

COULD AIR TRAFFIC MANAGEMENT LEARN FROM OTHER NETWORK INDUSTRIES?

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1 INTRODUCTION

The study “ATM Market Evolution due to Deregulation”, launched by the EUROCONTROL Experimental Centre/Society-Economics and -Environmental Research Area, aimed at exploring what similarities could be drawn between Air Traffic Management (ATM) at the start of a new era, possibly leading to deregulation of some ATM activities, and other industrial sectors that have already undergone such a process (i.e. mobile telecommunication, passenger air transport and the Internet) to see how the Single European Sky (SES) initiative might change the ATM market. This paper summarises the results of the study.

In the recent years, the demand for air transport grew rapidly causing serious capacity problems for ATM. The forecasts indicate that the European air transport demand in 2025 will be 2.4 times higher than in 2005 in terms of RPK [2]. In order to meet this demand without compromising quality or safety, the Single European Sky initiative was launched in 2004 by the European Commission aiming to set out regulatory principles with a view to restructure the airspace according to traffic flows rather than national boundaries, create additional capacity, and more generally to improve the overall efficiency of the ATM system.

The implementation of this initiative, called Single European Sky ATM Research (SESAR) has been started March 2006. This modernisation program was initiated by the industry and continued with a consortium including airspace users, air navigation service providers, manufacturers, airport operators, and military. SESAR is combining technological, regulatory and economic aspects and aims to deliver a Master Plan with a vision for the future of ATM. The second phase of the project will be a development and implementation phase to build the next generation of air traffic control systems.

In this context, the ATM market structure, its actors, and the services provided to users may experience significant evolutions. Two essential factors are driving the future changes. These are on the one side the factors related to the integration of the ATM architecture with changes in regulation, in services and in roles of actors in air transport, and on the other side the technological shift factor that will be facilitated by this integrated architecture. This paper focuses on the long term shape of the ATM organisation while adopting a market oriented vision by shedding light on possible ATM structure evolution based on experiences from “comparable industries”.

2 STUDY OF FIVE “ATM SUB-MARKETS”

This section presents the ATM actors, and provides a segmentation of the different services to airspace users (sub-markets). ATM coordinates air traffic organisation and

offers its customers (the airlines, military aviation, business and general aviation) principally safety and capacity. To achieve these objectives, ATM relies on a combination of several actors and is organised into specific services. From many services which are provided by different actors, the following are examined:

- Network design (Airspace Organisation & Management)
- Flow management (Air Traffic Flow Management)
- Traffic Control (En-Route Air Traffic control)
- Network Access (Airport as ATM Network Access Point)
- Pricing and Invoicing Functions (En-Route Charges Management)

On the demand side, this study focuses on “passenger” air transport operated by commercial carriers. The study therefore excludes analysis of military air transport and the specific needs related to freight transport, business flight, and general aviation.

Suppliers	Basic ATM Services (ATM inputs needed for airspace users)	Intermediate Services	Demand
<p>ANSPs (1 per State)</p> <p>Airports (several per State)</p> <p>Eurocontrol (CFMU, CRCO, EATMP, MUAC, CEATS, IANS)</p> <hr/> <p>Industry (Infrastructure & systems, Thales, BAE Systems, Lockheed Martin, etc.)</p>	<p>Airspace Organisation & Management Services</p> <ul style="list-style-type: none"> • Airspace management • Route network development • Airspace modelling <p>ATFM Services</p> <p>Air Navigation Services</p> <ul style="list-style-type: none"> • ATC Services <ul style="list-style-type: none"> • En-Route • Terminal • Airport • Advisory Services • Infrastructure Services • Other Services 	<p>En-route Charges Management</p> <ul style="list-style-type: none"> • Calculation • Billing • Collection • Distribution • Advisory services 	<p>“Traditional Airlines”</p> <p>Low Cost Carriers</p> <p>Charters</p> <p>Freight</p> <p>Military users</p> <p>General Aviation</p>

Table 1: Overview of ATM markets

2.1 Airspace Organisation & Management (AO&M)

AO&M activities comprise: i) the modelling of airspace structure, ii) the development of a coherent network, and iii) the management and coordination of actions in order to ensure system wide efficiency. These activities are carried out by the EUROCONTROL “Programme for Performance Enhancement in European Air Traffic Management” (EATM) on behalf of the participating states, and by the dedicated units of ANSPs in each State. In this sub-market, barriers to entry exist at different levels as the AO&M functions are vertically integrated with all other activities under mostly “State-owned” ANSP responsibilities. Access to flight data and simulation tools, knowledge of military zone constraints, and the ability to legitimately enter into bilateral agreements with foreign ANSPs are significant limits preventing contestability of the market structure.

The AO&M have a direct impact on aircraft trajectories, and thus on the fuel consumption and operating costs of airspace users. Investigations indicate that there are en-route flight inefficiencies resulting from both horizontal and vertical deviations. While the cost of vertical inefficiencies is still a research area, the total cost of the direct route horizontal inefficiencies have been estimated for 2005 by the EUROCONTROL Performance Review Commission at around 1400m€¹ [1].

On the demand side, there is only a need for AO&M as the result of constrained capacity. In an ideal ATM system, airspace users would operate in a “free-flight” environment allowing them to adjust their route, altitude and speed without restrictions. As this situation is not possible in dense traffic areas, a “second best” demand is to minimise deviations from the optimum trajectories. The function of airspace organisation and management is therefore to facilitate the most efficient design and management of airspace while taking into account tradeoffs.

2.2 Air Traffic Flow Management (ATFM) Services

Flow management services are provided by the Central Flow Management Unit (CFMU) of EUROCONTROL, with the aim to protect the control sectors from overload. It centralises the demand for traffic in the European airspace, and processes it in order to smooth traffic peaks where demand exceeds capacity so the available capacity is used in the most efficient manner. Whilst individual ANSPs can determine the amount of capacity that they make available, they do not determine which parties get access to that capacity. Rather, the current system can be understood as treating the provision of capacity by ANSPs as an input into the effective capacity of the European network. The allocation mechanism for this capacity is then substantially carried out by the CFMU.

Since the ATM capacity is becoming more and more constrained for air transport, the mission of ATFM is changing: it will not only be restricted to slot allocation but will also be extended to the maximisation of the use of available capacity. For this purpose, ATFM is moving towards Air Traffic Flow and Capacity Management (ATFCM) to balance demand and capacity within a gate to gate perspective by mean of a more collaborative approach to capacity management where the partners are involved in the planning phase.

As with AO&M services, ATFM does correspond to a demand linked to congestion. If capacity were always much higher than demand, then airspace users would not need ATFM services. In current situation with scarce capacity, airspace users would benefit from flow management strategies focusing on the minimisation of delay at arrival.

2.3 En-route ATC Services

ATC gives instructions to let aircraft fly while minimising the risks of collision with the relief, and with other aircraft. ATC units are created and managed by ANSPs that are in a monopolistic situation in each State. There are 36 ANSPs in charge of delivering ATC services in the EUROCONTROL area, organized in 75 “production units” i.e. control centres. These centres are again composed of sectors, which correspond to an airspace volume under the responsibility of a team of 2 or 3 controllers. There is a total of about 400 sectors in Europe.

At the strategic level, the ATC sectors are created and managed by national ANSPs, in function of operational constraints and traffic patterns which are subject to AO&M review, safety impact assessment, and capacity simulation and validation process. ATC functions thus often involve long decision and implementation procedures, requiring investments that take time to pay back. As part of other ATM costs, costs specific to ATC services are subject to a full recovery through amortisation of capital expenditure and direct allocation of operating costs.

The tactical management of ATC is done as a function of the quantity of traffic, the patterns of flows transiting sectors and number of controllers available at a given time. Flexibility in the management of sectors (grouping and de-grouping) exists, but is however limited to individual control centres. Flexible sectors grouping and de-grouping across different ANSPs, or even across different centres of the same ANSPs does not exist so far.

The customers of the service, which is provided by the ANSPs, are the airspace users. For a safe operation of flights, en-route ATC is essential. During the flight, pilots communicate with air traffic controllers and they receive instructions to adjust the flight routes. The price of ATC services is not used as a strategic lever to attract demand, although the observed price difference across control centres might, in some cases, influence the shape of preferred flight paths..

2.4 ATM Network Access Point

Airports are the entry and exit point of the network for airspace users' operations. Since the capacity of an airport for take-off and landings is limited due to factors such as runway space, air traffic control capabilities, taxiways, etc., the number of aircraft that can use the airport within a time period is limited. When insufficient airport capacities due to the increasing air traffic demand became a constraint for the airspace users, airports started to grant specific authorizations to the airlines for using the airport at a specific time known as airport "slots".

- Time niches (slots) are assigned according to the grandfather-principle; the airline gets a slot it had already owned the previously.
- However, airlines lose grandfather rights if they do not operate them for at least 80% of the time of one period (use-it-or-lose-it principle) where one flight period is six months.
- Airlines offering scheduled service over a longer duration are given priority over those who fly less frequently.

The fact that most airlines prefer to fly during peak hours (day-time) increases the capacity problem at airports. On the other hand, even if the carriers would agree to distribute their flights evenly between peak and non-peak hours, there are airport regulations which prohibit night flying because the residents who live around the airport area are disturbed by the noise of the aircraft. As a result, the airlines are not free to choose the time of their take-off and landing so slot allocation is a necessary restriction. Hereby, it is essential that the slot allocation is granted in a non-discriminatory way to ensure fair conditions for the network entry as the airports are geographical monopolies. The current slot allocation discriminates against the airlines which try to enter the market. In particular, the new emerging low cost carriers which fly at much lower prices than traditional airlines have difficulties to get slots at peak

hours at big airports and operate at secondary airports where capacity is not constrained and aeronautical fees are lower.

It is not always possible to extend the capacity of congested airports due to environmental impacts of aircraft operations at airports. Therefore, new approaches for slot mechanism have to focus on efficient allocation of the existing airport capacity. Some examples of the recommendations on alternative slot allocation systems are:

- Slot auctioning, where slots are distributed on a monetary basis to the airlines which are ready to pay the highest price [Reference 3]
- Slot prices depending on the time of day (peak/ off-peak) in order to distribute the capacity more equally between day and night [Reference 4]

2.5 En-route Charges Management

In Europe, en-route ATM services are subject to a charge regime that is based on ICAO principles. These are administered and collected by the Central Route Charges Office (CRCO) of Eurocontrol. The CRCO operates the charging system, whose principles are set by the International Civil Aviation Organisation (ICAO), on behalf of the States. The en-route charges are based on the cost recovery principle. Thus the EUROCONTROL Member States recover the costs of providing air traffic control facilities and services to ensure safe and efficient air traffic flow by means of route charges levied on users of their airspace. This charge is a function of the flight distance (as calculated from the last flight plan) and, less than proportionately, of the aircraft weight. The CRCO allows airspace users to pay one bill for the whole flight which is then distributed among the different States overflown.

The CRCO annual cost was in 2005, 17.7 m€ (0.3% of total en-route cost). The number of flight processed per staff member increased 7.3% in the same year. The CRCO is financed through a separate administrative rate that is paid by the EUROCONTROL Member States.

The fact that the en-route charges are collected by a EUROCONTROL unit is not criticised by the airspace users. This seems to be the most efficient way, since the required flight data for charges collection is already stored by another EUROCONTROL unit, namely the CFMU. The critics regarding the billing and invoicing function in the ATM market are more related to the role of the airspace users in the Enlarged Commission and in the Enlarged Committee, where the decisions on the route charges are taken.

2.6 Discrepancies between the supply of the services and the demand

The current ATM service provision in Europe is not as efficient as it should be for several reasons. ATM is a supporting network for the more general air transport network. The utilisation of the airspace has been liberalised since late 80s and as a result of the new market structure, it is now operated to meet passengers demand in the best way. New business models for passenger air transport including low cost carriers and on demand travel for executives emerged allowing users to choose between different service patterns.

En-route ATM is still provided mostly by national authorities² with one type of access rule (i.e. first comes first served) hence it can not correspond to the varying needs of

the airspace users. ANSPs do not operate under cost pressure and are allowed to charge the airspace users for a fair return on capital employed. In case of downturns in air traffic demand, the en-route charges increase as an additional negative impact. The fragmentation of the airspace by national boundaries leads to inefficiencies and constitutes a bottleneck for growth of the air transport. Within EUROCONTROL area the annual total cost of fragmentation is estimated between 880 m€ and 1400m€ which represents around 20-30% of the annual en-route costs [Reference 5].

Market instruments are missing in ATFM slots as well as in airport slots attribution leading to suboptimal allocation of the available capacity. The network access at airports is locally saturated in Europe and will be a growing constraint as traffic increases and new capacity is challenged by environmental issues.

The table below summarizes the discrepancies between the supply of ATM related services and airspace users' expectations.

ATM Service	Characteristics of the supply	Users' Requirements³
AO&M (EATMP&ANSP)	The 36 ANSPs and EATMP define the network.	Airspace users would in an ideal situation operate under "Free-flight" conditions. If this is not possible, AO&M should provide a harmonized network design without national boundaries or any unnecessary fragmentation.
ATFM (CFMU&ANSP)	The capacity of ANSPs is an input for the CFMU. The CFMU only allocates this capacity.	Airlines need gate to gate flow <u>and</u> capacity management to optimize the use of the available capacity.
En-route ATC (ANSP)	The current charging mechanism for ATM is based on cost recovery	Regulations that induce more incentives for efficient service provision and separation of infrastructure and service charges to avoid cross subsidizing
	There are many different operating systems and programming languages for en-route ATC within EUROCONTROL area	The European ATM should be harmonised for more efficiency
ATM network access (Airports)	The current slot allocation system is based on "grandfather rights": The airline which had the slot in the previous period gets it again, if it uses at least 80%.	Airlines expect non-discriminatory access to the network.
Route charges collection (CRCO)	The charging mechanism and unit rates are decided by the States and approved by the Enlarged Committee	Airspace users expect enhanced collaboration between ANSPs, CRCO and them
	The CRCO assists the Enlarged Committee regarding the rules & procedures of the route charges system	The system relies on goodwill of individual States. CRCO should enforce compliance

	The CRCO is currently studying various issues related to charges including lower/upper charges, fixed and variable charges, etc.	The implementing rules shall be developed by more than one stakeholder
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Table 2: Characteristics of the supply and users' requirements

3 COMPARISON OF ATM WITH SELECTED NETWORK INDUSTRIES

Deregulation or liberalisation is a set of regulatory reforms which refers to complete or partial elimination of regulation in order to improve the performance of the industry, e.g. to introduce lower prices and better quality of service. With regard to network industries, the aim of deregulation or liberalisation is to enhance competition in the industry. Over the past years, the European Commission launched a deregulation reform program to liberalise the market for the network industries covering telecommunications, electricity, gas, water, rail and air transport.

The study "ATM Market Evolution due to Deregulation" [Reference 6] examines the impacts of deregulation in the telecommunication industry, in the passenger air transport and in the Internet industry. This paper focuses on the two latter ones since the results of the study showed that these are the networks that could provide some ideas how the ATM market could evolve in the future to meet the expectations of its users and more generally of the society.

3.1 Internet Market

The Internet network has been treated from the beginning in a specific way by regulatory bodies. Indeed, it is the largest non-regulated network in the history of the humanity. Regulatory activities cover in most cases only the content of the web sites presented on the Internet [Reference 7].

Internet is not a single network, but an enormous network of networks that voluntarily chooses to interconnect with each other. At the top of the hierarchical structure of the system are the backbones that own national and/or international high speed networks. The second layer of the hierarchy includes so called retail Internet Service Providers (ISP). At the bottom of the hierarchy are the end users, i.e. consumers who browse websites, and use the internet to exchange various types of data.

End users generally want to have access to all other possible end-users, regardless of the network they are attached to. To provide such universal connectivity to their clients, the firms must interconnect with each other and share their network infrastructure. In general, end-users connect to ISPs and ISPs connect to backbones. Backbones connect to each other at the National Access Points (NAP). With regard to connectivity agreements, large backbones mostly peer with each other at the NAPs and these are called public peering. The growing congestion at the NAPs has increasingly necessitated private peering between the backbones which use direct connections between providers bypassing NAPs [Reference 8].

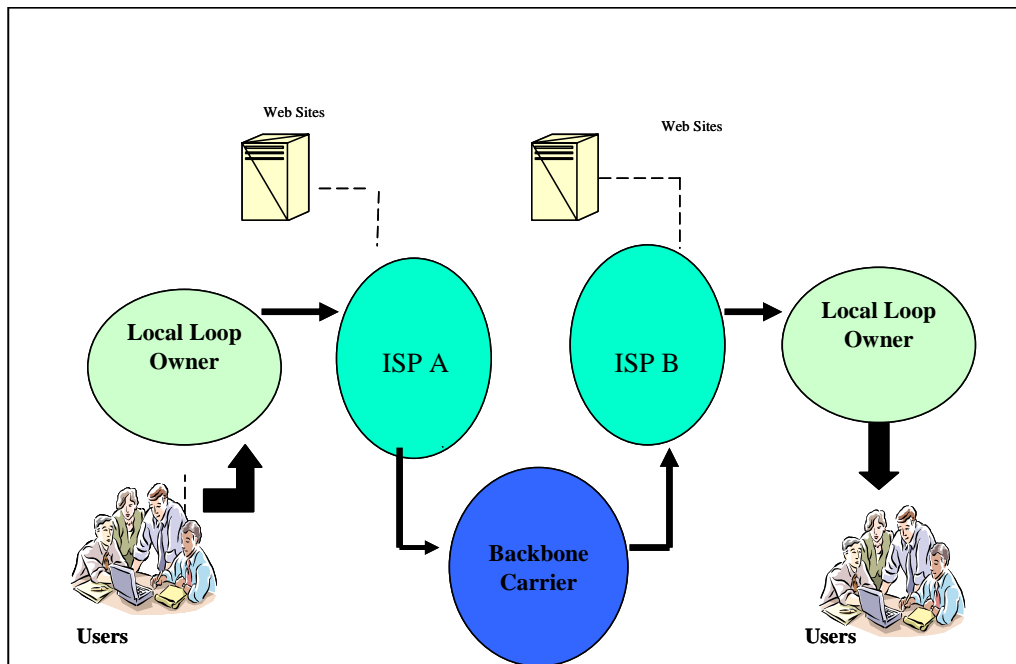


Figure 1: Internet Network

In 2000 an action plan was adopted by the European Commission to speed up the liberalisation and to extend the use of the Internet in Europe. The EU policy has resulted in a process of increasing introduction of Internet communication networks and services in the EU Member States. Between 2000 and 2005 number of Internet users increased 131.6% in the European Union⁴.

One of the examples of the regulation policy is the “local loop unbundling”. Local loop refers to the circuit running from users’ home to the local telecom network. Before deregulation, the national incumbent telecom operators have had complete control of the local loop and refused to give to their rival’s access to the network. Now they have to grant symmetric access to all ISPs.

The deregulation of the Internet resulted in high competition on the ISP market. The customers can choose between several companies providing different type of contracts. The regulation made it possible to provide complete service to the customers. As an example, in 2000 unlimited dialling for residential internet access (flat rate) was introduced in France by OneTel. In the following years, the French ISPs started to sell package with three services comprising unlimited high speed Internet access, TV channels and unlimited local telephone calls. Now Internet users can conclude only contracts with one Internet Service Provider, who in turn pay the relevant telecommunications costs to the local infrastructure owners, to other ISPs and to the backbones.

3.2 Passenger Air Transport Services

The European air transport sector was liberalized in three packages between 1980 and 1993 as part of the liberalisation/deregulation initiative of the European Commission. The sector has historically been dominated by national “flag carriers” which emerged along national boundaries after World War II. These historically

important airlines were state-owned or state-sponsored instruments of economic development. Examples are British Airways, Lufthansa and Air France.

The dominance of the flag carriers is now being reduced as the European airline market is being liberalised. The private airlines can design their routes depending on the needs of the passengers. The States intervene only to complement the network with subsidized destinations that are not profitable enough for the private carriers.

Today, there are many private airlines which are competing in a free market environment and the market share of the low cost carriers is rising permanently. Some results of the liberalisation of the air transport are:

- New ticket pricing strategies including widespread use of yield management, resulted in lower fares
- The fast growth of route expansion (hub-spoke and point-to-point flights)
- A process of mergers and takeovers within the industry
- Introduction of the innovative services like interlining, code sharing and e-ticketing

In recent years, airlines started to use different pricing strategies to attract passengers. Previously the prices were defined according to simple categories (e.g. economy class, business class); now, especially for low cost flights, nearly each seat is sold at a different price. On the one hand, this mechanism increased the average load factor of aircraft leading to higher revenues, on the other hand new demand was attracted due to the possibility of finding very cheap flight tickets.

After the liberalisation, a great number of low cost carriers have emerged so number of flight destinations and specifically the point-to-point flights has both increased rapidly. Contrary to the traditional airlines, which prefer hub-and-spoke system, the low cost carriers provide mostly point-to-point flights by using smaller airports outside of the city centres resulting in increased connectivity for passengers.

More generally, the strong competition lead by the liberalisation, forced airlines to think out new business models and innovative services in order to attract the demand so they can survive in the market. Service oriented thinking in business resulted in increased mobility, more frequent flights to lower prices which strengthened air transport's value for the passengers.

4 POSSIBLE ATM MARKET STRUCTURE EVOLUTION

The European air transport is an important contributor to the economy which is expected to grow further in the coming years. However there are some weak points of the industry that constitute bottlenecks for a sustainable growth. Parts of the air transport industry operate under competition and provide services that match the expectations of the market. In other parts like ATM, there are areas for improvement that needs be addressed within the SES initiative. En-route delays and airport delays at dense areas of Europe are the evidence of the capacity shortage which will extrapolate in the near future. Also the financial inefficiencies of European ATM resulting from its non-competitive business environment are becoming a problem for the airspace users as they cannot pass the increased costs to the passengers. The fact is that necessary improvements cannot be achieved by small modifications of the current system; a major change in the functioning of the ATM services regarding business model, regulation and ownership is essential for the future of the air transport.

Unlike most of other network industries, safety is the paramount issue for ATM which restricts possibilities for adopting all elements of market oriented services. Still, notions coming from the Internet and passenger air transport market like *backbone*, *flat rate pricing* or *intermediary agency* could be adapted to ATM services to arrange the industry according to the users' needs. These ideas are presented below within two scenarios that however do not exclude each other. Rather, they are market oriented business models for ANSPs that could also be complementary to each other. From the three scenarios in the *ATM Market Evolution due to Deregulation* study, "A third party in ATM service provision" and "Airspace backbone separation" are described in the following section.

4.1 A Third Party in ATM Service Provision

Both for passenger air transport and for the Internet services, user's are mostly in contact with an intermediate organization. For the Internet these are the ISPs to whom the consumers pay only one bill without caring about the cost of the each service element, or about the succession of network access and utilization that are needed to get the final service. Similarly, travel agencies act as intermediate bodies of the passenger air transport sector, selling "all inclusive holidays" to their customers that are composed of the flight tickets, hotel reservation and car rental. The agencies negotiate with the different actors on the related markets to get the best prices so they can make profits as well. The travelers prefer not to be in direct contact with the airlines or the hotels since they are only interested in having an attractive holiday packet as whole.

In the ATM sector, the airspace users are each in direct contact with ANSPs. In the future, an intermediate body (one organization for all of Europe or a small number of "international" organizations) hereafter called SESAP (Single European Sky Access Providers) could be the only interface for airlines to enter the European ATM network. Accordingly, the creation of third parties would introduce a more efficient and service oriented approach for ATM where the price of the service depends on its quality.

These SESAPs would have the right to buy or rent the network capacity for a certain period on certain routes and resell it to airlines according to specific agreements /

contracts. The price of these contracts would depend on the quality of the service (e.g. punctuality of the received ATFM slots, time of day of the flights, etc.)

Such a service could be provided by an existing organization (e.g. EUROCONTROL) or by a new consortium (comprising airlines, ANSPs, etc.) or by a mixture of existing and new actors. However, it should be noted that a SESAP which only consists of ANSPs would not be an efficient solution since it would lead to concentration on the supplier side in the ATM market, and would not bring a solution for the airlines' requirements.

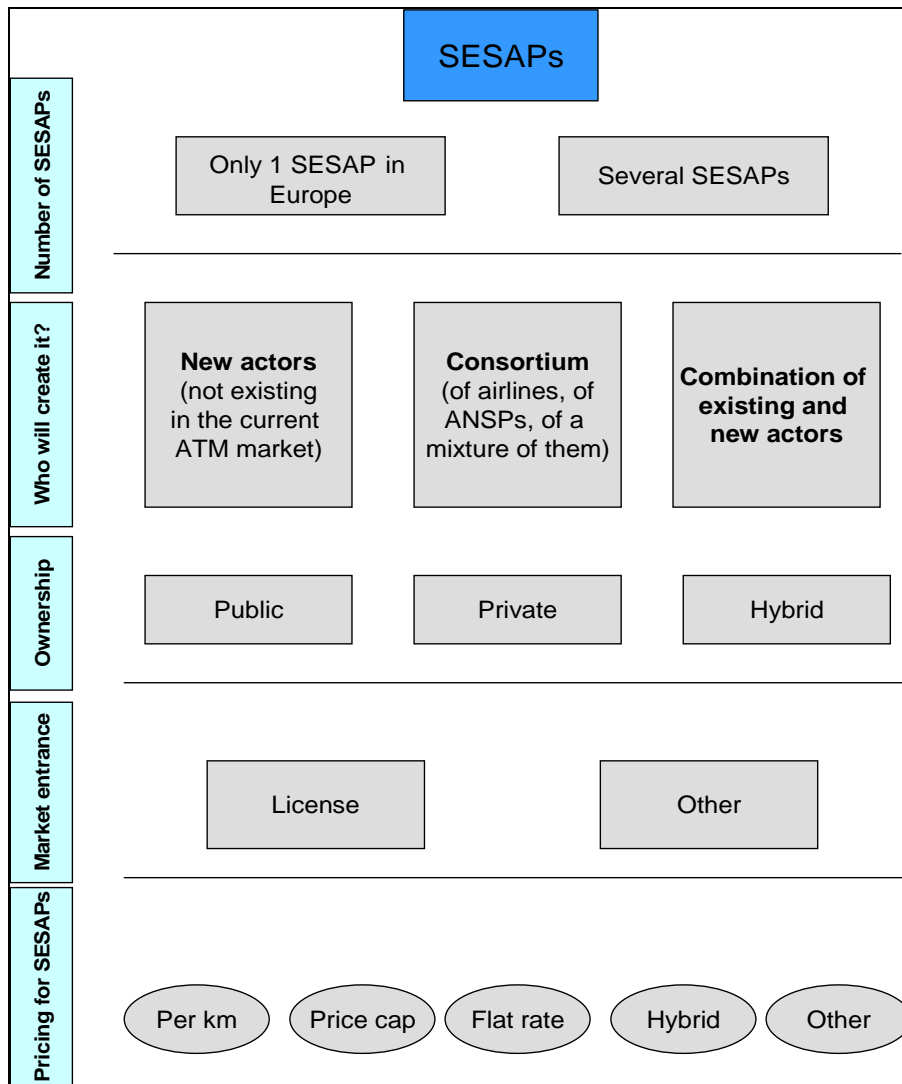


Figure 2: Possible approaches for creating ATM access providers

A new charging mechanism for ATM services within the scope of the introduction of SESAPs is not mandatory; however, there could be some modifications of the invoicing function. One possible approach would be to combine SESAPs charges with the rest of the ATM costs. The SESAPs would charge the airlines for their service and this charge could include the ATC cost as well. The flat rate system observed in the Internet industry could also be an innovative method for SESAP invoicing, while keeping a cost base system between ANSPs and SESAPs. Once the airlines pay a

“flat rate” that is depending on their requirements from SESAPs, it would be the mission of the SESAPs to negotiate with the ANSPs to get the necessary capacity with the best conditions.

One can expect that SESAPs would be in a similar position as the ISPs in the Internet industry so that similar benefits could be achieved:

- With SESAPs, there would be an actor on the ATM market which is able to take into consideration airlines’ specific needs in terms of network design, network utilization, and segment the market by proposing “contracts of services”. Then, the users’ needs would be considered in priority instead of designing ATM services based on operational constraints.
- It would be possible to introduce price discrimination (service quality in terms of punctuality of the ATFM slots, depending on the price) so users get better value for extra money
- Such a service would open the door to new bundles of services (gate to gate services, flight planning services, billing services, airport slot management and scheduling assistance, etc.) stimulated by possible competition between SESAPs (which are not geographically restricted).

4.2 Airspace Backbone Separation

The idea of creating backbones derives from the Internet industry. The backbones of the Internet provide the interconnection of the local ISP by giving them access to the global network. They transmit large amount of data over large regions of the world using long haul cables that ensure high-speed network connection. The lower airspace can be compared with the local ISPs in the Internet network and the upper airspace is equivalent to the Internet backbones.

In the passenger air transport industry, long haul flights between hubs are the backbones of the network connecting hubs. These are the airports where traffic is gathered from smaller airports and redistributed so the possible destinations are multiplied. The hub-and-spoke system allows for efficient connections for passengers from small- and mid-sized cities. It increases the choice of carriers at non-hub cities as well as the frequency of service.

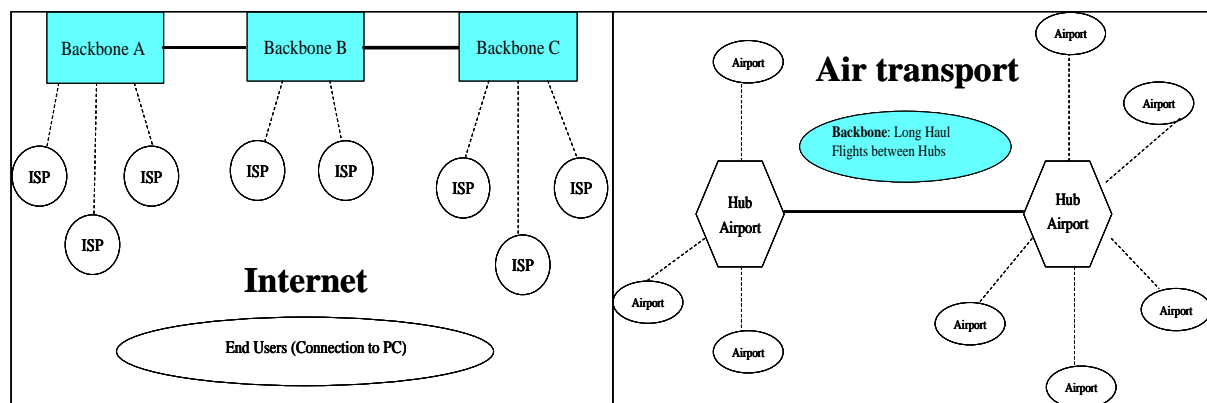


Figure 3: Backbones in the Internet and passenger air transport

Similarly, a new approach for the ATM market structure could be possible where the national ANSPs would be segmented (i.e. vertical unbundling) in independent units and re-grouped as new ATC centers (i.e. horizontal bundling) by creating backbones similar to Internet backbones. Such a re-organisation of the ATM would allow a completely new kind of air traffic control where the airspace design depends on the flow rather than on the geographical shape of the ATC centres.

The current national fragmentation of the European airspace does not allow the optimized use of the scarce airspace capacity. For the airspace users, the quality of the ATM depends on the smooth functioning of the gate to gate flow with minimum delays and efficient flight routes and the proposed market re-organization could answer the requirements of the airlines. The backbones in the airspace would create a possibility for additional capacity and high speed connection of the main destinations with fewer delays. Operators of long-haul flights could reserve capacity in these backbones and enter them to fly between two hub destinations. The fact that traffic control would be less complex once the aircraft is in the tube (it will follow a standard route) as well as the specific capacity planning for the backbones would increase the quality of the service to the airspace users both in monetary terms and in punctuality.

After the vertical unbundling of the airspace ATC, backbones could be created via horizontal bundling of the relevant ATC sectors. For maximum capacity, the backbones would be designed by keeping in view the dense areas of the airspace and they should be created as airspace corridors, similar to highways which allow large number of aircraft to make high-speed connections between destinations. These corridors could be designed dynamically in order to adjust the capacity to the traffic density.

If the airspace would be re-organized in order to create airspace backbones, the traffic control of the airspace should also be re-organized according to the different attributes and needs of the new fragmentation instead of considering the national borders. Probably, the control of the backbones will require different skills compared to the control of the lower airspace. Since the backbones would be controlled by consolidated centers, a training forum for the whole Europe could be necessary to create harmonized skills.

From the economic viewpoint, a prerequisite to operational unbundling of these services is “accounting separation”. All services provided by the ANSPs have strategic importance so their absence due to bankruptcy is not acceptable. Therefore, the units must be able to operate in a way that they cover their own costs.

Compared to the Europe, the controllers in USA manage the double amount of traffic per day which could also be a result of the harmonised ATM system for the whole country [Reference 9]. Consolidation of services in the upper sky might lead to a reduction in demand for ATM related jobs. However, since the implementation of the restructuring will take several years, the national human resources should have time to adjust according to the needs of the international backbones.

For backbones, there could be different en-route charges that would be collected by EUROCONTROL or possibly by other organizations. The cost of the ATC at lower airspace is higher than the upper airspace because the traffic within the lower airspace is denser and it is more complicated to control the lower airspace activities. Therefore, the en-route charges for the backbones could be cheaper than the charges

for the lower airspace. However, to regulate the high demand for such high speed connections, additional reservation fees could be necessary.

One can expect that the national ANSPs might resist against the unbundling of the control units because they would lose the lucrative part of the business by doing so. However, price differentiation regarding the different airspace levels similar to yield management of airlines could be used as an instrument to allow the cost recovery of both service types and facilitate the unbundling.

5 Conclusions

In this paper, the similarities that could be drawn between ATM at the start of a deregulation process and other network industries that have already undergone such a process are explored. The main findings of the study are listed below:

- The analyses of the five ATM sub-markets showed that discrepancies exist between the provided service and the airspace users' requirements. Generally, the airlines expect the ATM market to become more service-oriented and efficient.
- The airlines need a global ATM service but are confronted with fragmented functionality, corresponding to "second best" options.
- The deregulation of the three network industries resulted in fast development of the technology, introduction of new services types and lower prices. Accordingly, the demand for these services has been increased.
- The proposed scenarios for the future ATM market evolution aim at decreasing the discrepancies between the supply and the demand side of the market, enhance the capacity and finally improving the efficiency of the whole air transport market
- The safety aspect of the ATM industry makes a comparison with other network industries difficult. Still, if the functioning of several sub-markets of the Internet and passenger air transport industry is analysed, one can see that it is possible to adopt their business models at least partially to the ATM. Intermediate organizations between ANSPs and airspace user's as well as backbones that connect hubs could be examples for that.

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Notes

¹ Although flight efficiency improved slightly, its cost is higher compared to 2004 due to the increased oil prices.

² UK service provider NATS is an exception. In the year 2001, NATS was taken out of the hands of the civil aviation authority CAA and transformed into an operative company.

³ In 2003, the European Commission launched a study on the implementation rules of economic regulation within the framework of the implementation of the Single Sky. This study entitled "Study on the Implementation Rules of Economic Regulation within the Framework of the Implementation of the Single European Sky". For the viewpoint of airspace users' on ATM, the comments of the airlines and airline associations on this study are analysed.

⁴ See <http://www.internetworldstats.com> .