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Enabling Air Traffic Management (ATM) Data Services: Main Takeaways from the Second Virtual Workshop

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Highlights: ATM Data Service Provision in Light of Covid-19

Over the past two years (2018-2019) European aviation has been confronted with serious capacity challenges and high levels of delay. Subsequently, the Covid-19 pandemic has revealed that the European airspace system lacks resilience and the ability to absorb demand shocks, be these in the form of increases or drops in air traffic. The provision of Air Traffic Management (ATM) data services holds the potential to boost the system's resilience while enabling the development of virtual centers. Virtual centers, in turn, can make it possible to shift capacities in times of crisis of the kind we are facing today, where, for instance, a significant reduction of the capacity in one center may be needed. Building upon the first workshop on Enabling ATM Data Services, this second workshop aimed to share the latest progress made on the European Commission's study as well as to provide an opportunity for an open discussion with key stakeholders. This brief summarises the presented results and captures the main reactions received to the study.

Introduction of the Foreseen Possible Service Delivery Models for ATM Data Services

Service delivery mechanisms are logical models for the organisation of ATM Data Service Providers (ADSPs) in the future and are used to structure the Impact Assessment and the analysis of the different policy options related to ATM Data Services (ADS). Service delivery mechanisms build upon the definition of ADS (presented during the first workshop), and analyse how they might be provided in the future EU context. The adoption of certain service delivery models is not prescribed, but rather comes down to the business decisions of various actors. Three of the service delivery models originate from the Airspace Architecture Study (AAS), whereas the study team has proposed two additional models, namely the 3 Layers Model and the Union-wide Model. The models form the basis for the Impact Assessment given that they refer to the organisation of the ADSPs, which may provide multiple services. The study team also examines whether the models may coexist in parallel, whether there may be any interferences or hindrances for Air Navigation Service Providers (ANSPs), and/or if the models correspond to milestones or phases of a transitional process on a longer time period. Ultimately, service delivery models may require EU policy and legislative actions to be adopted, in order to be fully enabled.

Five different service delivery models have been defined besides the status quo, each of them with its own set of characteristics, after which they are named. Since there are many similarities between the models, the borderlines between them are at times blurred. Firstly, the 'Alliance Model', as apparent from its name, builds on the idea of ANSPs joining into alliances and delivering ADS or a sub-set of ADS to their members. A core assumption here is that ANSPs are *primarily delivering ADS to their members*. In this model, ANSPs remain vertically integrated and retain full control over their entire value chains, i.e., service delivery is entirely based on collaboration and the 'alliance' agreement. From a service delivery standpoint, some capabilities or systems may be transferred to the alliance based on the decisions of the members. The level of integration and data sharing is thus entirely dependent on the alliance decisions. From a technical viewpoint, the system architecture is not changed substantially, as alliances are being formed around the same ATM systems to reduce complexity and to enable better connection of systems, while avoiding huge development costs. If the different alliances use different systems, however, this may create a sort of 'lock-in' situation, making it difficult to switch from one alliance to another. What is more, the underlying infrastructure is not affected significantly apart from a limited rationalisation depending on the ambition of the alliance members. Alliances may range institutionally from loose cooperation to a joint venture or a special purpose company. Business models, therefore, remain largely intact. These developments do not alter market structures and there is no market or competition for ADS, since alliances are providing services primarily to their members.

The defining characteristic of the 'Separated Model', on the other hand, is that the boundary between Air Traffic Services (ATS) and ADS is clearly defined, whereby ATSPs 'purchase' data services from ADSPs. Data-related services, however, remain vertically integrated under this model. ADSPs may serve multiple ATSPs if they have the geographical coverage to do so, in terms of raw data. However, data production and data processing are not decoupled here, meaning that obtaining this geographical coverage for ADSPs may be challenging. Vertical integration is reduced by the distinction between ATS and ADS, but not fully split because of the integration of data services. The split between services, however, is introducing a split in the architecture between ATS and ADS, which, in turn, needs to be handled from an interoperability and technical standpoint. The boundary between ATS and ADS would be drawn at the level of the radar screen. In other words, it is not foreseen that the ADSP would provide the entire controller working position including all the hardware, so a certain level of configuration and set up would remain with the ATSP. This model assumes a departure from the traditional way of developing ATM systems. From the market perspective, a new market layer is created by way of distinction of services. The competition here will be limited due to the vertical integration of data production and data processing, and if geographically-fixed infrastructure is transferred to independent ADSPs then consolidation may occur on the level of this infrastructure.

The main trait of the 'Specialised Model' is that the data production and data processing layers are split. The Specialised Model is the first one where these are introduced as possibly different services, though they are not differentiated on the level of regulation. This model introduces the notion of *specialised ADSPs*, focusing only on data production or data processing. New surveillance technologies and platforms emerge, which enable independent data producers to enter the market, and ADSPs to focus on data processing only. However, the integrated data providers still have significant market powers. However, if there are independent surveillance data providers and other raw data providers it may happen that ATSPs purchase services from more than one ADSPs. From a technical viewpoint, the newly emerging technologies and platforms also bring new interfaces with the creation of specialised data producers. New interfaces between data producers and data processing providers will, therefore, have to be addressed. This allows for a certain level of rationalisation of geo-fixed infrastructure, which may be triggered by these new specialised players. From the market structure point of view, more agile and efficient providers may enter the data services or data production market, which creates a less concentrated market. However, the positive effects are limited given that incumbent providers may still be able to abuse their market power to squeeze out new entrants.

In the '3 Layers Model', the boundaries between the three service layers are clearly defined, creating two new ‘markets’: one for data production and one for data processing. This creates a more complex landscape for service provision introducing more interfaces, not only between the different layers but also within the layers. ADSPs may avail themselves of the services of other ADSP, which is the result of the specialisation in the data processing layer. The 3 Layers Model will thus require an entirely new systems architecture based on a more open and more modular design, capable of connecting to different models and applications easily. From a market perspective, the data production competition is determined by infrastructure ownership and the emergence of new technologies mentioned above. For data processing, new entrants can enter the market, which in turn allows for more specialisation and competition.

Finally, the 'Union-wide Model' is essentially the same as the 3 Layers Model, but additionally introduces the notion that *certain sub-services are provided on a Union-wide basis*. The Union-wide model is of particular interest because of its important rationalisation potential. If there is Union-wide service or sub-service layer then actors would need to be able to connect to it both upstream and downstream. Some technical decentralisation will be necessary to ensure redundancy, safety and security of the Union-wide service. As regards the market structure, since the Union-wide services are considered fully integrated horizontally, this essentially eliminates competition on that layer. If the solutions behind Union-wide services are tendered and provided by sub-contractors, this may periodically create competition for the market meaning that for a given time period there may be competition between sub-contractors to win tenders and to provide the technical background of the services.

Some stakeholders underlined that, regardless of the service delivery model used, the provision of ADS could entail safety issues as data needs to be transmitted from the production to the data processing, and onto the final destination. If not yet defined, data quality requirements will need to be established and then assurance will need to be shown by the ADSP to ensure that the data is compatible with its intended use. On interface, “safety at the interface” is a critical issue. Therefore, even if not the main focus of the study, this should be an element for consideration.

All in all, as we move towards the more layered service delivery models, it can be said that the level of complexity progressively increases due to the introduction of new players. However, the more layered service delivery models are also associated with an increase in the network-level benefits in the form of higher flexibility, scalability and resilience of the system.

Regulatory Aspects

The approach to economic regulation would be that it is independent from the business model chosen by the ATS providers with respect to ADS. Since ATS is based on designation, it would be subject to economic regulation, and the costs of the ATS would include the costs of underlying layers necessary for the provision of ATS.

Introduction of the Potential Use Cases of ADS and Their Respective Benefits

The study has sought to link up the service delivery models and underlying services they represent to the respective performance benefits. This is where the potential use cases of ADS come into play. The AAS looks at two sides of a coin: the dynamic optimisation within airspace capacity on the one hand, and at the scalability and resilience of the system on the other. The use cases of dynamic optimisation need to be understood on a network level ideally. A number of use cases have been identified, which build upon work done in the context of SESAR.

Firstly, 'baseline use cases', which can already be done today to some extent, include the shared development of systems and processes, shared R&D activities, and shared training platforms. It is important to note that the study refers to the shared development of the above systems and R&D activities *as a service*. This, in other words, presumes there would be an entity in charge of the system development as a service for the ANSP. Thus, the study does not refer to the actual development done by the system manufacturers (i.e. SESAR) but rather to the work done within the ANSPs on day-to-day basis, when technical staff within ANSPs are seeking to specify the functions of these systems and to translate these into technical specifications for the system manufacturers. This can be done jointly as a baseline use case, but also a service and cooperation. Some level of market defragmentation may be foreseen but this may not necessarily be a negative development if it drives efficiency gains. In sum, baseline use cases do not necessarily impact the ATS and there is no dramatic change from the current setup. ADS may reduce setup costs for the cooperation as well as transaction costs, while leading to a more coherent organisation. The baseline use case may entail some smaller efficiency benefits if system development is managed by an ADSP for multiple ATSPs.

The 'non-tactical use cases', on the other hand, do impact ATS, however, the impact is non-time critical in terms of contingency operations and planned delegation of services, such as night-time operations. Here, it is important to note that we are not referring to the delegation of ATS units but to the delegation of *airspace* (i.e., the service which is provided to the airspace users in that given airspace). This use case assumes ADS provision is done in a controlled manner and does not allow for a dynamic optimisation. This results in benefits in terms of resilience and capacity, however, these are 'event-based' as ADS is done in a non-tactical manner. On a day-to-day basis, therefore, the capacity and resilience benefits linked to this use case are not substantial, and may not suffice in coping with unplanned changes. In terms of the relationship between actors and the decisions that are taken regarding infrastructure, important efficiency benefits can be unlocked on a wider scope, if there is a shift towards ADS from bilateral agreements.

The 'time critical use cases' attempt to move the place of ATS in a time-critical manner, meaning that it could include a contingency between two parties or dynamic cross-border airspace adjusted to demand and optimising rostering between two ANSPs or flight information regions (FIRs). These use cases introduce a level of complexity and stringency of requirements that will necessitate greater attention to the interoperability of the parties and to their ability to meet these requirements. For instance, a common technical platform shared by the parties along with consistent data treatment may be needed. If it is bilateral (and done contractually) the level of complexity in implementing this for a truly dynamic optimisation may be higher. ADSPs can unlock these benefits without the need for a shared platform, however, the interoperability and other requirements might drive certain behaviors. The capacity, scalability and resilience benefits here, once again, are limited and only local in scale, given that ADS is operated bilaterally, and not on the network level.

Finally, there is the 'virtual center use case', which introduces the notion that more than two parties can provide non-dynamic optimisation, and eventually dynamic optimisation and capacity on-demand initially at the local or regional levels, and subsequently at the network level. The virtual center use cases, as well as other service delivery models or use cases, rely on a high level of interoperability, data consistency and flexibility in cooperation. An EU-wide approach to ADS stands to unlock the full potential of the benefits, which, in turn, increase as the level of dynamic optimisation increases. In order to realise the full potential of virtual centers, a data layer and logical split between services will be needed to avoid lock-in within any particular solution of a virtual center. Interoperability needs to be mandated to standardise interfaces between different ADSP as well as between ADSP and ATSU.

While the study has focused on the legal, economic and regulatory aspects related to each of the use cases, an attempt has been made to also identify the operational, technical and interoperability implications. In theory, some of the above-listed use cases are possible with bilateral cooperation and many ANSPs have, in fact, already set up delegations of airspace in Europe to optimise their operations across borders. Some barriers can be foreseen as we look to the dynamic optimisation across the network and these may increase as the scope of complexity intensifies. As we move beyond pure bilateral arrangements on a local, regional, and eventually on the network level, tackling the interoperability requirements, for instance, becomes less about a contract between parties and more about the Union-wide aspects.

Preliminary Findings on Interoperability and Interfaces between Service Layers and ADSPs

The study has sought to identify the minimum necessary requirements to ensure that ADSPs can operate in an interoperable manner in respect of interaction with other ADSPs or with ANSPs. Furthermore, the study has attempted to define the principles for interoperability required in a pan-European market for ADS and in the context of capacity on-demand. As mentioned above, the interoperability requirements become increasingly important as we move towards the more advanced, complicated models, in order to make ADS a reality and to ensure that any new market entrants will have knowledge of what is required to provide the service.

The study maps out existing EU legislation and seeks to clarify whether or not it supports the interoperability requirements for ADSPs. The EASA Basic Regulation 2018/1139 essentially provides a sufficient framework that could support and mandate aspects of interoperability, though it would need a number of amendments. In particular, essential requirements for ADSPs would need to be integrated into the Regulation. A new type of service would need to be introduced to Annex VIII, and the essential requirements for ATM/ANS systems and constituents would need to be modified. Whereas the basic framework provides for the mandating of interoperability, Delegated acts on certification and declaration would need to be developed. Until then, the principle of declaration as used under Regulation 552/2004 would continue to apply. Implementing Rules and Detailed Specifications would be needed to provide guidance for how to conform with Essential Requirements.

The study, furthermore, identifies four main categories where interoperability will be required in order to enable service delivery models. Firstly, standards will be needed for information exchange, which would create a boundary with the applications that rely on the middleware layer and ensure a decoupling of the applications from the technology. Second, standards for data contents and data quality are needed, which define a minimum set of data elements to be provided for an entity (e.g., flight object, system track, etc.), optional data elements and the data quality requirements associated herewith. Third, standards for end-to-end interoperability between applications, defining how data is to be exchanged (e.g., the process of transferring control from one ATSP to another ATSP, moving sector from one ATSP to another, exchanging flight data between ADSPs, etc.). And lastly, standards mandating certain operational concepts at the level of ATSPs (specifies the functional attributes of a service, potentially provided by an ADSP or established by an ATSP based on services from one or more ADSPs). Existing standards and specifications have been considered and cross-referenced with the above four categories. It was found that some of the existing standards may actually cover more than one of the targeted layers. Notwithstanding, the existing standards will need to be revised or complemented.

According to the study team's preliminary assessment, certification would probably require a higher level of trustworthiness and visibility of the basis for conformity. Moreover, it would offload ATSPs from tasks related to ensuring capabilities of organisations and verification of conformity of suppliers' products (ensuring more harmonised approach). On the other hand, certification may be more complicated and discourage new market entries, thereby increasing the cost of the 'system'.

The EASA Perspective on Interoperability

Interoperability is a one of the elements, among safety, security and performance, needed to ensure effective and seamless operations. Interoperability is thus not to be seen as an isolated characteristic and requires a systems-approach. Such an approach is key to ensuring compatibility with ground, airborne and satellite constituents, as well as the safety and reliability of the operation. The concept of a conformity assessment is used to refer to a set of processes that demonstrate that the above-mentioned essential requirements are met. When we talk about ADS, there is more to take into account than mere interface requirements, namely the operational and performance objectives. These need to be combined with the technical and safety requirements. In the case of ADS clear data input and data output requirements need to be defined.

The EASA perspective echoed the study team's conclusions in that the introduction of ADS does not dramatically change how we approach interoperability issues, though it calls for minor adjustments in existing legislation to cater to the specificities of ADS. The EASA Basic Regulation (2018/1139) already introduces the high level objectives and principles to ensure interoperability. This Regulation has introduced several options that can be used for the conformity assessment. Article 46 of the Regulation, in particular, foresees Delegated Acts to be developed in the coming years, which could enable opting for several options: firstly, ADSPs to declare the compliance of the systems and constituents with essential requirements. This is, in fact, what has been done since the initial interoperability Regulation was adopted back in 2004 with self-declaration of conformity by providers and manufacturers. Secondly, under the certification option, delegated acts may require certification of certain constituents. Thirdly, the organisations involved in the design, production or maintenance may also need to declare compliance.

All three options are now being assessed under a task force, Rule Making Task (RMT) 0161. The timeline for the development is in accordance with the European Plan for Aviation Safety (2020-2024). A proposed amendment is expected for Q3 of 2021. An EASA opinion is then expected to be sent to the European Commission by Q3 of 2022. The proposal should result in conformity assessment rules to replace current rules dating from 2004. It is anticipated that the detailed rules should be in place by September 2023.

Preliminary Findings on the Certification and Oversight of ADS

The existing common requirements have served as the basis for the analysis of the new specific requirements for ADS, in particular related to service quality, resilience, and continuity of services. Once again here the two main Regulations were studied, namely the EASA Basic Regulation (2018/1139) and the Common Requirements Regulation. While Regulation 2018/1139 established a high level framework for certification and oversight of ADSPs, it is clear that ADS would need to be defined as a separate service with its associated essential requirements. The study team has put forward some essential requirements for ADS with a focus on data and services to be included under Annex VIII, Section 2 on services of the EASA Basic Regulation. In the main body of the Regulation 2017/373 (on the common requirements), changes will be needed to reflect ADS as a concept through the amendment of Articles 6, 8 and 10.

The data used as a source for the provision of ADS needs to be of sufficient quality, complete, current and provided in a timely manner, which is to be set out in the EASA Basic Regulation. This would oblige ADSPs to ensure that the data they use in their services, coming from data producers (e.g., surveillance services) or other ADSPs is fit for purpose. The provision of ADS, moreover, needs to be precise, complete, current, and unambiguous to meet the safety needs of users. This, in turn, would require ADSPs to ensure that the services they provide do not affect the safety of the users of their services, be they ATSPs, other ADSPs or airspace users. Tools and applications used for the provision of information or advice to users should be properly designed, produced and maintained to ensure that they are fit for their intended purpose. The communication between ADS and between ADS, ATS and aircraft needs to be timely, correct and unambiguous, protected from interference and, if applicable, based on agreed standards. This would place an obligation on the ADS to ensure the quality of service of their data communication means, either own or contracted.

Further discussion will be needed to determine the competent authority for certification. The preliminary assessment finds that granting the competence to EASA would help to secure a harmonised approach across ADSPs, thus eliminating dependence on the varied capabilities and interpretations of different national supervisory authorities (NSAs) of the Member States. This, in turn, could help to create a level playing field between ADSPs and thereby foster the establishment of favorable market conditions for ADS provision. At the same time, applicants seeking certification could have the choice between EASA and the NSA as certifying authority. Requirements would also be needed to oblige ADSPs to report to their service users and to the competent authority in case of a non-specified behavior of their service.

Last but not least, transitional arrangements in cases where data or services from non-certified ADSPs has been used will require further examination, and the split of responsibilities between ADSPs and ATSPs will have to be determined. For a certain time period it could be expected that ADSPs would operate under previous ANSP certificates.

EASA Perspective on Certification and Oversight of ADS

The discussion on certification is similar to that on interoperability, as it is based on a uniform set of requirements applicable in this case to service provision and not to systems and constituents. As for interoperability issues, the approach and high level objectives specific to certification are contained in the same EASA Basic Regulation (2018/1139). The difference here is that the implementing rules and essential requirements for ATM/ANS are already in place in the Regulation EU 2017/373. Certification and oversight by a competent authority are key to ensuring safe, high-quality provision of services and to allowing mutual recognition of certificates throughout the EU. This, in turn, should also increase the freedom of movement and the availability of those services in the market.

The competent authority is the organisation responsible for issuing the certificate for service providers and also for the continuous oversight after the certification has been issued. Thus, enforcement mechanisms will also be needed. The way this is approached in the Basic Regulation 2017/373 is that EASA is the competent authority for pan-European services, including the Network Manager and the Data Service Providers. In the context of this Regulation, it is important to note, however, that the term Data Service Provider refers to providers of 'aeronautical database services' to be used by certified applications onboard an aircraft. It is, therefore, important that the introduction of the ADSP concept is done in a manner that prevents confusion amongst both types of service providers.

EASA is the competent authority for non-EU providers, whereas the NSAs are the competent authorities for organisations having their principal place of operation or registered office in a Member State, unless EASA is the competent authority. The application of Articles 64 or 65 in the Basic Regulation enable Member States to transfer responsibility for certification and oversight to EASA. Article 65 also opens the door for organisations operating in more than one Member State to transfer certification and oversight responsibilities to EASA. The existing regulatory elements would, however, need to be amended as to Annex VIII of the Regulation 2018/1139 and Regulation 2017/373.

In addition to Common Requirements for Service Providers in Annex III of Regulation 2017/373, Annex IV to Annex XII of Regulation 2017/373 contain specific additional requirements that are applicable to certain types of service provision. Since requirements are defined for each type of service, it would be possible for providers to be certified for a range of different services. However, that would require them to demonstrate compliance with all the requirements applicable to the different activities. Only organisations that can manage safety risks are required to have safety management systems in place. These include operators of aircraft, training organisations, approved maintenance organisations, ATSPs but also States. Other providers in Regulation 2017/373 are required to perform a Safety Support Assessment (Sub-part C of Annex III of the Regulation). For any change to the functional system involved in the delivery of the data service, the Safety Support Assessment as referred to in Sub-part C of Annex III, as an additional requirement to those set out in Sub-parts A and B, is the means to provide assurance that the service will behave and will continue to behave only as specified by the ATSP.

The approach for ADSPs could be similar to other services today under the overarching responsibility of the ATSP to conduct the safety assessment, in accordance with the principles in Regulation EU 2017/373. The interface between the ATS and any other support ANS (CNS, MET, AIS, NM, and potentially tomorrow ADSP) would need to be well defined between the parties in a Service Specification. The Safety Support Assessment produced by the support service provider would feed into the Safety Assessment of the ATS provider. A key enabler is considered to be a clear definition of the scope of the different services. While certification is possible for several different services, it should be done in a discrete and non-overlapping manner to ensure legal certainty.

A number of participants expressed concerns that safety and cyber security issues were not sufficiently addressed in the certification and oversight sectors, though they are set to gain in importance with the trend towards growing digitalisation and ATM systems running safety-critical operations. ADSPs, in future, may be delivering pan-European services, which cannot be sufficiently addressed with a safety support assessment as provided for in the current context of Regulation 2017/373. In view of this, participants stressed the need to consider a mandatory implementation of the safety systems as well as of software safety assurance for ADSPs. It was, subsequently, clarified that the current requirements in Regulation 2017/373 do, in fact, include security requirements (in Sub-part D, Annex III), which are applicable to most service providers, though not all. In addition, since its last amendment, cyber security aspects are explicitly defined in the Regulation.

With a view to allow ADSP to offer competitive prices for their services, the cost of access to raw data, so the input data for ADS should be regulated and be set at marginal cost. The cost of the ADS service itself would not be regulated directly. It would be an element of the cost of the ATSP which is the one that will be regulated.

Finally, there was overwhelming support for the work done by the study team as regards the need for an adaptation of the regulatory framework to accommodate the introduction of ADS. Among other rules, the EASA Basic Regulation and Regulation EU 2017/373 would need to be amended. Several aspects will have to be defined, including the requirements applicable to ADSPs, transition mechanism for current providers (that today perform functionalities which will eventually fall within the scope of ADSPs). In terms of the timing of the regulatory process, it was clarified that firstly the concept of ADSP should be taken forward in the future Single European Sky (SES) basic framework. In parallel, and as demonstrated by the presentations on certification, changes will need to be made to the EASA Basic Regulation. These will be presented to the European Parliament and Council as a package this year. After the adoption of the basic rules, the work on the Common Requirements Regulation can begin. While the aim is to finalise all work before the start of next Reference Period, it would have to be implemented step by step.

Liability Aspects of ADS: A Presentation by HungaroControl

Complexity, legal uncertainty and safety management are key elements when talking about liability aspects of ADS. The main objectives of the liability framework are to ensure and enhance safety and security through using liability as an incentive for the provision of safe services and products. Second, the liability framework aims to secure the possibility of fair and timely compensation to those who have incurred damages through a clear liability framework. Thirdly, it aims to provide legal certainty to entities involved in ATM service provision in respect of their liability exposure. Most importantly, when talking about liability systems it needs to be clear who is liable for what and what is the applicable law.

There is no EU law or international regime covering ANSP today, and the liability landscape is fragmented. The liability regimes vary based on the EU Member States' legal and constitutional approaches. ATM is inherently a complex system, especially when it relates to cross-border services. This, in turn, makes it difficult to identify risks and attribute tasks and responsibilities to the entities involved in managing those risks. Damage claims may arise from physical and mental injuries, death, damage to property and even ATM delays.

While States have an international law obligation under the Chicago Convention to provide ANS, this fact alone, does not clarify the ATM liability framework. Cases like the Überlingen or Linate accidents are illustrations of the legal complexity surrounding ATM liability. These are the so-called traditional complexities of ATM. The Überlingen accident, for instance, resulted in a complex web of litigations, civil and criminal procedures, involving procedures before Swiss, Spanish and German courts and a involving a variety of defendants (i.e., an airline, an ANSP, a controller, ANSP managers, a technology provider, a maintenance provider, and even a State). A wide range of liabilities were touched upon at these proceedings, including safety and criminal liability, strict liability, precarious liability, product liability as well as organisational and corporate liability among others. The lack of harmonisation in respect of insurance coverage is very visible in Europe today, and we can count up to 12 different types of insurance covers across the different ANSPs. Traditional liability concepts such as the effective Service Provider Doctrine or the Territorial State Doctrine are becoming outdated and are thus insufficient to handle the current situation. Liability is becoming increasingly fragmented and is shifting away from the States towards all the entities involved in ATM today.

In addition, there is the so-called 'new complexity' in ATM, which is linked to technological developments. Digitalisation itself is an important contributor to uncertainty. Liability may be gradually transferred to the technology developer and the virtual infrastructure providers. Product liability (e.g., liability for software defects) is growing in significance and it is not always clear whether software is a service or a product. Digital technologies have some inherent characteristics that increase this liability. These include considerations of data quality and integrity, increasingly automated decision-making and greater complexity resulting from the change of the human role. While digitalisation may increase the overall performance of systems and reduce human workload, it usually does not reduce legal and task complexity. A good example of such task complexity is the human supervisory role, which opens up the question of when it should be appropriate humans overrule the machine, and when the judgment of the machine should be applied instead of that of the human supervisor.

In the case of autonomous system defects, we may face a situation when these are not attributable to human error at all.

Geographical complexity is also increasing. Some business actors operating in the value chain are often subject to the legislation of third countries. Sometimes it is considered that the related risks are only theoretical but this is clearly not the case in aviation. The combination of the above make it increasingly difficult to identify the cause of damage, the liable entity, the applicable law and the competent court. It is, therefore, important to look at the wider perspective. There is ongoing work at the EU level, which focuses on different aspects of the data-driven economy, including its legal aspects. The EU is working to facilitate the uptake of emerging digital technologies by creating a clear safety and liability framework.

Considering the current fragmentation of the EU liability system and its roots in the different legal approaches of the Member States, the creation of a uniform EU liability framework will be challenging if not unfeasible. However, some of the gaps in the current legal framework could be filled. Firstly, we need to identify a number of principles and objectives that could drive legislative work in future. These include the clear allocation of liability, establishing a clear link between safety and liability, and the need for fair and certain compensation mechanisms. Potential measures in near future could include the development a detailed ADSP and ATM risk register to facilitate the optimal allocation of liability. Considering the fragmented nature of ATM liability today, the establishment of a dedicated EU ATM liability data base could help to create a higher degree of legal certainty. The operation of such a data base could be facilitated through the introduction of an obligation for States to report their approach on ATM liability and the applicable international arrangements.

Existing literature today is not conclusive as to whether the Montreal Convention should be applied in case of accident caused by an ANSP. This uncertainty makes it difficult to sustain fair compensation mechanisms. The introduction of obligatory liability insurance cover and the definition of the minimum level of protection for ADSPs would facilitate the process. Considering the fact that ATM service provision is closely linked to State sovereignty today, it needs to be clarified to what extent State liability for ANS provision needs to be privatised. In sum, the proposal for a mandatory insurance obligation for ADSPs was welcomed by participants, while acknowledging that the current discussion around enabling ADSP should not seek to resolve longstanding issues of the ATM liability landscape.

Preliminary Results on Insurance and Liability from the Study

The data provider elements, central to the discussion on enabling ADSP, will likely complicate what is already a highly complex ATM liability and insurance system. An assessment of existing agreements between Member States and ANSPs reveals their 'basic' nature, given that liability issues are only addressed in a superficial manner. The SES Legislative Package does not provide substantive rules on the liability of ANSPs, nor does it establish provisions to resolve conflicts of laws or jurisdiction. As such, it does not provide a sufficient framework for the liability of ANSPs on the EU level. It might follow that agreements that were in place in 2004 are still effective in order to address these SES package 'gaps'.

The liability provisions of the sampled agreements are based on the so-called 'territorial model'. Under this model, claims are addressed to the State that has delegated ANS to another State. Thus, in relation to an incident occurring in State A, where compensation is sought, the claim will be brought against State A. If State A in relation to the relevant airspace had delegated the ANS to a certified entity in State B, then while State A is liable to pay the compensation, State B would indemnify and so cover the payments made by State A.

The FABEC agreement presents elements of the alternative model, which is based on the same core principle (i.e., State A delegating ANS to State B, and State B indemnifying State A), however, the additional element is the obligation on State B that the ANSP is paying the compensation. State-to-state relationship has been the base of agreement, and in the given example, it would be the ANSP in State B paying the compensation for loss and damage suffered. There is also an obligation within the FABEC agreement that State B requires the ANSP in State B to take out an adequate insurance coverage for liability incurred. This, in turn, raises an interesting question as to whether it is up to the ANSP in State B to seek insurance from any market operator, and to what extent an insurance provider (be it in State A, B, C or even in a non-EU country) would be willing and able to provide the insurance. Another element coming out of the FABEC agreement is that the ANSP as an entity, which may in future be privately owned, even if State-licensed, may not be able to pay the compensation which is demanded of it and perhaps its insurance coverage may be insufficient to cover the amount through insolvency issues. In this case, in the FABEC agreement, State B is expected to act to the default insurer, meaning that the fundamental relationship where State B indemnifies State A is still valid (i.e., State A's risks are covered when delegating responsibilities to State B).

In the context of ADSP, yet another level of complexity is added given that a third Party is providing data. None of the agreements reviewed to date address the case of an ANSP outsourcing or delegating some of its services to a third Party (in this case an ADSP). This element is omitted from existing agreements between Member States. On this note, it was pointed out that Regulation 2017/373 contains provisions requiring ANSP to have insurance to cover all liabilities related to the execution of their tasks, and more concretely related to outsourced activities or activities managed through a contractor. If the same requirements could apply to the relationship between an ANSP and ADSP, part of the open questions may be answered.

The insurance industry is already engaged in the intellectual and practical exercise of providing insurance to ANSPs. An analogy was drawn to the autonomous vehicles sector, where liability and insurance aspects have been under consideration for over 10 years now, and it is still unclear how the issue will be addressed by the insurance sector. The insurance treatment of Uber drivers is still not clarified either. In view of this, the study supported the introduction of some sort of mandatory coverage regime, as suggested in the previous presentation.

Some stakeholders were of the opinion that over the past decade the liability towards the passenger and third Party on the ground, has found a solid legal framework in Regulation 2027/97, which transposes the Montreal Convention in the EU. This legal framework (based on a mixture of no-fault liability and fault-based liability) has solved the applicable law issue and all other major issues including insurance related to accidents. Moreover, it was noted that the insurance market has responded well to the accident-related issues, whereas the legal insurance requirements for airlines have been much lower as compared to what airlines actually take out as insurance. Others, however, noted that even if the Montreal Convention is replicated in the EU context, the question of liability would still remain crucial, and thus necessitating a clear allocation of liability.

Whereas the presentations primarily focused on State and ANSP liabilities, a question was raised as to whether it would be an option to address liability issues in the contractual provisions between an ANSP (as the client) and ADSP (as the supplier). As already acknowledged in the study with regards to use cases, contracts can indeed resolve many issues, however, these are limited to issues relating to the Parties to that contract, thus leaving out issues related to third Parties (i.e., non-signatories). Therefore, in order to enable ADS a clear allocation of liabilities will be needed, which, in turn, remains a regulatory task.

Lastly, a number of stakeholders cautioned against the risk of ADSPs, who would be providing only a low margin element of the financial equation, becoming discouraged from providing services because of the insurance premium price. Others pointed out the requirement for the CNS provider, the ADSP and the virtual center to all be insured (i.e., 'triplication of cost'), and urged against the payment of excessive premiums for the same liability.

Results from the Economic Impact Assessment

Two sources have been used in the study's methodology, namely Tool 19 of the EC Better Regulation Tool Box and SESAR JU's 'Methods to Assess Costs and Monetise Benefits for CBAs'. The combination of these has enabled the 1) identification of problem drivers and changes introduced by the new policy; 2) identification of the impacts of the selected policy options; 3) singling out of those impacts which are likely to be significant; and 4) assessment of the latter quantitatively, and wherever possible otherwise qualitatively.

The key changes triggered by the new policies linked to the service delivery models elaborated above were identified. These have been grouped into market structure changes (i.e., as a consequence of the vertical separation between the data production, data processing and the ATS); technical changes (i.e., shift to cloud-based solutions for flight data processing as well as the rationalisation of data production), and legal changes (i.e., certification, oversight, insurance issues).

A second step has been to identify these impacts, in terms of increase or decrease in costs, while also taking into account the indirect costs and benefits. Costs have been identified in two main groups, namely 'implementing costs' (e.g., one-off costs for insurance) and 'operating costs' (e.g., staff-related or maintenance-related costs). Subsequently, the indirect impacts were measured, i.e., those not directly linked to the increase or decrease in costs and which are thus more difficult to quantify (e.g., performance improvement in capacity, increased cross-border operations etc.).

It has been identified that the majority of the costs (60% of total ANSPs costs) were staff-related costs whereas 17% were CAPEX-related costs. In terms of the 'relative size' criterion, whereas a multitude of stakeholders are involved in the debate, those who stand to be most significantly impacted by the emergence of new models are the ANSPs. Therefore, the study has focused on the ANSP value chain. ATM data services, including production and processing of data, account for a market potential of up to €2.2 billion per year or 25% in the ANS costs. The study also estimates the cost reduction potential at about 15% of present costs of data production infrastructure and processing.

CAPEX costs and staff-related (or ATCO) costs are stable, whereas non-ATCO staff costs are variable and therefore the focus of the study has been on the latter. A quantitative analysis using the data envelopment analysis (DEA) tool has been used to measure the efficiency of production processes of firms (in this case of ANSPs) with inputs and outputs. Real values for the inputs have been derived from the PRB monitoring report (Annex IV) and the AC EUROCONTROL report (2015-2018). For the outputs, the composite flight hours were taken into account. The DEA tool has been widely applied for IA in the energy and tele-communications sectors, and was said to be particularly suitable for the heterogeneity of the ANSPs. The DEA compares the efficiency levels of the different ANSPs, and clusters them into different groups and then benchmarks them within the peer group. The majority of assumptions have been made in this clustering element.

The approach to clustering in the Alliance Model was based on the currently existing alliances, whereby a split was made between the Alliance group (which consists of 18 ANSPs) and the Non-Alliance group (including

12 ANSPs). For the purposes of the IA, it was assumed that these alliances would remain unchanged. Firstly, ANSPs were benchmarked against each other. The results showed that 3 ANSPs are fully efficient (out of 18) for the Alliance Group, whereas for the Non-Alliance group 4 are fully efficient (out of 12). Comparing the mean efficiency of both groups then yields insights towards the savings potential of CAPEX and non-ATCO staff of the Non-Alliance group. This comparison suggests that 25.89 M€ could be saved in non-ATCO staff costs (1.38% of total), and 9.71 M€ could be saved in CAPEX (0.9% of the total). Since the results were particularly close, a significance test had to be carried out, which, in turn, concluded that the results between the two groups are not significant (i.e., the differences could have been generated by chance). In other words, the efficiency of ANSPs within the Alliance Model are not expected to be significantly higher than that of non-Alliance members.

In the case of the Separated Model, on the other hand, the clustering was based on the Functional Airspace Blocks (FABs). For the IA, it was assumed that ANSPs would join ADSPs based on geographical (the geo-fixed infrastructure will be in the hands of the ADSPs) and operational requirements. The idea has been to identify the least efficient ANSP within each FAB which, it turn, would be more willing to adopt the new configuration defining the Separated Model due to the potential to reap efficiency gains in terms of capital and non-ATCO staff costs. 12 ANSPs were identified as being currently not efficient and thus potentially interested in becoming ADSPs under the Separated Model. The overall impact of the Separated Model was estimated to amount to ca. 15% of annual savings for both non-ATCO staff costs and for CAPEX annually (the equivalent of savings of 280.04 M€ in non-ATCO staff costs and 161.53 M€ in CAPEX, annually). An additional insight that was considered is that ca. 70% of the non-ATCO staff costs in the Separated Model are expected to be saved in FABEC and UK-Ireland, while 50% of CAPEX reduction could be realised in Southern countries (i.e., BLUE MED and SW FAB).

Lastly, the study team clarified that insurance-related costs and certification-related costs are not yet factored into the IA calculations given work is still ongoing on these aspects. The calculations are thus purely theoretical, and the benefits are based on assumptions (e.g., assumptions based on FABs and Alliances) since ADSPs do not exist today.

Reactions to the Economic IA Results

Stakeholders expressed concerns with regards to the manner in which the efficiency of ANSPs is measured, outlining that the underlying assumptions and criteria behind the categorisation of ANSPs as 'efficient' or 'non-efficient' are unclear. Furthermore, the need to more explicitly define which 'Alliances' were considered as part of the IA was underlined, as Alliances may be overlapping. In response to this, the study team clarified that the Alliances were based on the list provided in the PRB Annual Report (2018, Annex IV, CAPEX), which include ITEC, ICAS, 4-flight and co-flight.

A number of stakeholders sought further clarifications relating to various types of costs and their inclusion in the IA. For instance, some inquired as to whether the impact on the operational cost (OPEX) for the ANSP, but also for other stakeholders including airlines and airports, was considered in the IA. It was clarified that OPEX issues are indeed taken into account in the study, and that it is foreseen that the OPEX should not dramatically increase as a result of a service being provided as an outsourced service. While it is acknowledged that resources will need to be committed to running and maintaining the system, significant economies of scale would be possible when this is done by ADSPs. As regards the impacts on other non-ANSP stakeholders, the study team clarified that the scope of the IA has focused on the ANSP value chain for reasons elaborated above. This cost reduction on CAPEX and non-ATCO staff costs are only at ANSP level, given that some prioritisation has had to be done in line with the EC Better Regulation Tool Box.

Other stakeholders inquired as to whether the transition costs have been taken into account in the IA. While it was clarified that transition costs have been considered in general, they have not been entered as inputs into the two variables in the DEA tool, once again because prioritisation has had to be done. Staff costs and CAPEX have been primarily examined, though there was agreement that additional costs, which may not be so easily modelled (i.e., transition costs, certification and insurance costs) would need to be analysed and included in the calculation to further fine-tune the findings. Notwithstanding, it was pointed out that the transitional costs are inherently taken onboard by the study's 'approach'. In other words, the rationale for the study's focus on the EU framework level is to dramatically reduce the transactional and transitional costs.

A question was also raised as to whether the non-geographically-fixed assets (e.g., non-geofixed CNS) have been taken into account in the study. It was clarified that the CAPEX costs take into account all infrastructure that is currently deployed and implemented by the ANSPs including geo-fixed CNS infrastructure. The model assumes that peers will group around geographical and operational requirements which allow infrastructure investments to be saved.

In conclusion, the issue of non-ATCO staff costs and cost savings assumed under the various models should be seen as a 'further development of the market', given that the entrance of new market players (ADSPs) would create new employment opportunities. In the transition period, new service providers will emerge seeking to fill employment posts in order to offer services on a larger scale, opening up potential for efficiency gains. This has already taken place in other industries without any safety incidents or major disruptions, and can lead to productivity gains as services are offered under different models.

Results from the Social Impact Assessment

The AAS underlines the importance of thoroughly considering and involving staff in the change process, recognising that the full involvement, consultation and buy-in from staff is a pre-condition for the success of the initiative. The scope of the IA covers the current ANSP technical staff (namely the Air Traffic Safety Electronics Personnel, or in short ATSEPs), Air Traffic Controllers (ATCOs), ANSP management and administration, and not the least, the supply industry staff.

For the social IA, the service delivery mechanisms have been assessed against a range of criteria, again following the categories laid out in the EC Better Regulation Guidelines. The criteria include the organisational design, roles and responsibilities, culture, staff competences and training, working conditions, organisational health and safety, and the labor market overall. Less directly impacted work on this has been the access to services and human rights. There are, thus, seven sets of functional tasks that will need to be provided in the flow of operational data regardless of whether this is done in today's ANSP structure or through a future ADSP delivery mechanism. There are certain specialisms (competences) that fit these functional tasks that are also required. Some form of assurance will be needed that the various organisations providing services, whether they are vertically integrated within the same ANSP or divided, is done in a manner fit for the requirements and is in line with the culture management approach within ANS.

A deep understanding of the exact dimension of the organisational changes driven by ADSPs is key as these drive many of the social impacts. Two example mechanisms were used to illustrate many of the social impact factors, linked to the Separated and the Three Layer Models. In the case of a Separated Model of provision, ADSPs provide data to ATSPs. These could be separate companies, but could also have common ownership. Employment there could, therefore, be held by ADSP or by ATSP with seconded staff (as long as transparent accounting is possible).

In the Three Layer Model, there is further organisational division, a competitive market for ADS and for data production, as well as a level playing field arrangement enable new market entrants to compete to provide the performance-based service. It is assumed that the staff would need to be employed by separate entities. The new organisations for ADS and for data production would have specialist role and responsibilities for the Three Layer Model, and the need for an end-to-end view becomes more strict. The culture of the ADSP would need to comply with the Safety Management Systems (SMS) and Quality Management Systems (QMS) principles. Finally, the competences and training would evolve to meet the needs of new tools and applications. In some way this may not be a specific outcome of ADSP as the need for new tools and applications (e.g., Artificial Intelligence and Machine Learning) is already foreseen as part of the new ATM Master Plan, however, the training framework may need to evolve to fit that.

The study considers the organisational design changes that may occur for each of the ADSP delivery mechanisms. In the Separated Model there is a single vertically-integrated ANSP and two examples are presented. Within the first, the data processing is fully separated and we have an ADSP potentially taking data and servicing multiple ANSPs. However, the underlying geo-fixed assets and the specialisms within these may remain with the State-based ANSP. For second example, anything below ATS is considered as being done by an ADSP serving several ATSPs with the ancillary services included within this arrangement. There might be transparent accounting or division into a new organisation, however, the organisational design and roles may not change extensively. The ownership may evolve for the ADSP, therefore, potentially leading to an adapted leadership and culture, but most probably within existing stakeholders. Because the ADSPs serve multiple ATSPs you see an increase in specialisation of teams. The labor market would evolve over time as per the extent of collaborations and alliances.

Participants stressed the importance of making a clear distinction between the human and social dimension. The social impacts will be of central importance and thus necessitate careful assessment so that they can be properly mitigated. Moreover, concerns were expressed with regards to the presented economic savings and it was questioned whether these would be achieved as a result of laying employees off and/or degrading their working conditions. Others noted that placing external companies in charge and increasing the distance between the operation and the data holds the risk of reducing efficiency on an operational basis. What is more, the need to consider the specificities of ATSEPs' profiles was highlighted. Today in ANSPs, employees can easily switch from operational units, to R&D, to a centralised system network, meaning that professional backgrounds are often useful and easily transferable. The ADPS concept interrupts this, and thus calls for a comprehensive study of the social impacts. The SESAR JU Transition Plan will also need to be considered as part of the study. In conclusion, it was underlined that the transition will be gradual (as opposed to 'overnight') and social dialogue will need to take place within an organisation and all relevant parties will need to play their role to develop a conducive ecosystem.

Results from Safety Impact Assessment

Building upon the social aspects, the IA on the safety aspects was also based on the Separated Model and the Three Layer Model. From an organisational safety management perspective, five traditional areas were examined, namely safety policy and objectives, safety promotion, safety risk management, safety culture and safety assurance. In addition, a sixth area of interdependencies, resilient system performance, buffers and trade-offs were studied. Given the challenging nature of quantifying safety aspects the study has focused on the qualitative impact on safety, rather than on the quantitative impacts.

In the Separated Model, fragmentation is introduced in the managerial boundaries whereas in the Three Layer Model it is through the many layers of the ADSP involved in providing services to the ATSP that we have a higher fragmentation. In terms of risk management, the numerous layers make it difficult to identify end effects or root causes. Each of the ADSPs would probably work in isolation without having a full picture of what a failure in their own service could result in at higher levels. To address the fragmentation of the management system, controls could be implemented through the common requirements, to ensure that the ADSPs perform in a safe manner and provide the necessary assurance in the next layer in the service delivery model.

In conclusion, higher complexity leads to a higher degree of risk even if we apply the standard risk controls. This is not to say that the overall safety level of the system will be compromised, however, some mitigation measures may need to be implemented to ensure this does not happen (e.g., interoperability requirements, verification of suppliers, certification of certain critical parts of the system). Any increase in risk could be controlled through the regulatory framework that will be put in place. The safety management system should be applied for ADSPs as part of the mitigation measures. It may be referred to as a service management system that provides safety assurance to the next service user that the service behaves as specified.

Next steps

Following a careful consideration of the reactions and inputs received, the Commission together with the study team, will host another stakeholder workshop in September 2020, where the results of the final study will be presented.

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