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10th January 2021

Take advantage of the crisis to reinvent European air traffic control.

Executive summary

The motivation for writing this article comes from the conviction that, even if on the overall, Air Traffic Control (ATC) in Europe fulfils its role, especially, from a safety standpoint, it is suffering structural inefficiencies that become unbearable with the current crisis. An ambitious vision needs to be developed by the decision makers at States and pan European level (including the European Union EU). Using the current crisis as a starting point, one should significantly improve the efficiency of ATC in Europe both in operational and financial terms in the interest of the airspace users and passengers, with a motivating project that users and staff of this industry would support.

The article provides avenues in order to achieve it.

Air traffic is unlikely to recover in the coming months and the organisations providing air navigation services (Air Navigation Services Providers ANSP) in Europe are facing a "financing wall". With a fixed cost and less traffic, either the States subsidise their ANSP or the user charges per flight will significantly increase, which undoubtfully will trigger strong reactions from airlines already severely hit by the crisis.

The main root reason for the structural weaknesses mentioned, is the fragmentation of the air traffic system in Europe. It has been recognised for more than fifty years and was the main rationale for the creation of EUROCONTROL and for the initiatives of the European Commission (EC) in the domain. But the fact that international legislation (International Civil Aviation Organisation ICAO) recognizes that every State has complete and exclusive sovereignty over the airspace above its territory explain why these initiatives did not fully succeed. As such the EUROCONTROL history is the symbol of these ups and downs of the European construction.

As underlined by the European Court of Auditors, the legislative attempt of the European Commission to reform ATC in Europe, with the successive packages of The Single European Sky (SES) has contributed to incremental improvements in the performance and modernisation of the European Air Traffic Management (ATM) system. But it has not generated the expected paradigm change and has not sufficiently reduced its fragmentation. The resulting gridlock is detrimental to European air transport.

While recognising the value of the recent EC legislative proposal, the authors of this document propose a more ambitious approach, based upon the Wise Persons Group Report: a transition towards a pan-European ATC with EUROCONTROL reinvented.

The idea is to address fragmentation from the operational and technical standpoints.

For the latter one, if anything else is done, at least one could choose the

minimum option of common procurement preferably "« standardised commercial products" products for the Communication, Navigation and Surveillance (CNS) infrastructure and common development/procurement of Air Traffic Management (ATM) systems.

A more ambitious option could be to consider the CNS infrastructure as a service and no longer as an investment and, therefore, the total virtualisation of ATM systems. Under an "infrastructure manager", with EU funds (a fraction of the money spent in the SES technology pillar, SESAR, deployment), this could be second genuine European infrastructure after Galileo. Centrally funded, it would remove significant financial risk from the operational units, unbundling operational and financial systems.

For the former, as far as the airspace management is concerned, one can implement a top-down design to group Air Traffic Control Centres (ACC), independently from country borders, as was the initial objective of the Functional Airspace Blocks (FAB).

This should foster the harmonisation and, even more, the modernisation of operational procedures which are all out of date.

A more ambitious option could be a single service provider for Europe, reinventing the vision of the founders of EUROCONTROL.

In both cases, taking the existing delegation of control (Maastricht, Zurich and Geneva) as examples, it could easily be demonstrated that this does not jeopardise the State's sovereignty nor its air defence.

In both cases under a stronger political decision maker, the European Union Aviation Safety Agency (EASA) will retain its role as safety manager but there is a need for a more powerful Network Manager.

A single service provider for Europe paid by European funds would provide a robust financing and relieve the States from subsidising their ANSPs.

User charges will no longer pay the costs but the service. Nevertheless, they will continue to be collected by the Central Route Charges Office (CRCO) of EUROCONTROL

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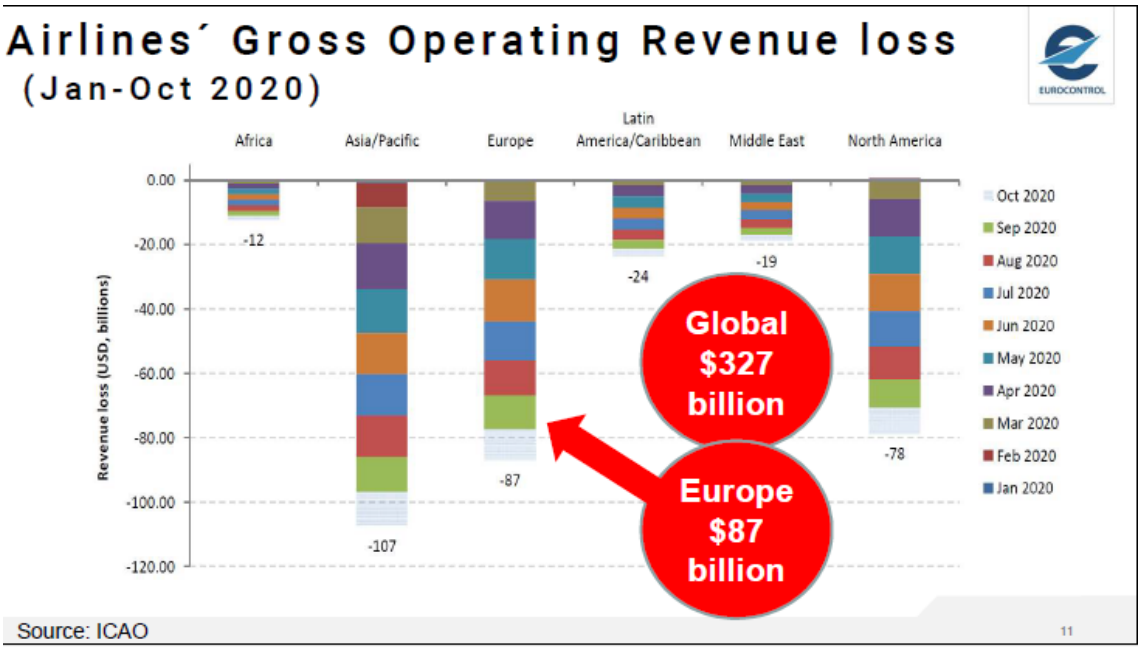
1. How did we get here?

1.1 There is no sign of the air transport crisis to diminish

The unprecedented impact of the COVID 19 crisis created by the SARS CoV2 Virus on all aspects of our society has not spared aviation. Whereas past economic crises were of a punctual and less dramatic nature, the current crisis will leave its trace for a much longer duration and, in a much deeper way, than anything experienced before. Although possible medical progress in fighting the novel Coronavirus might bring a cure in form of a vaccine or a treatment, the societal and economic impact cannot yet be assessed in its full magnitude.

The COVID-19 crisis is making all industries and businesses go through unparalleled times, with the aviation industry being one of the worst affected (90% traffic reduction during the crisis, and only 50% at the end of August 2020), the financial consequences for the various players are catastrophic.



- Even before the crisis, very few airline companies were profitable, and even fewer have the cash flow to get through this predicament. Despite the support some states have provided (worldwide the massive support was in the order of 120 billion USD) only the strongest airlines will survive. Vey likely, they will demand an efficient ATM system managed at a European level.
- With a decrease of more than 80% of passenger traffic (or 1.29 Billion passengers) the airports are hit extremely hard. According to Airports Council International (ACI): *The airports facing insolvency are mainly regional airports which serve - and are integral to - local communities. The potential ripple-effect upon local employment and economies is clear. Financial support from Government will be crucial in averting rising geographic inequality and damaged social cohesion. At the same time, larger European airports and hubs are not immune from the critical financial risk. They have cut costs to the bone and have resorted to the financial markets to shore up balance sheets and*

build emergency war chests. This sudden increase in debt - an additional €16 billion for the top 20 European airports - is equivalent to nearly 60% of their revenues in a normal year. This, along with the fact that these airports had to make thousands of highly skilled workers redundant, clearly jeopardises their future.

Largest Airlines & Airports
(Average Flights & Average Reduction - Last 7-days)

Rank	Airline	Avg. Flights	Flights vs 2019
1st	Turkish Airlines	603	-51%
2nd	Ryanair	353	-82%
3rd	Pegasus	300	-33%
4th	KLM	281	-57%
5th	Widerøe	269	-21%
6th	SAS	251	-70%
7th	Lufthansa	244	-83%
8th	Air France	215	-79%
9th	DHL	213	7%
10th	Qatar	158	-37%

Rank	Airport	Avg. Flights	Flights vs 2019
1st	İGA Istanbul	501	-56%
2nd	Amsterdam	462	-64%
3rd	Frankfurt	402	-69%
4th	Istanbul SG	393	-35%
5th	Paris CDG	372	-71%
6th	London LHR	336	-73%
7th	Madrid	331	-71%
8th	Oslo	250	-63%
9th	Leipzig	180	-13%
10th	Cologne	179	-49%

EUROCONTROL Agency Director General, Eamonn Brennan, presentation for the 26 November 2020 Provisional Council

It shows the % of flights in 2020 versus 2019 sorted by flight average numbers for airlines and airports.

During times like these, we are reminded of the importance of a well-functioning air navigation system as a critical part of the national readiness and the backbone of national and global infrastructure. This crisis highlights how vulnerable the current air navigation system is to fluctuations in demand.

The revenues of ANSPs collapsed as shown in the following picture showing the difference between the planned and actual user charges:

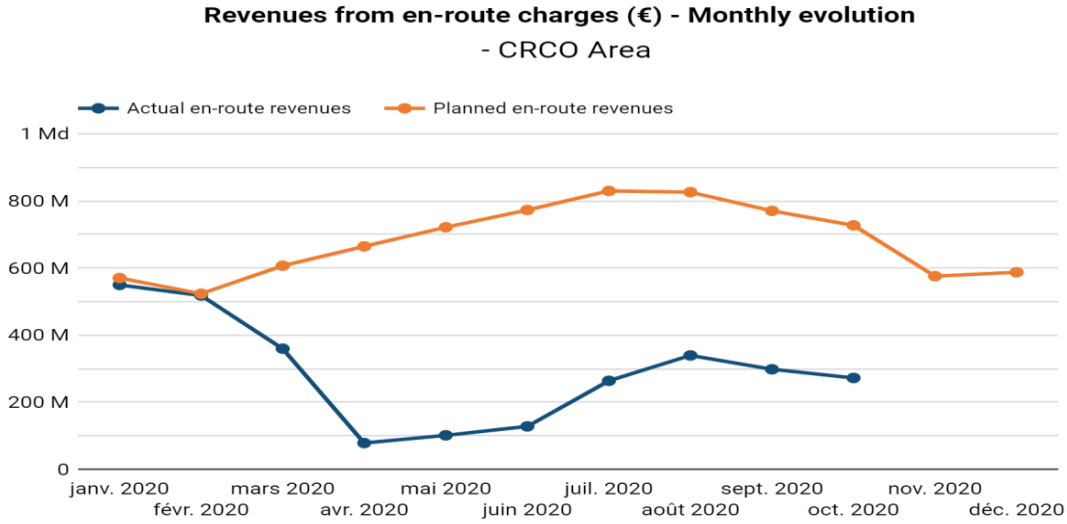
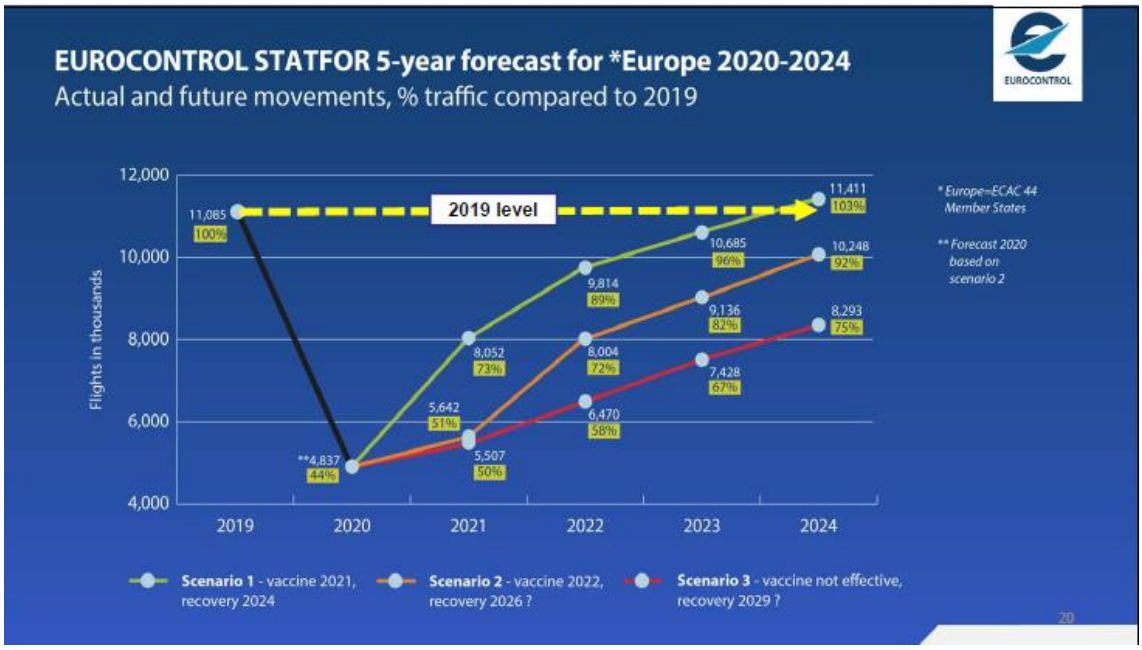


Figure 1 PRC Dashboard update 15.11.2020

Some initiatives have been taken to guarantee the short-term survivability of European ANSPs (e.g., EUROCONTROL States have agreed to a € 1.1 billion carry-

over program to help airlines. And the French Directorate General of Civil Aviation was permitted to make a loan of more than one billion euros).

Based upon EUROCONTROL forecast:



These are only short-term measures and states are facing a "financing wall". They have now to decide how to maintain the long-term service while not excessively increasing the fees as of 2021 and beyond.

If one makes some rough computations based on the optimistic scenario N°1:

- 2021 traffic = 70% of 2019 traffic and 2022 traffic = 80% of 2019 traffic
- With ANSPs costs remaining at the same level (i.e, 8 B€ in 2021 and 2022), the deficit will be 0.3*8+0.2*8 = 4 B€. leading to a significant increase of user charges.

In addition, as explained in §1.4, the route charges mechanism foresees that the 2020 deficit (est. 5B€) should be recovered in 2022. Since it would entail an unbearable burden in 2022, it has been agreed that the recovery of the 2020 deficit will be spread over 10 years.

In front of this situation, and already facing huge financial difficulties, airlines are requesting individual state support to compensate ANSPs deficits or even, as proposed by Michael O'Leary, CEO of Ryanair Holdings in:

How can we build back better European Aviation after COVID-19?

This request by the CEO of the major intra-European airline has the merit to be studied but such a possible assistance to a quicker recovery will have to be carefully assessed.

In this document, we stress that the current financing wall that ANSPs are currently facing, finds its roots in the organisation of the European system and its financing.

1.2 Since the Chicago convention, air traffic control is a public service enabling the "Freedoms of the air"[1]

In November 1944, the American government invited 55 States to an international civil aviation conference in Chicago. The resulting "Chicago Convention" set the foundations for the rules and regulations concerning air navigation in all its aspects and enabled a common and global air-navigation system to be created. The Chicago Convention also established the International Civil Aviation Organisation (ICAO). Today ICAO, headquartered in Montreal, manages all aeronautical spheres, and establishes world standards. It currently has 191 member states that all remain sovereign over their national airspace, a principle that still applies today *(Part I chapter I article 1: The contracting States recognize that every State has complete and exclusive sovereignty over the airspace above its territory).*

It requires member states to provide air navigation facilities over their territory, which comply with ICAO Standards and Recommended Practices. More precisely, the purpose of Article 28 is to secure a comprehensive, seamless and continuous network of air navigation services around the globe and to support the safety, regularity and efficiency of international air transportation.

However, the obligations for states under Article 28 are neither strictly nor narrowly defined. The States retain considerable discretion and individual appreciation regarding the means by which they intend to fulfil their obligations.

Each contracting State must declare the level of infrastructure and service they wish to make available to international aviation, and the degree of compliance of their air navigation facilities with relevant ICAO regulations.

Most importantly, under Article 28 of the Convention, a member state has the obligation to provide, as far as practicable, an infrastructure that meets the needs of an interoperable and seamless sky. The same state is also responsible to allocate licenses to operate to airspace users.

Consequently, the ICAO has "globally" harmonised its approach to all the domains of aviation including ATM.

However, technology and standards are being developed by different actors. While standards are global in nature and should be harmonised (by ICAO), technology is being developed by industry (manufacturers), typically for the different national air traffic service providers. Commercial Off the Shelf (-COTS) systems are only lately being introduced into ATC. Multiple technologies used by ATC have been prototyped by industry due to some historical and localrequirements by the states or their Air Navigation Service Providers, **therefore creating a piecemeal of systems.**

1.3 EUROCONTROL history is a concentrate of the ups and downs of the European Union

Based on the ICAO principles and standards, all contracting states were fulfilling their duties by providing the corresponding services individually as part of their governmental administration.

However, in 1958, the Director of the French Air Navigation Directorate, René Bulin, had the "vision" that civil jet aircraft would have to share the "upper airspace" which so far was only used by military aircraft and that the coordination/management would be more efficient at a European level. He convinced the United Kingdom, the Federal Republic of Germany, Belgium, the Netherlands and Luxembourg, the six member States

[1] https://en.wikipedia.org/wiki/Freedoms_of_the_air

founders, to sign the EUROCONTROL Convention in December 1960.

1.3.1 1960 is therefore the beginning of EUROCONTROL organisation and the Agency

One can read the official history of EUROCONTROL as a essence of the ups and downs of the European union, with a mismatch between successive EUROCONTROL conventions and its actual missions and with a fight on political competency between this states organisation and the European commission.

The Article 14 of this Convention said: "The Contracting Parties shall entrust to the Agency the air traffic services" in the [upper] airspace.

The Convention was ratified in 1963, but in the meantime, even if the Convention had been signed by a "pro-European" hand, the other "anti-European" hand in France and United Kingdom, with the issue of national military airspace control, refused to hand over the Upper Airspace.

René Bulin became the first Director General.

Nevertheless, the other four Member States (the Federal Republic of Germany, Belgium, the Netherlands, and Luxembourg) agreed in 1964 to set up a single international, air traffic control centre to manage their upper airspace in Maastricht.

In June 1963, these states agreed to establish the EUROCONTROL Experimental Centre and later-on the institute in Luxembourg in 1970, therefore turning a part of the Agency into an ANSP in its full-fledged dimensions, with headquarters, a centre, a research centre and an academy.

Two EUROCONTROL upper-level control centres were developed and built at Karlsruhe (Germany) and Shannon (Ireland). However, the commitment of these states to the Agency operational division was difficult to maintain in the face of a lack of universal support for a common system of control in the upper airspace. The German and Irish governments later re-nationalised these last two, and the Dutch government did not hand over the Amsterdam upper sector to Maastricht until March 1986.

At the same time, the EUROCONTROL Central Route Charges Office (CRCO) was set up.

1.3.2 Eventually the member states embarked on a process of redefining of the Organisation's mandate

Assessing the failure of Article 14 to "entrust to the Agency the air traffic services in the [upper] airspace" and to give EUROCONTROL Agency the role of "coordination", an amended Convention signed in 1976, took a further ten years to be ratified.

At the same time, the world economy was emerging from a decade of recession, which, together with the effects of the deregulation of air transport in Europe, resulted in such growth in air traffic that the fragmented ATM system was unable to cope.

Delays reached such levels that thousands of passengers were stranded for hours at European airports, making the headlines for several days.

ATM, which until now had been totally ignored by the public and politicians, aside from a few air traffic controllers strikes from time to time, found itself at the top of the political agenda overnight.

Miraculously, an organization which until now was practically unknown has emerged as the bearer of a European solution to a European problem: The European Civil Aviation Conference (ECAC), an intergovernmental organisation which was established by the International Civil Aviation Organization (ICAO) and the Council of Europe.

At that time, Daniel Tenenbaum, the ECAC chairman, called upon the ECAC's Ministers of Transport with a series of

MATSE (Meetings on ATS in Europe with Europe as ECAC), the EUROCONTROL agency was just called on to provide the secretariat and meeting facilities.

- In October 1988, **MATSE**/1 agreed to create the Central Flow Management Unit and to entrust the EUROCONTROL Agency with its development and management, thus giving this agency a particularly important operational role, in contradiction with its just ratified convention.
- In April 1990 **MATSE/2** initiated the European ATC Harmonisation and Integration Programme (EATCHIP), the beginning a long series of Plans. Discussions began in 1991 on changing the Convention again, but then the European Commission decided to get into the "game" by becoming a "member" of EUROCONTROL
- In 1992 **MATSE/3** updated EATCHIP in EATMS (European ATM system) with an ATM 2000 Strategy and APATSI (Airport/ Air Traffic System Interface)
- In 1994 **MATSE/4** "prepared for new institutional arrangements "
- In 1997 **MATSE/5** the revised Convention and the Central European Air Traffic Services CEATS were signed in 1997 and ATM 2000+ Strategy was launched with EATMP, European ATM Management Programme.

1.3.3 Today

Twenty-three years later, the revised Convention is not yet in force waiting for the ratification by the last state (Turkey) - unanimity being required for revising EUROCONTROL convention.

During the same period, the number of EUROCONTROL members increased, now coinciding with the perimeter of ECAC (i.e. 41 Member States)

In 1992, the Maastricht Treaty implemented the co-decision of the Parliament and the Council and the "right of initiative "of the European commission. The first implementation of the co-decision was the R&D framework programme in which there was a budget for ATC.

It meant that for the first time ATC R&D was no longer only paid by user charges only but as well by community taxpayer budget.

The European Commission became a member of EUROCONTROL with an Accession Protocol to the revised Convention on October 8, 2002.

1.4 In Europe, the cost of ATC is fully recovered by user charges

Historically speaking the route charging mechanism dates back to 1958 when ICAO held its first Route Facilities Charges in Montreal to "*formulate principles on the way in which charges for route air navigation facilities should be imposed where they are found to be necessary*".

The 1967 ICAO conference laid the foundation for today's route charging mechanism which is in place in the EUROCONTROL area.

The guiding principles were as follows:

- in general, the Conference believed that States should exercise caution in their charging policy, and that the charges imposed on users should consider the effect both on the aircraft operators and on the economy of the countries concerned;
- for route navigation charges, the system of charges must be non-discriminatory, both between foreign users and those of the State or States providing the route air navigation facilities and services, and between two or more foreign users;

- as far as possible, there should be only a single charge per flight, and this charge should be based essentially on flight distance and aircraft weight, combined with any other aircraft characteristic capable of affecting the nature of the service rendered.

Until 1970, the so-called "en-route" air traffic control, a public service, was funded by the states and therefore free for "users". A political /economical /philosophical question, not necessarily explicit: should infrastructures be paid for by the public budget since they participate in the development of the economy or by users?

The answer is not the same according to the modes of transport, railways, highways, etc.

1970 was the turning point for air transport politically, when it was seen as the transport of the “wealthy", which is no longer the case. Then, at that time the second option was chosen for air transport: infrastructures to be paid for by the users.

Based on the system adopted by ICAO, the seven member states of EUROCONTROL signed the multilateral agreement on the collection of "charges" for the use of en-route air navigation services and equipment. In addition, the non-EUROCONTROL member states signed bilateral agreements empowering EUROCONTROL to collect route charges. In 1971, the Central Route Charge Office (CRCO) began operations. In accordance with ICAO recommendations that full cost recovery should be gradual, the recovery rate for EUROCONTROL route charges started at 15% from November 1971. This rate was increased to 30% on November 1973, then doubled to 60% on November 1975. In October 1981, the rate rose to 100%.

The principles for establishing the route charge base and the principles for calculating unit rates are detailed in the EUROCONTROL document “Principles for establishing the cost-base for en route charges and the calculation of the unit rates”:

For each flight, the formula for the route charge is as follows:

$$\text{Charge}_{(\text{en-route})} = \text{SU} * \text{Unit rate}$$

The Service Unit (SU) is calculated as a function of the maximum take-off weight (MTOW) and the distance (D) flown:

$$\text{SU} = \sqrt{\frac{\text{MTOW}}{50}} * \frac{\text{D}}{100}$$

It is worth explaining that not all traffic pays route charges and that there is a certain level of cross subsidy from airlines towards General Aviation and military flights.

In year N, the Service provider forecasts for year N + 1 the traffic it will control and therefore the number of SU, it forecasts its costs and deduces its Unit Rate from these elements.

For the unit rate computation, there are rules to define what can be put in what is called the "cost base, roughly the operating costs, depreciation charges as well as the interest on their unappreciated assets. In addition, EUROCONTROL Member States add to the costs of en-route control their contribution to the Agency's budget. The operating costs are, mainly, the salaries of the staff and the maintenance of the technical infrastructure (main part being the bespoke ATM computer systems specific to each organization) and the ANSPs have the right to add the cost of their National Supervisory Authorities (NSA).

Based on these elements, the unit rates of each ANSP are submitted at the autumn CRCO enlarged committee[2] for approval

[2] *The Enlarged Committee for Route Charges supervises the operation of the route charges system and reports to the EUROCONTROL enlarged Commission via the Provisional Council. It determines the principles for establishing the costs incurred by States in respect of en-route services and determines the common rules for calculating the route charges. EUROCONTROL’s Member States are all represented, as are airspace user organisations.*

and in year N + 1, the CRCO collects the fees with a global periodic invoice per airline and pays each ANSP its due. Depending on the reality of traffic and costs, there is an adjustment in year N + 2.

So, for 50 years and until the crisis, one of the advantages of this collection of charges by the CRCO is that if an aircraft operator has not paid the amount due, measures may be decided to enforce recovery, with obligation for the contracting states to implement these measures, including, as the last resort, blocking flights of the defaulting operator on departure.

The single European sky (see below) legislation introduced a novel approach to cost efficiency target setting mechanism and a new risk sharing mechanism was introduced. SES States/ANSPs operate under the determined costs method which comprises specific risk-sharing arrangements aiming at incentivising ANSPs economic performance. As part of the determined costs method, the costs planned for the reference period (RP) are set in advance and frozen for the length of the RP. If actual costs are lower than the determined costs, then the State/ANSP can keep the difference. On the contrary, if actual costs are higher than determined, then the State/ANSP must bear a loss. This mechanism provides incentives for States/ANSPs to effectively control their costs and to flexibly adapt to unforeseen changes in traffic volumes. (ACE report 2017)

1.5 The Single European sky was a legislative attempt of the European Commission to reform ATC in Europe

The Single European sky was a legislative attempt of the European Commission to reform ATC in Europe.

More details can be found in

The Single European Sky gridlock: A difficult 10 year reform process, Marc Baumgartner, Matthias Finger Utilities Policy, 31, 289–301.

All major intergovernmental initiatives in Europe to modernize ATM have been triggered by major crises affecting the travelling public, and thus politicizing the issue. The Balkan War in 1999 was a major crisis for European aviation, and airspace users complained because delays in 1999 were 30 percent higher than in normal times.

The Commission commented on the delay situation and indicated that there was a need to act in order to permit the management of the airspace, regardless of the countries' borders (EC COM 614/1999, "The creation of a Single European Sky" SES).

The SES was progressively implemented in three steps, namely SES I (2004), SES II (2009) and an unsuccessful attempt to go further in 20013 with the so-called SES IIþ package.

The SES is accompanied by an ambitious technological deployment roadmap, called DEPLOY, which later became SESAME, and still later SESAR.

1.5.1 Single European Sky I (2004)

This package took the form of four regulations, namely (a) EC Regulation 549/2004, which laid down the framework for the creation of the SES (the so-called Framework Regulation), (b) EC Regulation 550/2004 on the provision of air navigation services (ANSs) in the SES (the Service Provision Regulation), (c) EC Regulation 551/2004, on the organization and use of airspace in the SES, including the creation of so-called Functional Airspace Blocks (FABs) (the Airspace Regulation), and (d) EC Regulation 552/2004, on the interoperability of the European Air Traffic Management network (the Interoperability Regulation).

For technology, a Single European Sky ATM Research (SESAR) master plan was drawn up, whereas for safety, the

European Aviation Safety Agency (EASA) was declared responsible.

Moreover, when initiating the SES, Mrs Loyola de Palacio, who was at that time vice-president of the EC in charge of Transport, considered that the development of a common foreign and security policy within the EU had provided opportunities for organizing the involvement of the military.

The intention was to assess the real impact of military operations on civil air traffic, as well as to better understand the military requirements and needs (Fartek and Rivet, 2011).[3] The involvement of national defence representatives within the EC working structures was an important step forward, yet it was premature. Indeed, the vision was too advanced, and the member states remained reluctant to establish a link between civil and military ATC.

As with all other sectors, the EC periodically reviews the application of its actions (EC COM 845/2007 final, "First report on the implementation of the Single Sky Legislation: achievements and the way forward").

Consequently, it requested the newly created Performance Review Commission (PRC) to assist in this evaluation. The PRC delivered its report in December 2006, recommending, among other things, acceleration of the FABs, corresponding technology development (SESAR), as well as empowering EUROCONTROL, especially in its pan-European functions and ATM network design. As a result, the Commission proposed, in 2009, an SES II package.

1.5.2 Single European Sky II (2009)

This package identified fragmentation as the major bottleneck in improving the performance of the European aviation system.

The SES II package puts the delivery of the SES under the overarching objective of performance, and is now structured into five pillars, namely (a) technology with SESAR as its key element, (b) a legislative pillar, which sets a target date for the implementation of the FABs and creates the role of the network manager attributed to EUROCONTROL, (c) safety of ATM and Communication Navigation Surveillance (CNS) attributed to EASA, (d) the airport pillar, and (e) a cross-cutting human factor pillar

Even if this aspect was already prominently mentioned in the so-called "Performance Report" dated 2006, through EC Regulation 1070/2009, the foundation for an increased performance in ATM was laid, with Implementing Rule (EU) 691/2010 establishing a performance scheme for ANSs and network functions under the responsibility of the PRB.

For the performance reference period starting 1 January 2012 and ending 31 December 2014, the EU-wide performance targets are as follows:

- Environment target: an 0.75 increase of the average horizontal en-route flight efficiency indicator in 2014, as compared to the situation in 2009;
- Capacity target: an improvement of the average en-route ATFM delay so as to reach a maximum of 0.5 min per flight in 2014;
- Cost-efficiency target: a reduction of the average EU-wide determined unit rate for en-route ANSs from 59.97 EUR in 2011 to 53.92 EUR in 2014 (expressed in real terms, EUR 2009), with intermediate annual values of 57.88 EUR in 2012 and 55.87 EUR in 2013.

[3] Fartek G., Rivet F., The Introduction of Military Dimension into the SES: A new Paradigm for the European Commission, in Achieving the Single European Sky: Goals and Challenges, Editors Daniel Calleja Crespo and Pablo Mendes de Leon, Wolters Kluwer ISBN 978-90-411-3730-2 Amsterdam 2011

There will be a second reference period (RP2), starting January 2015 and lasting until the end of 2019 (EC COM 390/2013 article 8).

The PRB has published a comprehensive (http:// www.eurocontrol.in) advice to the Commission on the setting of EU-wide performance targets for RP2.

1.5.3 Towards SES IIb (2013)

The plan for SES II plus was explicitly stated by Commissioner Siim Kallas in his speech in Limassol in October 2012, entitled "10 years and still not delivering".

He noted that Commission Decision of 21 February 2011, setting the European Union-wide performance targets and alert thresholds for the provision of air navigation services for the years 2012-2014 (OJ L 48, February 23 2011, p. 16). the targets, especially in matters of costs and delays, have not been reached and that five billion euros are wasted annually due to inefficiency.

On 11 June, 2013 the EC published COM 408/2013, "Accelerating the implementation Single European Sky", or SES IIb. The proposed regulation (EC COM 2013/410 e COD 213/186) further aims to remove the fragmentation of the European ATM system by enabling industrial partnerships (namely in FABs) and reinforcing the role of the network manager.

The European Parliament did not pursue this proposal.

Some of the implementation regulations were adapted (Performance and Charging 2018 check details) and the Performance Review Body saw a new set up which was independent from EUROCONTROL'S PRC (on the ex-post evaluation of the Single European Sky Performance and Charging Schemes in Reference Period 1 and first year of Reference Period 2.).

2. The current situation

2.1 SES did not achieve its initial objectives as acknowledged by several official reports

In 2015 the EU institutions decided to conduct an evaluation of the SES implementation:

- The SES unit itself organised a workshop (05/05/2015) on this subject and issued a report to the parliament (16/12/2015) both highlighting that "*the FAB operational objectives have not been achieved regarding the optimisation of airspace and resources, which in turn generates inefficiencies in the entire European air traffic management system and extra costs of close to €5 billion a year. These costs are passed on to airlines and their customers and result in increased journey times, delays and emissions. Infringement proceedings have been initiated against 23 Member States*".
- The European Court of Auditors (ECA) conducted an evaluation of the SES and issued the Special report n° 11/2019 "*the EU's regulation for the modernisation of air traffic management has added value – but the funding was largely unnecessary*" highlighting that:

  It must be recognised that if efforts to accommodate demand are not successful and airspace congestion continues, not only would this have a detrimental effect on passengers and other stakeholders.

  The fact that the European ATM system comprises a patchwork of national ATM systems operated by national ANSPs means that interoperability and network efficiency is a serious challenge.

The SESAR programme has delivered new concepts and technologies but this has not translated into technology uptake at a sufficiently rapid pace, partly due to the challenge of availability of the required standards.

The SES has contributed to incremental improvements in the performance and modernisation of the European ATM sector but because it does not take sufficient account of the interdependencies has not generated the expected paradigm change in terms of performance by ANSPs and has not sufficiently reduced fragmentation of the European ATM system

In short, while the EC had been quite successful at liberalizing air transport, and somewhat successful at regulating access to airports, it is currently in gridlock when it comes to realizing the Single European Sky, which is a centrepiece in overall air transport liberalization and performance.

2.2 The reasons for this gridlock

As highlighted at the Budapest Air Forum: Single European Sky, the way forward 9 November 2018 in the presentation "The Single European Sky – why is its implementation late?" by Marc Baumgartner:

The reasons of why the SES implementation is late. First, there exists diverging interests of the actors, which are fighting for power. Second, EC has become a micro-technical regulator instead of policy maker. Third, institutional fragmentation has been created and increases and investments continues into old technologies. Moreover, the current route charging mechanism hinders the network-centric approach. Yet, there needs to be a change in the business model of the manufacturing industry.

2.2.1 Lack of political strength to face diverging interests of the actors involved:

Basically, there are too many actors involved, with too diverging interests to find common ground for agreement.

- one must consider the following two underlying factors, which are preventing speedy realization of the SES: Some states have seen the SES initiative as a direct attack on their state sovereignty and in particular the need for the National State (under article 28 Chicago Convention) to take ultimate legal liability for Air Traffic management over its sovereign airspace. This has resulted in very lukewarm responses by the national states when changes were proposed by the EC to delegate more decisions power away from the national state to the European Commission and its possible associated Agencies (e.g., EASA).
- ownership of the ANSPs: ANSPs are either fully or partly owned by nation states, which have few incentives to change this context, given that they benefit from the ANSPs' revenues.

Fundamentally, the airspace users (airlines) and the EC are the only actors who have a clear interest in the SES. However, the airlines have diverging interests and the Commission appears to be too weak to impose its vision, given in particular the power and the interests of the manufacturers and the member states. Indeed, the aggregate interest of these member states is not in favour of the creation of an SES, considering the interests of their ANSPs, the unions, the airports and the military.

2.2.2 EC has become a micro-and technical regulator instead of policy maker

Technical and operational issues have been addressed by legislation at political level instead of being developed in a harmonized and technical and operational

level. Two significant examples can be mentioned:

- The introduction of Controller Pilot Datalink (CPDLC) has mandated an old technology with known performance limitations instead of moving to the next generation of available technology the users were forced to invest in retrofitting a new fleet of aircraft with a e.g. a new digital technology
- The EC has mandate Free Route Airspace without addressing the underlying elements of revenue streams which might be lost for the national ANSP. With the introduction of a new charging regime (actual route flown and not the filed Flight plan route) is hindering an efficient deployment of such a free route airspace

2.2.3 Unproductive use of EU funds cemented fragmentation and perpetuation of old technologies

When SESAR Joint Undertaking was created the idea was to pool the research funds of the European Union for the ATM sector. EU Funds were made available and a roadmap (ATM Masterplan) was created to modernize the ATM technology. A SESAR deployment manager composed of industry was created by the European Commission to distribute the research funds into selected Pilot Common Projects. Instead of working together for the deployment of new technology the funds were used to upgrade national systems and sometimes old technology (see TRAN committee report on SESAR). This has led to an increased fragmentation of the service delivery as the funds used to improve the national systems increased the barriers to interoperability.

2.3 The gridlock is detrimental to European air transport

The situation as presented in previous chapters can be considered as shared by all aviation stakeholders: the European ATM system is a too fragmented system unable to meet its operational, financial, and now environmental performance objectives.

This objective of defragmentation has been at the heart of the European agenda, since the creation of EUROCONTROL, and reinforced by the EC since the beginning of the 2000's with a sequence of legislative packages as explained in previous chapters.

Unfortunately, due to diverging interests and despite several attempts, the path towards this de-fragmentation has not delivered as expected, and the system is now facing fundamental issues:

- The technological infrastructure is expensive (30% higher costs in Europe than the FAA in the USA), obsolete (the technologies of the European system have evolved only slightly, and are obsolete with regard to the state of the art in the digital field), and has suffered major failures in terms of modernization.
- Even if there is an operationally competent Network Manager, regulatory weakness prevents it from being truly effective. This has been particularly visible when the traffic grew in 2017-2019 and the delays exploded.
- The institutional level has become more complex and fragmented with the inherent problem of efficiency (governance, political decision-making), and additional costs.
- The performance approach had unforeseen counter-productive effects.

2.3.1 An inefficient technological infrastructure

Technological infrastructure covers the three segments C, N and S (Communication Navigation Surveillance) as well as ATM systems:

- Communication: this infrastructure is made up of Ground-to-Ground networks (mainly data and voice networks between control centres, but also between centres and Radars, Radio Antennas, etc.) and Ground-to-Air networks (data and voice

communication between aircraft and control centres). With a rapidly growing extension of communications between aircraft and AOCs -Airline Operations Centres-, as well as dedicated passenger communications, these three segments are currently segregated but must be considered globally in view of the possible synergies.

- Navigation: means of navigation in support of aircraft (excluding on-board equipment) such as landing aids (ILS, MLS, GBAS, etc.) or means of navigation en-route and in the approach zone (VOR -DME, GNSS, ...)
- Surveillance: whether dependent, ie requiring cooperation from the aircraft (secondary radar, ADS-B, cooperative multi-lateration, etc.) or non-dependent, ie without interaction with the aircraft (primary radar, multi- active or passive non-cooperative multi-lateration…).

For all 3 domains C, N and S, the infrastructure was until the 90s essentially ground-based, the use of satellite resources developed considerably in the last 30 years and will continue to develop, in a complementary way, or even as interesting alternatives, both in terms of economy and performance (ADS-B by satellite by AIREON, Ground-on-board communication via various services such as Iridium, Inmarsat, etc.).

- ATM systems: cover the systems necessary for the work of Air Traffic Controllers (ATCO). Historically, they were limited to the systems in the control centres (Radar Processing Systems, Flight Plan Processing or processing of ancillary information - e.g., Weather, AIM / NOTAM, as well as Controller workstations). Nowadays, many interconnected systems contribute to air traffic control, such as centralized systems at European level (Initial Flight data Processing System - IFPS, Network Management Systems -NMS, European Aeronautical Database, EAD,..), but also Airport management systems (Collaborative Decision Making CDM, ….) and finally at airline level with ATM systems in support of operations in AOCs.

The consequences in terms of ATM system performance are far from negligible:

- At the economic level, the comparison between the European ATM system and systems in other geographical areas, shows that for equivalent operational complexity the costs of this technological infrastructure are 30% higher in Europe compared to the FAA in the USA.
- Another aspect, that is also an economic problem, is the waste of spectrum. The aviation sector is taking advantage of its requirements in terms of safety, to block a spectrum of frequencies valued commercially and financially at amounts largely exceeding the means of aviation. The technologies used are well below current technological standards and we can anticipate an increasing pressure to release frequencies or to make aviation pay, at market price, the cost of using these frequencies.
- Disconnect between ground and airborne technology. Rules, procedures, etc, have not evolved with time and have not been adapted to the technology available. For instance, when a VOR is out of service, ATCOs must communicate that information and take mitigation measures such as telling aircraft to hold somewhere else, while all aircraft are flying RNAV and could continue navigating as planned despite VOR breakdown.
- Rigidity of the system in Europe: the proliferation of equipment and their heterogeneity make the possibilities for pan-European evolution more complex. This is due to:
  - the obligation to synchronize deployments while each ANSP puts forward its own priorities that are

rarely compatible with each other. This is particularly true in the case of difficulties experienced by systems renewal programs which put the finalization of their development as a first priority over any other development (we can site as example 4Flight in France as mentioned in the Report from French senator M. Vincent CAPO-CANELLAS).

- the additional cost of deployments due to the need to upgrade as many systems as there are ANSPs in Europe.

This prevents the systems from being adapted to the changes that are operationally necessary, at an affordable cost, even though these changes have been demonstrated to be technically possible. We can clearly see the consequences in the difficulties of deploying the solutions developed and validated within the framework of SESAR. As already mentioned, this sub-optimal deployment was also strongly underlined by the "European Court of Auditors" (ECA) in its 2019 report on the deployment of SESAR.

- Weaknesses in systems interoperability, detrimental to operational efficiency:
  - data exchange between Control Centres are based on technologies and protocols dating from the 80's,
  - the flight plan format which, even if upgraded in 2012, is still based on extremely limited data exchanges, not allowing all the information available in airline systems to be exchanged with ATM systems, which could contribute to a significant improvement in the processing of ATM systems, in particular in terms of flight trajectory forecasting.

Finally, it should be emphasized that this fragmentation leads in some cases to a deterioration in technical and operational performance (we therefore manage to do less well for more money). The two most obvious cases are:

- surveillance where over-equipment at ground level leads to over-interrogation of on-board systems far beyond the maximums provided for in the "Safety cases" of these systems.
- Weather forecast (or even nowcast). It is noticeable that weather has more and more impact on the delay in summer season. Recent PRR report (PRR2017) showed that there is no standard how to cope with weather. Nearly all states have mandated the ANSP to get the weather data from the national weather service, preventing any kind of European wide weather forecast. This fragmentation is detrimental on the way the ATM system is managing adverse weather situations especially in terms of delay.

2.3.2 A toothless Network Manager

The main mission of the Network Manager (NM) is to find the optimal balance between the capacity of the system and the demand coming from the Airspace Users (mainly the airlines but also the business aviation and Military Air Force). Another mission related to this Demand Capacity Balancing (DCB) management is crisis management (e.g., the Eyjafjallajökull volcano crisis).

This search for the optimum is carried out continuously at 3 timescales:

- Strategic (from 3 years to 6 months before the actual flight)
- Pre-tactical (from 6 months to the morning of operations)
- Tactical (just before - a few hours - and during the flight)

This function is based on a technical infrastructure made up of a set of powerful modelling, simulation, and optimization tools, as well as of a very significant data warehouse enabling the most accurate

demand forecast at the different timescales mentioned above. The analysis is then reflected in the Network Operation Plan (NOP) and the NOP Gateway which is the reference tool to support collaboration in all the three phases.

At each of these timescales, NM estimates when and where there is a risk of imbalances between demand and capacity and takes measures to reduce these imbalances, or if this is not possible to minimize operational impacts.

The measures available to the network operator are largely specific to each phase:

- At the strategic phase: using the tools mentioned above, the network manager establishes the best forecast of demand (by city pairs, by time slots) as well as the capacity of the system (airport, airspace, etc.). In the event of an imbalance, the Network Manager assesses the possible measures (mainly the optimization of the airspace design: - route network, military areas, sectorization, delegation of airspace, etc.) and negotiates with all the players (mainly ANSPs, airports and military), the best measures to adapt capacity to demand. If this is not possible (generally for particular periods of heavy traffic such as major sport events, or particular tourist periods) a Collaborative Decision Making (CDM) process with Airspace users and providers is engaged to find the less damaging options on demand.
- At pre-tactical phase: the main tool is a CDM between actors, with measures easier to implement (sector opening scheme, balance between military needs and the civil needs with adapted opening scheme of military reserved areas, reduction of demand to cope with reduction of runway capacity is case of bad weather...). The ultimate case is to organise a dedicated conference with actors concerned by specific congestions (e.g. weekly conference during summer 2019) to decide commonly the most appropriate measures.
- At tactical phase: up to the mid 2000's the sole tool available was to allocate slots for take-off and thus to impose ground delays to the airlines. These slots were allocated two hours before take-off, to allow users to be able to manage the consequences of these delays. R&D in the 2000's based on the experience of the US FAA Air Traffic Control System Command Center (ATCSCC) showed that this allocation of slots two hours before take-off was sub-optimal (due to the many events that may happen during these two hours). As a consequence, new more dynamic methods have progressively been designed and deployed, reducing use of ground delays in favour of tactical measures just before take-off (some minutes delays or slight route changes) or in flight (flight level capping, dynamic rerouting, speed control, management by flows, slot swapping…). All these dynamic measures requiring specific CDMs between all actors involved (Airlines, Military, Airport, ANSPs) in a specific identified hot-spot.

All these measures are fundamentally based on the technical infrastructure and availability of data at the level of the Network Manager but also Collaborative Decision Making requiring a global win-win spirit. Unfortunately, Air Transport is highly competitive at the level of airlines, and to a lesser, but non-negligible extent, at ANSP level (mainly due to the performance approach and the strong pressure to protect national Airports Hubs and Airlines). This sometimes hampers the implementation of a global optimum (it is a well-known problem that the global optimum is not the sum of local optima).

Since the Network Manager does not have the legal power to impose solutions, there are situations where no compromise is found, leading to sub-optimal situations for the European Network.

This is particularly true for Airspace design at the strategic phase where there are well known cross-border hotspots where the optimal solution at European level would generate some losers and some winners (even if limited to impact on route charges). This equally exists at pre-tactical and tactical phases.

Problems also exist at a data level, where some actors are reluctant to share their data (here also to preserve own interests against potential perceived competitors).

2.3.3 A fragmentation at institutional level

While the two SES legislative packages were intended to strengthen European management of ATM, this actually resulted in the reverse with an over-complexified and fragmented institutional landscape of the European ATM system.

The following diagram schematically represents the current landscape, essentially based on a clear delineation between regulatory functions and services:

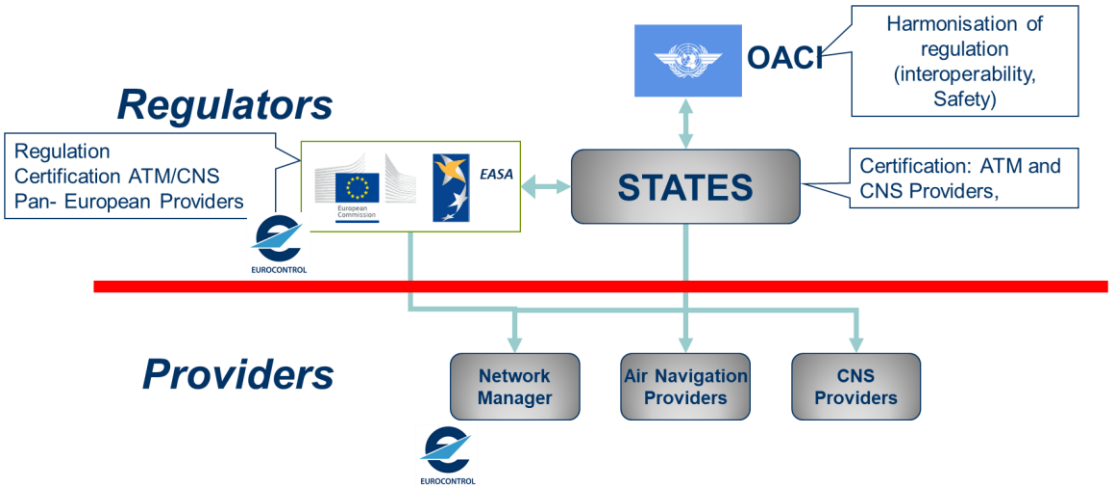


Figure 2: from a slide made by Pierre Andribet for DASC conference 5 years ago in Prague

With for the regulatory functions a separation between:

- the development of regulations: formally under the responsibility of the European Commission (EC) but practically delegated to the European Aviation Safety Agency (EASA) which develops "opinion" which are then enforced as regulation by the European Commission following its normal comitology process. In these functions, both the EC and EASA rely partially on EUROCONTROL expertise.
- the certification process, which is under the responsibility of the EU states, which are required to delegate this power to independent entities called National Supervisory Authorities (NSA), except for Pan-European services (such as the Network Manager) which are certified by EASA.

And for the Service provision:

- National Air Navigation Service providers, generally one per state, which provides the following services to airspace users:
  - Air Traffic Management (ATM)
  - Communication navigation and surveillance systems (CNS)
  - Meteorological service for air navigation (MET)
  - Search and rescue (SAR)
  - Aeronautical information services/ Aeronautical information management (AIS/AIM).

A variety of organisation types exist for ANSPs, from part of governmental administration to a purely private company.

A majority of ANSPs are state-owned companies.

- Exceptionally, some of these services are provided at a multinational level:
  - Maastricht Upper ATC Centre (MUAC) provided by EUROCONTROL to control upper airspace of Belgium, The Netherlands, Luxemburg and part of Germany)
  - GSSP to provide enhanced GNSS service (Navigation service) at European level using the EGNOS system
  - AIREON providing satellite based ADSB service (Surveillance service)
  - ARINC and SITA providing Datalink service (communication service)
- The Network Manager, a pan-European service provided by EUROCONTROL as described above.

In addition to this complex landscape, we should add some key actors with:

- The FABs which were initially proposed to group national ANSPs in bigger entities that were operationally independent, allowing economy of scale and an optimised management of Airspace. Instead, it has led to the creation of an additional unproductive layer between the Network Manager and individual ANSPs (Over time it has become more and more silent and thus just useless).
- the Performance Review Board, an independent entity in charge of defining performance objectives and monitoring performance on behalf of the European Commission. This should be replaced by an independent economic regulator.
- the SESAR Joint Undertaking (with EC and EUROCONTROL as co-founders and 19 selected industrial partners) in charge of maintaining the ATM Master Plan, and of coordinating and co-funding the R&D assessed as necessary to implement this Master Plan.
- EASA with an extended mandate of the basic regulation gained competence in the field of ATM/ANS in 2018 (EU 2018/1139).

Even it is not the model to follow, this institutional setup should be compared to the significantly simpler landscape in USA as depicted in following picture:

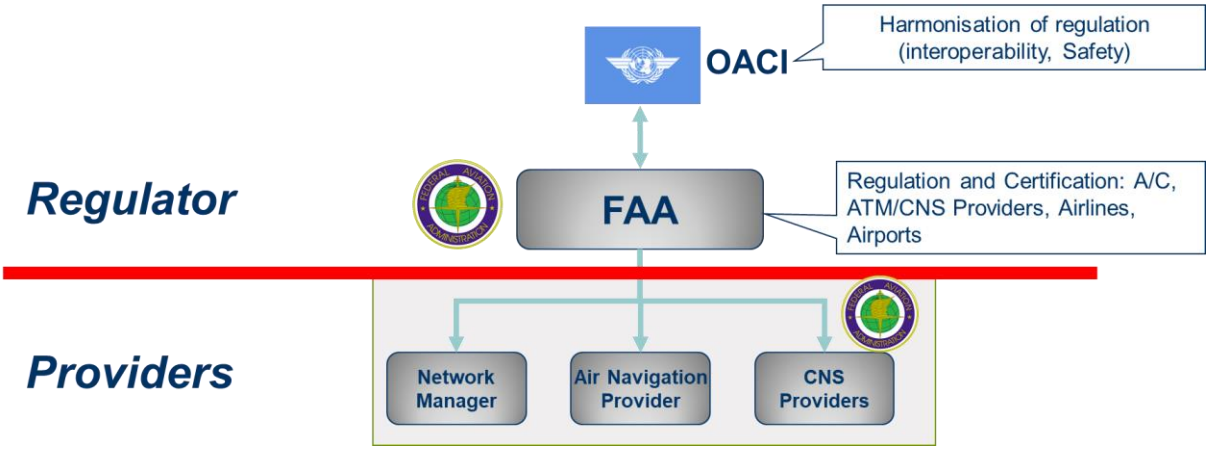


Figure 3: from a slide made by Pierre Andribet for DASC conference 5 years ago in Prague

With an administrative (called in Europe: Functional) separation between the regulator and the service provider, but both being part of the same administration (The Federal Aviation Administration, FAA)

2.3.4 A counter-productive performance approach

This was particularly true with the way the objectives on costs were handled with harmful effects blocking the required increase in staff recruitment, which was nevertheless necessary to cope with the resumption of traffic in 2017. This was also true when the requirement to overhaul the project completely for RP3 for reasons of COVID has highlighted the weaknesses and fragility of the current set up during a crisis situation.

In addition, (Njoya et al., 2020) Button (2019) as cited in Finger and Serafimova (2019) pointed out at the 10th Florence Air Forum *that the problems with FABs are indicative of the lack of incentives.*

Moreover, he indicated that FABs had not been fully implemented because, in economic terms, there was no incentive to adopt them or penalty for not doing so.

Penalising ANSPs for not delivering optimal capacity was a solution also proposed by IATA (2018) in response to a growth in summer delays of over 130 percent compared with 2017.

Moreover, Finger and Serafimova (2019) indicate that the financing and incentives (or conversely, penalties) must be performance- and objective-based, with a firm commitment from the Member States to make appropriate investments.

3. Where do we go from here?

3.1 A Wise Person Group to shape the future

In the ECA report already mentioned, the auditors developed some recommendations:

The EU's regulation for the modernisation of air traffic management has added value – but the funding was largely unnecessary which issued the following recommendations:

The Commission should:

- *review the SES high level goals;*
- *analyse other policy options targeting defragmentation;*
- *ensure full independence and capacity of NSAs and cover the inspection gap at the level of the charging scheme;*
- *streamline the performance scheme;*
- *review certain key performance indicators;*
- *review the EU's support structure to R&D in light of its objectives;*
- *reinforce the accountability of the SESAR JU;*
- *prioritize EU support to R&D solutions that promote defragmentation and a competitive environment.*

Following this report and recommendations**,** in 2019, the European Commission (DG MOVE) created a Wise Persons Group (Report of the Wise Persons Group on the future of the Single European Sky 2019) and tasked this group to reflect on the future of the Single European Sky (SES) to produce recommendations for the direction that European ATM should take, in order to deliver better performance and better services while taking into account the continuous growth of air traffic.

The 15 members of this group produced the following recommendations. These recommendations could easily be seen as the roadmap for the European Commission for the future of Single European Sky.

The recommendations were:

A network-centric approach

- *Recommendation 1: Confirm and strengthen EUROCONTROL Network Manager role by providing it with the necessary executive powers to manage the ATM network, including by managing European capacity and infrastructure based on standardized technology, while ensuring a clear division of responsibilities between the Network Manager and ANSPs.*
- *Recommendation 2: Fully integrate airports into the network on the basis of linking the Network Operations Plan and Airport Operation Plans, using extensive Collaborative Decision Making.*

Implementation of a digital European sky

- *Recommendation 3: Implement a Digital European Sky based on an agreed roadmap building on the recommendations described in the Airspace Architecture Study, managed by the Infrastructure Manager, ensuring resilience of the system.*
- *Recommendation 4: Create a new market for ATM data service providers as recommended by the Airspace Architecture Study.*
- *Recommendation 5: Use the performance and charging scheme to support the digitalisation of air traffic services, and public funding to support deployment only where necessary from a network perspective.*

Evolving role for people delivering the ATM services

- *Recommendation 6: Facilitate the transition towards the Digital European Sky by reviewing current licensing and training requirements for ATCOs, with full involvement of staff representatives.*

Simplifying the regulatory framework

- *Recommendation 7: Simplify and strengthen economic regulation, while relying on a market-driven approach wherever possible.*
- *Recommendation 8: Establish a strong, independent and technically competent economic regulator at European level.*
- *Recommendation 9: Establish a Seamless European (Upper) Airspace System including a common route charge.*
- *Recommendation 10: Encourage airports to procure tower services through competitive tender or contract, where operationally feasible and positively impacting users*

3.2 The EC legislative proposal to implement these ambitions

Following the recommendations from the Wise Persons Group, the European Commission initiated in the second half of 2019, the process to develop a legislative package to amend SES accordingly. The objective was to launch consultation in 2020.

Unfortunately, the COVID-19 crisis happened. The revenues of ANSPs collapsed, and if there was no obligation to ensure the continuity of air traffic control, European ANSPs would have gone bankrupt. Short term actions as described in chapter 1, needed to be taken. This delayed the development of the planned legislative revision of SES.

The European Commission took on board the impact of this crisis, and the latest environmental priorities as expressed in the new European Green Deal[4], and decided to

[4] European Commission, "The European Green Deal - COM(2019) 640 final," 12 2019.

progress in the process of amending SES regulations at the end of 2020 summer. In the EC press release 'Single European Sky: for a more sustainable and resilient air traffic management' Commissioner for Transport, Adina Vălean, declared: *"Planes are sometimes zig-zagging between different blocks of airspace, increasing delays and fuel consumed. An efficient air traffic management system means more direct routes and less energy used, leading to less emissions and lower costs for our airlines*

The European commission published on the 22nd of September 2020 the amended proposal for a regulation on the implementation of the Single European Sky,[5] and the proposal for a regulation amending Regulation 2018/1139 as regards the capacity of EASA to act as Performance Review Body of the Single European Sky. The main points of this proposal are:

1. New approach to the performance scheme with an independent PRB agency (hosted by EASA) in charge of assessing and approving the performance plans for en-route air navigation services.
2. There should be now two national entities clearly delineated and independent from the service provider:
   - NCA National Competent Authority in charge of safety oversight (safety certification of service providers) and other tasks described in the EASA Basic Regulation.
   - NSA National Supervisory Authorities in charge of issuing economic certificates, overseeing the correct application of procurement requirements of CNS, AIS, ADS, MET and terminal ATS services, and certifying these services vis-à-vis performances regulation, and monitoring en-route services performances.
3. Strengthened role of the Network manager.
4. Functional Airspace Blocks (FABs) should no longer be regulated,
5. Unbundling of CNS, AIS and ADS infrastructures, and of MET and terminal ATS services, subject to market conditions.
6. a possibility of introducing a common unit rate for en-route air traffic services across the Single European Sky airspace, with a focus on "clean technology" and modularity to foster investments. The unit rates should be set by the NSAs, rather than by Member States, after verification and approval of the Agency acting as PRB. Possible modulation of charges to incentivise implementation of new technologies (decision at EU level)
7. common information services for unmanned aircraft (i.e. drones)

The ambition remains the same as the 2013 proposal: The main objective of the 2013 SES2+ proposal was to (SWD 20201871-SES*) "improve the competitiveness of the European aviation system vis-à-vis other comparable regions, and in particular developing further the SES initiative, which implies de-fragmenting the European airspace, reducing delays, increasing safety standards and flight efficiency as to reduce the environmental footprint of aviation and the costs related to service provision.*

That same objective should be maintained, with an even greater emphasis on delay reduction and flight efficiency, in order to contribute to reducing aviation's carbon footprint, while maintaining the

[5] For a better understanding of the proposal two documents are worth mentioning:
Questions & answers – Single European Sky: for an efficient and sustainable air traffic management
Commission staff working document 'A fresh look at the Single European Sky'

goals of cost-efficiency and de-fragmentation. Safety in ATM is a paramount constant objective and is being effectively addressed and managed under Regulation (EU) 2018/1139 ('EASA Basic Regulation') and at national level. Clear links between the two Regulations should therefore be established".

Whilst the political discussions on the EC proposal for a SES 2+ legislative proposal have started in the Council and Parliament, the proposal has highlighted the divergence of views of the Airlines and user organisation (IATA 2020) on the one side and the Air Navigation Service Provider Community (CANSO 2020). тThe proposed recast fails to create a common agreed and shared vision and many of the proposal by the EC are not actually proposing a reform of the sector, but rather a request for more competence at the European Level versus the national competence in the matter of Air Traffic Control. The proposal does as well put the Economic Regulator at EASA and therefore blurs the line between safety, certification and economical regulation. Even if a functional separation for the performance regulator is proposed, it nevertheless blurs the lines of the independence. The SES 2+ recast legislative proposal is a proposal for more competence been handed to the EC and has the potential to delay the much needed reform of the ATM sector.

3.3 The authors' proposal for a transition towards a pan European ATC with EUROCONTROL reinvented

As explained in previous chapters, the new initiative from the European Commission is a step forward, in line with the recommendations from the ECA report and of the Wise Person Group conclusions. In particular, in terms of safety, the current position of EASA and the National Competent Authorities (NCA) has proven its efficiency and will be further strengthened with the new proposal requiring full independence from providers and economic regulator.

The rest of this legislative proposal by the European Commission is a step forward, but, the authors of this paper believe that it will not be sufficient to solve the latent issues that the COVID crisis has dramatically underlined.

This paper is therefore proposing a step even further in terms of defragmentation, that would require significant organisational changes of the European ATM system, mainly along the six following axes:

- A stronger political decision maker, with significantly increased transfer of competence to the EC in the ATM domain,
- A Network Manager with stronger power in terms of Airspace design and capacity management.
- A defragmentation of Air Navigation Service provisions. Even though the Functional Airspace Blocks finally failed, the rationales behind their creation are still valid, and it is more the implementation (bottom-up approach) that should be revised.
- An infrastructure manager not only in charge of the management of pan-European programmes, but also responsible for standardisation (in cooperation with industry through standardisation bodies such as EUROCAE but not limited to) and gradually taking over the overall procurement at European level of the ATM/CNS infrastructure according to the market rules, including the deployment of new data-services.
- A strengthened R&D setup for Europe, more agile, less bureaucratic and facilitating innovations in a significantly more digital environment.
- A real pan-European Performance Manager with expertise allowing for a holistic approach towards performance regulation.

3.3.1 A stronger political decision maker

Policy decisions made in Europe should be based on a clear transfer of competence from the states on certain areas. Its role should not be limited to regulations development and to co-funding of national projects, but should cover following roles:

- the focal point for ICAO with the support of the Network Manager and of the infrastructure manager.
- A decision maker for route charges (modulations, unique en-route route charges).
- Owner of a **binding** master plan which is no longer the repository of all technical ideas coming from all actors, but a tool to give a strong direction on the targeted system in terms of organisation and modernisation, and the transition steps to implement this target using new technology to create a single standard.
- Owner of the overall investment plan.

The issue of the geographical scope of EU, especially in the context of Brexit should be addressed. Possible solutions could be:

- Two-layered governance: intergovernmental (ECTL Council) at a pan-European level and an EC decision maker for EU states,
- Aviation agreement with non-EU states to centralise at an EC level pan-European dimension.

3.3.2 A more powerful Network manager

The recent regulation proposes to reinforce the role of the Network Manager mainly in two aspects which is already a good step forward:

- Making the Network Operation Plan binding for all service providers,
- Putting the Network Manager in a position to manage the capacity brokering process, including the possibility to facilitate delegation of Airspace.

To go further, the Network Manager should be empowered with four key pan-European roles:

- Airspace Manager: allowing a Top-down Airspace design to avoid current lose – lose fights at the well-known hot-spots.
- Capacity manager: based on pan-European DCB analysis, decision on the best measures for a better balance including mandatory delegation of airspace from congested ANSPs to less congested neighbouring ANSPs.
- Control Command centre role: similar to the role performed in the US by the Air Traffic Control System Command Center with a final say on dynamic **Demand Capacity Balancing measures.**
- Weather forecast, both in term of technical system with a centralised approach (as currently done by the US ATCSCC) to ensure a coherent information available for all operators (from airlines to ANSPs and Airports) and to organise an efficient Collaborative Decision-Making approach to cope with adverse weather (especially in summer during strong convective situations)

3.3.3 A defragmentation of Air Navigation Service provisions

The failure of the Functional Airspace Blocks should not prevent any kind of optimisation of the service provision organisation, considering that current fragmentation is sub-optimal (too many ANSPs below the critical size).

New models should be investigated:

- A single service provider for Europe, reinventing the vision of the founders of EUROCONTROL.
- Top down design of ACCs (operationally meaningful) with designated ANSPs with possible periodic competition (would need separation of the infrastructure manager of service) a common ground-to-ground network with a gate-to-gate perspective.

3.3.4 A real pan-European Performance Manager

The reform of the performance scheme proposed by the recent legislative package, with an equivalent position between a central, independent and powerful Economical Regulator agency (hosted by EASA) and national Supervisory authorities seems theoretically achievable, provided that this PRB and NSA are fully independent from any providers, and from safety regulation. It will, however, must pass a revision of the EASA's Basic regulation and will have to start from scratch as it does not have any data, nor has the staff to provide the needed expertise and it will reduce to a limited geographical scope. Instead of starting from scratch it would make much more sense to build the future independent economic regulator around the expertise of the Performance Review Unit (PRU) and the performance Datawarehouse of EUROCONTROL. A mixed committee for the governance of the independent regulator shall include EU and non-EU EUROCONTROL Member States.

The proposed scope of the future economic regulator introduces a new fragmentation of performance and shifts safety into the field of "resilience performance". This will be a challenging undertaking as the interdependencies between the various Key Performance Areas have not been catered for.

3.3.5 A real infrastructure manager

The recent regulation foresees this role should be limited to the management of the pan-European implementation programme (such as RVSM 20 years ago). This would solve the issue underlined by the ECA concerning the SESAR Deployment programme that did not permit the implementation of the solutions developed by SJU and is widely considered as promising.

This regulation also foresees a separation between operational services and technical services considering that the later should be subject to market competition, but only as an option and leaving the final decision at a national level.

The authors of the paper consider that this would be insufficient to solve the current inefficiencies identified above, due to fragmentation. They recommend that all the CNS/ATM infrastructure should be managed at pan-European level to achieve a real improvement to the current system. This will become important in the coming years, in particular to accommodate the new airspace users such as drones (at low, medium and very high altitude). In order to face the challenges of the newcomers, the incumbent (current ATM system) will have to adapt in a harmonised way.

Several options are possible for this overall management of the CNS infrastructure. There are two principal possibilities:

- The first option and the easiest one to progressively implement would be to move from a model of purchasing specific solutions by each ANSPs to common procurement of preferably off the shelf’ products. It can be emphasized that this is the model followed by airlines, which rely entirely on aircraft manufacturers to define products. The obvious advantages would be a reduction in costs by promoting reuse, but also would allow manufacturers to invest in innovation, which is a marker of differentiation. Finally, the existence of European standards deployed in Europe at an

operational level would help the export of European industrial products.

- A more ambitious option, but with greater benefits, would be to see the CNS infrastructure as a service and no longer as an investment. This is partly included in the recent regulation but only at a national level, while this paper considers that real benefits will appear only if this is applied at a pan-European level. This applies to all of the CNS domain, for example:
  - For surveillance, the regrouping of the entirety of surveillance infrastructure (Radars, and also the multi-lateration infrastructure, ADS B , etc..) to the infrastructure Manager (transfer of ownership and financial compensation to be defined), would allow optimisation of this infrastructure including a progressive transfer to a service oriented contract (maintaining possible competition where necessary but in an optimal manner benefiting of economic of scales).
  - This kind of model would also be possible for Navigation where the interest to maximise efficiencies also has synergies with satellite means of navigation.
  - The same method could be used for Communications and mainly regarding air-ground communications where a synergy is to be found with other types of A/G communication such Airlines operations and passengers' communications.

  It is worth mentioning that the feasibility of service-oriented service has been demonstrated with well-known implementations, such as ADS-B surveillance to ITT, by the FAA, EGNOS in Europe to ESSP, and ADS-B by satellites to AIREON. The main risk would be to create counter-productive industrial monopolies both economically and technologically. Other difficulties will be the fear of loss of sovereignty over a critical area and the risk of resistance by the technical services currently in charge of these missions.

Until now for ATM systems, standardisation and interoperability have been considered as the solution. On paper, the current relationship between ICAO defining high level orientations and RTCA/EUROCAE working together to refine the standards before they are endorsed by ICAO is correct. However, in reality it does not work as it is a purely bottom-up approach with ANSPs using the EUROCAE tool to prevent any attempts that would defragment the system. It was claimed that interoperability standards (IOP) would be sufficient. 15 years later, if we look at the results however, they have spent tens of millions of Euros (hundreds?) with at the end a failure and no implementation in sight.

Therefore, we suggest three possibilities:

- The first possibility would be the delegation of management of technical systems which technically no longer need to be collocated with control positions. This already exists at the level of Maastricht which manages the technical systems of the military air traffic services of the Netherlands and Belgium from the Maastricht ATC centre, while the control positions are still located in the respective national military centres. A more ambitious experiment was carried out here too by the Maastricht centre with the Slovenian control centre. This experiment tested the feasibility of installing and operating the central systems (Radar processing and flight plan) by the Maastricht control centre using the same software as the systems at the Maastricht centre, while the Control positions remained in Slovenia and were operated by Slovenian controllers. The experiment demonstrated its technical and

operational feasibility and is still waiting for political approval.

- The second option would be to rely on common development/procurement of ATM systems. This already exists, at least partially, with examples such as ARTAS (advanced Radar processing system procured by EUROCONTROL and deployed in a significant number of ANSPs), or such as COOPANS which is a "Purchasing group" of several ANSPs which together specify the evolutions of their system, jointly purchase and simultaneously put into service the new versions of systems. All of these examples have demonstrated the feasibility of common procurement, as well as the benefits in economic terms, but also in terms of standardization of human-machine interfaces (it is thus shown that the problem of national specificities is rarely an ATCO issue).
- The last option and certainly the most ambitious and which was identified in the Wise Person Group recommendations as the final goal, consists in the total virtualisation of the systems. This virtualisation consists first of all in moving from a very monolithic systems architecture to an open, standardized and modular architecture. This would then make it possible to completely review the overall architecture of the ATM system in Europe and even its economic model by setting up ATM data server service providers (maybeone or two radar data service providers with the ANSPs as a client, idem for flight plan data, weather data, aeronautical data servers, etc.). The various experiments carried out so far have demonstrated the technical feasibility of such an approach. The benefits in terms of costs, due to economies of scale, appear obvious, we also see that in terms of scalability this would greatly simplify the functional improvements with a very limited number of systems to upgrade, but also in terms of sizing where it would be easy to better adapt the infrastructure to the needs. As for CNS as a service, the main risk would be the creation of industrial giants or even a monopoly. When relying on new technological platforms or network there is a risk that the winner will take it all. Currently there are only very few companies worldwide which have the computing power to realise such an undertaking and none of them is in Europe.

All these options would require a strong infrastructure manager to take the lead, the authors considering that the unique solution would be to designate EUROCONTROL in that role as they are the sole organisation that can provide the required expertise and overview needed for such a continent-wide undertaking.

3.3.6 An agile and efficient setup for R&D

SJU has been a particularly good tool to pool European funds and justify the investment of research money in the sector, however as R&D is co-funded by its members it has shown its limitations:

- Priorities were always a compromise between national interests driven by their individual strategies linked to an uncoordinated investment plan (despite the attempt of the Master Plan to steer R&D along a shared vision).
- High administrative burden and bureaucratic procedure drastically impeded the required agility of R&D. Sometimes three years were spent from the agreement on a new idea to the initiation of the research project.
- No possibility to stimulate innovation exists outside the signed partnership and in order to embark easily in this partnership, new actors must be recognised for their added value.

The authors of this paper propose that a new technological pillar be set up by EUROCONTROL and the European Commission, merging the SESAR JU and

the EUROCONTROL R&D into a Joint Research Centre such as the ones that already exist in other domains.

A Joint Research Centre would have the advantage to:

- Really focus R&D budget (mainly EU R&D funds) on common interest R&D, aligned with an ATM Master plan vision, avoiding spreading these funds to sponsor particularism and fragmented R&D.
- Increase flexibility and agility of R&D, allowing quick re-orientation to answer urgencies such as the capacity issues in 2018 and 2019 and more recently the pandemic crisis.
- Animate a European innovation hub for the ATM sector. This hub would be close to the needs and close to the network of R&D centres of excellence in our domain and above all, to other domains which will naturally come to ATM which can bring the state-of-the-art expertise lacking in the standard ATM R&D network (digital industry, machine learning/ artificial intelligence, cybersecurity, drones etc.,).

3.3.7 Summary of the options

The recommendations made above can be summarised as follows:

- On the operational side:

Possible evolutions	Benefits / Concerns	
NETWORK MANAGER		
Stronger roles for the Network Manager		

• Final say of NM in all CDM processes:
  • Airspace manager
  • Capacity manager
  • Command centre role in a dynamic DCB
• Weather forecast central management
	Efficiency:	increase of en-route capacity (elimination of cross-borders hotspots)
		Better management of adverse weather situations
		Global optimum for all stakeholders

	Political:	Global optimum may imply losers in the current performance scheme. Possible impact on ANSPs revenues
Operational service provision		
Option 1: Top down design of ACCs		
• Optimal design of ACCs to best serve European traffic flows, • Designation of service providers based on competition or the merger of existing ANSPs	**Efficiency:**	increase of en-route capacity Shorter routes (operational and environmental efficiency) Cost efficiency (Economy of scale)
	Political:	Sovereignty
	Social:	issues with ANSP staff to be addressed with appropriate harmless transition measures
Option 2: A single service provider for Europe		
• Self-explanatory	**Efficiency:**	Idem as above with higher flexibility in terms of Airspace design beneficial to all aspects
	Political:	Sovereignty Financial risks shared at European level
	Social:	issues with ANSP staff to be addressed with appropriate harmless transition measures

- On the technical side:

Possible evolutions	Benefits / Concerns	
CNS		
Option 1: Standardised commercial products common procurement		
• As airlines, ANSPs should buy standard 'off the shelf' products • Performance based procurements	**Efficiency:**	Cost reduction (no more specific developments) European Standards might help European industry to develop products for global market Ability to define an acceptable standard, simply and efficiently (avoid over-specification sometimes induced by "consolidating" experts' opinion)
	Social:	resistance to change by technical staff
Option 2: CNS as a service (not anymore an investment):		
• C, N and S domain managed at European level by Infrastructure manager • Procured as a service	**Efficiency:**	Economy of scale Scalability Global optimisation Easier evolution Creation of technical monopolies
	Political:	Sovereignty
	Social:	issues with ANSP technical staff to be addressed with appropriate transition measures
ATM systems		
Option 1: Delegation of management of ATM technical systems		
• Subcontracting of ATM systems operation, as experimented by MUAC with Slovenia, and implemented operationally for Dutch MIL by MUAC	**Efficiency:**	Savings in investments, maintenance, and technical operations
	Political:	Sovereignty
	Social:	issues with ANSP technical staff to be addressed with appropriate transition measures
Option 2: Common development/procurement of ATM systems		
• Extension to all systems and subsystems of existing Joint procurement initiatives (ARTAS, COOPANS, …)	**Efficiency:**	Savings in investments, maintenance, and validation Harmonisation of HMI Ability to define an acceptable standard, simply and efficiently (avoid over-specification sometimes induced by "consolidating" experts' opinion)
	Social:	resistance to change by technical staff

Possible evolutions	Benefits / Concerns
Option 3: Open and modular architecture and ATM Data Service providers	
• From current monolithic system approach to a modular architecture • Service-based model (e.g. common - centralised data-servers such FDPS, RDPS…)	**Efficiency:** Cost efficiency Flexibility Scalability Opening opportunities for additional added-value services Ability to define an open architecture satisfying all stakeholders Transition from current systems without disruption **Social:** issues with ANSP technical staff to be addressed with appropriate transition measures
Research and Development	
Merge of SJU with EUROCONTROL R&D in a single European Joint Research Centre	

3.4 A new financing scheme

The COVID 19 Sanitary crisis has had a catastrophic impact on the air transport sector. Despite a recent increase in traffic in the European region, which is currently levelling out at about 50-60% of the 2019 traffic, it is forecasted that this reduction in traffic will continue for some time.

The multilateral agreement of the CRCO area has been based on two main components, weight and distance flown. This has led, in the current situation, to a break away from those components, leaving ANSPs cash-strapped. This should not happen anymore if we want a resilient, flexible and efficient ATM system going forward. In order to achieve that, we propose that a review of the current route charging arrangements in the CRCO area is undertaken. The members of the CRCO multilateral agreement should reflect urgently on the current situation and ensure that the ATM critical infrastructure is appropriately funded in the future to cover the essential services provided by ANSPs, as shown by this pandemic (search and rescue, repatriation, medical cargo and supply flights).

Analysis of different route charging mechanisms used by other States of regions should also be considered in this review.

The authors of this paper propose that part or all of the activities involved in the provision of ANS are funded independently of the current “airspace users pay all” principle.

The possibility of creating an infrastructure fund at multinational level to finance ANS provision should be considered. Such an approach would prevent a situation where states have to step in to financially support ANSPs which run out of funds when traffic significantly decreases (experienced in 2001 and during the current pandemic).

This new type of financing would be easier to implement in the context of the options described above which will take significant elements of the ATM infrastructure as common European assets or services. The ultimate step being a single ATM provider with a single ATM/CNS infrastructure managed as European infrastructure.

3.5 A roadmap for change

The Wise Persons Group recommended that the role for the people delivering the ATM services should evolve in order to facilitate the transition towards the Digital European Sky. Whereas the recommendation proposes to look into the current licensing and training requirements

for ATCOs, one of the biggest challenges to achieve the above recommendations is to take the current staff along on this journey towards a more efficient pan-European ATM system.

Some 17 799 staff (31%) were ATCOs working on operational duty, split between ACCs (55%) and APP/TWR facilities (45%). On average, 2.2 additional staff were required for every ATCO in OPS in Europe. In 2018 (ACE Benchmarking report 2018) 56 718 staff were employed by ANSPs. An additional 2000 staff work in the various European institutions such as EUROCONTROL, EASA and EUROCAE in the matters which will be affected by our proposal. It is therefore urgent that a roadmap for change is created to assist the evolution of the system.

4. Documents worth reading

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