Analysing the dynamics of ATM in EUROPE 1998 - 2020
EDITORS’ NOTE:
The present EUROCONTROL Experimental Centre report was developed within the Air transport Evolution research thread as one of several exploratory studies that constitute the foundations of strategic research on air transport evolution.

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What were the past, what are the present, and what will be the future dynamics of air traffic management in Europe? The report endeavours to answer this question. It is not the technological but rather the economic and institutional dynamics which constitute the subject of the report.

In order to study these dynamics, we have isolated three interacting components: the infrastructure, operations and regulation. These constitute the common theme of the analysis.

The report is divided into four parts:

- the studies carried out in recent years into the three components;
- the framework proposed for the analysis, or the method adopted;
- the sequential analysis, that is to say the analysis of the dynamics of the sector from the adopted viewpoint;
- the analysis of the mechanisms and counterfactual analysis.

**Studies carried out**

**Infrastructure**

The diagnosis offered is that ATM is in the process of developing systems into systems of systems, in the same way as the defence industry did in the early 2000s. In the system model, there used to be a clearly identified client – an ANSP – capable of defining its need and ensuring competition between manufacturers in order to obtain the best system at the best price. In the system of systems model, the client is no longer capable of independently defining the specifications of the future system and must depend on expertise distributed among the manufacturers. Several systems need to be introduced simultaneously (in the case of ATM, at control centres, in aircraft and in the airspace), because these systems are network-centric and the functioning of the whole allows information-sharing and coordination of local and central decisions. Client-supplier relations and modes of competition and cooperation are radically changed. This raises the question of whether a single contractor is capable of giving the necessary impetus and creating an architecture of coopetition (a combination of competition and cooperation). Boeing failed in this role in ATM, but has fared more successfully in the defence industry. Whatever the case, the nature of the infrastructure is changing, its development requires new models for the relationships between clients and suppliers, and management of the infrastructure is also evolving towards a new model.

The problems of congestion and infrastructure development can be approached in two ways: from the viewpoint of the engineer (planning of investments, centralised development of new technologies, a congestion management algorithm) or from the viewpoint of the economist (emergence of markets, competition and cooperation, incentives). ATM has in the past been dominated by the first viewpoint and largely remains so, but pressure is growing for the introduction of a more economics oriented viewpoint (regulation, privatisation). However, are the two viewpoints compatible, and how do we ensure a dynamic transition from the one to the other?

**Operations**

At operational level, the service-provision structure has remained unchanged (vertically integrated national monopolies). It is only the status of the operators which has changed, with the development of corporatisation and privatisation. Various structural developments have for a long time been envisaged. The first of these is separation of the ancillary services and of the radar and telecommunications infrastructure. The second is separation of the upper airspace from the lower airspace (which was already at the basis of the creation of EUROCONTROL and the Maastricht Centre). The third is a technological development, in which a single technological system is to replace the obsolete vertically integrated national ANSPs, and revolutionise the organisation of service provision.
Regulation

There is economic regulation (safety regulation is another question altogether) because of the monopoly situation. This type of regulation is based on the fact that the monopoly is deemed to be «natural», i.e. the structure is stable, and even when it relates to the future (a regulation contract for the coming years), it is backward-looking (the future being envisaged on the basis of the past, with a practically unchanged structure). The problem posed by ATM is of a different nature, as there is a need to invent a new type of regulation which will allow a transition away from monopoly situations, i.e. what is commonly referred to as fragmentation. This will be restructuring regulation.

The invention of this new form of regulation is linked to the choice of organisational format. The situation which has prevailed since the European Commission actively intervened in ATM is that of a Commission which seeks to act as the regulator in the sense that it sets objectives and issues common rules, but does not intervene in day-to-day regulation, which is the responsibility of a multitude of national regulators. The various forms of organisation which might be envisaged in order to move away from this situation are as follows:

- a club of regulators (as exists, for example, in the energy sector);
- a meta-organisation (an organisation in which the members are organisations, in this case national regulators);
- a European sectoral regulator (like EASA in the case of safety).

Proposed framework for the analysis

In order to analyse the dynamics of European ATM, the report bases itself on a sequential analysis. This presupposes the definition of a specific period beginning at a starting point and finishing at an end point. For the subject in question, it was decided to take 1988 as the point of departure. This was the point when the strain on the system (as manifested by delays) prompted the intervention of the European Commission, and when technological developments were planned which are to dominate the subsequent dynamics. The year 2020 was selected as the end point. This is the timescale which serves as a reference for a number of technological and institutional developments. Once the period had been defined (1988-2020), critical points were identified (1999, 2004, 2008, 2013). These are points which enable us to define the unique sequences (intervals between consecutive critical points) which define the evolutionary course of the system as a whole. The critical points determine the moments at which such courses can change; we identify problems and possible solutions, and opt either for the status quo or for one of these solutions which signal a change of course.

Once the starting points and end points, critical points and sequences have been defined, the analysis itself is based on highlighting both real and counterfactual mechanisms (what would have happened if a different solution had been adopted?). The emphasis is placed in particular on the lock-in effects, the escalation effects (where, by opting for and sticking to one particular approach, the costs of moving away from it escalate), and the spill-over effects, and on reversibility and irreversibility.
Sequential analysis of the dynamics of European ATM

This executive summary will give a brief synopsis of the sequential analysis, taking over the breakdown into three components.

Infrastructure

The infrastructure problem is placed on the European political agenda as a result of congestion, which is causing major delays. The solutions sought are technical ones, viewed from the viewpoint of an engineer: the creation of the CFMU, the introduction of R-NAV, and the search for interoperability between the systems. The initiative launched by Boeing is of a completely different nature, since it comes from a private enterprise. In Europe, an initiative is launched in response, in the form of an alliance between Airbus, EADS, Thales and DEPLOY (in 2002). However, this initiative involves a more technological approach and becomes a public private partnership (SESAR) within the framework of SES I. It is linked to neither a restructuring of airspace nor to the creation of a European infrastructure manager. SES II introduces the possibility of centralised «network» functions at infrastructure level, but they remain vague, because the link with the tasks currently carried out by EUROCONTROL at infrastructure level is not explained. The way in which SESAR will be deployed in 2013 and exactly how these infrastructure functions will evolve have not been specified.

Operations

The beginning of the period is marked by a trend towards corporatisation, commercialisation and privatisation of the ANSPs. This trend is not accompanied by any structural changes, neither the «unbundling» of the ancillary services, which has long been envisaged, nor separation of upper from lower airspace. The only separation is at national level, between a regulator and an operator, which remains a vertically integrated public-sector or private monopoly. With SES I comes a second development, namely the introduction of the concept of FABs. The failure to separate upper from lower airspace prevents creative destruction and genuine restructuring. The FABs have developed mainly into projects involving one large and one small State, thereby allowing the larger States to prove that they are willing to broaden their attitude towards airspace and allowing the smaller States to maintain their control centres. The service provision structure thus remains in essence unchanged, with no economies of scale, no facilitation of technological innovation and no reduction in fragmentation (the number of control centres remains unchanged).

Regulation

The regulation of the ATM system is marked throughout the period by a choice which still obtains: regulation is at performance level (with the creation of the PRC in 1998, and the creation of a Performance Review Body in the framework of SES II). This approach to regulation via performance envisages the future on the basis of the past and fails to tackle the problem of restructuring, as some other form of regulation might do. The national regulators created by the separation of regulation from operation at national level reproduce the fragmentation and do not reduce it. The Commission assumes the role of regulation without a regulator: it seeks to formulate general rules, without entering into detail and without monitoring compliance with those rules.
Counterfactual analysis and analysis of mechanisms

The assessment of the sequential analysis needs to be carried out as a counterfactual examination of the critical points identified.

In an initial sequence, the diagnosis is offered (fragmentation which needs to be eliminated, the use of new technologies, the introduction of a regulation framework which can lead to restructuring). Spontaneously, the mechanism whereby this intended result can be achieved is sought, by analogy with other sectors (electricity, telecommunications, etc.), by means of an opening-up to competition. This will be done at upper airspace level, lower airspace being left to the responsibility of the States. This option is discarded, and cooperation is the only answer as the fundamental mechanism in the evolution of ATM towards restructuring. This raises a question: can cooperation be piloted in a top-down manner or does it have to emerge between States (in a bottom-up manner)?

This is the whole crux of the debate which will lead to SES I. For political reasons, SES I will establish that cooperation (hence the process of restructuring) will be left to the initiative of the States. They are the ones who will propose the creation of FABs. A minimal framework is imposed, and it no longer envisages separation of upper from lower airspace. An assessment is scheduled after four years.

The expected mechanism is the customary one given the manner in which the Commission and European politics proceeds: a problem is placed on the European agenda; a diagnosis is offered, namely that what is required is an initiative at European level; the Member States are reluctant to lose some of their sovereignty and agree only to a minimalist initiative, thereby leaving themselves more room for manoeuvre; the Commission has at this initial stage no political power to impose anything more ambitious and must accept a minimalist compromise, but calls for an assessment after a number of years; the assessment demonstrates all the limitations of the adopted policy; the Commission thus manages to push through a more ambitious plan; via an escalation mechanism, we thus move from a diagnosis establishing the need for a policy at European level to a very unambitious first initiative and thence, on the strength of assessments demonstrating the limitations of this first initiative, to a second and more ambitious initiative. A European policy is thus a continuous deployment, step by step, on a long-term basis, with no going back, and becoming successively more in-depth.

The year 2008 needs to be understood and analysed in this manner. Loyola de Palacio offered a diagnosis and put in place the conditions for a European initiative. The Commission was ultimately obliged to lower its sights, and what was implemented (SES I) was a plan based mainly on inter-State cooperation initiatives. In 2008, an assessment had to be made of this initial European project. Either the initiatives of the States would prove to be ambitious and lead to genuine restructuring, or – more likely – they would prove to be timid and to have fallen far short of what had been expected. The latter being the case, a more ambitious SES II at European level had to be launched.

The assessment carried out in 2008 both by the Commission and by the Performance Review Commission proved, as might have been expected, to be negative: the initiatives taken by the States on FABs are timid and vague, and they are almost all based on an absence of any real restructuring.

The plan is therefore to move on to SES II. It is fairly unlikely then that there will be a move back from a restructuring mechanism based on cooperation to one based on competition. On the other hand, what seems likely is that there will be a move from a bottom-up mechanism to a more top-down mechanism, probably with a return to separation between upper and lower airspace to allow this more top-down approach. In order to facilitate this change in European policy to a top-down approach, it is undoubtedly necessary to envisage the creation of a European infrastructure manager and a European regulatory body.

The year 2008 should therefore have been a turning point in the course of European policy, marking the transition from a bottom-up approach to a more top down approach, whether this be a relatively moderate change initially (with the idea of a further in-depth review after four years – the gradual escalation process), or whether it be more pronounced (with the creation of a European infrastructure manager and a European regulator). However, SES II, despite the negative assessment of SES I, is continuing on the same course as SES I, with no real reorientation.
So what can we expect from the next stages – 2013 and subsequently 2020?

The introduction of a mechanism based on competition in place of one based on cooperation appears unlikely. It seems that there is a lock-in effect and irreversibility in the choice of a mechanism based on cooperation for the evolution of European ATM. This raises three questions:

1. **Can an unchanged mechanism based on cooperation (with no European infrastructure manager and no European regulator) lead to restructuring during SES II when it failed to do so during SES I? If so, why?**

2. **Will the turning point which failed to materialise in 2008 take place in 2013 (creation of a European infrastructure manager and a European regulator)?**

3. **What might be the deployment dynamics of SESAR?**

**Examination of question 1**

What chain of events could lead to restructuring between now and 2013, when there has been no such restructuring during SES I? The only envisageable chain of events would be that separation introduced at national level between regulator and operator might lead those States which themselves become regulators to introduce competition between their old national operator and other operators, or that States which become regulators cooperate with one another to impose restructuring on their operators (for example, Germany, France, Switzerland and Benelux ask their operators to restructure all controlled airspace). Under the existing regime, this would require interlinking of the strategic restructuring plans developed by the FAB coordinators, the performance plans of the national supervisory authorities, and delegation of operating rights. For the time being, the FAB projects do not envisage the closure of any centres and seem to be rather a means for the smaller States for example to protect the existence of their control centres or even to obtain additional ones. It appears fairly unlikely that SES II will therefore lead to restructuring if the approach adopted in the course of SES I is maintained, given that SES I itself is deemed a failure from this point of view.

**Examination of question 2**

Will the turning point which was expected in 2008 but failed to materialise take place in 2013? If the assessment of SES II is as negative as that of SES I (see the question above), it is likely that there will be a reaction at European level. The creation of a European infrastructure manager will in that case be more likely, as will the creation of a genuine regulator, responsible for regulation with the intention of restructuring. However, the restructuring in question will at best take place in the period 2013-2020. That raises the following question.

**Examination of question 3**

Given that SES I produced very limited effects in terms of restructuring by way of regulation and cooperation (FABs), expectations for the evolution of the European ATM sector are placed increasingly on SESAR. This raises two questions. The first is will SESAR succeed as a technological research programme? The history of ATM is littered with major projects which were unsuccessful. The possibility of another failure is not out of the question. Delays and cost slippage are also a possibility. The involvement of manufacturers in the project and the fact that the envisaged technologies have been studied for a long time now may, however, be cause for reasonable optimism.

This raises the second question: «Is SESAR a pure technological research programme, or is it something else?» Technology is not a dimension in itself, independent of market structures and institutions. The technology and its development are part of these structures. Will the deployment of SESAR not be handicapped by the failure to restructure ATM? Does the idea of a single system or unified specifications not presuppose a single or unified interlocutor (European infrastructure manager)? Can the envisaged different technologies for upper and lower airspace be deployed despite the fact that this distinction has not been made at institutional level? To what extent is the success of SESAR linked to the restructuring which has not been carried out and for which the process seems to have been postponed beyond 2013 because there was no turning point in 2008?

A catastrophic mechanism would be one in which the failure to restructure the sector would lead to the failure of SESAR, this failure in turn further delaying restructuring. It is this mechanism which implies that the technological deployment of SESAR is not possible without prior institutional restructuring (separation of upper from lower airspace and a move towards a European infrastructure manager).
ATM is a system. As such, it can be broken down into components which interact (this is characteristic of all systems). ATM can be seen as a technical system, breaking down into technical components. In this report it is considered as an economic and institutional system, for the purpose of understanding its dynamics. The point is to identify relevant components in order to understand these dynamics of the system and its management. With this aim, we have therefore isolated three interacting components, namely:

▶ Infrastructure
▶ Operations
▶ Regulation

The studies carried out in recent years relate to these three components and they will be found throughout the analysis.

**Studies carried out**

These therefore relate to the three components.

**Infrastructure**

There appeared to be two crucial points for the analysis at infrastructure level: ATM is in the process of evolving from the status of a system to that of a system of systems. ATM has traditionally been dominated by the viewpoint of the engineer but is increasingly becoming subject to that of the economist.

- From system, to system of systems

Systems of systems appeared in the defence industry (see Annex 1). There are three fundamental dimensions: reasoning in terms of capabilities rather than technical systems, the network-centric aspect, modularity and technological developments. What has fundamentally changed is the fact that the relationships between the military public client and businesses have been profoundly modified. In the past, the client was able to formulate its requirements, lay down specifications, and make businesses compete on the basis of these specifications. The same applies in ATM, in which ANSPs identify their requirements, then specify the system which they wish to put in place, and let industrial suppliers compete with one another. In the defence industry, the systems of systems have led to a much more complicated arrangement, in which the public client confirms the fact that it is no longer capable of defining its requirements itself, works in an initial phase with a small number of firms between which it encourages alliances with a view to selecting the best concept, in a second phase lets the alliance which it has selected use competition between other firms in order to select the best solutions at network infrastructure and sub system level, and then follows the development of the system of systems. Systems of systems change the relationships of cooperation and competition between clients and firms. The diagram next page illustrates this new modus operandi.

The transition from systems to systems of systems poses several problems: the traditional client (the military in the defence industry, the ANSPs in ATM) is no longer able to independently define its requirement for systems of systems. It is no longer able to define the competition and cooperation conditions (a strategy of coopetition, based on the best possible mix of cooperation and competition). This opens up a window for an actor to play the role of entrepreneur redefining the coopetition strategies and the markets. Boeing sought to occupy this role in ATM (see Annex 2) in 2000-2001 by creating a Boeing ATM subsidiary and launching a Working Together Team which brought together all the actors involved in ATM, and it played a similar role in the defence industry by obtaining, in an alliance with SAIC, the contract for the Future Combat Systems program, the US Army’s system of systems.
Analysing the dynamics of ATM in Europe (1998-2020)

• From the viewpoint of the engineer to that of the economist

A number of European networks are faced with the problem of bottlenecks which need to be managed in the short term (to deal with the congestion) and in the long term (by increasing the capacity of the infrastructure). An interesting comparison can be made with the electricity sector here.

In the electricity sector, the network has been separated between production and distribution to consumers at national level. This separation has created markets: a market for access to the network, a day-to-day capacity purchasing market, a market for long-term contracts with large-scale consumers, and a competitive market for distribution to the individual consumer. However, tensions have appeared at national borders. Several breakdowns have affected the European network, with problems in one country having an impact on an entire interconnected part of Europe. As a result, there have been attempts at regional integration, for example the laying of cables between continental Europe and the British Isles. Such integration operates within the framework of a market-type economic approach and within the framework of national regulation, which is also being regionalised. Do we have to let independent operators construct new extensions to network capacity (companies which are specialists in laying undersea cables)? Can the electricity producers and/or distributors do this extension work, or does it have to be the work of an alliance of national network managers? In short, the separation of infrastructure from operations has led to the emergence of markets and to problems of market regulation (abuse of dominant positions, cartels), giving rise to economic reflection on the management of the tensions in the network (the price of congestion) and on the extension of capacity in the form of a more powerful and less congested European network.
The ATM sector has evolved in a different manner and remains dominated by an engineering approach. Each country has sought the best technical solution at national level, and no real system design market has developed. For years, the growth in capacity has been planned at national level on the basis of traffic forecasts and taking into account cost constraints, whilst seeking to smooth out developments. The service is charged at production cost, and no price has been established. A central body (the CFMU) matches demand (flight plans filed by airlines) with supply (sectors opened by the various control centres) on the basis of an engineering algorithm (first flight plan filed, first served). Efforts to extend capacity at regional level (FABs) are conducted without any market reasoning.

The questions which arise for the major European infrastructures, which are experiencing capacity problems and need to go beyond the national framework, are whether in order to do so it will be necessary to adopt a central engineer-type reasoning or move to an economist-type approach, based on market mechanisms, and how to move from one to the other. Will it be necessary to create an infrastructure management function, and if so how (see Annex 3)?

Operations

The key issue as regards operations is whether or not to maintain ANSPs in their traditional form.

\* From national (public or private) monopolies to new forms of service provision

Traditionally, each country used to have a vertically integrated ANSP providing services for all its national airspace (en route, approach, airports), and developing its own system (internally or using private industrial suppliers) and support services (telecommunications, MET, radar, etc.). The ANSP was part of the public administration.

A policy of corporatisation and privatisation was introduced from the mid 1980s onwards with the aim of changing the way in which services were provided (more attention to costs, and more attention to the needs of the clients - the airlines), but it has not affected the actual service provision structure, which has remained vertically integrated.

Two structural approaches have been envisaged, but as yet have not been implemented.

The first is separation or « unbundling » of the ancillary services and the introduction of competition for the provision of these services. MET services, telecommunications and the radar infrastructure could be taken away from the ANSPs and sold to them as a service. This has been envisaged at least since the 1980s, but it has not been put into practice.

The second approach is vertical separation of airspace. This idea too goes back a long way, since it led to the creation of EUROCONTROL in the 1960s. A number of countries envisaged separating their upper from their lower airspace with a view to entrusting control of the upper airspace to a new organisational body. Ultimately, only Belgium, Luxembourg, the Netherlands and Germany (for part of its airspace) delegated the management of their upper airspace to EUROCONTROL’s Maastricht Centre. Other projects were based on this approach, such as CEATS in Central Europe and the Balkans, and NUAC in Scandinavia.

A third structural approach involves developing the ANSPs via technology: if common technical systems are introduced, the boundaries of the national ANSPs could gradually become obsolete. At present, each ANSP runs its control system at its own pace within national boundaries (in the current situation, the boundaries are superimposed and cross one another - sector boundaries, centre boundaries, system boundaries, national boundaries - see Annex 4). If a common pace of transition to a unified technology is imposed, it is possible that the structure of those ANSPs which are vertically integrated on a national basis will end up looking outmoded and give way to new service provision structures.

Regulation

Because ANSPs have stuck to the model of a vertically integrated service provision structure on a national basis, separating the regulator from the operator has involved introducing national regulators, and a European regulator responsible for assessing performance a posteriori. Regulation has related to national monopolies, on an unchanged structural basis.

The ATM sector, however, no doubt like other network industries in Europe but more markedly so, required a new type of regulation based on an adapted organisational form.
The invention of restructuring regulation

When Mrs Thatcher’s government launched the huge wave of privatisation of the various public utilities in the early 1980s, these privatisations created integrated monopolies, for financial reasons. The regulation which was then put in place was regulation of monopolies carried out by independent national regulators. The regulation therefore related to trends in costs and quality of service within a national framework and on the basis of old dynamics. Only technology (the Internet and mobile phones in the case of telecommunications, for example) called into question the regulation of the national monopolies by introducing competition.

The regulation required to go beyond the framework of what is generally analysed under the term of «fragmentation» is of a different kind. It involves moving away from a situation in which ANSPs are monopoly providers of national services by inventing a restructuring form of regulation, favouring technological and organisational innovation, involving and by means of competition.

In ATM, the question is not how to continue to regulate national service provision monopolies, but how to introduce restructuring dynamics, leading to economies of scale and economies of scope, and to an accelerated diffusion of innovation.

The invention of organisational forms of regulation

In the various network industries, the European Commission, which does not have authority to decide whether an operator should have public or private status, has imposed on various countries a separation between operators and regulators, so as to bring into play the dynamics of competition. The result is a European Commission formulating common rules and objectives, dealing with a large number of specialised national regulators in charge of national monopolies. To get beyond this situation, three organisational forms are possible.

The first is a club of national regulators which exchange practices and endeavour to coordinate with one another in order to manage regional problems. An example of this is ACER (Agency for the Cooperation of Energy Regulators) for the energy sector, and electricity in particular.

The second is a meta-organisation. This is an organisation, the members of which are organisations. Its existence is more formal than that of a simple club. It can formulate rules and take decisions, generally by unanimous vote.

The third is the creation of a specialised European regulator. Up to now, neither the States nor undoubtedly the Commission have really wanted to see the creation of European regulators, since these would have considerable power, thereby encroaching on that of both the States and the Commission itself.

These three components – infrastructure, operations and regulation – having been defined, it is necessary to specify what form the analysis will take.
Proposed framework for the analysis

Discussing the future of a system like that of European ATM requires a method in order to articulate different or opposing points of view. One approach generally used is the scenario method. This method is ballistic in nature. On an analytical and historical basis, courses are mapped out which are based on trends and lead to more or less probable futures. The process involves understanding major developments, and sweeping the field of possibilities working from the basis of the uncertainty regarding the appearance of one or more configurations. Typically, in the case of air traffic control, the trend variables would be the demand for transport, linked to economic growth exercising constraints on the future of the system. On the basis of different levels of growth, pointer scenarios might emerge which support reflection on possible futures, and scenarios often serve as warnings.

In comparison with this predictive perspective, the method adopted here is different and entails a process of a reflective nature which specifies an end point. The aim is to conduct a process of reflection on the dynamics of the system, which as in the scenario method integrates the major trends but in a different manner. The process entails discussing the dynamics which have developed, taking into account the possibilities which presented themselves along the way and which were rejected at the various stages in the evolution of the system. Further on, the investigation looks into the claw-back effects in relation to these possibilities. Is it conceivable to return to a given point in time in order to rebalance the dynamics of the system?

The approach is thus based on a sequential analysis, from which we develop a «counterfactual» type of reasoning.

By sequential analysis we mean the division of a period between a starting point and an end point, this period subsequently being divided up into sequences on the basis of identification of critical points which result (or do not result) in a transition from one path to another. The choices related to the determining dimensions studied earlier – infrastructure and technology, operations, and regulation.

The counterfactual approach proposes discussing, at the level of the critical points, the changes of course which were envisaged, considering those which were implemented and those which were not. It investigates the possibility of a return to these turning points at subsequent periods. In other words, can we readjust a dynamic path which allowed a set objective to be achieved by selecting a course which was rejected at an earlier critical point?

These two methods, the sequential analysis and the counterfactual approach, will be looked into in greater detail with their primary application to the case of the management of air traffic.

Sequential analysis of ATM (starting point, end point, critical points and sequences)

In order to study the dynamics of a system, it is necessary to determine the relevant reference period for the study, and sub-sequently the sub-periods within that period which have structured the history of the dynamics of the system. It is necessary to define an initial status and a final status, with a course of sequences in between. The sequences themselves can be understood only in relation to breaking points or turning points. Changes occur at critical moments, when different situations can arise. These critical moments can be interpreted in different ways. For example, events take place which a priori are very imperceptible but which cause major changes. This might be the case with the appearance of a new technology, a change in the nature of the demand, or in regulation decisions, which seem to pass unnoticed whereas in fact they represent turning points. This may also be the case with revelations – moments when the actors or stakeholders are suddenly aware of a profound change, of a need to rethink their operating method and do so. On the other hand, seemingly important changes may turn out to have very little impact and simply merge into the run of things without any major upheaval. Thus sequential analysis as applied here is structured around a starting point, a desired end point, and a period between the two, comprising sequences structured by breaking points or turning points.

• Sequential analysis of the past (starting point, end point, critical points)

To recap on the key points in the process, it is first of all necessary to determine the starting point of the analysis. This, as with the division into sequences, is based on an analysis of trends in supply and demand – growth, delays, costs, restructuring – supported by archive documents and academic works.
**Starting point**

One possibility would have been to go back to the creation of EUROCONTROL in 1960, this European FAA which failed for national sovereignty reasons. It would have been a relevant choice insofar as it raised the problem of European airspace as a resource available independently of the States. The failure of the initiative will have shown that there were two problems in the construction of these dynamics: the problem of the resolution of the property rights attaching to a rare resource (in the case of ATM, national sovereignty over the airspace, a source of revenue), and the problem of centralisation, in other words the management of the system by a single operational centre in the interests of efficiency (a single control system in unified upper airspace).

This could therefore have been the starting point. However, the failure of this first vision of EUROCONTROL will have had only seemingly minor consequences other than creating a strengthened coordination and harmonisation tool. The identity of the Agency itself, in the absence of any clear definition, will have fluctuated depending on the personality of its successive directors, and gradually included additional functions (the CRCO, Maastricht at the beginning of the 1970s) with the programming of a geographical expansion which will have diluted the original idea.

This could undoubtedly have been adopted as the starting point. However, from 1960 to the mid-1980s, the Agency as an international body simply existed in parallel with the developments in the national systems. Nevertheless, we will see that the founding principles behind EUROCONTROL will remain as possible representations of the system for the future.

The adopted starting point is therefore the middle/end of the 1980s, when there was a change in perspective combined with the appearance of serious constraints on the system. The change in perspective concerns the liberalisation of air transport and the planned corporatisation or privatisation of the air traffic control services. The aim is to bring the system into line with the business model, from which greater reactivity and better performance is expected. The constraints are linked to the growth in air traffic, which was poorly anticipated, with under-investment in air traffic control resulting in delays which continue to increase for the airlines, which no longer wish to pay route charges but to buy a service. This new perspective, which is in fact nothing more than an alignment with other public services, is a starting point, and we must try to understand how it fitted in and could be reconciled with that of EUROCONTROL. In this regard, the starting point announces an increased level of independence on the part of the national air traffic control service providers, with the possibility of the development of an air traffic control market.

It is situated in 1988 by the placing of the problem of ATM on the European political agenda. As from 1987, an initial wave of regulation on the liberalisation of air transport affects Europe. The pressure exerted by the growth in traffic on the air traffic control infrastructure results in a communication from the European Commission in 1989 in response to the Council of the European Union, which is acting on behalf of the airlines.

The diagnosis made in those years by the airlines and in academic journals was as follows:

**Infrastructure**

There are thirty States with different strategies for managing their airspace (they have different classes of vertical level, and of traffic flows, which are not coordinated), there are 22 operations management systems with 33 different programming languages, there are air routes which are on average 10% too long, and there are military training zones which are no longer appropriate following the end of the cold war.

**Operations**

There are 51 control centres, a level of productivity which (partly for technical reasons) is less than half that of the US – administrations which are not subject to evaluation of performance vis-à-vis users, bureaucratic and public service management methods which are not very responsive and are inefficient in forecasting trends in medium-term demand and in adapting to what ultimately happens.

**Regulation**

This is carried out at national level, with delegation of some powers to supranational level, but this does not have the force of law – EUROCONTROL is above all a collector of route charges, which works on the harmonisation of systems on a consensual and voluntary basis.
Quite apart from this diagnosis, it is difficult to introduce new dynamics owing to the inability to resolve the problems with the various unions and because of the conservatism of the profession.

Now that we have determined the starting point, the fact remains that throughout the course of the period which we will study, including its dynamics, very little in the way of major upheavals occurred. As we will see when we study the sequences, despite the proliferation of initiatives, the dynamics of the system are marked by very few surprises and very few unexpected developments. Twenty years on, the diagnosis made at the outset still applies almost identically, which gives pause for thought as to the manner in which the problems have been tackled, problems such as fragmentation, automation or the introduction of a paradigm shift in air traffic control technology (in other words the place of the controller – the human – in the system), and cost performance.

The end point

The end point to some extent involves taking stock of the history of EUROCONTROL. Is the idea of a European airspace placed at the service of the European people and optimised from the technical and economic viewpoints a practical possibility?

Infrastructure

Taking as a basis the previous diagnosis, a number of traits emerge which mark out the end point. In infrastructure terms, between one and three compatible air traffic control systems which can be placed in competition with one another seems to be the desirable end point. The objective is to improve performance and avoid the duplication of costs, both on the ground and in the air. Also, in accordance with the possibilities offered by new technologies, a second objective is restructuring the airspace and routes, no doubt freed from the notion of the sector and from the need to reproduce traditional air traffic control practices.

Operations

The current configuration is that of ANSPs becoming more independent of States. This independence is not, however, accompanied by a programme of liberalisation as in other network industries. The monopoly rights over national airspace have not been challenged, nor has there been any separation of activities between the infrastructure (even if this is somewhat difficult to define), operations, and the services contributing to operations. The model is thus that of telecommunications in the early 1990s, without the stimulus of competition introduced by new technologies (mobile phones and the Internet). It is therefore a rigid model, which cannot constitute an end point, which can only be the provision of services in an environment in which major restructuring will have taken place, taking advantage of economies of scale, allowing new actors to enter the scene, and offering new services to the airlines, in other words a greater concentration of supply and a greater diversity of services.

Regulation

Creating a European airspace, defining the infrastructure and system for tomorrow, and allowing a change of ANSP model is conceivable only if an adapted regulatory framework is adopted. This framework calls for a European vision which stimulates greater centralisation and at the same time eliminates regulatory and bureaucratic redundancy. Models were proposed at the time of the implementation of the Single European Sky reform. We will adopt here as the generic model the one presented at annex (Annex 5), which distinguishes between the regulation of economic performance, i.e. regulation by means of performance objectives, through the introduction of competition, and the regulation of operations, i.e. the optimisation of network activities through centralisation of the infrastructure function, and which also introduces specific forms of governance.

Where the analytical narration is applied to the case of ATM, the sequences of the dynamics of the system are highlighted between the starting point and the end point. These are characterised and then taken over, demonstrating how, by means of an analysis in «counterfactual» terms, it is possible to conceive of different orientations or paths to arrive at the end point, but also how alternative orientations or paths could have led to different results.

◆ The counterfactual perspective

Counterfactual reasoning – «what would have happened if?» – is often used in everyday life. A recent line of research has sought to determine a more scientifically constructed application of such reasoning. The first point is to investigate the plausibility of
the alternative. For example, if we go back to the creation of EUROCONTROL, starting from the hypothesis of a European FAA managing air traffic control operations in European upper airspace, the point would be to question its likelihood, but in a constructive manner: could EUROCONTROL have represented a key player at the time, in the context of a still divided Germany during the cold war period? If so, what would have been the characteristics of the situation, which made it a key player? If we acknowledge that we have pertinently illustrated the plausibility of the supposition, we then need to examine what the consequences would have been: what would have happened to the control centres, to the status of controllers, or to the definition of a European system? Did credible projects exist and if so what was their content? On the basis of this content, what type of dynamics could have been set in motion, what would have been the brakes on those dynamics, and what change to the original conditions would have made it possible to support those dynamics? Counterfactual reasoning thus prompts us to examine the terms of what was plausible and evaluate the probable consequences on the basis of causal links.

Counterfactual reasoning has generally been applied to very focused and specific questions where a long period does not come into play, such as what would have happened at the battle of Waterloo if Grouchy had arrived on time? Here it is used on the basis of sequences and breaking points which are apparent or prolong continuities. The point of the exercise is to illustrate mechanisms at work in the dynamics of the system throughout the period. In particular, the growth in regulation by performance and the regulation of continuity with the creation of the Single European Sky will appear as an escalation mechanism, one of continuous progression. This very mechanism results in a particular course being adopted and creates lock-in effects. The clash of the two mechanisms, escalation and lock-in, will be discussed, raising the question of the possibility of reversibility, of U-turns, with a view to reaching the end point. By applying counterfactual reasoning, we will thus see that the choices made in the segregation of airspace (FABs, separation of upper from lower airspace), in terms of the introduction of competition or cooperation, of whether or not to separate the infrastructure from service provision, of a top-down or bottom-up approach, are key to constructing and discussing changes of direction regarding the dynamics of the system.

Once these methodological points have been put in place, the sequential analysis of the dynamics of ATM can be carried out.

Sequential analysis of the dynamics of European ATM

In the sequential analysis, the beginning of each period is marked by a regulatory initiative by the European Commission. The choice is obvious because it indicates the placing of ATM on the European political agenda, via communications of the Commission at the request of the Council of Ministers, which is expressing the need for a change.


Sequence 1 - 1988-1999 - The need for a technical solution in the existing framework and the atmosphere of liberalism

The need for a short-term technical solution, in the existing framework, is due to an urgent reaction in the face of the increase in delays attributable to air traffic control (20% of flights suffer delays of more than 15 minutes in 1988, 25% in 1989). There is a lack of capacity in relation to the growth in traffic volume, which was poorly anticipated (for example, in 1987, the actual volume of traffic was 2.5% higher than that forecast in previous years, and for the period 1985-1990, the average annual increase in traffic volume reached a record level of 7.1%, with a higher number of passengers despite a trend towards a reduction in average aircraft size). The resulting problem of delays initially prompts a search for immediate solutions within the existing institutional framework (see the Communications of the European Commission of 1988 and 1989 regarding ATM capacity problems). The proposed solution entails increasing coordination between the European States at capacity management level by centralising European ATM and increasing research and development efforts. As a last resort, the Council of Ministers will decide in favour of a solution within ECAC rather than at Community level.

During the period, reflection does not stop at a simple search for purely technical solutions. A review of the existing framework is proposed in 1996 in the form of a White Paper, the very title of which contains the prospect of liberalisation of the sector in the same way as other public services (1996, Air Traffic Management – Freeing Europe’s Airspace).
In line with the breakdown: infrastructure, operation, regulation, the period can be characterised as follows:

**Infrastructure**

Apart from the introduction of R-NAV, the initiative in terms of infrastructure largely involves flow management, and it is decided to centralise operations in October 1988, which will give birth to the CFMU and with it the possibility of operating beyond the borders of the European Union. EATCHIP, which defines a strategy for the management of en-route air traffic control, is implemented at the same time. Various phases are planned to run throughout the period, from the beginning of 1990 to 2000 (evaluation of national systems, programme to develop integration and harmonisation, replacement and upgrading of interfaces between national systems, introduction of a European system for 2000 and beyond). From this time onwards, pressure groups are formed to promote technology based on satellite navigation with a view to resolving the ground-air problem. The aircraft separation constraints would consequently be applied to flight paths, with controllers getting involved only in the event of a conflict. The traditional en-route and sector concepts become a thing of the past. The vision of the future is thus 4-D trajectories with a measure of autonomy and communication between the aircraft, a combination of Automatic Dependent Surveillance and GPS.

**Operations**

Technical solutions are sought in the context of a specific environment, i.e. the commercialisation of ATC provision. The providers are expected to change they way they work. Commercialisation is supposed to introduce a style of business management which is more reactive to the needs of the airlines and, with its performance objectives, more transparent. The first State, far from Europe, to embark upon the corporatisation of air traffic control with the creation of an autonomous body and a clean break from the public service model is New Zealand, in 1987. Australia, Canada, South Africa, Switzerland and Ireland will follow, Germany starts thinking about the corporatisation of the DFS as of 1993, and NATS is privatised in the UK in 1998. The same year, the new commercialised service providers form their own professional association (CANSO), which now expresses the industry’s views and will be present at all discussions on the development of ATM.

**Regulation**

Although there was little regulatory movement in this period, there are nevertheless two important points to note. Firstly, the approach developed in connection with the White Paper, and secondly the creation of the Performance Review Commission. The approach set out in the White Paper is one of liberalisation with the introduction of separation between regulation and service provision in respect of air traffic control. This involves grouping regulatory functions together, but without creating a new institution as such. It would be for the Commission to decide the framework, i.e. the rules to be applied in the European Union. Separation at national level does not seem to be central to this. What the Commission wants is to form groupings, i.e. restructure the sector. Only if countries choose the monopoly route will a national regulator have to be created. One of the problems emerging is how to reconcile this approach with Eurocontrol, which is itself working on a revised Convention. The White Paper studies various options, including a return to the original concept from the 1960s. The option is, to say the least, unworkable since the national service providers want to enhance their independence and powers and would prefer Eurocontrol to be dismantled completely. A second option would be simply to opt for a solely Community-based solution, but the only lever in such a case would be the Single Market and improved safety for air transport. Lastly, a third option, which seems more achievable, is the enlarged European solution, involving a reinvented Eurocontrol Agency taking on the lion’s share of responsibility for technical specifications and airspace management. The second important point at a regulatory level is the creation of the Performance Review Commission, at the instigation of the airlines. This body could have been endowed with investigatory and disciplinary powers, but will ultimately be limited to a role of setting general objectives and drafting reports on capacities, costs, delays and bottlenecks. It is supposed that by introducing performance indicators and benchmarking, the service providers will be encouraged to align their behaviour on the most efficient examples, thus introducing a virtuous circle (a so-called sunshine regulation).

Thus, in the light of these developments, the period begins with a problem of performance - the lack of capacity, the delays – and ends with the institutional spotlight on performance, but without altering the regulatory framework. It contains the seeds of the Commission decision to embark upon a restructuring of the sector, as the service providers are granted greater independence in their financial management.
Sequence 2 - 1999-2004 - decision not to open the market up to competition from the top

The arrival of Loyola de Palacio as Transport Commissioner changes the dynamic in the ATM system, involving a move away from the existing state of affairs in order to give the system a European dimension. Europe has committed to the single internal market, the single currency, and similarly is set to create a single sky, independent of national borders. Technical solutions at national and Eurocontrol level will not be enough. A reorganisation is required, as demonstrated by the inability to deal with the problem of delays, which will reach record levels in the summer of 1999, with an 80% increase in charges between 1993 and 1998.

In order to implement the Single Sky, the 1999 communication proposes a number of principles, including a redefinition of European airspace, disregarding national borders, with a civil/military redistribution taking into account the geopolitical changes, the introduction of financial performance incentives in particular as regards route charges and the mobilisation of trans-European network type funds for the management of specific cross-border locations. Furthermore, the separation between regulation and service provision is reaffirmed, this time at national level, particularly since there is a tendency to move service provision out of the public domain by setting up corporatised monopolies. A High Level Group, meeting in 2000, sets out guidelines reaffirming the role of the Commission as the main regulator with the idea of phased development, starting with Europe’s upper airspace, in phase with lower airspace, with upper airspace being used to test innovative technologies such as “free routing”. Between 2000 and 2003, studies will facilitate the writing of regulations on economic regulation, the possibility of introducing competition and the design of European airspace. Two approaches emerge from these studies, defining plausible alternatives. Firstly, a programme of sustained liberalisation which might mean rebundling the services offered and a reduction in fragmentation and costs. Secondly, the creation of cooperation mechanisms resulting in the introduction of the most efficient techniques. The second alternative won out, the first serving as a deterrent, as the Member States and industry were not in favour. The ingredients of the liberal model were simple. The creation of upper airspace in Europe. Large blocks of airspace, including cross-border areas, are defined on the basis of the traffic flows and bottlenecks, facilitating the redefinition of the routes. The States delegate their rights as regards the provision of control services to the blocks of airspace. The airspace blocks are opened up to competition with the launch of a call for tenders. The most coherent and attractive tender is selected. The drive for economies of scale in operations and purchases of control systems leads to restructuring. Furthermore, in connection with the liberalisation initiative, the auxiliary services would have been separated from the service providers and opened up to competition – the possibility of creating an infrastructure manager at European level was envisaged. This way forward was not adopted due to the opposition of the Member States, the service providers and the controllers. The first Single Sky package was thus the result of a political compromise, the best possible consensus. It abandoned the purely liberal approach, but gave the States the tools they needed to restructure – the creation of airspace blocks on a cooperative basis, with the possibility of introducing financial incentives in route charges. A safeguard was, however, introduced in the form of an evaluation four years following implementation of the Single Sky legislation. In connection with the separation of infrastructure, operations and regulation, a number of other initiatives should be highlighted.

Infrastructure

First of all, the Single Sky package contains a regulation whose purpose is to achieve system interoperability within Europe in the air traffic management network. It specifies that rules for implementing the standards and specifications will be developed at European level which will be binding on parts manufacturers. Fragmentation is thus tackled by means of harmonisation. But the technological revival has largely been marked by two new arrivals, first Boeing, USA, which in 2000 creates its own ATM division to develop a new air traffic control system, largely based on satellite technology. This business strategy (see Annex 2) has had the indirect effect of creating in Europe, in a second phase, the ATM Alliance (economic interest group founded in 2002 by Thales, EADS and Airbus) proposing to incorporate into the Single Sky a programme of industrial deployment (DEPLOY), in particular data-link, including the airlines in the process. The programme was later to metamorphose into SESAME, then SESAR.

Operations

The move towards greater independence for ANSPs, taking them out of the public domain, is not accompanied by significant restructuring, nor is there any tangible progress on the idea of concentrating service provision through mergers and acquisitions. There were productivity gains, but without any great reduction in costs.
Regulation

The Single Sky package introduced, in addition to national supervisory bodies, a European passport for controllers and a process for certifying air navigation service providers in Europe. In parallel with the Commission's signature of the revised Convention, thus acceding to EUROCONTROL, which becomes a technical agency carrying out mandates for the Commission, SES governance introduces comitology (with the Single European Sky Committee) and advisory groups (ICB and Social Dialogue).

Thus, although the Single European Sky period is marked by the implementation of regulatory tools to enable States to start restructuring and reduce fragmentation, the route chosen is not liberalisation or competition by decoupling upper and lower airspace in Europe. The SES is now driven by incentives to cooperate.

Sequence 3 - 2004-2008 - Failure of the FABs and the rise of technology

The Single European Sky package, presented as a major turning point, left the structure of ATC provision unchanged. Service provision was still the preserve of vertically integrated national monopolies, each operating in their national airspace. Competition was not introduced, nor was the unbundling of the components of service provision, in particular the separation of infrastructure. Restructuring efforts by the States were expected through the creation of functional blocks of airspace (FABs). These blocks were clearly defined from the outset: large blocks created in upper airspace on the basis of traffic flows, regardless of national borders (operational characteristic) with these blocks being assigned corresponding income (financial characteristic), subject to calls for tender and specifications and to be used as a basis for redesigning routes and introducing new ATC technologies (restructuring mechanism). But the form these blocks took was watered down. Any proposed improvement on the part of Member States could justify being called an FAB, as long as there was a prospective «business case». Restructuring does not in this case involve the closure of old control units and the creation of new ones through «creative destruction», but simply a greater effort to coordinate and study the feasibility of transferring sectors between centres in the event of overloads, with each actor in the system having reasons to oppose competitive airspace blocks in upper airspace (national service providers fearing the opening up of the market to competition and their dismantling; European airlines fearing the loss of cross-subsidies between upper and lower airspace as regards route charges, which would benefit overflights by US airlines; Member States concerned about the loss of national sovereignty; controllers harbouring uncertainties about their pay and conditions and possible relocations). Hence the approach adopted, which is to pair national borders, with the larger country in many cases leaning on its smaller neighbour (UK-Ireland; Spain-Portugal; Italy-Greece-Balkans; France-Switzerland; Sweden-Denmark; Germany-Benelux; Bulgaria-Romania), with an initiative from air traffic controllers, who try to revive the original, central position of Eurocontrol under the Mosaic proposal. These initiatives, which will primarily give rise to feasibility projects, an additional step being the FAB Central Europe grouping (a Franco-German initiative), yield disappointing results, which are highlighted at the end of the period in the Commission Communication released in 2007. Similarly, the Performance Commission notes in the crescent-shaped area at the heart of Europe, where traffic is at its densest, that there are nine States and four FABs. The question arises as to whether, with this approach adopted by the States and the ANSPs, the FABS are not simply adding an extra level of fragmentation in service provision. On a more general note, any assessment of the contribution made by the Single Sky has to be mixed. Admittedly, implementing legislation was issued on the transparency of costs in the route charges system, on the European controller licence, on the certification of service providers by the national supervisory bodies. The legislative framework seems in place, but there is little by way of real change. Only the technology initiative went ahead, in a more structured way.

Infrastructure

The Initiative Alliance (Airbus, EADS, Thales with the Deploy project), which proposed the industrial development of new technologies steered by the manufacturers of control systems with the help of airlines, was integrated into the Single European Sky in the form of SESAME in 2005 and then SESAR in February 2007, a European joint undertaking founded by the Commission and Eurocontrol with industry participation at the same level in the form of a Public Private Partnership. This body, one of the most ambitious of the Commission with a total budget of some 2.1 billion euros, is in charge of defining the air traffic control system of the future. The definition phase, which resulted in the definition of a Master Plan, was completed in 2008 with a development phase scheduled for the period to 2013, then the actual industrial development phase to 2020.
Operations

The situation remains much the same over the period. The diagnoses made 20 years earlier are still valid, with less pressure on service providers in terms of capacity due to the economic downturn.

Regulation

Regulation is one of the efforts which were made to compare the performance of ANSPs. There is no change to the overall framework. Although there are objectives in terms of delays and capacity, regulation by performance does not take the form of binding obligations, incentives and sanctions.

The period in question is thus characterised by the implementation of a framework, with tools that can be mobilised, but which have been diverted from their original purpose, in particular liberalisation and the creation of airspace blocks in Europe. Inevitably, as subsequent assessments have shown, this leads to a further turning point with the introduction of a second package of regulations – the Single European Sky mark II.

Sequence 4 - 2009-2013 - Half-hearted implementation of past decisions

There is a renewed drive to find ways of speeding up implementation of the Single European Sky. The problems of delays have shifted to the airports, the environment emerges as a lever to highlight the importance of creating an optimal European route network, shortening distances and thus increasing fuel efficiency. The conclusions of the High-Level Group are in tune with this new environment. It makes ten proposals where the environment and airport issues feature with an emphasis on good regulatory practices and steering by performance. These principles are reflected in the preparatory work of the Commission in its Communication of 2008. The objective is to strengthen the previous approach by introducing a more restrictive and centralised framework with an emphasis on the infrastructure function (action plan on airport capacity). The Regulation of July 2009, which amends the first SES Regulation, introduces little new, with the exception of a performance system established at European level which may lead to the creation of a performance review body, the possible appointment of an FAB coordinator to facilitate their introduction, and the development of network management functions. Although the performance system adds a degree of structure and constraint, with three to five-year objectives and the text also provides for the power to centralise network functions, the Commission's margin for manoeuvre remains unclear as regards the use of these new tools, since the performance system needs to remain compatible with national plans and objectives, the FAB Coordinator is bound by confidentiality, the network functions do not involve the adoption of binding measures of a general nature or the exercise of discretionary powers, and the Member States have the right to delegate the exercise of such functions to Eurocontrol or an impartial body. Thus, from a general perspective, the second package introduces new features and enhancements without really questioning the approach adopted at the outset, but the end of the period introduces a further turning point as it will see the evaluation of the FABs, currently in the implementation phase, and of SESAR, at the end of its development phase. The comments here focus on the infrastructure and regulation, since the operational structure remains unchanged.

Infrastructure

During consultations on the second SES Regulation, CANSO objected strongly to the establishment of centralised management of the infrastructure that would group together the functions of airspace design and flow management. The view was that these activities were carried out locally or regionally by the service providers and that they should remain under their responsibility, even in the event of centralisation. The second version of the SES does not therefore claim to create an adequate structure, although the possibility is there, since everything remains at the initiative of the Member States. This point will be discussed in connection with the final sequence.

Another important point concerns SESAR. In its progressive form, from Deploy to SESAME, the SESAR Master Plan incorporates the presentations of major Eurocontrol programmes. It comprises 16 overlapping workshops covering all aspects with a succession of validation and decision-making phases. Its complexity makes it a huge management challenge, designed to represent a break with past failures. In addition, the joint undertaking will cease in 2013 and give way to industrial deployment. For now, the future of SESAR seems to me to have been designed in the light of the two Single Sky levers which the FABs constitute (to what extent, and how, can FABs contribute to the emergence and spread of new technologies and the system of the future?) and the idea of a European infrastructure manager (although the industrial calls for tender and the coordination of investments constitute infrastructure manager functions).
Regulation

Performance monitoring is beefed up, with the creation of a specialised structure. In theory, regulation through performance can take three different routes.

- The first is prescriptive by nature. Norms and standards are defined. Then the means and procedures to achieve them are defined. The party whose performance is monitored applies a defined plan. There are controls, as well as sanctions for unsatisfactory performance resulting from failure to apply the plan defined at the outset.

- A second way is a management approach. The parties whose performance is monitored are asked to produce plans to achieve performance targets, and each party can opt for its own solution. The plans are either adopted or invalidated, then monitored throughout.

- The third way, regulation by output performance, involves defining final objectives, leaving the party totally free to choose a particular option, without controls, except in the final evaluation.

Thus, in the case of ATM, it is clear from the performance arrangements that they are somewhere between two and three: ongoing monitoring of execution for a period of 3-5 years, with control and alerting mechanisms during execution. This point will be discussed later.

Finally, attention should be drawn to the widening scope of EASA in ATM and airports, and consideration should be given to the facilitating transformation of Eurocontrol in the dynamics of the system. Eurocontrol was probably slow to adapt in the past, with a conflict of terms and internal competition between One Sky for Europe (Eurocontrol) and the Single European Sky (the Commission). The shift of emphasis within the Agency is being reflected in the new structure, with new divisions and the role of a technical support agency backing up European Commission initiatives.

Sequence 5 - 2013-2020 - divergence or convergence towards the point of arrival

This is the key sequence of the period, but clearly the most difficult to address. Will technological development (SESAR) and institutional development converge and will this get us to our destination, which can be defined as follows: a single future ATC system, or two or three competing but compatible systems; operational concentration of service provision as a result of restructuring and elimination of fragmentation; a supranational European regulatory framework which avoids the costs of duplication?

Counterfactual analysis and analysis of mechanisms

The assessment of the sequential analysis needs to be carried out as a counterfactual examination of the critical points identified.

In an initial sequence, the diagnosis is offered (fragmentation which needs to be eliminated, the use of new technologies, the introduction of a regulation framework which can lead to restructuring). Spontaneously, the mechanism whereby this intended result can be achieved is sought, by analogy with other sectors (electricity, telecommunications, etc.), by means of an opening-up to competition. This will be done at upper airspace level, lower airspace being left to the responsibility of the States. This option is discarded, and cooperation is the only answer as the fundamental mechanism in the evolution of ATM towards restructuring. This raises a question: can cooperation be piloted in a top-down manner or does it have to emerge between States (in a bottom-up manner)?

This is the whole crux of the debate which will lead to SES I. For political reasons, SES I will establish that cooperation (hence the process of restructuring) will be left to the initiative of the States. They are the ones who will propose the creation of FABs. A minimal framework is imposed, and it no longer envisages separation of upper from lower airspace. An assessment is scheduled after four years.
Analysing the dynamics of ATM in Europe (1998-2020)

The expected mechanism is the customary one given the manner in which the Commission and European politics proceeds: a problem is placed on the European agenda; a diagnosis is offered, namely that what is required is an initiative at European level; the Member States are reluctant to lose some of their sovereignty and agree only to a minimalist initiative, thereby leaving themselves more room for manoeuvre; the Commission has at this initial stage no political power to impose anything more ambitious and must accept a minimalist compromise, but calls for an assessment after a number of years; the assessment demonstrates all the limitations of the adopted policy; the Commission thus manages to push through a more ambitious plan; via an escalation mechanism, we thus move from a diagnosis establishing the need for a policy at European level to a very unambitious first initiative and thence, on the strength of assessments demonstrating the limitations of this first initiative, to a second and more ambitious initiative. A European policy is thus a continuous deployment, step by step, on a long-term basis, with no going back, and becoming successively more in-depth.

The year 2008 needs to be understood and analysed in this manner. Loyola de Palacio offered a diagnosis and put in place the conditions for a European initiative. The Commission was ultimately obliged to lower its sights, and what was implemented (SES I) was a plan based mainly on inter-State cooperation initiatives. In 2008, an assessment had to be made of this initial European project. Either the initiatives of the States would prove to be ambitious and lead to genuine restructuring, or – more likely – they would prove to be timid and to have fallen far short of what had been expected. The latter being the case, a more ambitious SES II at European level had to be launched.

The assessment carried out in 2008 both by the Commission and by the Performance Review Commission proved, as might have been expected, to be negative: the initiatives taken by the States on FABs are timid and vague, and they are almost all based on an absence of any real restructuring.

The plan is therefore to move on to SES II. It is fairly unlikely then that there will be a move back from a restructuring mechanism based on cooperation to one based on competition. On the other hand, what seems likely is that there will be a move from a bottom-up mechanism to a more top-down mechanism, probably with a return to separation between upper and lower airspace to allow this top-down approach. In order to facilitate this change in European policy to a top-down approach, it is undoubtedly necessary to envisage the creation of a European infrastructure manager and a European regulatory body.

The year 2008 should therefore have been a turning point in the course of European policy, marking the transition from a bottom-up approach to a more top-down approach, whether this be a relatively moderate change initially (with the idea of a further in-depth review after four years – the gradual escalation process), or whether it be more pronounced (with the creation of a European infrastructure manager and a European regulator). However, SES II, despite the negative assessment of SES I, is continuing on the same course as SES I, with no real reorientation.

So what can we expect from the next stages – 2103 and subsequently 2020?

The introduction of a mechanism based on competition in place of one based on cooperation appears unlikely. It seems that there is a lock-in effect and irreversibility in the choice of a mechanism based on cooperation for the evolution of European ATM.

This raises three questions:

1. **Can an unchanged mechanism based on cooperation (with no European infrastructure manager and no European regulator) lead to restructuring during SES II when it failed to do so during SES I? If so, why?**
2. **Will the turning point which failed to materialise in 2008 take place in 2013 (creation of a European infrastructure manager and a European regulator)?**
3. **What might be the deployment dynamics of SESAR?**
Examination of question 1
What chain of events could lead to restructuring between now and 2013, when there has been no such restructuring during SES I? The only envisageable chain of events would be that separation introduced at national level between regulator and operator might lead those States which themselves become regulators to introduce competition between their old national operator and other operators, or that States which become regulators cooperate with one another to impose restructuring on their operators (for example, Germany, France, Switzerland and Benelux ask their operators to restructure all controlled airspace). Under the existing regime, this would require interlinking of the strategic restructuring plans developed by the FAB coordinators, the performance plans of the national supervisory authorities, and delegation of operating rights. For the time being, the FAB projects do not envisage the closure of any centres and seem to be rather a means for the smaller States for example to protect the existence of their control centres or even to obtain additional ones. It appears fairly unlikely that SES II will therefore lead to restructuring if the approach adopted in the course of SES I is maintained, given that SES I itself is deemed a failure from this point of view.

Examination of question 2
Will the turning point which was expected in 2008 but failed to materialise take place in 2013? If the assessment of SES II is as negative as that of SES I (see the question above), it is likely that there will be a reaction at European level. The creation of a European infrastructure manager will in that case be more likely, as will the creation of a genuine regulator, responsible for regulation with the intention of restructuring. However, the restructuring in question will at best take place in the period 2013-2020. That raises the following question.

Examination of question 3
Given that SES I produced very limited effects in terms of restructuring by way of regulation and cooperation (FABs), expectations for the evolution of the European ATM sector are placed increasingly on SESAR. This raises two questions. The first is will SESAR succeed as a technological research programme? The history of ATM is littered with major projects which were unsuccessful. The possibility of another failure is not out of the question. Delays and cost slippage are also a possibility. The involvement of manufacturers in the project and the fact that the envisaged technologies have been studied for a long time now may, however, be cause for reasonable optimism.

This raises the second question: «Is SESAR a pure technological research programme, or is it something else»? Technology is not a dimension in itself, independent of market structures and institutions. The technology and its development are part of these structures. Will the deployment of SESAR not be handicapped by the failure to restructure ATM? Does the idea of a single system or unified specifications not presuppose a single or unified interlocutor (European infrastructure manager)? Can the envisaged different technologies for upper and lower airspace be deployed despite the fact that this distinction has not been made at institutional level? To what extent is the success of SESAR linked to the restructuring which has not been carried out and for which the process seems to have been postponed beyond 2013 because there was no turning point in 2008?

A catastrophic mechanism would be one in which the failure to restructure the sector would lead to the failure of SESAR, this failure in turn further delaying restructuring. It is this mechanism which implies that the technological deployment of SESAR is not possible without prior institutional restructuring (separation of upper from lower airspace and a move towards a European infrastructure manager).
Since the late 1990s and the beginning of the new millennium, the concept of a system of systems has started to emerge and gain ground in a number of different domains. It is used in the field of transport, in particular air traffic control, but it is in the field of defence in the United States that this concept has really taken hold.

This note reports on this widely discussed concept.

First of all I will seek to define the concept.

Secondly, I will illustrate how it has been applied in the field of defence.

What is a system of systems?

The concept of a system of systems is much talked about. Some common elements are, however, starting to emerge: an approach which is based on capabilities rather than technical systems, is network-centric and embraces modularity and technological developments. We will address these various issues before going on to explain why the concept is controversial.

Approach based on capabilities

Traditionally, the military formulate their needs in terms of platforms: a fighter, bomber, tank, submarine, frigate, etc. The threats were fairly clearly identifiable and these platforms were designed to make the appropriate response. In the late 90s, the threats become more difficult to determine and evolved extremely quickly. This was the case, for example, with missile systems. On 30 August 1998, Korea launched a missile over Japan. This was unexpected, and above all the intelligence services were surprised by the technical sophistication of the missile (three stages, with solid fuel). Such a missile can easily be improved to bring the USA within range. So threats evolve rapidly, while system development takes a long time. If we link the development of a system to a threat identified at a point in time (t), by the time the system has been deployed the threats will have changed completely. We must think in terms of deployment of capabilities. We can no longer define a threat, design a system and deploy it, in a matter of a few decades. «The goal is to deploy an initial capability as soon as technologically practical and then build and improve upon this baseline through incremental enhancements» (Biggs & Stuchell, 2003, p. 24). The military, as of the end of the 1990s, no longer thinks in terms of weapons and platforms, but in terms of capabilities, e.g. monitoring the field of battle. If this capability needs to be implemented, it is possible to mobilise assets such as ground radar, fighter aircraft equipped with reconnaissance pods, airborne radar, a navy Atlantic II, drones, etc. In other words, best use will be made of a multiplicity of systems that need to share information and interact between themselves. The concept of capabilities is linked to the Concept of Operations - CONOPS and the implementation of a range of systems that interact with each other and coordinate to act as effectively as possible.

Systems of systems are thus bound up with the idea that we must first consider developing scenarios to determine the purpose of a system, deduce the required capabilities, and only then think about the technology.

But the notion of capabilities must be understood in the context of major uncertainties: «The burden of the decision-maker is that of planning the best route through a web of possible futures with incomplete maps. Currently, there does not exist a process or a set of tools that enable our decision makers to evaluate whether decisions to authorize spending trillions of dollars on a infrastructure project, implement a particular public policy, and/or develop a new piece of technology are together good, bad (or indifferent) for the nation over a generation or more» (DeLaurentis & Callaway, 2004, p. 829).
Network-centric system of systems

Once the capabilities have been identified, the system of systems will be built around a network that will enable the various constituent systems to interact, share information and coordinate with a view to taking the most effective action: «The network-centric transformation vision relies heavily on the ability of various nodes to share information in real time using a range of interconnected networks. Achieving the NOW [Network Centric Warfare] vision will require lashing networks together, maintaining networks in the face of constant change, making intelligent trade-offs amongst competing system designs, and tasking various platforms with their operational roles» (Dombrowski, Ghotz & Ross, 2002, p. 97). The system of systems supposes three things: scenarios or concepts of action, networks of networks and sensors distributed in space.

Modularity and evolution

Since the systems of systems are developed in the midst of uncertainty (about the capabilities, about the technologies) and since we know that the system will have to meet new requirements in the future, modularity is an essential feature. It can be defined as follows: «Modularity is a general systems concept: it is a continuum describing the degree to which a system can be separated and recombined, and it refers to both the tightness of coupling between elements and the degree to which the rules of the system enable (or prohibit) the mixing and matching of components’ capabilities» (Schilling & Paparone, 2005, p. 281). It presents certain advantages: «The primary goal of deliberately increasing modularity is to enable heterogeneous inputs to the system to be translated into a variety of heterogeneous capability configurations. Therefore, whether a system responds to a shift in its context (by becoming more modular) is a function of both the degree to which the elements of the system are separable and the pressure to be able to produce multiple configurations from diverse potential inputs» (Schilling & Paparone, 2005, p. 281-282).

Modularity thus allows the system to evolve by adapting as effectively as possible to changes in its environment.

The systems of systems: a controversial concept

The big question is: do SoSs represent a step change or not? The experts themselves are divided. Some believe that systems of systems are nothing more than systems which are more complicated than others. Building nuclear deterrents in the 1960s with a range of systems (submarines, ground-based missiles, aircraft) around a communication system allowing the president to be informed of the situation and order a nuclear strike.

A survey of researchers demonstrates that 75% defined an SoS as a large system with many sub systems, 20% take a more progressive view, while only 5% are actually right. «It is concerning that approximately 75% of subject matter experts consulted in the study viewed an SoS as just a big system with lots of subsystems, with a perspective that it requires only traditional SE. This perspective is «we know how to do it…we don’t always do it the way we know how» (that is another problem). About 20% of the subject matter experts consulted in the study offered a more progressive view. These people viewed an SoS as many cooperating systems, where we know in advance that they should play well together. The approach is to build them in a way that allows them to play together with network enabling as the good first step.

Only about 5% had the desirable perspective of SoS as collaborative systems that will be brought together in the field, recognizing it as a «pick-up» game that will always be a pick-up game as needs will change. In this view, the perspective is that the SoS involves many legacy systems that we «wish they played together, but who could have predicted they would need to interact?» In this view, there is «surprise synergy» and the challenge is perhaps to build to support ultimate network centricity (USAF SAB, 2005, p. 26).

Others believe that there has indeed been a step change. Previously, the military was able to identify its needs, formulate the system specifications it wanted, ask competing firms to tender for the production of these systems, then test the result and move to implementation: «The traditional requirements generation approach rested on the premise that the operational community could identify— years out—a needed capability and that a system could be built to defeat a specific, predictable,
and identifiable threat. A very formalized structure was in place to describe the threat, justify the mission need, and describe the shortcomings of the existing systems. Specific performance levels had to be established against specific threats» (Biggs & Stuchell, 2003, p. 23). Now, it is difficult to develop operational military concepts and systems of systems independently. The concepts depend on existing and future technologies: «While the requirements-based approach emphasized building a system to discrete standards to defeat known adversary capabilities, the capabilities-based approach recognizes that the pace, as well as the utility and extent of the capability itself, is not known. This is not the next generation fighter, but an entirely new system of systems architecture from the ground up» (Biggs & Stuchell, 2003, p. 23). No institution can define the required capabilities and the systems of systems needed to realise them in isolation. There cannot be just one architect: «History has shown that no single technology, program, or even agency alone can solve a system-of-systems type problem. History is also replete with examples of disruptive «unintended consequences», in which careful analysis of the interactions among and between technology, policy, and economics was absent. Ultimately, then, the «call to action» in this document has the promise for improving future system-of-systems, notably the transportation system, not through promotion of a single piece of technology or combinations of technologies, but instead through the promotion of a new «calculus», a new way of thinking (DeLaurentis & Callaway, 2004, p. 830).

Therefore, the development of systems of systems has led to organisational arrangements on the basis of «unique and unprecedented approach» (Biggs & Stuchell, 2003, p. 28).

Lead Systems Integrator (LSI) contracts

The LSI (Lead Systems Integrators) system is set in place as of 1997 for ballistic missiles and then as of 2002 for the Future Combat Systems of the US Army and the Deepwater Coast Guard programme.

An example: the FCS

In the early 2000s, the US Army considers a global modernisation programme in the form of a system of systems, namely FCS (Future Combat Systems). The programme essentially involves the US Army, but also the Marine Corps, and involves designing the ground combat system of the future.

The system includes a central network whose software architecture is the largest ever developed in the military domain (63 million lines of code and 14 platforms). The programme covers soldiers’ equipment, sensors, remote-controlled air systems (drones, helicopters), remote-controlled vehicles, tanks, mortars, guns, and vehicles of all kinds (command vehicles, medical vehicles, etc.). This is the first time the US Army does not develop separate programmes for the design of tanks, mortars, artillery vehicles, but opts instead for a set of ten or so additional combat vehicles, plus drones to inform, guide and support these vehicles, i.e. a system of systems. The objective is to be able to deploy a force on the ground anywhere in the world within a few days, which raises problems of complex coordination with various means of transport (aircraft, ships, helicopters). All this has to be developed in a record time of 5 ½ years (the time traditionally required to produce a single platform). To be operational by 2012-2025, the project has to be able to integrate, as it develops, technologies that do not yet exist but will emerge in ten to fifteen years (46 technologies critical to the success of the project were immature when it was launched). This pre-supposes extremely powerful and sophisticated simulation tools capable of monitoring and steering the development of the programme throughout its life cycle.

On 9 May 2000 the Army selects four teams to propose the system architecture within two years: a Boeing team, a SAIC team, a General Dynamics/Raytheon team and a team built around Lockheed. Each team must submit an initial concept with a (network-centric) communication system, a command vehicle, an unmanned armed vehicle to engage the enemy, an unmanned vehicle to guard the rear, sensor systems, and a second concept presenting the approach followed in the design of the system of systems. Of the four teams, only one was built around a traditional central supplier of the US Army – the General Dynamics/Raytheon alliance. General Dynamics again had to form an alliance with Raytheon, a missile expert, but with a sophisticated capacity in the field of computers and electronics. The other three teams were new to the role of senior partners of the US Army. During this phase, Boeing and SAIC decided to join forces to offer a joint bid. On 8 March 2002,
it is this alliance that is finally chosen as Lead Systems Integrator. Subsequently, it is this lead integrator that asks the firms for competitive tenders for the components of the system. A General Dynamics/BAe Systems alliance was awarded the contract for the design and manufacture of the manned vehicles.

Analysis of the LSI

During the LSI contracts, the Department of Defense (DoD) recognises that on its own it is not equipped to formulate the concepts on which the system of systems must be developed. It therefore decides to cooperate with private companies. The central problem is the dependency on one or more vertically integrated companies (which might promote their own internal solutions as regards sub-systems). The DoD will therefore attempt to reduce this dependency by not awarding the contract to a single company, but an alliance of companies (which will then neutralise each other; without excluding the possibility of future competition). It will try to play an architectural role, possibly by encouraging consolidation among companies in order to have partners with strong skills and by fostering cooperation (alliances) and creating competition between these alliances. It will go with a mixture of cooperation and competition, i.e. coopetition (Depeyre & Dumez, 2008).

Architectural role of the customer

- Gives rise to alliances
- Selects an alliance as the LSI through a competitive process
- Provides the LSI with the task to select suppliers through a competitive process
- Regulation:

  Organizational Conflict of Interest rule winner take all (competitive process)

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<td>Supplier</td>
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Legend
- Selection through a competitive process
- Alliance
- Competition
- Cooperation
Upstream of the first stage, the customer encourages alliances between companies. During the first stage, it creates competition between these alliances around the concepts and capabilities of the system. It then selects the best tender and designates the LSI alliance. It is this alliance that will steer development of the system of systems, creating competition between the other companies for the provision of the various sub-systems. The alliance itself is not allowed to compete at this stage (because of the «Organizational Conflict of Interest» rule). During the development phase itself, the customer, the LSI and the suppliers work together to complete the overall deliverable. On account of the complexity of the system, it is the LSI itself which runs the simulation and the tests.

The LSI takes responsibility for most of the tasks:

- Concurrent engineering of requirements, architecture, and plans
- Identification and evaluation of technologies to be integrated
- Source selection of vendors and suppliers
- Management and coordination of supplier activities
- Validation and feasibility assessment of SoS architecture
- Continual integration and test of SoS-level capabilities
- SoS-level implementation planning, preparation, and execution
- On-going change management at the SoS level and across the SoS-related integrated product teams to support the evolution of requirements, interfaces and technology» (USAF SAB, 2005, pp. 2-3).

The Army felt that this was the only way of embracing the new age, by removing the shackles of the past, in particular the groups that make up the current armed forces (navy pilots, air force pilots, helicopter pilots, etc.). The Army itself, for example, was not capable of explaining to the helicopter pilots that their numbers should be reduced and that their missions would be carried out by drones. The resources of private companies are considerably more developed than those of the military. Moreover, companies such as Boeing have experience in the completion of very large projects.

However, this new form of organisation has experienced a series of problems.

The problems related to LSI

A whole series of problems have arisen.

There was cost slippage (but this is not uncommon and par for the course with major projects of this type).

It is felt that the gap between the capacities of the customer (the military) and of the LSI companies is too large. In the team which is developing the central computer network, there are 28 Boeing employees for every military representative.

And it is the LSI that will test the system. Indeed, the system is so complex that only the individual developer will be able to test the system, which is problematic (no independent evaluation). Furthermore, the system is so sophisticated that tests will take place very late in the process. And yet it is usually at this stage that problems emerge and that the biggest cost slippages and delays occur.

In the case of the Deepwater Program for the Coast Guard, the customer took back the LSI tasks and demoted the Lockheed-Martin/Northrop-Grumman alliance, which had encountered major technical problems with the ships developed.

Congress urges the public customer to reclaim its role as leader, and redevelops the technical and managerial skills it needs to do so - and seeks to terminate the LSI contracts with the private companies.
ATM in Europe

ATM is a system of systems. Several factors are moving it towards the systems designed in the military field.

• Systems will be more distributed than they were. In particular, new interactions will be formed between the onboard systems of aircraft and ground systems.

• A system of communication, sharing information, will force the operational concepts to evolve and will lead to joint decision-making.

• It is difficult to identify a single architect to develop this systems of systems arrangement. An institutional arrangement is required which allows several actors with complementary skills to coordinate.

• The conditions governing any public-private partnership must then be specified, paying particular attention to the phenomena of dependency and skill imbalances.

• The system of systems must be developed with a judicious combination of competition and cooperation, i.e. by coopetition.

References


Boeing’s entrepreneurial strategy in ATM

Introduction

As Casson has noted «[…] theories that neglect the entrepreneurial dimension can offer only a partial explanation of the behaviour of the firm» (Casson, 2000, p. 116). Because of modelling, however, which struggles to take unpredictable and undefined factors into account, the theories most often advanced disregard this dimension, as noted by Baumol in a famous image: «The theoretical firm is entrepreneurless – the Prince of Denmark has been expunged from the discussion of Hamlet» (Baumol, 1968, p. 66).

Things would nevertheless seem to be changing. Recent studies have specifically focused on the entrepreneurial dimension of firms’ behaviour and on entrepreneurial strategies. Notwithstanding, many theoretical problems remain. The definitions are often quite vague, such as the one below, for example, which features in the introduction to a special edition on strategic entrepreneurship: «Strategic entrepreneurship is entrepreneurial action with a strategic perspective». (Hitt et alii, 2001, p. 480).

One school of thought has tried to link entrepreneurial strategy with breakthrough innovation. However, while Schumpeter had attempted to break the link between entrepreneurial innovation and technology, such studies tend to rebuild this link by defining breakthrough innovations as follows: «[…] those foundational inventions that serve as the basis for many subsequent technological developments» (Ahuja & Lampert, 2001, p. 523).

In order to analyse entrepreneurial strategies, it would seem worthwhile to review the historical and theoretical background of theories on entrepreneurship and the entrepreneur, in order to identify the key elements of these various theories. For the historical angle, we can look, inter alia, at Hébert & Link (1988), Elkjaer (1991), Van Praag (1999) and Casson (2005a & 2005b).

A review of theoretical analyses of the entrepreneur reveals that they are diverse and can be broken down into six main dimensions: the entrepreneur as an abstract function, as a concrete figure, as being at the centre of a web of relationships, as a type of strategy, as fixed in a specific temporality and as capable of different forms of success. Aside from these dimensions, proposals can be made in relation to entrepreneurial strategies, which can subsequently be discussed in a case analysis.

In an initial section, representing a return to the analytical tradition centred on the concept of the entrepreneur, this article will, based on the six dimensions identified, put forward six proposals suitable for discussion in a case analysis.

The next section will be devoted to methodology. It will demonstrate the usefulness of a case study to discuss the proposals made, and will specify how a case was selected; Boeing’s entrepreneurial strategy in Air Traffic Management (ATM).

The third section will be devoted to the case study itself. At the beginning of the 2000s Boeing wanted to shake up the air traffic management sector, traditionally organised around the Federal Aviation Authority (FAA) and its suppliers, Lockheed-Martin and Raytheon. A few years down the line, this strategy was mothballed.

The final section will be devoted to the discussion of the theoretical proposals in the light of the case study, followed by a conclusion.

Return to the theory of the entrepreneur and formulation of proposals

The concept of the entrepreneur first appeared at the end of the 18th century. It has since undergone many developments, broader than Schumpeter’s analyses, which are most often quoted, and which may be grouped around six major themes: the entrepreneur as a function, as a figure, as an interpersonal position, as linked to a certain type of strategy, as operating in the framework of a specific temporality, and as knowing outcomes which are often hard to assess.
Proposal 1. The entrepreneur takes a risk. Either by self-financing the project, or by having others finance it. Any analysis of an entrepreneurial strategy must be able to specify this risk, which often depends on a «slack of resources» (Ahuja & Lampert, 2001).

In the Anglo-Saxon tradition, the entrepreneur is more often seen as a figure. This figure may be individual or organisational. As an individual figure, the entrepreneur has been studied in social psychology since McLelland (1961), who makes n-achievement - the need for achievement - the entrepreneur’s main motivation, before money or power. A great many sociological studies have added to the analysis of this figure (for a summary, see Thornton, 1999). However, the figure of the entrepreneur has also been regarded as organisational, and attempts have been made to characterise the entrepreneurial firm as an organisation. This was the case for Schumpeter himself, who reflected on the profile of such a firm. In The theory of economic development (1912), he states that innovation is essentially assured by new firms. In Business cycles (1939), innovation is seen as the preserve of big companies with a monopoly, seeking to foreclose the competition. Miller (1983, p. 771) on the other hand, proposed the following definition: «An entrepreneurial firm is one that engages in product-market innovation, undertakes somewhat risky ventures, and is first to come up with «proactive» innovations, beating competitors to the punch». However, most significantly, Miller tried to characterise the «entrepreneurial activity of the firm» by comparing it to a typology of firm profiles: simple firms, planning firms and organic firms. There would therefore seem to be a link between the firm’s various figures and its different entrepreneurial activities. In simple firms the entrepreneurial activity is directly linked to the personality of the director, which is less the case in planning firms or organic firms. More recently, Van Praag & Versloot, (2007, p. 353) proposed a new definition of entrepreneurial firms: «Entrepreneurial firms are defined as firms that satisfy one of the following conditions: (i) They employ fewer than 100 employees; (ii) They are younger than 7 years old; (iii) They are new entrants into the market». This definition excludes incumbents who may under certain conditions have an entrepreneurial strategy. Rather than viewing the question as a dichotomy between firms which are entrepreneurial by nature and others which aren’t, or according to a typology, some authors see the subject of entrepreneurship as a continuum of entrepreneurial intensity ranging from highly conservative firms to highly entrepreneurial firms (Barringer & Bluedorn, 1999).

Proposal 2. The figure of the entrepreneur may be individual or organisational. In the latter case, the entrepreneurial strategy is just as likely to come from a newcomer as from an established or even dominant firm.

In old French, «entreprendre» means to seduce a woman, and includes the sense of an attack (Marschesnay, 2008). The relationship dimension of entrepreneurship is therefore present - and ambivalent - in the word itself. We find it again in the theory advanced by authors who insist on the capacity of the entrepreneur to convince others, and to get them moving. According to Jean-Baptiste Say, entrepreneurs must have a reputation in order to raise funds: they must convince. For Marshall, the entrepreneur is a «natural leader of men» and for Knight he must have a «power of effective control over other men» (Knight, 1971, p. 269). «He must lead, even inspire» (Baumol, 1968, p. 65). However, others insist on the fact that the entrepreneur must «be strong enough to swim against the tide of the society in which he is living» (Heertje quoting Schumpeter, 1982, p. 86). Thus we can identify among the theorists of the entrepreneur the two components of cooption, a combination of competition and cooperation. This relationship dimension can be compared with the position of the entrepreneur in the field. For individual entrepreneurs, this position is a matter for a sociological analysis. For firms which develop an entrepreneurial strategy, the analysis of this strategy must be linked to that of the position of the firm in the organisational field. Traditionally, it is felt that entrepreneurial strategies, which shake up established markets, are generally developed by newcomers. However, other studies (Methé & Alii, 1997; Ahuja & Lampert, 2001; Depeyre & Dumez, 2009) have demonstrated that dominant firms may also have entrepreneurial strategies. However, these dominant firms, by definition, occupy a position in the organisational field. It is above all Greenwood & Suddaby (2006) who have correlated a dominant firm’s ability to develop entrepreneurial

It was Cantillon who, in a posthumous work of 1755, turned the notion of the entrepreneur into a concept. More specifically, Cantillon paved the way for the French tradition of the analysis of the entrepreneur as a function (Elkjaer, 1991). In his view, there are various functions within the economy and all but one - that of the entrepreneur - are based on fixed data (agricultural salaries, annuities). It is the entrepreneur who assumes the function of referee in a context of uncertainty, and takes on the risk. For Jean-Baptiste Say, in the same tradition, entrepreneurs take on risk by raising funds or by risking their own funds, but their role also extends to coordinating activities in the firm and on the market. It is Walras who subsequently paints the role of entrepreneur most clearly as an abstract function, that of coordination and combination of production factors. However, mathematics reveal it as a paradoxical function since, when in equilibrium, the entrepreneur makes no profit, as though it were impossible to carve out a legitimate place for the entrepreneur in a mathematical theory of the market (Baumol, 1968).

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strategies with its position in a given organisational field. Indeed, entrepreneurs must have a structure of opportunities at their disposal (Glade, 1967; Miller, 1983; Thornton, 1999; Shane & Venkataraman, 2000). More specifically, a dominant firm located at the intersection of several organisational fields can develop entrepreneurial strategies which shake up one of these fields. Two effects are at play in this scenario. On the one hand, the firms in question benefit from «superior access to information» (Casson, 2005b, p. 345), and are in a «boundary bridging» position (Greenwood & Suddaby, 2006). On the other hand, firms in a position to be at the intersection of a number of fields have less to fear from a retaliation strategy if they adopt an entrepreneurial strategy which shakes up one of the fields in which they are present if their competitors in this field are not also present in the other fields. Here we revisit the notion of market commonality (Chen, 1996; McGrath et alii, 1998). Firms which have little market commonality with their competitors have greater opportunities for innovation through the transfer of a practice from one market to another, and less risk of a competitive retaliation strategy than competitors specialised in a single market or present on the same markets.

Proposal 3. Entrepreneurial strategies suppose the specific position of a firm at the intersection of various organisational fields. They are often based on an analogy (a practice borrowed from one field is transposed to another). The entrepreneurial strategy of a firm in a position to develop such a strategy creates significant uncertainty in the organisational field in which it takes place, and shakes up the competitive and cooperative relationships.

The content of the strategy developed by the entrepreneur has, especially since Schumpeter, been identified as the innovation, perceived as a breakthrough. Schumpeter took pains to specify that this breakthrough was not necessarily linked to technology but could intervene at other levels (such as a new form of organisation). However, as we have seen, many studies continue to put technology at centre stage. Say had emphasised the creation of value by the entrepreneur, Baumol made a clear distinction between the value-creation strategies of the manager and those of the entrepreneur: «We may define the manager to be the individual who oversees the ongoing efficiency of continuing processes [...] The preceding description is not intended to de-nigrate the importance of managerial activity or to imply that it is without significant difficulties. Carl Kaysen has remarked that in practice most firms no doubt find themselves in a position well inside their production possibility loci and one of their most challenging tasks is to find ways of approaching those loci more closely, i.e. of increasing their efficiency even within the limits of known technology. This is presumably part of the job of the manager who is constantly on the lookout for means to save a little here and to squeeze a bit more there» (Baumol, 1968, pp. 64-65). The manager develops the company’s routines in order to maximise value. The entrepreneurial strategy emerges from the routines in place and seeks new ways of creating value. These are successful, which is the most important aspect of entrepreneurial strategies when creating a new market: «Radical forms of market-making entrepreneurship, however, involve designing products or specifying services that did not previously exist and for which there was, therefore, no market. In the absence of the entrepreneur, therefore, it is not the case that markets would be merely out of the equilibrium, as the Austrian view suggests, but that markets would not exist at all». (Casson, 2005b, p. 336). This point gets to the very heart of the nature of firms. «Firms exist because of the ability to create and co-create markets, which allow them to realize their objective of capturing value out of their appropriable advantages and (dynamic) capabilities.» (Pitilis & Teece, 2009, p. 11). The creation of a market as a fundamental dimension of the entrepreneurial strategies must not be perceived too narrowly (the creation of a new product representing the creation of a new market segment) or metaphorically. If an entrepreneurial strategy consists in creating a market, the firm must consider which competitors it must bring into that market to allow it to develop. It must cooperate with these competitors so that the collective strategies allow the market to develop and compete, in order to capture an adequate share of the created value. The phenomenon of coopetition is therefore at the very heart of entrepreneurial strategy.
Proposal 4. The content of an entrepreneurial strategy is the creation of a market. Any analysis must focus on what is involved in a strategy of this type, with special reference to coopetition: a firm which creates a market must cooperate with its competitors to define that market and set it up, at the same time as competing with them on the said market in order to capture its share of the value. The entrepreneurial strategy of a firm which creates a market must include an element of self-restriction, with the firm choosing to abstain from doing certain things. [this last point should no doubt be presented as a result - HD]

It has been stressed that the temporality of the entrepreneurial action is very specific in nature. Schumpeter speaks of a «discontinuous change» (Schumpeter, 1912, p. 64). This discontinuous change may be interpreted in terms of a crystallisation, as described by Arendt (1951). Above all, however, entrepreneurial strategies develop rapidly and decline just as rapidly. «The systematic promotion of optimism explains many of the human resource management practices characteristic of entrepreneurial firms. It also explains why firms find it difficult to operate in a steady state; they either grow in an atmosphere of optimism or decline sharply in an atmosphere of pessimism. A switch to pessimism is precipitated when the entrepreneur loses credibility as a consequence of an adverse change in conditions that he cannot explain» (Casson, 2005b, p. 343). This fast-moving temporality, swept up in an accelerated movement towards success or failure, is to be compared with a «virtuous circle» effect in the first instance and a «vicious circle» effect in the second: «The virtuous circle argument would suggest that although many firms would like to pursue such strategies they are unable to do so. This inability stems from their exclusion from a virtuous circle in which (a) the pursuit of novel, emerging, and pioneering technologies leads to breakthrough inventions, (b) breakthrough inventions when they occur, create wealth and surplus resources, and (c) these surplus resources fund the next cycle of entrepreneurial experimentation, which in turn leads to more breakthrough inventions» (Ahuja & Lampert, 2001, p. 540).

Proposal 5. Entrepreneurial strategies develop in a specific temporality (rapid success and/or failure, crystallisation).

We could therefore consider that the outcome of entrepreneurial strategies is easy to assess: either they succeed, rapidly and spectacularly, or they fail, in exactly the same way. In reality, the assessment of outcomes is much more complex. A distinction must be made between the outcome for the company which implemented the entrepreneurial strategy, for the market it created (it may have created a market which functions well and produces value, without having succeeded in capturing a significant share of that value for itself) and for society in general. The nature of the outcome is in itself difficult to define. It may be «positive or negative, immediate or long term, or tangible or intangible» (Zahra & Dess, 2001, p. 9).

Proposal 6. It is difficult to assess an entrepreneurial strategy. The outcome may be immediate or long term, tangible or intangible, profitable for certain actors and not for others.

These proposals must now be put to the test. Testing will be carried out via a case study.

Methodology

The methodology selected to study entrepreneurial strategies is the case study. The dynamic aspect of the phenomenon under study justifies the choice of the methodology in question (Ragin & Becker, 1992; Yin, 2002). The key is to understand the origins and implementation of an entrepreneurial strategy. The case is presented in a narrative style, which seeks to articulate the actions and discussions of the actors in a dimension of strategic interaction (Dumez & Jeunemaitre, 2006).

The case was selected according to two criteria: a large firm which develops an entrepreneurial strategy without creating a new product (in order not to automatically link entrepreneurial strategy with product innovation or technological innovation). The case selected is that of Boeing between 2000 and 2004, developing a strategy presented as revolutionary for the air traffic management sector.

The data comes from two sources. Firstly, an analysis of the specialised press (mainly: Aviation Week and Space Technology, Assembly, Interavia Business & Technology, Avionics Magazine, Business & Commercial Aviation). Secondly, a series of interviews carried out with actors in the field during the implementation of Boeing’s strategy (Airbus, Boeing, EUROCONTROL,
the Federal Aviation Authority, Lockheed Martin, Raytheon and Thales). These interviews were semi-structured, lasted between two and three hours, and were theoretical in nature, seeking to establish the representation models of the actors’ strategy and to test the models developed by those actors (Fiore, 2006).


**Presentation of the case**

On 6 June 2001, the Federal Aviation Authority announces a plan aimed at modernising ATM in the US over the coming decade.

ATM capacity is highly restricted by the fact that: controllers and pilots continue to communicate by radio; aircraft follow routes by positioning themselves in relation to a network of beacons on the ground; controllers cannot simultaneously control more than around 15 aircraft in the same airspace – the sector – while attempting to prevent flight-path conflicts; and when passing from one sector to the next aircraft are each time obliged to change controllers via the radio link. The plan is worth USD 11.5 billion, and aims to increase capacity by 30%. At this time, the two traditional system suppliers for the FAA, Lockheed Martin and Raytheon, are also working on systems which aim to combine ground equipment with the satellite links.

Several hours later, on the same day (6 June), Boeing convenes journalists and announces a plan to revolutionise ATM.

**What Boeing did**

In November 2000 Boeing creates a Boeing ATM body, the staff of which will increase six-fold in two years, going from 40 people from the outset to 250 in 2002, half of whom will be engineers. These engineers will initially be recruited from in-house programmes which are being downscaled (Joint Strike Fighter, Space Shuttle) [slack of resources]. The initial engineers will be joined by ATM specialists employed from outside Boeing [investment and risk-taking]. This subsidiary will then seek to win contracts - and will succeed in doing so - but will be far from covering its costs. The project therefore requires a major investment from Boeing. Prior to this, Boeing has made two purchases directly linked to ATM: the Preston Group, in September 1999, which carries out air-traffic modelling (computer-generated air traffic modeller) and Jeppesen, in October 2000, which helps airlines to plan flights (flight data planner). Both firms are highly specialised and unique.

Most importantly, also in 2000, Boeing bought out Hughes. Hughes has, by this stage, built 40% of the communication satellites operational worldwide, and is the technological world leader in space-based communications, reconnaissance, surveillance and imaging systems. This acquisition increases the size of the space and communications division by a third, bringing its turnover to USD 10 billion. This is the division to which Boeing ATM is attached.

When Boeing creates Boeing ATM, it also creates Connexions by Boeing and Boeing Capital Corporation (BCC). BCC, founded on the model of GE Capital, is to specialise in financing satellites and, more generally, in proposing public-private partnerships to various authorities. Connexions by Boeing is to propose a new in-flight service to provide high-speed Internet and entertainment services to airlines.

**What Boeing said**

The principle behind Boeing’s strategy is as follows: Boeing’s main pillar of activity (in 2000, USD 31.2 billion, i.e. 61% of turnover) is commercial aviation. However, the forecasts for this activity are relatively disappointing - at around 4-5% growth in the coming decade. One of the obstacles is ATM, which constitutes a bottleneck for the activity: if the sky is saturated, aircraft sales stagnate. The company must do everything in its power to improve ATM while simultaneously identifying other drivers for growth. The forecasts for growth in the spatial domain, and in particular for satellites, are around 15% for the coming decade. However, the improvement of ATM is dependent on satellites for positioning the aircraft, their surveillance, and for the communications between aircraft and between aircraft and the ground.

Moreover, in the period immediately preceding their announcement, Boeing concluded one of the most successful projects in the history of aviation, the 777. This project combined work on the requirements of the clients (the airlines) in order to define
the aircraft requirements, the use of simulation and modelling since the aircraft was designed using IT, and the involvement of the project’s sub-system suppliers very early on in the process. The method was named the Working Together Team (SP Benson, 1994; 1995; 1996). Whereas the traditional suppliers of ATM systems have a logic of selling «turnkey systems» to the government, Boeing prefers to define the requirements of the major systems based on the requirements of its clients, and thus to find much more modern and efficient designs.

On a similar but unrelated note, Boeing feels that in ATM, as in the military, the present period is characterised by a transition from systems to «systems of systems». In the military, it is no longer a question of designing aircraft, missiles, tanks or ships, but rather networks in which these various platforms constitute nodes which exchange information and coordinate with the others in order to carry out complex missions. Similarly, in civil aviation, the aircraft should no longer be seen as a system, with ATM as another system, but rather the aircraft and ATM should be perceived as a system of systems in which aircraft must be more autonomous and in which information must therefore be shared and exchanged, with an autonomy of decision allowing more efficient adaptations. The complexity of such systems of systems is generally too much for the client, be they civil or military. Only an actor with experience of designing such systems and of powerful simulation and modelling techniques can help the client formulate its requirements.

Information exchanges and processing are central to the systems of systems and their support is carried out via satellites, an activity in which Boeing increased its involvement by buying out Hughes. Moreover, Boeing acquired key highly-specialised competencies in ATM by buying Jeppesen and The Preston Group.

Boeing thus stresses the need to move beyond the traditional FAA/Lockheed Martin/Raytheon association and that it possesses the competencies enabling it to coordinate such a move, while at the same time having the necessary independence in relation to the current set-up.

Lastly, the idea has long been in play that value is no longer to be found in the actual technical systems but rather in services. The highest-earning firms are those which offer solutions to clients rather than selling them their systems (Cova & Saille, 2009). The model in this instance is General Electric, which does not sell jet engines to airlines but rather a financial service via its subsidiary GE Capital and maintenance during the life cycle of its jet engines, earning the largest share of its revenues through these services rather than from the sale of the jet engines per se.

All these elements are independent and generally heterogeneous, although links do exist. In the statements made by Boeing, the idea clearly emerges that Boeing is not seeking to sell systems to its clients but to discuss with them in order to identify their true requirements, then to define a solution in the form of a system combining various systems with a services dimension. This idea can be adapted to many different domains. The managers of Boeing speak of a «business transformation strategy» through which the company has diversified from passenger aircraft into defence, space, communications, air traffic management and financial services. We can therefore identify a process resembling what Hannah Arendt (1951) calls crystallisation: independent and heterogeneous elements meet and crystallise to form something which appears radically different.

What Boeing didn’t say

Boeing stresses that its approach is, in a certain sense, disinterested: the firm has no interest in ATM as such, its sole objective is to eliminate the bottleneck which is jeopardising its main activity; the sale of commercial aircraft. Boeing also emphasises the importance of satellites in its project. The ATM revolution is to be achieved through the abandonment of ground systems and not by a combination of ground systems and satellites, as in the solutions being worked on at the time by Lockheed Martin and Raytheon. Moreover, Boeing states that the degree of precision needed exceeds that of GPS, therefore a new type of satellite is necessary. However, what strikes the actors in the ATM organisational field is both the scale of the investment (a unit of 250 people, half of whom are engineers) and the absence of any business model to ensure a return on this investment. The sale of satellites per se would not cover the investment made; the improvement to ATM will have an effect on sales of commercial aircraft only in the very long term, and this is itself very uncertain. Moreover, any improvements will also benefit Airbus, Boeing’s main competitor in the field. When John Hayhurst, Boeing ATM’s president, is questioned, he responds by stating that the firm’s «sole aim is to reduce the impact of gridlock in the skies, which could seriously threaten aircraft sales». He also stresses that Boeing is not interested in either owning or operating the system, and is examining several third party operating options (SP Bois, 2001). When asked about project financing, Hayhurst declines to comment: «Hayhurst would not comment on Boeing’s business model for the venture or who would pay for the satellites, only that Boeing is considering alternative business concepts to the usual «turnkey» systems that are generally provided to the government. He said Boeing was not planning...
on becoming the owner/operator of the system, but eventually the company would be looking for help on costs». (SP, Croft, 2001). Boeing is landing contracts with the FAA, in collaboration with Lockheed Martin (En-Route Automation Management), and with NASA. However, these contracts clearly do not cover the initial cash outlay, which given that staff numbers at Boeing ATM will go from 100 to 250 people over a two-year period, will be considerable.

The industry actors see what Boeing does, and what Boeing says and doesn’t say, and are thrown into a state of great uncertainty over the firm’s strategy. An article in early 2002 (SP Jensen, 2002) provides a good summary of the situation in the organisational field. It underlines that Boeing’s strategy would appear, in relation to its other activities «broader in scope» and that the other actors are «probably curious», and in many cases «no doubt suspicious». However, Boeing ATM «has been advancing aggressively». Officially, «the company’s main motive is quite simple and understandable—>to grow». The approach has a «Don Quixote-like» feel, and the question arises «is Boeing chasing windmills»? The article tackles the questions which the other actors are asking themselves: does Boeing want to build a satellite network now that it has acquired Hughes Communications? Or is it intent on becoming the world’s dominant air traffic services provider? Boeing management avoid the question as follows: «We’re not trying to sell satellites [and] we don’t want to manage a worldwide ATM system; that would probably be done by three or four major air traffic service providers», [Matt Vance, WTT manager, addressing suspicions of Boeing ATM’s motives]. «We’re more like ‘enablers’». The article concludes: «In other words, the company is using its clout in an attempt to facilitate an industry-wide effort». The article highlights the dilemma faced by a firm such as Boeing when developing this type of strategy: «It is large enough to capture industry attention, but attention laced with suspicion».

The interviews carried out with industry actors in 2002 confirm the situation. The actors in the organisational field (we cannot speak of «competitors» because Boeing is not painting itself as anyone’s competitor and is situating itself on a plane where there is no competition and it is merely an «enabler») are deeply troubled by Boeing’s strategy because they cannot discern a clear intention.

In private, Boeing managers explain that the business case would never be agreed. An investment by the State would be necessary, and they cite the example of the motorway network: most of the network was financed by the State and is free, but a part of the network was financed by the private sector and is tolled.

**Implementing the strategy**

Boeing’s strategy will take concrete shape around the Working Together Team dedicated to ATM.

The challenge for Boeing is to ensure that the actors, in an initial phase, together agree on a creative definition of the system requirements. Boeing has identified a number of circles. The first is made up of the FAA, EUROCONTROL, the Department of Defense and NASA. EUROCONTROL, the body responsible for ATM coordination in Europe, is invited to participate for an obvious reason: if an onboard system is to be designed, this system has to be compatible with the ground systems installed worldwide. The DoD is involved for security purposes, and for coordination between civil and military traffic, NASA because satellites are involved, and because this organisation carries out research on all advanced air transport systems. But most importantly for Boeing, the FAA is marginalised. Traditionally the FAA is the client and identifies the system requirements, in a position of monopsony. Boeing feels that it has suffered a number of failures in this role, whereas the DoD, for example, has experience in successfully running very large systems. The cooperation with EUROCONTROL, NASA and the DoD is an attack of sorts on the FAA, which, according to the plan of attack, loses its monopoly and finds itself on an almost equal footing with the other actors. The second circle is made up of Lockheed Martin, Raytheon and Thales. Traditionally, these are the major suppliers of ATM systems. Their relationship with Boeing is ambiguous. They are under no risk in the short or medium term. They know that they could not take the place of Boeing. They do not have Boeing’s political assets, nor the simulation or modelling techniques, and they lack experience in this type of approach. Boeing strives to cooperate with them, and is, for example, Lockheed’s contract partner in ERAM (en-route automation management) for the modelling part. The third circle is made up of stakeholders such as airlines and controller representatives (who are extremely worried because they fear that Boeing wishes to privatise ATM).

Boeing therefore succeeds in bringing to the table all the actors of the ATM organisational field as perceived by the firm (i.e. an organisational field which has been extended by Boeing’s strategy to actors which did not traditionally feature). The next thing to do is to achieve results. June 2001 saw the release of a document which specified the requirements for the future system (Boeing, 2001) and the general concepts on which it must be based. The group worked on the document but at the same time, without a direct link to the discussions of the group’s participants, the Boeing ATM teams added their own contributions.
to ensure that progress was made. Some participants refuse to endorse the contents of the document and Boeing is not able to present it as the work of the WTT.

Although the WTT is the centre point of Boeing’s strategy, it is not the sole contributor. The CEO is in touch with the policymakers and Boeing, as mentioned above, lands a series of contracts, alone or in partnership. These contracts allow Boeing to acquire knowledge in the domain, to force certain actors to enter into dialogue with them, to build partnerships and, most importantly, to win it a place as a recognised actor in the field.

Game over

In a statement on 4 March 2004, Boeing management announce that Boeing ATM has been dissolved. They explain that 9/11 led to a fall in traffic which made the search for revolutionary solutions less urgent. A section of the team is taken over by Phantom Works, the R&D unit which designs new systems for Boeing. Harry Stonecipher explains that Boeing will be ready on the day that governments once again take up the issue of ATM, which will inevitably occur: «We are scaling down our investment and making an organizational change to meet current demand. When governments are ready to build an advanced air traffic management system, we will be ready to respond quickly». He added: «Our experience as a large-scale systems integrator and expertise in network-centric operations positions Boeing well to create an advanced air traffic system». Moreover, Boeing continues to exert pressure on the policymakers and continues to seek to obtain contracts in the United States and elsewhere in the world to modernise ATM.

Discussion

It now remains to discuss the case in terms of the theory-based proposals.

Proposal 1. Boeing took on a major risk by developing a strategy in ATM. This risk involved setting up a body of 250 high-level staff members working at a loss over a period of several years. The risk was eased by the size of the Boeing group and the many projects it was running in parallel. The rhythm of development of these projects produced a slack of resources (Ajuja & Lampert, 2001) which facilitated the development of entrepreneurial strategies.

Proposal 2. A large company such as Boeing can adopt entrepreneurial strategies, either in its main organisational field (Greenwood & Suddaby, 2006) or in a field where it is barely present, as was the case for Boeing in ATM.

Proposal 3. Boeing occupies a unique position. It is the only firm with balanced civil/military interests (Depeyre & Dumez, 2009). On the one hand, therefore, its market commonality with other firms is weak (Chen, 1996; McGrath et alii, 1998). It is more difficult to find mult market balance for Boeing (Baum & Korn, 1996; Gimeno, 1999). On the other hand, it has a wide experience in similar domains; the development of large technological systems, with an approach that tends towards steering projects and coordinating a large number of actors rather than taking on all the tasks itself. The domains are sufficiently diverse (private clients, civil government clients, military government clients) and sufficiently similar (coordination of large projects with a strong technological element) to pave the way for similar innovation, and result in entrepreneurial strategies. For the case in question, an approach adopted for the development of a commercial aircraft, the Working Together Team, had been set up for general purposes in the company and was adopted for use in a new domain. Lastly, the organisational field was profoundly affected by the entrepreneurial strategy developed by the firm. The actors in the field struggled to decide whether Boeing was a competitor or a partner with whom they had better cooperate. Lockheed Martin and Raytheon, for example, sell air traffic control systems, control centre systems and ground equipment such as radars. Boeing sells neither systems nor equipment of this sort and in principle is not therefore a competitor in this field. Boeing spoke of its desire to replace ground equipment with satellites, a sector in which it occupies a powerful position. However, Lockheed Martin and Raytheon will continue to develop air traffic control systems and to sell control centres. Boeing assigns itself the role of «enabler» of the anticipated revolution in the sector - a role which neither Lockheed Martin nor Raytheon can occupy (it is impossible for them, in practice, to «shake up» the FAA, their client). The obvious question arises of whether or not they have to cooperate with this «enabler». If they do not, they contribute to the failure of the project, but if the project succeeds, they would be permanently marginalised. If they participate, they officially accept the position of subcontractors to the enabler. In the event, they choose to participate, while at the same time trying to guide the process and at times by fighting it from within: they make it known, for example, that the
document published by Boeing (2001) is not that of the WTT but a Boeing document. What comes through clearly in the interviews is the uncertainty created in the organisational field by Boeing’s entrepreneurial strategy. By openly making available a massive amount of resources for the strategy, and by not revealing its business plan, Boeing worries all the other actors, who are not able to ascertain whether it is a disinterested strategy in the short term, with the aim of selling more commercial aircraft in the long term, whether it aims to develop Boeing’s satellite activities, or whether there is another goal at stake: ultimately offering an ATM service to replace that traditionally provided by the FAA.

**Proposal 4.** Boeing’s strategy consists in shaking up an existing market (a client, the FAA, and the suppliers, Lockheed Martin and Raytheon) in order to create a new market, which requires an expansion of the traditional organisational field to include new actors. There is an inherent contradiction to this strategy: Boeing wishes to be simultaneously outside of the market, in an organisational role, and at the same time an actor within the market. In order to develop its strategy to destabilise the existing market, its first action is to create a competitive structure at demand level. It invites inter alia EUROCONTROL and the Department of Defense to join the first circle of the WTT. The FAA is no longer at the centre of the market as the sole client. Moreover, it is Boeing which volunteers itself as a sort of Walrasian auctioneer, facilitating the coordination of orders between the various actors. Boeing is evidently attacking its competitor, the FAA. This is clear from its decision to announce its revolutionary project for ATM on the same day as the FAA presents its Operation Evolution Plan (OEP) to the press. However, Boeing takes pains not to appear to be in direct competition with Lockheed Martin and Raytheon, but instead expresses its desire to cooperate with them, for example through contracts. Boeing thus develops a framework for cooperation in which it attacks certain key actors in the current market structure. This attack on competitors is ambiguous and could be a way of forcing the FAA to cooperate while at the same time expressing a desire to cooperate with other actors involved. This wish to cooperate could also be a competitive weapon vis-à-vis other actors - the cooperation with EUROCONTROL or the Department of Defense is clearly a competitive weapon with which to attack the FAA. In the cooperative dimension, the phenomenon of self-restriction plays a part. The actor wishing to create a market through an entrepreneurial strategy cannot wish to confiscate the whole market for its own profit, at the price of seeing the creation of the market fail. It must find an intermediate position between the Walrasian auctioneer, who possesses perfect information at no cost and is entirely altruistic (Casson, 2005b), and the monopolist. For example, on the only roughly identifiable market, that of satellites, Boeing felt that its role of enabler would allow it to position itself, around its strategy. At the same time, the activity was reduced but maintained to a lesser degree in Phantom Works. Most interviews is the uncertainty created in the organisational field by Boeing’s entrepreneurial strategy. By openly making available a massive amount of resources for the strategy, and by not revealing its business plan, Boeing worries all the other actors, who are not able to ascertain whether it is a disinterested strategy in the short term, with the aim of selling more commercial aircraft in the long term, whether it aims to develop Boeing’s satellite activities, or whether there is another goal at stake: ultimately offering an ATM service to replace that traditionally provided by the FAA.

**Proposal 5.** Boeing’s entrepreneurial strategy took place within a «discontinuous change» (Schumpeter). This discontinuity can be analysed as a rapid crystallisation of heterogeneous elements. Such elements have their own history and therefore take place within a continuum, whereas their crystallisation produces a rupture. In the strategy put in place by Boeing, nothing is new. The technologies discussed had been in the pipeline for 15 years or more; the WTT dated from the 90s - since the development of the 777. The actors questioned, in the same interview, explained that there was nothing new in what Boeing wanted to do, then admitted that they had been impressed by the very fact that things which had been discussed for 15 years could become a reality. The strategy itself was implemented between November 2000 and March 2004. The increase in scale was extremely rapid, from 40 people at the creation of Boeing ATM in November 2000 to 250 people in 2002. The important thing was simultaneously to seem credible (hence the purchases of Jeppesen and the Preston Group, made beforehand) and to win the backing of the other actors in the project. One actor, in an interview, explained that the WTT members were extremely sceptical at the launch of the project, then got very excited about it, then returned to their original scepticism.

**Proposal 6.** The assessment of Boeing’s entrepreneurial strategy is a delicate matter. Its failure is manifest: Boeing dissolved its Boeing ATM body, which had never managed to achieve financial equilibrium and which had failed to mobilise all the actors around its strategy. At the same time, the activity was reduced but maintained to a lesser degree in Phantom Works. Most importantly, the concepts put forward by Boeing had been endorsed by all the relevant actors and Boeing is recognised as an actor in ATM, which was not the case in 2000. The initiative taken by Boeing was relayed through the creation in Europe in July 2002 of the Air Traffic Alliance (Airbus, EADS and Thales) and the subsequent launch of SESAR, a large European ATM modernisation programme (2005). Boeing is present in SESAR with the Air Traffic Alliance. Boeing’s entrepreneurial strategy therefore led to the appearance of a rival strategy by large European firms, followed by cooperation between Boeing and these firms. It is not inconceivable that Boeing may make a return and reoccupy the role of enabler in the modernisation of ATM, in particular if the FAA is not able to achieve the necessary modernisation of ATM. We can therefore say that Boeing failed, but that the firm asserted itself as an actor in the field and remained in that position; that its ideas spread further afield, and that it remains in a favourable wait-and-see position, ready to pick up the baton in the future.
Conclusion

This paper aimed to reach an understanding of entrepreneurial strategies by reviewing the literature devoted to the concept of the entrepreneur and by comparing it with a case study.

It demonstrates that the six dimensions identified in the literature as components for the analysis of the concept of the entrepreneur can be identified in the case study and provide a fruitful framework for analysis. It confirms inter alia that this type of strategy is linked to a slack of resources in large groups, coming from the differing rhythms of activities (in the case study, Boeing took advantage of the fact that certain projects - Joint Strike Fighter and Space Shuttle - were being downscaled, to adopt an entrepreneurial strategy in ATM). The fact that the activities of these groups were sufficiently diverse while at the same time sufficiently focused allowed an equivalent innovation to take place (the transfer of an approach developed in the framework of one activity to an activity which had already been developed or to a new activity). The content of an entrepreneurial strategy is the creation of a market plus the invention of a new product. Sometimes, the two coincide. We chose an entrepreneurial innovation which did not involve a product innovation so as to attempt to highlight more directly the market-creation dimension. The firm wishing to create a market must situate itself between two opposing positions: that of Walrasian auctioneer altruistically organising the market and that of the monopolist; between pure and disinterested cooperation with the market actors and complete competitive domination. This polarity links cooperation and competition, thus the coopetitive dimension is at the heart of entrepreneurial strategies.

When this type of strategy is carried out by large firms, it creates a situation of great uncertainty in the organisational field concerned. The competitive and cooperative relationships are completely disrupted. It is generally felt that the entrepreneur exploits situations of uncertainty. However, large firms which adopt an entrepreneurial strategy decide to create uncertainty themselves. They must identify the areas which will necessitate an attack (so that things change) and areas where cooperation will be necessary, so that the market can exist with multiple actors. Within this coopetitive strategy, the case study draws attention to the self-restrictive aspect of entrepreneurial strategies: the actor who wishes to create a market must restrict itself in its ambitions to capture the value to the detriment of its competitors and partners, in order to maximise the value creation by the market. The study of the links between coopetition and self-restrained strategy would seem to open up a fascinating field of research.

References


**Specialised Papers (SP)**


Analysis of the infrastructure management function in ATM

EXECUTIVE SUMMARY

The note is made of three sections.

Section one studies the European infrastructure management function from a broad perspective applicable to utilities. Within the function it introduces a distinction between network management –i.e. investment, infrastructure design- and system operator –i.e. management of short term infrastructure capacity. Then, it proposes to characterise possible alternatives in accordance with two dimensions, the level of integration –i.e. more or less centralisation at the European level- and the level of scope –i.e. the components of infrastructure or related ones which will be included in the infrastructure management function. Finally, the selection of alternatives rest on an efficiency criterion, which consist of activity or infrastructure component integration efficiency –i.e. optimising for each component the efficient level of integration- and activity or infrastructure component scope cross-efficiency –i.e. the efficient gains resulting from managing in coordination pair or multiple activities or infrastructure components. Efficiency criterion would be based on economic and technical indicators to which applies cost-benefit analysis.

Section two reviews the proposed architecture alternatives for infrastructure function in the Single European Sky studies on airspace design and economic regulation. It gives account of the current position of the Council of Ministers position on the issue in response to the European Commission regulation SES II proposals. Both reviews illustrate the wide range of possible arrangements with regard to levels of integration and scope to define a framework for the infrastructure management function, and the reluctance of Member States to give too much power to a European centralised alternative.

Section three focuses on Electricity to provide with comparison. It studies the potential for cross-fertilization in choosing alternatives for the infrastructure management function. Similarities between the two sectors are stressed in terms of network management –i.e. investment in capacity, regional initiatives- and system operator functions –short term management of available capacity. Differences relate to the more ambiguous definition of infrastructure in ATM and the possible evolution according to technology. Electricity appears more advanced in pursuing unbundling of network management and system operator at the national level together with independent regulatory agency. The prospect of increased integration as laid down in the third regulatory package in regard to regulation –i.e. Agency for the Cooperation of Energy Regulators (ACER)- and infrastructure management –i.e. European Network of Transmission System Operators for Electricity (ENTSOE) may also be viewed as ahead developments in comparison with ATM although the technical centralisation of operations regarding management flows have not yet been achieved in electricity and mainly thought on a commercial basis.

Why and how a European infrastructure management function in network utilities?

The development of a European internal market for utilities relies on the effective working of a unified European infrastructure network. Currently the European network is made of decentralised national networks where infrastructure is nationally managed and has not been originally designed to address the creation of a single European market for utilities.

Without coordination, the working of decentralised networks is as a whole suboptimal. It produces short term inefficiencies – congestion bottlenecks at cross border due to lack of capacity- and long term inefficiencies –difference in time in infrastructure investment with costs duplication.
Therefore, reducing inefficiencies through the development of a European infrastructure function assumes to define a level of integration at the European level and a level of scope in the activities and responsibilities assigned to the infrastructure management function. It also assumes defining ways of performance measurement in the reduction of inefficiencies and accountability procedures together with the proper financing.

Integration and scope

Some considerations about the levels of integration and scope may be worth noting. Here the level of integration refers to the choice of institutional alternatives that covers a wide spectrum, from decentralised loose interactive collaboration processes to the set up of a dedicated body in charge of the infrastructure. The level of scope refers to activities or infrastructure components to be included in the network management function –i.e. the management of long term investment in capacity, the involvement in regional projects, in the maintenance of the infrastructure- and system operator –the regulation and operation of the day to day available capacity.

From that perspective, deciding on an infrastructure management function corresponds to choosing a final arrangement in terms of levels of integration and scope. In the case of ATM, a high level of integration -centralisation at a European level- with a low level a scope -limiting the scope to system operation on air traffic flows would suggest reducing the infrastructure management function to an operational Air Traffic Flow Management activity as the existing CFMU.

A decision making mechanism

Thinking in terms of integration and scope allows for introducing a decision making process-mechanism in choosing alternatives. A first step is to study the infrastructure components in separation. To what extent relying on a de-centralised or centralised setting produces additional efficiency gains, at which costs. A second step is to consider the interaction between components whether they require more or less transverse collaborative procedures to produce efficiency gains. In other words, on the one hand, the efficiency analysis of integration relates to an itemized dimension (benefits and costs) according to the activity and her need to be more or less under a centralised arrangement. On the other hand, whether regulatory bridges between activities are needed to produce additional efficiency gains for the activity raised the issue of a more or less of enlarged scope of the infrastructure management function.

In terms of definition, efficiency gains which applied to alternatives are of different nature: those that relate to the activity –i.e. economic assessment of better performance outcomes, and those that relate to the cost of achieving a specified level of performance –i.e. which include in the assessment the likelihood of costs duplication, the implementation of inefficient rules, the increase in transaction costs.

Assume the infrastructure components in ATM are made of airspace design (the design of routes, sectors and FABs according to traffic flows); radars coverage; CNS and radio frequencies, at which levels of integration and scope should they be considered? The efficiency outcome will vary for each component depending on at which level of centralisation it is decided and managed, and on efficiency gains stemming from the management of the interaction of the other components.

Efficiency and management tools

In the process of defining alternatives applied to the components a differentiated set of management tools may be available. These are of different nature according to the component, producing more or less regulatory burden.

Thus, deciding on long term investment, on restructuring to increasing capacity, might require scenario building on demand forecast and growth, with predictions to be made at a decentralised level and involving an aggregation process. It would rest on devising business cases and plans ensuring the financial viability of the investment.
Current ATFM procedures, which are in use as a system operator function, may have a wide choice of management tools to deal with congestion and slot allocation such as booking mechanism, congestion charge, etc.

Therefore, once decided the level of integration and scope, the alternatives have to be defined in relation to the available management tools and the degree of freedom the infrastructure manager will be granted in exercising them. Expected efficiency gains would also have to be assessed according to the selected management mechanisms.

**Governance, expertise and financing**

Whichever the chosen level of integration and scope, an important step towards studying the infrastructure management function – network management and system operation- is who and how it might be performed. It raises the issue of institutional separation of the infrastructure from service provision or leaving it vertically integrated to local incumbents. In the former case, an enlarged market for infrastructure may develop more rapidly if decentralised independent infrastructure managers are permitted to expand through strategic alliances and mergers, together with access for new entrants. In the later, when the infrastructure is vertically integrated, the market for infrastructure becomes a market driven by service provision interests.

The choice of separation versus vertical integration usually very much hinges on the balance of power between the stakeholders associated with infrastructure management and efficiency gains that may be attached to one or the other alternative. In that respect, a prevailing principle might be to consider the governance issue starting with the benefits and costs borne by particular stakeholders.

An example might be given with ATFM system operations. In ATFM users are on the demand side, ANSPs on the supply side. Meeting demand and supply through particular arrangement introducing various forms of incentives to increase performance or flexibility (booking mechanism, penalties on delays, yield management) has direct repercussions on costs and revenues for both stakeholders. A simple governance rule would make both parties negotiating and presiding over the chosen institutional and regulatory alternative.

Besides any component of the infrastructure function may have repercussions on each other (Airspace design and air traffic flows, interoperability of ATC systems and airspace management), thinking governance in relation to the bearing of costs and benefits for stakeholders may prove a sound ridding principle.

Finally as regards the financing options for the infrastructure management function, alternatives include an itemized item for infrastructure in the users charges, the creation of a fund for infrastructure investments, the use of private sector bearing the risk of infrastructure developments.

**ATM developments and the situation in progress**

From the beginning the Single Sky has referred to the European Air Traffic Management Network (EATMN). The concept of infrastructure management has not been mentioned in isolation. Yet, the first SES studies have studied the issue from different angles, in particular in relation to airspace design and economic regulation.

**Already put forward proposals**

In the case of the airspace design study, considering the creation of a European Regulator as put forward in the 2000 High Level Group report, the proposal was to give the European Regulator the responsibility of setting policy and standards, harmonising airspace rules, proposing routes and sectors design, together with the adoption of an enforceable action plan. Within Eurocontrol an Airspace Unit Policy would be created and act as a technical supervisory authority with coordination between airspace modelling and CFMU. In other words, the chosen alternative was to increase significantly the level of integration with limitation in scope to airspace design and traffic flow management.
A step further was the first study on economic regulation. It included in the framework of infrastructure management function, and the FAB enabler as a way of restructuring, enlarging the scope of the infrastructure management function. It brought forward as previously a high level of integration –centralisation at the European level- together with significant linkage about the airspace design on FABs, the related charging regime and means of imposing cooperation. Although it detailed possible institutional arrangements such as users club for ATFM governance –i.e. ANSP and airline companies- it did not refer specifically to an ATM manager function. However, it defined a performance regime applicable by a European regulator to the different components of the ATM system –i.e. management of the network infrastructure; system operations on ATFM; Air Traffic Control; and ancillary services. Therefore, the envisaged infrastructure function appeared at the same time with a high level of integration but with institutional fragmented structure, which suggest a low level in scope, which correspond to a perception of minimum cross-efficiency between ATM components.

The second study on economic regulation was more comprehensive in the definition of the function – i.e. network management and system operation. It has discussed the more or less active or passive role of an ATM infrastructure manager at the European level, in particular, should there be a European Infrastructure Oversight Body or Manager. If the diagnosis would be that coordination processes were already in place but lacked to introduce sufficient compliance and enforcement to produce the desired efficiency gains, then an oversight structure would have been preferred. On an extended model of the PRU/PRC, it would have had an analytical function in the gathering and treatment of information, an identification function in the required investments projects in infrastructure capacity, a compliance function in ensuring that the projects would go to their end. In the context, reinforcing the role of the oversight body into a more active infrastructure manager would have meant that a centralised structure would be established with the remit of dealing itself with the financing of cross-border projects as the ANSPs would be considered as reluctant to spontaneously involve themselves in. Hence, the second economic regulation study added the possibility of low level of integration and scope in management infrastructure function supporting the case for improvement by means of increased coordination processes.

Finally, a more integrated and enlarged scope level option might be said at the far end of the spectrum. It would be a Network Optimisation Manager, of which the governance would be under ANSPs and Users. It would place under a unique body the network management –avoiding duplication costs and coordinating investments with the FAB/Airspace design issue, the system operator function –ATFM and traffic/capacity forecasts. The body which would be under performance criteria and reviews would be accountable before the European Commission in respect of the Single European Sky regulations.

Therefore, as illustrated in the SES Studies, different options are thinkable with regard to the infrastructure management function, with different levels of integration of scope. So far they have not been fully subject to a comprehensive impact analysis of efficiency gains per ATM components and cross efficiency gains between components of the system.

The current views

The Single European Sky II regulatory package will be debated in first reading before the European Parliament early 2009. From the European Aviation conference of January 2008, to the SESII proposed regulation and the ongoing process of ratification before the Council and Parliament a number of attributes emerge, which may characterise the future of the Infrastructure Management function. Rather, what it should be in details, various interventions give an idea about the room for manoeuvre for developing such function.

A first consideration both from Eurocontrol and the European Commission presentations is an apparent alignment with regard to the substance of the function which includes improving route, sector design and optimising the use of the network. It encompasses planning for the network and network optimisation. SESII places in the scope of the function, the Flow management and slots, the route design, the frequencies and codes, the new SESAR technical functions.

With the regard to the working and decision-making processes, the Eurocontrol perspective stresses that the governance of the network manager should represent all stakeholders involved in the different activities. As for the European Commission, she had to study more substantiated options, either stay in a status quo of voluntary cooperation or find way of coercing the Member States to consider proposals at the European level, or even after consultation processes define what should be the network in its design dimension, which could be referred as a «total system approach». The total approach would raise the issue of the FABs in the system, as illustrates the legislative text proposed by the European Commission and amended by the Council of the European Union early December this year.
Thus, in its introductory part, the Council recognizes the importance of accelerating «the introduction of functional airspace blocks and the strengthening of European networks functions». But the Council have amended articles proposed by the Commission with regard to an increased role at the European level of network management and design – in particular with respect to additional network functions and radio frequencies. It has also come against the proposal from the Commission to set up common projects to improve the collective air navigation infrastructures in relation to worries about the impact on budget and navigation charges.

The main concern which the Council amendments might produce in regard to a European infrastructure function also expresses in the elimination in key articles of the word «regional» with is replaced by «functional airspace block».

Thus, in terms of performance scheme, plans, targets, charging, assessment, the reference is to national plans or functional airspace blocks and not regional plans. The prevailing of the national dimension also applies to criteria for setting up the supervisory authorities of which the institutional independence is left open to Member States according to «their own administrative arrangements», and which «shall not prevent the national supervisory authorities from exercising their tasks within the rules of organisation of national civil aviations authorities or any other public bodies».

The same rationale applies to the airspace creation of a Single European Flight Information Region (EFIR). It would have transferred the competence on airspace to the European Community. The article has been rejected by the Council, finding that it did not add value to the precedent formulation about the creation of a European Flight Information region, which «leaves the door open for Member States to request such a flight information region at ICAO, should the necessary conditions prevail in future».

Likewise, network management and design where the «network functions shall be aimed at supporting initiatives at national level and at the level of functional airspace blocks» will have to be performed «without prejudice to the responsibilities of the Member States with regard to national routes and airspace structures» – the functions being the design of the European route network, and the allocation of radio frequencies, coordination of radar transponder codes.

On the whole, the Council amendments to the Commission proposals entrenched the Single European Sky within national boundaries and a bottom-up approach with regard to the infrastructure management function, characterised by low level of integration and scope. An interpretation might be: the European Community has not to have in her remit the responsibility of a one European single airspace, the design of FABs according to regional plans based on the sole perspective of European air traffic flows. As the current initiatives illustrate, FABs are more the grouping of countries – through existing Flight Information Region- and national ANSPs, going along with coordination and performance defined within these national or supranational boundaries.

At present, it is too soon to exactly know what will be the end result of Parliament-Commission-Council of Ministers process to tell the room for particular alternatives on integration and scope.

Cross-fertilization with Electricity markets

As in ATM, the new regulatory package to promote an internal market for electricity; awaits reading before the European Parliament early next year, although it regards a third regulatory package and a second reading. The internal market for electricity offers an interesting point of comparison to assess the regulatory developments in ATM.

To an extent not yet experienced in ATM, integration has been supported by liberalisation and the integration process has relied on market forces, in particular in creating a regulatory framework incentivising cross-border exchanges through interconnection. A more competitive open market to cross-border exchanges has permitted to exploit complementarities between national electric systems in terms of capacity supply to meet fluctuations in demand. As a general rule governing market integration, a supplier from a country where price electricity is high has incentive to import electricity from low price countries insofar as interconnection charge makes it profitable.
Thus, the internal market for electricity has been based on competition in supply and distribution. It has created an economic environment for long and short term contracts with electricity exchanges and the use of sophisticated economic instruments such as auction pricing.

In terms of regulatory framework, it has translated into the setup of national independent regulators with high economic component on pricing, investment plans, and separation of the infrastructure components from supply and distribution. Introducing unbundling with separate national infrastructure managers –private or public- creates the possibility of an internal market for infrastructure which might develop according to joint ventures, alliances, mergers. It also introduces various types of operators which might be more or less independent and regulated –i.e. merchant lines operators. The third regulatory package as drafted by the Commission increases the constraint on unbundling whereby an electricity supplier or distributor cannot own and operate infrastructure. However, the Council of Ministers is opposing the view leaving the possibility for electricity companies to «retain ownership of transmission networks provided that the networks were operated by an independent transmission network operator and that additional assurances are given».

By contrast the Single European Sky appears less driven by an economic perspective –i.e. cost recovery mechanism preventing profits- but more by an engineering perspective as progress is expected from technology leap (SESAR) with ATM infrastructure remaining more ambiguous to define with regard to separation.

However, both Electricity and ATM have common features with potential for cross-fertilization: in the management of short term capacity according to forecasts and real time demand and supply; in cross border initiatives (7 Regional initiatives in Europe for Electricity, 8 FABs with SES), in the substance given to European regulation and infrastructure management in the regulatory package (ACER and ENTSO for electricity, ESA and European Management -EATMN function in ATM); also in the willingness to go beyond voluntary and unanimity procedures.

References


Meetings

Commission Européenne (DTREN, SESAR)
Commission de Régulation de l’Électricité (CRE)

Conferences

EC Conference, Towards a more performing, European aviation system, Brussels, 22 January 2008
7th Stakeholder Group (SG) meeting - Mini Forum - for the region France-UK-Ireland, Belfast, 3 December 2008
The management of organizational boundaries: The case of the European Air Traffic Management

There is a paradox regarding the notion of boundaries. One can rightly say it is omnipresent in social sciences (Lamont and Molnar, 2002) and in particular in management science, and, at the same time, it is rarely thematized as such, and in all its dimensions. In management, vertical boundaries have been studied via the study of make or buy decisions, horizontal boundaries via the study of alliances or mergers and acquisitions. At the micro level, internal boundaries of the firm have been studied most often through the idea of «spanning boundaries» in knowledge management or innovation (Nonaka, 1994 ; Brown & Duguid, 2001 ou Miller & al., 2007). At last, more recently, what Lamont and Molnar (2002 : 168) call «symbolic boundaries» (categories actors agree upon and use to define reality) have been covered by boundary objects studies (Carlile, 2002 ; Osterlund & Carlile, 2005). What strikes in all these studies is the fact that they do not really connect between them. The title of Araujo, Dubois et Gadde’s paper (2003) is «The multiple boundaries of the firm», but these authors explain that they will exclusively focus on vertical boundaries. Santos and Eisenhardt (2005) say they focus on external boundaries of the firm, those that separate the firm from its environment, neglecting internal boundaries. There is a conceptual and practical link, however, between boundaries of different kinds. An internal boundary, for instance, can become an external one (it is decided to transform a division into a business unit, and this unit being sold afterwards) and an external boundary can become an internal one (a corporation acquires a firm that is transformed into an internal division, but this division is given autonomy). Besides, the notion of boundary refers to multiple dimensions: technology, power, space, social (issues of identity), symbolic, etc. The way these dimensions interact remains in great part unexplored. As put forward by Santos and Eisenhardt (2005 : 505), however: «the study of organizational boundaries is foundational».

The present paper aims at exploring the multiple dimensions of boundaries, and their interactions, and the interdependence between the different kinds of boundaries. This will be done through the discussions of three propositions drawn form the scientific literature on boundaries.

1. There is no such thing as «natural boundaries». Organizational boundaries are the result of decisions about capability units that are always debated.
2. Once decided, boundaries tend to be stable. They tend to be entrenched.
3. But the debate about boundaries leads to the displacement of boundaries if some actors adopt an architectural role and try to change boundaries either by competition or cooperation, or a mix of both (coopetition).

A case study will allow a discussion of these propositions. The selected case is the Air Traffic Management industry in Europe. Authors work on it for ten years on.

In the first part of the paper, we will investigate the theoretical foundations of the notion of boundaries, relying of course on the literature related to organizational boundaries, but also to ecological, geographical, historical boundaries. We will then explain our methodology, before the case study itself. At last, before to conclude, we will discuss the propositions in the light of the case study.

Theoretical issues of the notion of boundary

In this first part, we will attempt to define boundaries and then draw three theoretical propositions.

The definition of boundaries

A lot of studies dealing with boundaries do not define precisely what they are. What makes the separation between two divisions belonging to the same firm, or between this firm and its environment? A simple definition borrowed from biology
can be useful: «the regulation of flows across heterogeneous space». (Cadenasso et alli, 2003, p. 757). This definition can be elaborated a little further: a boundary is a mechanism (potentially or actually) rarefying or regulating flows between two heterogeneous spaces, and making these flows visible. Inside the boundaries, authority can be exercised and flows of exchanges are less visible. Across boundaries, flows are regulated and more visible. But a boundary can be activated at some moments, and non activated at others and, moreover, the rarefaction and regulation of flows across the boundary, their visibility, is a question of degree and depends on the scale it is analyzed: «[…] the perception of a boundary as abrupt or gradual will depend on the grain size at which the boundary is being measured or modeled; a boundary that appears abrupt at a coarse grain size may appear gradual at a fine grain size». (Strayer et al., 2003, p. 726).

The determination of boundaries

Some theories, among them very often economic ones, think there exist natural boundaries for organizations. It is the case, for example, with the transaction cost approach. Depending on the specificity and frequency of transactions, certain activities must be kept inside the boundaries of the firm while others can be outsourced. Two remarks can be made, however. On the one hand, in dynamics, specific assets can become nonspecific, as stated by Langlois et Robertson (1995). Even if natural boundaries existed, they would change over time. But on the other hand, as noted by Barney (1999: 138), when the transaction cost theory is presented to businessmen, they ask: «what role do firm capabilities play in this approach to firm boundaries?». And when they get the answer: «Very little», they remain puzzled. The issue of boundaries has obviously to do with capabilities. Firms know what they do – their activities – and, from this, they try to know what their capabilities are (Richardson, 1972). They develop and consolidate their activities on the basis of similarity, «yoking» them to quote Abbott (1995). Jacobides and Winter (2005) use the words «institutional packages», referring to the set of activities that tend to be lumped together within the boundaries of one division (within an organization) or one firm (within an industry). Managers seek to maximize economies of scale and economies of scope, the knowledge basis (Kogut & Zander, 1992), and minimize diseconomies (control, risk). As said by Potts (2001: 424: «Stable clusters of connections are required for production processes, which is essentially why firms have boundaries». But capabilities are never frozen. The managers try permanently to determine the optimal position of the «clusters» of activities that define the capabilities, hence the decisions to modify the internal («internal asset orchestration») and external («external asset orchestration») boundaries of the firm (Helfat, 2007). As organizational boundaries are linked to capabilities and as these capabilities are never exactly known but are the object of trials and errors (Resource Based View speaks of causal ambiguity - Lippman & Rumelt, 1982; Powell et alli, 2006), organizational boundaries are never «natural». They are determined through decisions made by the managers of the organization. The managers organize units of capabilities in yoking similar activities, taking into account multiple parameters (as those analyzed by Santos & Eisenhardt, 2005: efficiency, power, competence, identity). Doing this, they define «transaction-free zones» (Baldwin, 2008). In these zones, there is no transactions «defined as mutually agreed-upon transfers with compensation» (Baldwin, 2008: 156) or invisible transactions with cross-subsidiation. From these theoretical elements, one proposition can be drawn:

Proposition 1. There is no such thing as a «natural» organizational boundary. Organizational boundaries derive from decisions made by the managers and regarding capability units, always debatable.

Boundaries of different kinds tend to pile up and to reproduce themselves

Object of a decision, boundaries tend afterwards to pile up and reproduce themselves. Geographers speak of «entrenchment» or «entrenchment» - Hartshorne, 1936; Minghi, 1963). Inside the boundary of a capability unit, the same technology is used, that can be different from technology used outside; a same identity is shared, the same categories are in use. Studying science, or «entrenchment» - Hartshorne, 1936; Minghi, 1963). Inside the boundary of a capability unit, the same technology is used, and external («external asset orchestration») boundaries of the firm (Helfat, 2007). As organizational boundaries are linked to capabilities and as these capabilities are never exactly known but are the object of trials and errors (Resource Based View speaks of causal ambiguity - Lippman & Rumelt, 1982; Powell et alli, 2006), organizational boundaries are never «natural». They are determined through decisions made by the managers of the organization. The managers organize units of capabilities in yoking similar activities, taking into account multiple parameters (as those analyzed by Santos & Eisenhardt, 2005: efficiency, power, competence, identity). Doing this, they define «transaction-free zones» (Baldwin, 2008). In these zones, there is no transactions «defined as mutually agreed-upon transfers with compensation» (Baldwin, 2008: 156) or invisible transactions with cross-subsidiation. From these theoretical elements, one proposition can be drawn:

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Entrenchment has also to do with the visibility of flows and exchanges (Chevalier, 2004). Within a capability unit, a tissue of cross-subsidizations is not visible as such, even if actors have an idea of what they are. Every boundary displacement makes the phenomenon visible, entirely or partly, and is therefore tricky. This is a reason why boundaries tend to be stable and reproduce themselves.

As rightly seen by Jacobides, incentives can exacerbate the problem: decided within existing boundaries, they reinforce parochial, narrow attitudes and amplify compartmentalization (Jacobides, 2006: 157).
At last, asynchrony of multiple decisions made within a capability unit is also part of the entrenchment dynamics. The rhythm of technology change is not synchronous with the one of staff turnover. When deciding upon a new technology, one takes into account the inertia affecting other dimensions of the organization and one hesitates to shake existing boundaries. And once the decision has been made on technology, it has an effect on following decisions regarding staff and organization. As an effect, asynchrony of decisions leads to a stabilization of boundaries.

Hence proposition 2:

Proposition 2. Once the decision determining the boundaries has been made, boundaries of different kinds (technological, organizational) tend to pile up and entrench, reproducing themselves.

The displacement of boundaries

The dynamics of reproduction of the boundaries is counterbalanced by a dynamics aiming at displacing them. Technology, organizational activities and capabilities, customers and suppliers, are continuously changing. Boundaries are progressively deinstitutionalized, i.e. an erosion of the legitimacy of the existing boundaries (Oliver, 1991). Between different actors belonging to the same organizational field, a boundary misalignment can occur: some of them go on operating at the national level, some others becoming international actors (Greenwood & Suddaby, 2006). A debate rises: where are the boundaries to be placed in order to define the optimal capability units? A game of strategic interactions develops, some actors adopting strategies destabilizing the existing boundaries and, in response, some others adopting restabilising strategies (Depeyre & Dumez, 2009). The actors that aim at destabilizing existing boundaries can be of two kinds: either they only try to change their own boundaries, or to change the boundaries of the industry. In the latter case, they think they are in a position to play an architectural role for the whole industry (Jacobides & Billinger, 2006; Jacobides, Knudsen & Augier, 2006). To do so, they can use competition (entering new markets by/or acquiring competitors for example) or use cooperation (alliances, establishing joint ventures), or can attempt to combine competition and cooperation in practicing coopetition (Brandenburger & Nalebuff, 1996; book to be published; authors to be published). In response, other actors can try to defend the existing boundaries as they are or to displace them a minima to optimize the existing capability units. In such a game, the dynamics of internal and external, horizontal and vertical boundaries are interdependent. The creation of an internal vertical boundary can help the signature of a horizontal alliance between two firms, one being vertically integrated and the other not. In that case, the creation of a vertical boundary is a condition of the displacement of a horizontal boundary. One can see how important it is to take into account the different kinds of boundaries and their multiple dimensions when analyzing the dynamics of boundaries.

Proposition 3. Even when they are entrenched, boundaries remain debatable. When controversies increase, strategies aiming at changing the boundaries develop, and strategies aiming at maintaining them develop in response.

Methodology

To analyze the dynamics of boundaries in all its dimensions and interdependences, the case study analysis seems the more appropriate (Ragin & Becker, 1992; Yin, 2003) for three main reasons. The observed changes are complex and the causal dynamics at work, as the actors' motives, are difficult to identify; the analysis includes an historical dimension and an inductive approach allows to highlight sequences of actions and to pinpoint causal factors; finally, the objective is to extend the theoretical approach (Greenwood & Suddaby, 2006) through a process by which theoretical orientations are confronted to an observed material. The case is therefore instrumental in the sense of Stake (1994). The selected case is an industry, not an organization. Indeed, only an industry can allow the tracing of the dynamics of boundaries. The industry has been chosen for two reasons. First, in this industry the term «boundary» is not metaphorical: national boundaries play an important role in the dynamics of the industry. Second, this industry shows an intertwining, a superposition, and an interaction of many boundaries of different kinds: national, organizational, technological, and jurisdictional. It is the European Air Traffic Management (ATM) industry (Beyer, 2008; Dumez & Jeunemaître, 2001; Grushka-Cockayne, De Reyck & Degraeve, 2008). Authors have been working on that industry for about ten years on, having carried out studies for the European Commission (2001, 2003) and Eurocontrol (1998, 2003, 2006, 2008). During this period, seventy-two interviews have been conducted, longing two hours or more, the first of them dating back to 1996. These interviews concerned staff of the European Commission, of national administrations, of national service providers, systems suppliers, airline companies, controllers, military. Transcripts of these interviews have been coded following a grounded theory approach (Locke, 2001; Dumez, 2004).
The case study: boundaries and capability units

When commercial aviation has developed, a decision has been made, internationally and on the basis of the theory conceived by Grotius on the freedom of the seas: the sky would be free, no country being able to prohibit the access (except in time of war or crisis) or to set up a toll. A priori, national boundaries should not play any role in that industry. The Chicago Convention, signed in 1944, establishes that each state is in charge, however, to guarantee the safety of the sky over its territory, especially to avoid collisions between aircraft (Mendes de Leon, 2007). And each state has the right to let aircraft pay for the cost of this essential service. In the US, the passenger pays a tax the amount of it being written on the ticket. In Europe, airline companies pay route charges calculated on the basis of the weight of the aircraft and the route followed. Each country has organized its own control system. In order to do so, it has designed a network of beacons allowing pilots and controllers to know exactly where the aircraft is at certain times and to draw routes, a radar system allowing the controllers to follow the aircraft, a telecom system so that a dialogue be possible between pilots and controllers, a weather information system, a rescue system in case of a crash or a problem, and control centres. An aircraft crossing a national boundary is generally leaving a control system and entering a new one. The pilot says goodbye to the controller of the country she is leaving and says hello to the controller of the country she is entering. As VHF frequencies are saturated and as it takes time to leave and time to signal the entry in a new airspace, national boundaries rarely flows. The traffic flow is rarefied by boundaries that are in no way natural, but are the result of the organization of capability units decided at the national level. As said before, routes have been designed through a network of beacons and sectors have been designed from these routes and their crossings, to balance the work of the controllers. When aircraft fly up and down on crossing routes, sectors are Small. It is for example the case with the very complicated Chartres sector in France: routes North/South cross routes West/East (transatlantic routes) as aircraft fly down and fly up approaching or leaving the Paris airports. When aircraft follow simple routes at a high altitude, sectors can be much wider. At night, when the traffic is light, different sectors might be regrouped. During the day, they are progressively degrouped as the traffic increases. Sectors cannot be too small: as said before, when an aircraft leaves a sector, it must signal it to the controller of this sector, and it must signal its entry to the controller of the new sector. That takes time. The sector is the basic capability unit and the boundaries separating these units rarely flows and play as a constraint for the growth of the traffic. Sectors are managed at the level of a control centre, for human resource management (controllers work in teams) and for technical (maintenance of computer systems). When centres are big, they are usually divided in two rooms. Small countries have set up one control centre, big countries several. One centre could probably manage the entire European upper airspace and is footloose (a centre set up in Ireland could manage the German airspace), but big countries have chosen to build several centres for safety reason: if one centre shuts for technical reason or because of a strike of the controllers, another one can manage at least part of the traffic. What Americans call «pork barrel» issues have also played a role: local politicians have strongly lobbied to have centres in their area. Boundaries have also been superposed and entrenched because of public procurement: each country has defined its own requirements for the technological system it needed, and has acquired or developed this system for its centres. These systems have to compute the flight data in order to support the controllers’ work. Each airline company announces flight plans. These flight plans are analyzed by the system that must be able to forecast when a flight will enter a sector at a certain altitude, ascending or descending. The systems include a safety net: when a risk of collision occurs between two flights, this risk is signalled to the controller. France, for example, has developed its own system with teams of engineers being part of the administration, as the French Thales, one the suppliers of this type of systems with Lockheed Martin, Raytheon and Alenia, developed a system it supplied to other countries (Denmark, Ireland, Sweden, etc.). Developed for each country, the systems had no reason to be interoperable. Interoperability in Europe has been a big problem, dealt with by Eurocontrol and the European Commission so that the boundary between two systems do not rarely flows too much (Dumez & Jeunemaitre, 2001).

To sum up, the Air Traffic Management industry presents a piling up of boundaries. At the lowest level, the smallest capability unit, boundaries separate the sectors the controllers are in charge of. Then there are boundaries defining control centres that yoke a series of sectors, with teams of controllers and maintenance of the systems. National boundaries superpose themselves to these ones (and determine them): sectors are defined and control centres are built at the national level (with a very few exceptions). Public procurement of technical systems, the recruitment of controllers, are decided asynchronously on a national basis and reinforce the entrenchment on the national basis.
The debate about the boundaries

At the end of the 1990s, the deregulation of commercial aviation, the development of the hubs and spokes system, have induced a traffic growth and the ATM system has reached a state of saturation: flight delays burst and their cost increased considerably. Airline companies try to contain their own costs and ask for a decrease of route charges. The debate raised on the organization of capability units on the fragmentation of the European ATM. As said in the theoretical section, organizational boundaries are primarily capability unit boundaries. They are determined through a balancing between economies of scale and scope, on the one hand, and diseconomies (costs of control, safety, etc.). This is confirmed by the case study. As regards the technological for example, it is clearly sub-optimal that each country asks for the development of a specific system (or develops its own system, like France). At the same time, the development of a unique system at the European level entails a risk. The optimal situation would probably be a competition between a maximum of two or three systems. The same could be said of the route design and the setting up of control centres at a national level. The probability for that level to provide the optimal balancing of economies and diseconomies is low. A comparison with the United States is always difficult, but gives nevertheless a broad idea: the traffic is far higher than in Europe, the number of control centres is far lower, and the cost of a controlled flight hour is 62% inferior to that in Europe. For historical reasons, national boundaries as sedimentation of political, organizational and technological boundaries have been entrenched around sectors and control centres. Although the optimum cannot be determined with precision, the capability units are clearly sub-optimal. This entrenchment has also to do with the visualization and opacification of financial flows (cross-subsidization within the boundaries). Organizational boundaries opacify some money transfers (within boundaries, some activities finance other ones while this financing is not made visible) while at the boundary itself flows are made visible. Cross-subsidization is the second element of the economics of boundaries, the first being the design of capability units. Innovation can be promoted by a certain opacity of the financial transfers between traditional activities and new ones within a capability unit, but cross-subsidization can also strongly prohibit change. In the ATM industry, the same organization (the national service provider) usually manages upper and lower airspace. It seems more efficient to specialize control centres in the upper airspace and the lower, the number of control centres managing the upper airspace being reduced (one or two big centres could probably manage the whole European upper airspace). But, this solution redesigning the capability units makes visible the fact that controlling the upper airspace is far less costly that controlling the lower airspace. This was the case when hen Denmark, Finland, Norway and Sweden decided to explore the creation of a private company managing a common centre specialized in controlling their merged upper airspace. The cost of this centre appeared substantially inferior to that of the centres that would have specialized in lower airspace. The new boundary stemming from the creation of the private company would have prohibited cross-subsidization of the control of the lower airspace by the control of the upper airspace. The «yoking» (Abbott, 1995) of both controls in the same organization opacify a cross-subsidization of the former by the later. The same phenomenon is common in Europe. The flights by American airlines companies over Europe in the upper airspace without landing there partly cross-subsidize the control of lower airspace used by European airlines. Cross-subsidization induced by existing boundaries is a factor of stability: as soon as a boundary is discussed, the actors benefiting from this cross-subsidization mobilize themselves in order to maintain the status quo. In contrast, at the same time, other actors can have a direct interest in change.

The dynamics of boundaries

Some actors try to change boundaries when they think new ones would be more efficient. In the ATM, two actors, Boeing and the European Commission, attempted to play an architectural role in the industry.

Since the 90s, Boeing has been thinking of what kind of systems could be integrated in the cockpits to improve the ATM. ATM is not an industry Boeing is part of, except this issue of the embarked systems, the only common boundary. Boeing’s problem is to sell aircraft: ATM can be a bottleneck for this activity. The diagnosis made by Boeing is that actors within the industry are not able to innovate radically, radical innovation being what is needed. Suppliers of systems and hardware (radars, control centres) like Lockheed Martin, Thales or Raytheon try to sell the systems they have on the shelf, they are reluctant to work on a radical innovation (based for example on the massive use of satellite technology). The actors in the industry are locked in

2 «Accounting is an aspect of all legal, formal organizations and the organizations’ accounts maintain boundaries by measuring financial flows across these boundaries and by establishing which resources do or do not belong to the organization». (Brunsson, 2006, p. 18)
analysing the dynamics of ATM in Europe (1998-2020)

entrenched boundaries. They tend to consider the future with the eyes of the past. Only an external actor – an outsider – can help introducing new solutions. Boeing has stressed two dimensions: technological and operational boundaries and organizational boundaries. On the first point, Boeing has estimated that the sectors represent the main bottleneck. To solve the problem, Boeing’s engineers have been working on the concept of «seamless space», breaking down the boundaries. On the second point, the organizational one, Boeing has tried to group all the actors of the industry to define the requirements if the needed technological and operational system. Boeing created a Working Together Team (WTT). The objective was to span boundaries existing between aircraft manufactures, service providers, systems suppliers, controllers, airlines. Boeing had in mind the American situation, but also the European one: aircraft fly over both continents and the embarked systems and procedures had to be the same on both sides of the Atlantic. European actors like Eurocontrol or Thales took part in the WTT. Two points must be highlighted. Boeing introduces itself as an outsider, operating outside the traditional boundaries defining the industry, and being in a position to redesign more efficiently these boundaries. Boeing is not competing with the actors of the industry and can create the needed cooperation between them. Nevertheless, the project failed and, in 2004, Boeing closed down its ATM subsidiary it has set up four years ago (although half of the engineers were appointed to Boeing's R&D unit, Phantom Works, and went on working on ATM, as if Boeing was from that moment on, a semi-dormant company in the industry).

The European Commission is the other actor that has been trying to play an architectural role in the industry, attempting to change the existing boundaries. The official role of the Commission is to conceive and propose integrating policies between the Union member states. The Commission took an initiative for the ATM in 2001 with the Single European Sky. At the time the project was launched, competition was identified as the main factor for changing boundaries. The idea was to draw a separation between the upper airspace and the lower airspace, to merge all the national upper airspace into a single European one. Then a competitive bid would have been organized for the service provision in this unique upper airspace. There would not have been competition in the market (it is not thinkable that an aircraft could choose between two air traffic control systems) but competition for the market (specification of requirements and licensing of a monopoly position for a limited period of time, the contract being awarded to the best offering service provider). Progressively, the approach evolved. Cooperation supplanted competition. One of the Single European Sky elements focused on interoperability, to make certain that the different systems used in Europe could dialogue. Another element created the concept of Functional Airspace Blocks (FABs). It aims at promote cooperation between countries to define capability units spanning boundaries. United Kingdom and Eire, France and Switzerland, Spain and Portugal, for example, have entered into talks to create such blocks. So an actor playing an architectural role, the European Commission (jointly with Council and the Parliament) has created a frame to make possible the changing of boundaries. Then, actors belonging to the industry have developed cooperative strategies modifying the boundaries. These strategies have been offensive or defensive. For example, as mentioned before, Denmark, Finland, Norway and Sweden have tried to elaborate a joint project feeling under the threat of the offensive projects of the German service provider. In the same line, controllers themselves have presented a project called MOSAIC grouping different service providers in central Europe (Benelux, France, Germany) aiming at constituting an alternative to the threat of privatization or grouping by twos. Cooperative projects are stimulated by a climate of competition, actual or potential.

Discussion

The discussion will come back to the three propositions derived from the review of literature on the management of organizational boundaries. The first proposition states that organizational boundaries are never «natural»: they are determined by a decision taking into account on the one hand economies of scale and scope and, on the other hand, diseconomies of different kinds and balancing the benefits and costs of opacity and transparency, in order to design the best practical capability unit. The case study is on line with the proposition. The displacement of boundaries in the ATM industry aiming at widening the scope of the capability units seems clearly improve the functioning of the industry (economies in the cost of development of large technological systems, economies of maintenance, better operational efficiency). But the optimum in placing the boundaries is difficult

3 This form of organization had been used to develop the 777, one of the biggest success in the history of the commercial aviation. The Working Together Team grouped the customers, Boeing’s engineers and the future suppliers and mobilized computer aided design (Benson 1994 ; 1995 ; 1996).
to determine in practice. This illustrates the notion of causal ambiguity developed by Resource-Based View theorists. Should Europe go in the direction of a unique service provider, as the Federal Aviation Authority is in the United States ATM system? Should Europe only go in the direction of the constitution of a few big service providers in situation of competing and cooperating at the same time? A series of decisions have to be made to restructure the industry in the absence of a natural path to follow.

Once the decisions made (it is the second proposition), boundaries tend to sediment and be entrenched. The multiple dimensions of activities (technological, organizational, relational, etc.) and the asynchrony of the decisions related to these dimensions explain the phenomenon. The fact that the French and the German air traffic controls make the decision of developing a new technological system at different periods of times reinforce the boundary separating the two capability units. As boundaries are not natural and tend to be entrenched, they are debatable and even controversial. From time to time, the controversies become more and more intense. Regarding the European ATM, the end of the 1990s was such a period because of the increasing delays. When this occurs, strategies aiming at changing the boundaries can develop. Some actors think they can play an architectural role that consists partly in changing their own boundaries but more deeply in defining a frame allowing other actors in the industry to change theirs.

Two elements are of particular importance in this frame. The first is the combination of competition and cooperation (coopetition). In our case, the European Commission evolved from a competitive approach to a cooperative one. At the very beginning, the idea was to promote competition between national service providers to make the boundaries change into a more efficient way. Then, cooperation was favoured (interoperability concerning the technical systems and FABS concerning the operational dimension). In fact, the Commission used a coopetitive approach: cooperation among small players, among small and big players, among big players, is developing in a climate of potential competition. It is why competition looks credible in the future that cooperation develops. And the development of cooperation can be a precondition of the development of competition. At the organizational level, moving a boundary can favour cooperation and competition. For example, the French ATM organization is vertically integrated with a unit of engineers specialized in designing and building technological systems for France. If this unit became a subsidiary (if a vertical boundary was created), it could compete with suppliers like Lockheed Martin or Thales. Privatization of public organizations has often led to this kind of evolution: ex internal units have been vertically separated and have experienced competition afterwards (Cox, Harris & Parker, 1999). The creation of a vertical separation can also have an impact on horizontal boundaries, allowing alliances. If, for example, the French ATM wants to enter into an alliance with its German counterpart, its vertically integrated structure is an obstacle, as the French technological system is designed by the teams belonging to the French organization while the German organization turns to the market to acquire its own system. The creation of a vertical boundary in the French organization makes the alliance easier: the apparition of vertical boundaries can favour the abolition of horizontal ones.

The second element of the architectural role of certain actors consists in trying to synchronize decisions. The Single European Sky has been adopted for four years (2004). At the end of this period (2008), it has been assessed. A new step (Single European Sky II) has been voted in 2009 and will be assessed after four years. Actors are obliged to elaborate their decisions within this synchronized frame. The European Commission has launched in parallel a project, SESAR, that prepares the technological shift twenty years ahead that Boeing was working on between 2001 and 2004 (and Boeing’s teams of Phantom Works have got contracts with SESAR). This long term horizon is a mean to make boundaries evolve.

As seen before, actors in the industry change the boundaries through a coopetitive game. Some of them (DFS in Germany, NATS in the United Kingdom, Swisscontrol in Switzerland) have been corporatised or privatized and this shift has started to change symbolic boundaries (Lamont et Molnar, 2002). These actors have a more commercialized approach and seek to extend the boundaries of their capability units across national boundaries.
Conclusion

The case study shows how fruitful it is to take into account the different types of boundaries (internal, external, horizontal, vertical) and their different dimensions (technology, organization, etc.) in a synoptic way.

We would like first to come back to some notions the analysis of boundaries through our case study has put forward. The concept of capability unit is related to the idea that there are no such thing as «natural» boundaries, that could be determined for example by transaction costs or economies of scale and scope. When they place a boundary, be it internal or external, managers think of a capacity and this is done in a context of causal ambiguity. Boundaries are the object of a decision and are always debatable and debated. Boundaries induce a rarefaction of the flows (financial, informational, etc.). This intensity of this rarefaction can evolve over time. Once determined, the boundaries tend to sediment and be entrenched. In that dynamics, asynchrony of decisions made in multiple dimensions (technology, human resources, organization of sub-activities, etc.) plays a key role. As environment evolves, controversies concerning the perimeter of the capability units can intensify and some actors can develop strategies aiming at changing the boundaries. These strategies can only pertain to the boundaries of a few capability units, or to a large set of boundaries. In this later case, the strategy can be called an architectural one and is developed by an actor with a particular status. This actor belongs to several organizational fields and is not constrained by the symbolic boundaries like other actors only belonging to one field. This kind of strategy entails a willingness to impose synchrony to other actors in the industry. The dynamics of displacing the boundaries relies on two changing processes, competition and cooperation, that combine in a coopetitive approach.

The chart illustrates these different points.

Some other studies are requested to test the approach.
Reference


Auteurs, à paraître.


Analysing the dynamics of ATM in Europe (1998-2020)


Ouvrage, à paraître


SES II Institutional Design: Pursuing Efficiency Gains

The SES2 regulatory package occurs in a renewed context where legislative action is justified according to four main requirements: the need to move from cost containment to full cost efficiency; the need to introduce coherence and give substance and reinforce existing initiatives (FABs, NSAs, Economic Regulation); the need to consolidate the ATM system in accordance with the future technology prospects (SESAR); and, importantly, the need to incorporate environment in the perspective.

So far, SES1 has set up the general regulatory framework. It has introduced separation of service provision and regulation as well as the scope for economic regulation and the restructuring of airspace design through FABs. The SES1 implementation has relied on a bottom up approach based on the willingness of Member States to develop initiatives. It has resulted in mitigated outcomes (see PRC assessment of the SES impact, FABs assessment, etc).

Therefore, SES2 shall, at the same time, adapt to the new context and introduce a new dynamics. It leads to consider how an underlying rationale might achieve that end and how the rationale might translate into a fine-tuned institutional framework.

The note is structured according to the above considerations. In the first place, the SES2 rationale is addressed: what should be the objectives and the means. In the second place, the note draws on a proposed architectural design together with comments on underlying principles and advanced regulatory schemes.

SES2 rationale

The overriding principle in SES2 is considered to be efficiency optimisation. The optimisation applies at the same time to the ATM network (in terms of medium term and long term capacity, of airspace design, direct routing and operations) and to regulation (in terms of regulating monopoly, clarifying responsibilities).

In both cases, the efficiency optimisation assumes that the SES2 framework shall be a driver to achieve dual efficient scale in service provision and regulation.

The means by which the optimisation momentum is considered to be set into motion is better regulation, governance and performance.

Means have particular content or principles, which are here recalled and used when drawing the institutional architectural design of regulation.

Better regulation is based on the efficient management of expertise in the system, in making the most of the existing, and when required placing it under a competitive process. It is also about the cost effectiveness of the regulatory framework, which shall minimise direct and transaction costs, but also indirect costs of possible litigation. In that regard, the rule making process shall be assumed to avoid inefficient rules that are more prone to legal challenges and disputes, to prefer settlement procedures where exists the possibility of bargaining power between parties, to introducing limited to strict liabilities rules in accordance with the scope for controllable or non controllable environments. In addition, better regulation assumes avoiding the duplication of costs and institutions, the minimising of overlap duties and therefore the clarification of roles and responsibilities.

Governance looks at the attributes of the regulatory approach, which result from the design of institutions. Obviously, the way of deciding on the remit, the powers, the resources and the appeal procedures of a regulatory body are main components of the issue. It includes the proper level of governance (national, regional, European). But also, optimising efficiency of governance entail thinking about internalising the conflicts of regulation on the bearers of risk of regulation (user clubs perspective where the parties that might be in opposition are associated within the governance of the institution), about making more liable those who are best able to make cost-effectiveness assessment of applying or not regulation, about designing particular onus of the proof processes to make more or less difficult appeal to regulatory decisions.
Thinking **performance** in terms of efficiency optimisation requires introducing allocative (better use of scarce resources) and distributional (redistribution of gains and losses among parties) efficiency. The latter is of particular importance as should no compensation mechanism be properly devised, no agreement among parties to adhere to the regulation might be reached. Without entering into the details of the efficient optimisation of performance, particular characteristics might be stressed: the creation of metrics and target setting; the implementation of ex ante incentives schemes; their review and ex post assessment; the introduction of benchmarking techniques as support for yardstick competition. Overall, the performance framework shall be forward looking (including taking into account likely lock-in technology pathways) and sound (balancing performance measurements with the cost of investigating into details).

Bearing in mind the efficiency optimisation overriding principle, alongside with the means of better regulation, governance and performance, the sketch of a general institutional framework might be put forward.

**Institutional framework**

![General Institutional Framework Diagram](image-url)
Comments on the institutional framework

Although not fully comprehensive, the architectural institutional design attempts to illustrate how the principle of efficiency optimisation alongside with the means (better regulation, governance, performance) might lead to a clarified regulatory framework. Willingly, the framework does not refer to Eurocontrol, even if, it goes without saying, the various parts of Eurocontrol shall contribute. Rather than covering all aspects of the framework, major properties are pointed out together with emphasis of more focused details of possible significance.

In broad terms, the framework conveys the following envision. ANSPs have been made more independent from the states alongside with independent oversight going to be fleshed out (NSAs). It is on this momentum that the SES2 pursues efficiency optimisation based on constraints on dynamics, the European Commission acting as prime regulator.

Therefore the regulatory framework would rely on the increasing maturity, specialisation, and independence of stakeholders and would support the ATM system governance in accordance. Put simply, stakeholders would face their own responsibilities beyond the existing controversies. They will have to abide by efficient optimised performance targets derived from prime regulation.

In that respect, although the institutional architectural design gives credence to consultation processes, it above all simplifies and clarifies responsibilities and functions, with two newly formed bodies, on the one hand on performance and economic regulation, on the other hand on network optimisation with regard to infrastructure, airspace design and system operations.

Governance is here adjust so that it internalises conflicts on regulation, promoting a board structure of independent NSAs and users in the area of cost efficiency, and a board of ANSPs and users in relation to FABs, routes, capacity, flow management, and investments in infrastructure.

As it might be understood, prime regulation introduces bidding target performance setting schemes, even if defined in general terms and details powers to make them enforceable. From the better representative and equipped board dealing with the burden of regulation, specific configurations would be devised. The FABs and economic processes might serve as example.

Under a prime regulator drive, after advisory and consultation processes, FABs and economic regulation might be subject to bidding top down constraints managed by de-centralised operational bodies –i.e. in the institutional framework, respectively the Network Optimisation Manager (NOM) and the Performance and Economic Regulation Commission (PERC).

FABs constraints might be set in terms of number, rules of financial autonomy, cost saving and restructuring targets (airspace and service provision). It would be to the NOM, where the involved parties are subject to board members governance to comply and organise competing proposals, decide upon business models arrangements –i.e. ANSPs alliances and compensation schemes.

Economic regulation might be set up according to the profiling of a European average rate per service unit associated with average density (number of managed landing and take-offs close to airports) and complexity (crossing routes, bottle necks, overflights) metrics, the FABs and local unit rates being pegged to the profile within bands according to characteristics of density and complexity and cost-effectiveness targets. It would be to the PERC to enter into the details of the scheme, involving parties (NSAs and users) to give substance to the scheme in respect of the general constraint. The procedure for dealing with infringements might as well be defined in general terms, for introducing safety net and restructuring remedy.

Hence, in respect of the efficiency optimisation principle both from a network and economic regulation perspective, the institutional framework and detailed regulation would match the means brought forward as key drivers: better regulation, governance and performance.