focused on winning short-term contracts and may refuse to make long-term investments. Another respondent comments that movability of trained controllers would be a major blocking factor, next to ownership issues and infrastructure.

With respect to sector less operations, we felt that respondents were reluctant to provide feedback as they are not fully familiar with this concept. Overall, they stress that the safety case needs to be seriously considered under various traffic conditions (also heavy traffic). In addition, operational and economic benefits of this operational concepts need to be proven

V. QUALITATIVE ASSESSMENT - CONCLUSION

The table below gives an overview of the qualitative assessment of the options discussed above. This assessment is based on the literature review and the stakeholder input discussed above.

TABLE I. SUMMARY OF QUALITATIVE ASSESSMENT (1= POSITIVE – 4 = NEGATIVE)

| | Option 1: Perf. Reg. | Option 2: unbun- dling | Option 3: tendering * | Option 4: sector less |
|---|----------------------------|------------------------------|-----------------------------|-----------------------------|
| Technologically feasibility | | | | |
| Is the technology there to realise it? | 1 | 1 | 1 | 4 |
| Time scale necessary for implementation | 1 | 2 | 3 | 4 |
| Economic feasibility | | | | |
| Possible cost reductions | 3 | 2 | 1 | 1 |
| Cost of introduction | 1 | 2 | 2 | 4 |
| Effect on performance improvement incentives | 3 | 2 | 1 | 1 |
| Potential negative side effects | 2 | 1 | 3 | 3 |
| Regulatory feasibility | | | | |
| Easy implementation | 1 | 2 | 2 | 4 |
| Acceptability | | | | |
| By nations | 1 | 3 | 4 | 2 |
| By ATCO's | 1 | 1 | 4 | 3 |
| By other ANSP personnel | 1 | 3 | 4 | 2 |
| By airlines | 1 | 1 | 1 | 1 |
| Impacts | | | | |
| Impact on capacity | 3 | 2 | 3 | 1 |
| Impact on safety | 1 | 1 | 1 | 2 |
| Impact on environment | 3 | 2 | 3 | 1 |
| Social welfare | 3 | 2 | 2 | 1 |
| Distributional impacts | 3 | 3 | 3 | 1 |
| Contribute to defragmentation/realisation of economies of scale | 4 | 2 | 2 | 1 |

* tendering of the entire ATM services

Overall, we conclude that we do not expect any dramatic performance impacts of performance regulation. On the other hand, the implementation of any proposed changes may be immediately feasible at short term and relatively low costs. Hence, it is still an interesting option to further include in our analysis. Sector less operation, on the other hand, could have strong and positive impacts but still faces significant challenges from a technical and implementation side. For instance, safety concerns are not out of the picture for the moment. Unbundling seems rather promising as it does not face any challenges that are difficult to overcome. Many ATM experts and sector stakeholders also consider this option as the most attractive option for introducing elements of competition in the provision of ATM activities. Moreover, it has been relatively successful in other sectors. For tendering, in contrast, political acceptability and social tensions are probably the main barriers. It is also not clear if within this option ANSPs will have an incentive to behave cooperatively if they need to collaborate in certain areas (increased information sharing) and compete in others (for ATS licenses).

For further – quantitative – assessment the four options are retained, given the expected trade-off of potential effectiveness and acceptability.

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