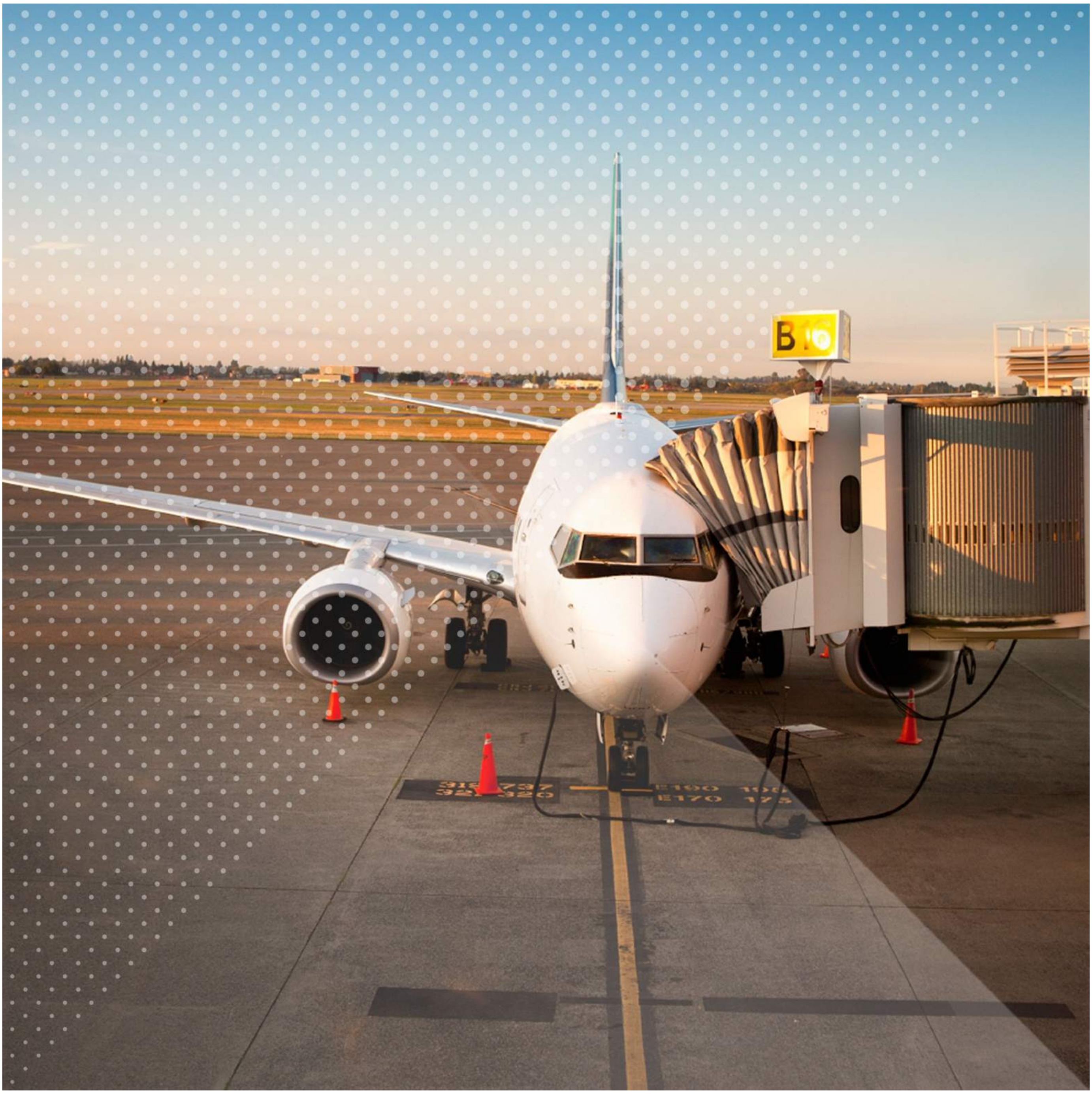
steer davies gleave

Policy options for the modulation of charges in the Single European Sky

Final report
April 2015

Prepared for the European Commission, Directorate-General for Mobility and Transport

Our ref: 22632401
Client ref: MOVE/E.2/SER/2012/527-1/SI2.667437



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Contents

Figures

Tables

Appendices

DISCLAIMER

Whilst this report has been produced at the request of the European Commission, the content of this report does not reflect the official opinion of the European Commission. Responsibility for views expressed in the report lies entirely with the author.

This analysis is based on data supplied by our client/collected by third parties. This has been checked whenever possible; however Steer Davies Gleave cannot guarantee the accuracy of such data and accepts no liability to third parties for any inaccuracies.

Detailed Summary

Purpose of the study

The Single European Sky (SES) has introduced a common charging scheme for air navigation services (ANS) in the European Union (EU). This scheme is based on Articles 14, 15 and 16 of Regulation (EC) No 550/2004 (the Service Provision Regulation) and detailed in the recently revised Commission Implementing Regulation (EU) No 391/2013 adopted on 3 May 2013 (the Charging Regulation). The charging scheme covers the list of services that can be financed by air navigation charges (for both en-route and terminal services), the means by which the costs of these services must be established and made transparent to airspace users, and the calculation of unit rates and charges for each charging zone using a common formula. According to Article 16 of the Charging Regulation, Member States may decide to modulate air navigation charges to increase the efficiency of ANS and to promote their optimal use.

En-route and terminal navigation charges in Europe amount to some €8 billion each year, and a 2011 study for Eurocontrol estimated the cost of Air Traffic Flow Management (ATFM) delays to amount to more than € 1.25 billion or €1.66 per ATFM delayed flight. It is therefore important for the European Commission (the Commission) and ANS stakeholders to investigate, on a regular basis, potential actions that may lead to better use of resources and result in improved cost-efficiency. In principle, the framework of charging could be further developed to encourage greater flight efficiency and a reduction in delay using various mechanisms for modulating charges, some of which have been discussed over a number of years. The Commission requested Steer Davies Gleave to investigate a number of these mechanisms and make recommendations on their potential application. The study has focused on four specific modulation of charges schemes, as follows:

- Workstream A - the introduction of congestion pricing;
- Workstream B - harmonising the allocation of costs between en-route and terminal ANS;
- Workstream C - the modulation of charges to incentivise equipage of aircraft with SESAR technology; and
- Workstream D - a move towards common charging zones.

Objectives of modulation of charges

The objective of the SES is reducing delays, improving safety standards and increasing flight efficiency in order to reduce the aviation environmental footprint and the costs of service provision. Against this background, and based on our broader understanding of the principles of economic regulation as applied in transport and other sectors, a review of the legislative framework for ANS and discussions with stakeholders, we have identified the following general objectives for modulation of charges in EU airspace:

- **Economic efficiency:** a scheme should incentivise economically efficient decisions in the planning and use of airspace, for example by encouraging airlines to route flights in order to minimise overall economic and social costs and by incentivising Air Navigation Service Providers (ANSPs) to manage airspace capacity in order to optimise overall flight efficiency.
- **Complementarity:** a scheme should complement other aspects of SES policy and work alongside the SES Performance Scheme in incentivising improvements across the Key Performance Areas of cost efficiency, environment, capacity and safety.

- **Intelligibility:** the scheme must be capable of being understood by airspace users, ANSPs and other industry stakeholders, such that they can take the price signals that it provides into account in flight and capacity planning.
- **Revenue/cost neutrality:** the scheme should not have the effect of increasing or decreasing ANSP or FAB revenues or costs for airspace users overall.
- **Minimal administration costs:** the costs of administering the scheme, including gathering the information required to calculate charges and the operation of systems supporting billing of airlines, should be proportionate to the benefits of the scheme.
- **Credibility:** the scheme must be workable from the perspective of all stakeholders, and it should be possible to implement it without dislocation of industry planning and operations.

This report describes how the modulation of charges schemes covered by the four workstreams could operate and sets out a number of recommendations relating to their implementation.

Congestion pricing

Background

Airspace congestion is a significant problem across the SES. Work undertaken by the University of Westminster valued ATFM delay at €81 per minute in 2010 and the Performance Review Body (PRB) has subsequently valued the costs of total ATFM delay in 2011 at €1.4 billion, including en-route delay costs of €0.9 billion and airport delay costs of €0.5 billion. Hence, although delay is projected to decrease in line with targets set for Reference Period 2 (RP2), there is a case for investigating whether delay might be further reduced through the modulation of ANS charges. In principle, there are two broad approaches to reducing delays by means of modulating charges:

- Differentiating charges for access to different volumes of airspace at different times such that the more congested volumes attract a higher, and the less congested a lower, charge; and
- Introducing performance incentives, for example by applying a discount to charges for flights experiencing delay, with the level of the discount related to the extent of the delay.

The term congestion or scarcity pricing, as conventionally defined and as applied in other transport sectors, refers to the first approach, and provides the focus for much of the analysis and discussion in this report. However, the second is also a potential means of addressing the costs of congestion through pricing, and we have therefore also considered how such an approach might operate in the case of ANS. In our view, both could operate in parallel, although each would affect the structure of ANS charges in different ways.

Previous research

There have been several studies of congestion pricing over a number of years, covering various aspects of the issue including congestion impacts, the possible design of a congestion pricing scheme and the potential impacts of more efficient use of airspace. Most recently a study of the possible effects of differential charging on the use of Polish airspace, undertaken at the University of Belgrade, concluded that the benefits could be substantial provided that there was sufficient spare capacity in airspace adjacent to the more congested areas[1]. However, other studies have highlighted the difficulties of calibrating congestion pricing, noting that the demand for airspace appears to be relatively inelastic with respect to ANS

[1] Jovanovic et al. 2014. Anticipatory modulation of air navigation charged to balance the use of airspace network capacity, Transportation Research Part A.

charges as compared with fuel costs. A number of studies have concluded that more research is needed before a robust congestion pricing scheme can be introduced.

In our view, few of these studies consider the practical issues surrounding the implementation of congestion pricing, and none has investigated how congestion charges might influence airline decisions given the constraints of flight planning and operations. The implicit assumption is that efficient price signals can be provided at appropriate points in the planning process such that flights will be rerouted or rescheduled to give a more optimal distribution of traffic with less congestion and delay. The extent to which timely price signals could be provided, and the ability to predict airline reactions to them, has been a key issue for investigation in the course of our work.

We have also investigated how congestion pricing has been applied in other sectors, in particular road transport. Road-based congestion pricing schemes have been implemented in a number of cities, including London, Milan and Stockholm, and have had a significant impact on levels of congestion. While this experience is not necessarily directly transferable to ANS, not least because road pricing schemes have typically been aimed at encouraging the use of public transport rather than alternative routes, it nevertheless highlights a number of important lessons having more general application. In particular, it has demonstrated the potential for perverse incentives, the need for extensive trialling prior to implementation and the importance of consulting stakeholders in order to ensure a thorough understanding of the scheme's objectives and likely effects.

The structure, management and pricing of European airspace

Consideration of how best to achieve an efficient use of airspace requires an analysis of how air traffic can be distributed across four dimensions, namely the three dimensions defining physical location and time. It also requires consideration of how airspace is currently organised and managed. This can be understood in terms of different levels of management defined according to both geographical and operational factors, in particular:

- Sectors, generally representing the smallest units of managed airspace, which vary considerably in terms of their geographical size and the number of flights accommodated;
- Flow Management Positions (FMPs) with responsibility for controlling traffic flows over a number of sectors;
- Air Control Centres (ACCs) controlling a number of FMPs within a defined area, usually covering a major part or even all of the airspace of a Member State;
- ANSPs responsible for the management of airspace at the national level, typically including a number of ACCs, as well as the management of the associated costs and revenues; and
- FABs, introduced through the SES legislation and including a number of ANSPs with the aim of optimising the management of airspace through better co-ordination or integration of ANS across national boundaries.

It is also necessary to distinguish between en-route and terminal air navigation as the issues surrounding implementation of congestion charging are different in each case. In the context of this workstream, we use the term terminal air navigation to refer to air navigation services provided to aircraft in the vicinity of an airport before landing or after take-off and subject to a terminal charge, and en-route air navigation to refer to other air navigation services provided between a flight's origin and destination and subject to an en-route charge .

The configuration of airspace at the sector level can be complex, with sector boundaries determined according to the location of air navigation equipment and the characteristics of the network of flight paths within a given geography. In principle, each sector is subject to a defined capacity, measured in terms of the number of flights that can be safely managed within it during a given time interval. In practice, this can vary according to factors such as the complexity of flight paths and the deployment of ATCOs within the ACC. Note also that elementary sectors can be combined into a collapsed sector depending on the amount of traffic seeking access to a given volume of airspace and the number of ATCOs needed to manage it safely and efficiently.

Airlines and other parties wishing to operate flights within and through European airspace must submit a flight plan to the Network Manager Operations Centre (NMOC). These are submitted up to six days before the flight, but the preparatory planning work may begin more than a year in advance as the airline develops its route structure and schedule and determines fare levels. In parallel, the NMOC works with ACCs to plan capacity and produce a routing scheme for flights operating on a given day, based on the capacity declared by ACCs. As flight plans are submitted, the NMOC modifies them in the light of emerging information on capacity and develops operational plans for the coming week.

Airspace congestion is managed through a process of regulation, whereby the NMOC designates sectors in which expected flight volumes exceed capacity as regulated sectors for a defined period. Where a flight is planned to operate through a regulated sector, the flight crew may be instructed to change the plan in a number of ways, for example by delaying take-off or rerouting through other sectors. In practice, relatively few sectors are regulated on any given day. Sample data provided by the NMOC indicated that only 38 en-route sectors, less than 2% of the total, were regulated for ATC Capacity reasons on 8th June 2013 (a day with a relatively large number of summer flights). Regulations are generally applied for a relatively short period of time, and their implementation and management is a dynamic process.

Under current SES legislation, charges paid by airspace users are set in order to recover specified categories of ANSPs' costs, with the revenue risk arising from variations in traffic shared according to a defined mechanism. The basic charging formulae for en-route and terminal air navigation services have, however, been in place for a number of years, with the payment made for a given flight intended to reflect both the costs of serving it (approximated by distance travelled within the relevant volume of airspace in the case of en-route charges) and its value to the airline (approximated by Maximum Take-off Weight (MTOW), which is related the number of passengers carried). The individual unit rates vary by charging zone, with zones largely corresponding to regions of airspace managed by individual ANSPs.

Analysis of current levels of congestion

In order to identify "hot-spots", we have investigated the extent and location of airspace congestion across the SES using data for 2013 provided by the NMOC, beginning with an analysis of ACC capacity constraints and then investigating congestion at the sector level. Analysis of regulation data confirmed that congestion is considerably greater in the summer as compared with the winter, with total delay arising from congestion during the period April to September more than three and a half times that during October to March, and the proportion of summer flights subject to congestion-related regulation more than two and half times the equivalent proportion over the winter. At the network level, the data also indicated substantial variations in congestion over the week and through the day. From discussions with Eurocontrol and other stakeholders, we understand that the higher level of delay at weekends is the result of a reduction in capacity due to reduced availability of ATCOs rather than the level of demand.

However, analysis at the sector level suggests that patterns of congestion vary significantly and that defining sector "hot spots" for the purposes of congestion charging is challenging. We have investigated the frequency and stability of regulation of two terminal sectors (at Heraklion and Zurich airports) and two en-route sectors (in the vicinity of Marseille and Krakow airports) and have concluded that typically the need for regulation varies from hour-to-hour, day-to-day and week-to-week. Given these variations, it will generally not be possible to predict levels of congestion at this level substantially in advance of the times at which they arise.

Options for congestion pricing

We have developed a number of options for congestion pricing for ANS, defined in terms of the structure and level of, and process for setting, charges. These are summarised in the table below.

Option combination	Description	Rationale for inclusion in the study
C1:D2:P2	Differentiated unit rates, with higher rate for specific sectors during periods in which capacity utilisation is expected to exceed a defined threshold. Differential determined empirically in order to generate incentives to reroute flights. Charges posted at a single point in time.	Allows investigation of a relatively sophisticated structure of charges, providing an incentive to minimise distance travelled within a congested sector rather than to simply avoid the sector completely.
C2:D1:P2	Introduction of fixed supplement, payable when a flight passes through specific sectors during periods in which capacity utilisation is expected to exceed a defined threshold. Differential determined according to economic and social cost of delay. Charges posted at a single point in time.	Allows investigation of the impacts of a simpler charging structure and, through comparison with the previous combination of options, an understanding of the trade-off between economic efficiency and greater simplicity.
C2:D2:P2	Introduction of fixed supplement, payable when a flight passes through specific sectors during periods in which capacity utilisation is expected to exceed a defined threshold. Differential determined empirically in order to generate incentives to reroute flights. Charges posted at a single point in time.	Allows investigation of the impacts of a simpler charging structure and a better understanding of how underlying operating costs determine incentives.
P1	Dynamic, iterative process for setting charges.	Allows qualitative investigation of the scope for improving the allocation of airspace through progressive modification of charges.

For each of the main options we have calculated illustrative congestion charges for a number of en-route and terminal sectors using the following methodology:

- In the case of en-route sectors, we have determined for three separate routes (Fuerteventura – Friedrichshafen, Budapest – Madrid and Bucharest – Berlin) the congestion charge that would need to be applied for access to a single congested sector on the flight path in order to encourage the airline to take an alternative route. The congestion charge was calibrated such that the operating cost of the alternative route, taking account of the additional fuel and air navigation costs of the longer flight path, was just equivalent to the cost of flying along the congested route.

- In the case of terminal sectors we have calculated, for four separate routes (London – Amsterdam, London – Edinburgh, London – Milan and Frankfurt – Istanbul), the level of congestion charge required in order incentivise an airline to retime a flight, relocate it to an alternative origin/destination or cease to operate it altogether. The calibration was undertaking using a model of flight operating economics developed by Steer Davies Gleave and assumptions about required route operating margins.

In both cases, the assumed airline decision making process was simplified in order to make the basis of the calibration as transparent as possible and clearly illustrate how charges would need to be set to encourage changes in airspace user behaviour.

The table below summarises the estimated congestion charge supplements for both en-route and terminal sectors under the main options. They suggest that charges based on the economic and social cost of delay (C2:D1:P2) would be substantially higher than those calibrated according to operating costs (C2:D2:P2), with the former resulting in increases of more than 100% in the cost of travelling through the equivalent airspace as compared with the current position. They also suggest that, regardless of the option, the level of the congestion charge would vary significantly between sectors.

Route	Congestion supplement based on economic and social cost of delay (€)	Congestion supplement based on operating costs (€)[2]
En-route congestion charges		
Fuerteventura - Friedrichshafen	400	28
Budapest - Madrid	367	98
Bucharest - Berlin	859	82
Terminal congestion charges		
London – Amsterdam	654	244 - 854
London – Edinburgh	1,120	242 - 788
London – Milan	1,120	300 – 1,004
Frankfurt - Istanbul	1,791	430

Source: Steer Davies Gleave analysis

Implementation issues

The analysis described above assumed that it would be possible to provide price signals to airlines at appropriate points in the planning process such that they could react in a way that changed the distribution of traffic across airspace. It also assumed that these reactions could be anticipated with sufficient confidence to allow congestion charges to be posted at a single point in time (option P2), and that ANS monitoring and billing systems would have the capability calculate charges accurately, notwithstanding the greater complexity of the charging structure. In practice, the process of setting charges would probably need to be more dynamic (option P1), since airline reactions to a given set of congestion charges could not necessarily be predicted in advance.

[2] In the case of terminal congestion charges, the level of the required supplement is particularly sensitive to the type of aircraft and we have therefore calculated a range for the majority of routes.

The process of setting charges would be particularly challenging in the case of en-route charges, which would need to reflect emerging demand for airspace in the hours before flight plans were finalised. A key issue is whether it would be possible to establish, within relatively short timescales, charges that relieved rather than simply relocated congestion in space and/or time. In addition, the need to ensure revenue and cost neutrality would probably mean introducing some form of redistribution of ANSP revenues (generated by the congestion charge) back to airlines under defined mechanisms administered by the Central Route Charges Office (CRCO). This could be on the basis of a percentage reduction in charges available to all airlines, simplifying administration and preserving the incentives generated by the congestion charging scheme.

The introduction of congestion pricing would also need to be coordinated with other aspects of SES policy, not least the financial incentive mechanisms to encourage ANSPs to meet performance targets to be introduced under the Charging Regulation. In our view, this element of the current regulatory framework would need to be retained in the event that a congestion pricing regime was adopted, since the latter would provide no incentives for capacity expansion. Moreover, our investigation of the incentives provided under the existing arrangements suggests that they could be usefully strengthened by increasing the cap on permitted incentive values (currently one per cent of ANSP revenues), which we judge to be insufficient to incentivise capital projects already being developed.

At the same time, we note that it may be possible to increase the capacity of air navigation services in the short term without substantial investment. We have already highlighted the impact of limited availability of ATCOs at weekends on effective capacity. In principle, capacity constraints of this kind could, and arguably should, be addressed through a change in working practices rather than through the introduction of new capital equipment and technology. One option for providing the required incentives would be the introduction of rebates on air navigation charges in the event that delay was caused by a temporary reduction in capacity, analogous to the performance penalties applied in the UK rail industry and elsewhere. Such rebates would underpin the business case for implementing the necessary changes to working arrangements, with avoided rebates offsetting and possibly covering any implementation costs (for example, the payment of higher rates to ATCOs for weekend shifts).

We have also discussed the implications of congestion charging for flight planning and ANS monitoring and billing systems with the CRCO, NMOC and other stakeholders. We note that much of the information required to calculate ANS charges at a more granular (i.e. sector) level is already collected by NMOC, and that changes to billing systems, while significant, would be limited to the determination of charges based on more detailed identification of individual flight paths than is currently required. However, airline flight planning systems would need substantial modification in order to support dynamic price setting, and the costs of this could be considerable.

Recommendations

Our recommendations on congestion pricing are summarised in the table below. In each case, we provide an indicative timescale for adoption, taking account of the potential benefits of the modulation of charges scheme as well as the implications of our findings in relation to other workstreams and the potential synergies between them. In our view, given the challenges raised by congestion charging, the development and implementation of a scheme would require an extended programme of work over a ten-year time frame and should not be regarded as a priority.

Recommendation		Suggested prioritisation	Rationale
A1	We recommend that the focus of further development work should be on en-route rather than terminal congestion charging.	3-5years	Not an immediate priority, but the focus of the initiative on en-route should be confirmed at an early stage to provide direction to further development.
A2	We recommend that any further work on the appropriate level of congestion charges should focus on the option of introducing a fixed supplement into the existing charging formula.	5-10 years	Should be undertaken as part of an implementation programme. Would need to take account of flight economics at the time, as determined by aircraft technology, fuel and carbon prices and other factors.
A3	We recommend that the current Regulations 390/2013 and 391/2013 relating to incentive schemes for ANSPs is reviewed with the aim of determining whether an increase in the value of incentives, above the value of one per cent of revenue permitted under current legislation, could provide an effective impetus to enhance capacity.	Within next 2 years	We suggest that any modifications to the guidance in order to strengthen incentives are developed in advance of RP3.
A4	We recommend that consideration be given to the introduction of an operational performance regime, based on the payment of rebates determined according to the level of delay incurred.	Within next 2 years	This would help to incentivise improvements in ANSP efficiency in advance of the development of a congestion charging scheme, and should ideally be implemented in RP3.

Cost allocation harmonisation

Background

ANSPs employ a range of operational practices for controlling both en-route and terminal airspace, with procedures varying considerably according to local circumstances. Departing aircraft are controlled by the airport tower until airborne. In relatively empty airspace they may be either controlled from the tower for up to 80 kilometres, or handed directly to an en-route controller, supervising their climb to cruising altitude in upper airspace. From cruising altitude they descend back to final approach, at which point they are again controlled by the airport tower. As airspace becomes more complex, however, it becomes necessary to subdivide it into sectors controlling smaller elements of the flight:

- Final approach control, controlling separation between potentially conflicting aircraft descending towards the same airport or runway;
- In some cases, approach control of arriving aircraft at up to 100 kilometres from the airport, routing their descent until they are on final approach; and
- In others, a Terminal Manoeuvring Area (TMA), in which all aircraft leaving or arriving at an airport, or group of airports, are controlled.

In addition, operational procedures may vary according to the situation of the airport itself. For example, where there are many airports in close proximity in busy airspace, it may be necessary to have separate controllers for relatively small volumes of airspace around each airport, while in the case of airports surrounded by quiet airspace it may be possible for all aircraft to be controlled from an en-route centre.

The allocation of costs between en-route and terminal ANS therefore requires an understanding of the boundaries between different activities organised in different ways and subject to different degrees of complexity according to the location in question. Accordingly, the Charging Regulation requires that "…Member States shall, before the start of each reference period, define the criteria used to allocate costs between terminal and en-route services for each airport and inform the Commission accordingly." The same Article 8(2) defines terminal services as comprising:

- "Aerodrome control services, aerodrome flight information services including air traffic advisory services and alerting services;
- Air traffic services related to the approach and departure of aircraft within a certain distance of an airport on the basis of operational requirements;
- An appropriate allocation of all other air navigation services components, reflecting a proportionate distribution between en route and terminal services."

Article 8(3) defines the cost of en-route services as the eligible costs defined in Article 8(1), less the costs of providing terminal services defined in Article 8(2).

In practice, ANSPs have significant freedom in defining the basis of cost allocation, not least because operational practices vary substantially between airports as already noted. As a result, approaches to cost allocation vary considerably between Member States, notwithstanding the implementation of a common legislative framework for charging.

Current approaches to cost allocation

We have sought to identify the different approaches to allocation adopted by ANSPs by investigating 2012 actual costs reported by them in accordance with RP1 (set out in the Reporting Tables) and additional information collected through a series of questionnaires sent to both ANSPs and National Supervisory Authorities (NSAs). The table below shows the allocation for each ANSP indicated by both the Reporting Tables submitted and the data provided through the questionnaires.

ANSP	As reported in the stakeholder questionnaire			As reported in the Reporting Tables	
	En-route	Approach	Terminal	En-route	Terminal
Aena	43%	33%	24%	80%	20%
ANS CR	No response provided			81%	19%
BelgoControl	56%	12%	32%	74%	26%
Luxembourg Terminal	No response provided			0%	100%
DFS	78%	0%	22%	78%	22%
DSNA	81%	0%	19%	80%	20%
Finavia	31%	21%	48%	74%	26%
HungaroControl	80%	4%	16%	83%	17%
LFV	75%	18%	7%	88%	12%
LPS	No response provided			90%	10%
LVNL	55%	14%	31%	67%	33%
NATS	82%	0%	18%	82%	18%
Skyguide	No response provided			59%	41%

Source: Stakeholder questionnaire responses for 2012, 2012 determined costs from October 2011 Reporting Tables

The results of our underlying analysis suggest wide variation in the allocation of individual categories of cost to en-route and terminal services. For example, the proportion of staff costs allocated to en-route varies between 90% and 66%, that of other costs varies between 91% and 61%, and the proportion of depreciation varies between 98% and 67%. Whilst these ranges seem broadly consistent across cost categories, the range in each case is wide. However, it remains difficult to determine how far it reflects underlying differences in extent of terminal activity rather than differences in allocation methodologies.

Options for cost harmonisation

We have considered two broad approaches to cost harmonisation, as follows:

- A bottom-up approach, whereby the allocation driver by cost category for any direct, indirect or joint/common cost to be allocated would be prescribed. Such an approach, while recognising that the majority of ANSPs use some form of Activity Based Costing (ABC) to allocate costs, would provide for a transition towards the use of prescribed drivers in order to increase transparency.
- A top-down approach, whereby a standard metric or metrics for the allocation of total costs or costs by category between en-route and terminal activity would be applied. The approach would recognise the difficulties of allocating the costs using bottom-up ABC processes, and that there would be some trade-off between certainty and transparency to airspace users on the one hand and accuracy on the other.

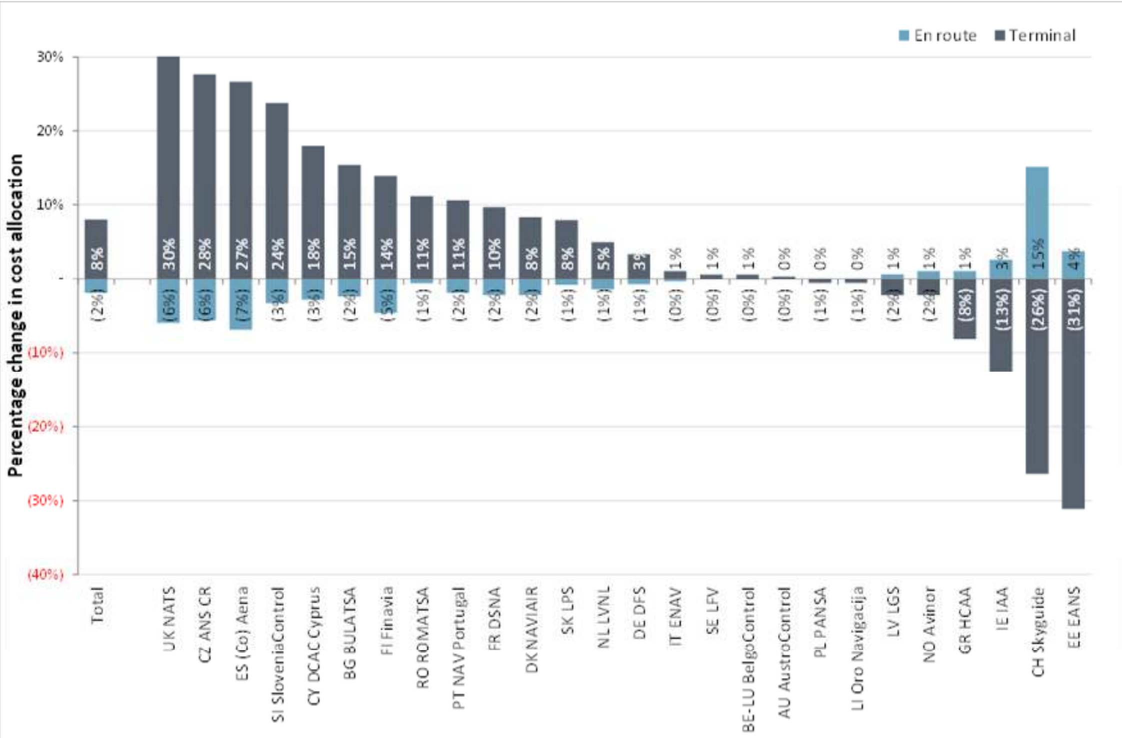
The table below provides a summary of the options, including two variations of the top-down option, and highlights some of their implications.

Option	Summary
CH1: Bottom-up approach	Would require prescriptive identification of drivers for different categories of cost at a detailed level, based on ABC principles. This, in turn, would involve extensive stakeholder consultation and discussion in order to reach consensus and detailed monitoring to ensure consistent application of agreed conventions.
CH2a: Top-down approach – single metric	Application of a single metric to apportion relevant cost categories between en-route and terminal activity. The choice of metric would similarly need to be established through consultation and discussion, taking account of an appropriate balance of objectives. Monitoring of the application of this approach would be considerably less onerous than in the case of CH1.
CH2b: Top-down approach – multiple metrics	Application of multiple metrics, selected after determining the main drivers of different categories of cost and similarly agreed through consultation and discussion. Monitoring would be less demanding than under CH1 but potentially somewhat more onerous than under CH2a (depending on the number of metrics and their application).

In our view, it not clear whether a bottom-up approach would eliminate all ambiguity relating to the allocation of costs, and it is unlikely that ANSPs and NSAs would accept a single set of conventions for making allocations. The costs of overseeing and enforcing such an approach would also be onerous, and there is no guarantee that NSAs would have sufficient resources to ensure compliance. Our assessment of the impacts of cost harmonisation has therefore focused on the top-down approach.

Impact of a top-down approach

Given the importance of ATCO activity as a driver of both en-route and terminal costs, we have considered whether ATCO hours might be an appropriate basis for allocating all cost categories under a single metric approach (CH2a in the table above). In principle, an ATCO staff-hours metric could be derived from timesheets, with each ATCO recording the number of hours spent on en-route and terminal activity. In practice, we have not been able to obtain this data and have therefore investigated the impact of reallocation of costs between the activities on the basis of total staff costs shown in the Reporting Tables as a proxy for ATCO costs. The results are shown in the figure below (with Member States providing incomplete data excluded from the analysis).



In this scenario, terminal cost allocation increases for more than half the Member States, by up to 28%, as shown in the figure. En-route costs therefore decrease in those States but by a smaller percentage as en-route costs are much higher than terminal costs. The overall effect on the allocations modelled for the different Member States is an 8% increase in terminal costs and a 2% fall in en-route costs.

While in principle, apportionment on the basis of ATCO costs seems appropriate, it might need to be based on different approaches in different ANSPs. For example, an ANSP with separate en-route and terminal control centres might have clearly separate groups of en-route and terminal staff, and find it easier to base apportionment on their headcount, rather than the more complex calculation of their salary costs and benefits, including pensions for former staff. Alternatively, an ANSP without a distinct terminal sector, with some or all ATCOs providing both en-route and terminal services, would need to base ATCO costs on an apportionment of ATCO hours, probably based on timesheets or records of work performed on each shift. In addition, while the potential impact of requiring ANSPs to apportion all costs on the basis of ATCO costs might have a similar effect to apportionment on the basis of staff costs, we also note that ATCO costs are themselves likely to be based on apportionment using other metrics.

We have also considered a wider range of metrics that could be applied under a multiple-metric approach (option CH2b above). Our assessment of their suitability is summarised in the table below using the following legend:

- ✓ Metric that could probably be used to apportion the cost category;
- ✗ Metric not suitable to apportion the cost category; and

? Not clear whether or how the metric could be used to apportion the cost category.

Type	Metric	Staff	Other	Depreciation	Cost of capital	Exceptional	Comments	Reported in RP2
Output	Composite Flight Hours (CFH)	✓	?	?	?	×	Circular definition based on previous apportionments	✓
	Flight hours	?	?	?	?	×	Standard measure	✓
	Flight kilometres	?	?	?	?	×	Can be obtained or calculated, used to apportion approach to en-route and terminal	×
	Service units	✓	?	?	?	×	Requires arbitrary weighting of en-route and terminal	✓
	Territory controlled	?	?	?	?	×	Not reported, open to manipulation	×
	CRCO guidance	×	?	✓	×	×	Applies to “facilities” and not staff or cost of capital	×
	Tons controlled	?	×	×	×	×	Not reported, not consistent with the weighting specified in the Charging Regulation	×
Input	Staff costs	✓	?	×	×	×	Reported, but broader than ATCO costs	✓
	ATCO costs	✓	?	×	×	×	Not reported, may not reflect efficient mix, some ATCOs may handle both en-route and terminal	×
	ATCO headcount	✓	?	×	×	×		×
	ATCO hours	✓	?	×	×	×	Not reported, not recorded if locations or ATCOs are dedicated	×
	ATCO workstations or ATCO working positions	✓	?	×	×	×	May be relevant for costs related to office space, not reported, lumpy, open to manipulation	×
	Sectors controlled	✓	?	×	×	×	Not reported, lumpy, open to manipulation	×
	Radio frequencies	×	?	?	×	×	Not reported, may be appropriate for some equipment costs	×
	Turnover	×	×	×	×	×	Reported, but only appropriate to overheads	✓
	Location of equipment	×	?	✓	×	×	Not reported, but depreciation (and other costs) for equipment such as radar and ILS could be based on a measure of distance from an airfield	×

Source: Steer Davies Gleave analysis

Overall, neither discussions with stakeholders, nor our analysis support the use of any particular metric. We consistently found that the most appropriate approach to allocating or apportioning costs would depend on the circumstances of the particular ASNP and the staff, operating cost or asset concerned. In principle, it would be possible to apportion a small percentage of overhead costs on the basis of a metric such as turnover, but if turnover had itself been calculated on the basis of a metric such as ATCO hours, this approach would not differ in practice from apportioning all costs on the basis of ATCO hours.

Airport and air navigation cost allocation

During stakeholder discussions on a previous study for the Commission (covering the Cost of Capital and Pensions), airspace users raised the issue of cost allocation between single organisations providing both airport (runway, passenger terminal and apron services) and ANS. Across the SES, there are a small number of organisations that provide both ANS and manage and operate airports. In addition, there are a number of organisations that have corporate governance structures encouraging close links with other government departments and subject to cost allocation as applied by a public sector body. These include DGAC Cyprus and Hellenic CAA. There are also additional public sector organisations with autonomous budgets, in particular in France (DSNA) and in Poland (PANSA), and oceanic services are also provided by Avinor (Norway), IAA (Ireland), NATS (United Kingdom) and NAV Portugal.

We have undertaken a review of these organisations, including trends in costs between 2010 and 2013, and are not in a position to draw any firm conclusions regarding the allocation of central function costs from any of the annual reports, due in part to the lack of transparency provided by the statutory accounts. However, as central function costs tend to be relatively low in comparison to the other direct operating costs of the airport and air navigation businesses as well as in comparison to businesses in other sectors, we consider that it is unlikely that they explain the changes in charges observed. At the same time, as these shared costs are likely to be relatively low, the efficiencies to be gained from operating the ANSP as part of an airport operating group are also likely to be low. This suggests that there is a case for separating the ANSP from the airport operator group, improving transparency and enabling both organisations to pursue their own strategic objectives with greater freedom.

Recommendations

Our recommendations on harmonisation of cost allocation are summarised in the table below. In our view, there is no material interdependency between the findings of this workstream and those of the others. In addition, with the exception of full implementation of B5, we consider that our recommendations could be adopted within a relatively short timescale.

Recommendation		Suggested prioritisation	Rationale
B1	Transparency of cost allocation principles and metrics used, as required by the Charging Regulation, should be better enforced. Principles should also be developed to ensure more consistent enforcement by NSAs.	Within next 2 years	This would reaffirm stakeholder confidence in the Charging Regulation objectives.
B2	Consideration should be given to clarifying the definitions of terminal, approach and en-route services for the purposes of legislation and supporting policy guidance.	Within next 2 years	This would help to inform the development of cost allocation methodologies and should ideally be undertaken prior to RP3.
B3	We recommend that the option of bottom-up cost allocation is not pursued.	Within next 2 years	An early statement that the Commission does not intend to pursue an onerous, bottom-up exercise would reassure the industry.
B4	We recommend that information on ATCO hours, disaggregated by en-route and terminal activity, should be reported by ANSPs as part of their Reporting Tables.	Within next 2 years	This information would help to inform the development of cost allocation methodologies and a requirement to report it should be in place by the start of RP3.
B5	We recommend that consideration should be given to mandating the organisational and financial separation of ANS and airport businesses where these are currently undertaken by a single corporate entity.	Within next 2 years	While a requirement to separate these businesses could be established within a short timescale, policy should allow a reasonable timescale (a further two to three years) for implementing the separation itself.

Modulation of charges to incentivise early equipage of SESAR

Background

The objective of the SESAR project is to modernise and harmonise the technology and operations of the European ATM System. It forms part of the wider SES initiative, which aims to increase capacity and safety while reducing ATM costs and the environmental impact of the aviation sector. The deployment of SESAR is supported by a detailed legislative framework, based on Implementing Regulation 409/2013 which, inter alia, defines the following measures:

- **Common projects:** these are intended to introduce ATM Functionalities (AFs) considered to be essential contributors to the improvement of ATM performance across the EU, particularly in relation to Key Performance Areas.
- **The deployment programme:** this defines the detailed deployment activities underpinning the implementation of common projects.
- **Governance mechanisms:** these ensure a timely, synchronised and coordinated deployment of SESAR involving all stakeholders and the relevant EU and SES bodies.
- **Targeted incentives and financial support:** these include grants, loans and schemes for the modulation of route charges to support the implementation of common projects.

Article 8(2)(d) of Regulation 409/2013 states that the "policy level" will be responsible for "identifying incentives for SESAR deployment and enforcing the framework partnership agreement concluded with the deployment manager". In addition, Article 16(2) of the Charging Regulation stipulates that Member States may modulate air navigation charges to accelerate the deployment of SESAR ATM capabilities, in particular to give incentives to equip aircraft with systems included in the common projects.

Lessons from previous experience

We have reviewed a number of other schemes for incentivising the adoption of new technology, focusing in particular on experience from deployment of the European Rail Traffic Management System (ERTMS) which has a number of features in common with SESAR. In addition, we have sought to draw lessons from the deployment of Data Link in ATM, which is anyway related to the deployment of certain SESAR technologies, and from the incentivisation of the equivalent technology in the Canadian ANS industry.

There are currently more than 20 standalone train control systems across the EU, resulting in a significant barrier to trans-European interoperability. ERTMS is intended to address the associated inefficiencies by establishing a single, EU-wide standard for train control and command systems while maintaining a minimum level of safety agreed by Member States. In order to support the realisation of this objective, Article 32(4) of Directive 2012/34 states that "the infrastructure charges for the use of railway corridors shall be differentiated to give incentives to equip trains [with the relevant technology]", and the Commission is currently considering the scope for introducing incentives based on modulation of track access charges.

There are many differences between the ANS and rail industries, and ERTMS is substantially different in scope from SESAR (with the latter embracing a wider range of technologies than the former). In addition, ERTMS is at a mature stage of development, with some equipment already in place and operational. However, some comparisons can be drawn between the two projects and the experience of ERTMS deployment can usefully inform the development of schemes for incentivising SESAR technology. In particular, ERTMS has highlighted the importance of collaboration between infrastructure managers, transport operators and other stakeholders and the need to ensure that the incentives that they face are aligned. It has also demonstrated the potential for delay, notwithstanding a legislative framework requiring implementation by defined dates, and the impact of lengthy administrative processes governing the release of EU funding for investment. As regards the detailed design of an incentive scheme, the experience of ERTMS suggests that a discount-based scheme, introduced only after the majority of the necessary infrastructure investment has taken place, is most likely to achieve the desired outcome.

Link 2000, later called Data Link, was developed to enable Controller Pilot Data Link Communications (CPDLC) as a means of reducing voice channel congestion and supplementing voice communications. The original deployment programme had a number of phases, including an Incentives Phase during which a differential charges scheme, whereby aircraft equipped with the technology would pay lower charges than unequipped aircraft, was to be introduced. In practice, the overall programme has been subject to major delays, with a number of ANSPs failing to undertake the necessary ground-based investment and the deadline for retro-fitting many aircraft also not met. Moreover, the differential charges scheme was not implemented, and stakeholders have identified a number of other shortcomings in the programme including a lack of effective overall management, administrative complexities surrounding access to funding and problems with the certification of the technology. Hence, the programme does not provide direct experience of the implementation of a modulation of charges scheme, but nevertheless demonstrates the need for effective coordination of stakeholder activity and accessible funding if incentives are to operate effectively.

By contrast, the deployment of Data Link on aircraft using Atlantic routes to and from Canada has been more successful, with some 85% of aircraft now equipped with the technology compared with 60% in January 2010. NavCanada, the Canadian ANSP, has sought to incentivise take-up through differential charging and significant, albeit limited, savings are available to airspace users able to communicate via Data Link. However, the charging differential appears to have been driven primarily by ANSP cost savings and, according to NavCanada, the relatively rapid take-up of the technology by airlines appears to be the result of the introduction of new aircraft rather than specific investment in Data Link. This example therefore provides some evidence that modulation of charging schemes providing some incentive to adopt new technology can be implemented, although the overall impact of the scheme is unclear.

SESAR Pilot Common Project

As noted above, the deployment of SESAR is supported by a detailed legislative framework, based on Implementing Regulation 409/2013 which, inter alia, provides for the development of common projects. These are intended to introduce AFs considered to be essential contributors to the improvement of ATM performance across the EU, particularly in relation to Key Performance Areas. As part of its overall responsibility for oversight of SESAR, the Commission initiated the first common project, known as the Pilot Common Project (PCP).

The PCP includes six AFs, all of which are considered sufficiently mature to enable their implementation and to require synchronised deployment. Of these, only three involve the participation of airspace users and only one, Initial Trajectory Information Sharing (AF6), requires users to undertake substantial investment (equivalent to some 66% of the total costs of AF6 of €0.4 billion in Net Present Value terms). In our view, AF6 is the most appropriate candidate for support through the introduction of an incentive scheme since the technology, which is intended to improve the predictability of flight trajectories, leads primarily to productivity gains for ANSPs and only minimal direct benefits in the form of reduced fuel consumption and carbon emissions for airspace users. While in time, cost savings for ANSPs may result in lower ANS charges, from the perspective of users the timing and extent of any reduction is uncertain and probably insufficient to justify the upfront investment cost. In principle, the resulting coordination failure can be addressed through an incentive scheme.

The design of an incentive scheme

Against this background, we have developed an incentive scheme according to a number of principles reflecting good practice in the design of incentives, the characteristics of AF6 and the concerns that stakeholders have expressed about the deployment of the technology:

- Airspace users should not receive any more in incentive payments than is necessary to ensure that they equip their aircraft with the required technology. In effect, the incentive scheme should "close the gap" in the airspace user's business case, turning a negative NPV into a zero or slightly positive one.
- The overall costs of the scheme should be lower than the expected benefits of AF6.
- The design of the scheme should be consistent with the deployment timescales set out in the PCP Regulation. In particular, we have assumed that critical mass will be achieved if 45% of flights operating in Europe are equipped by 1 January 2026 and 100% of air traffic centres are equipped for 1st January 2025.
- Eligible airspace users should be incentivised entirely through a discount in the level of ANS charges that they pay.
- The scheme should be supported with other measures to address the concerns expressed by stakeholders, ensuring that airspace users have greater confidence that the benefits of AF6 will be realised.

We have also made a number of assumptions concerning the evolution of the aircraft fleet, the costs of deploying AF6, the expected level of financial returns and other factors in order to calibrate the required incentive payments and determine the cost of the scheme. These are set out in detail in Chapter 4 of this report. Note that, throughout, we have assumed that the scope of deployment and the operation of the incentive scheme is restricted to Eurocontrol Member States. This assumption was adopted to ensure a consistent and sufficiently detailed dataset for the purposes of analysis, although we recognise that in principle the scope could be extended to members of ECAC.

Given previous experience of incentive schemes based on the modulation of charges, as summarised above, we have investigates two different schemes for incentivising airspace users to equip aircraft with AF6. These are summarised in the table below.

Option	Summary
A: discount only scheme	Eligible airspace users equipping their aircraft with AF6 receive a discount on ANS charges for flights operated with equipped aircraft. The associated reduction in ANSP revenues is compensated for with EU or national funding.
B: discount and levy scheme	Eligible airspace users equipping their aircraft with AF6 receive a discount on ANS charges for flights operated with equipped aircraft. The associated reduction in ANSP revenues is balanced by increased charges paid by airspace users operating non-equipped flights.

Source: Steer Davies Gleave analysis

We have also investigated a further refinement of Option A, whereby the full value of ANSP productivity gains is passed on to airspace users in the form of reduced charges, increasing the incentive to invest. This would mean that ANSPs, unable to rely on productivity gains to remunerate ground-based investment, would require additional grant funding.

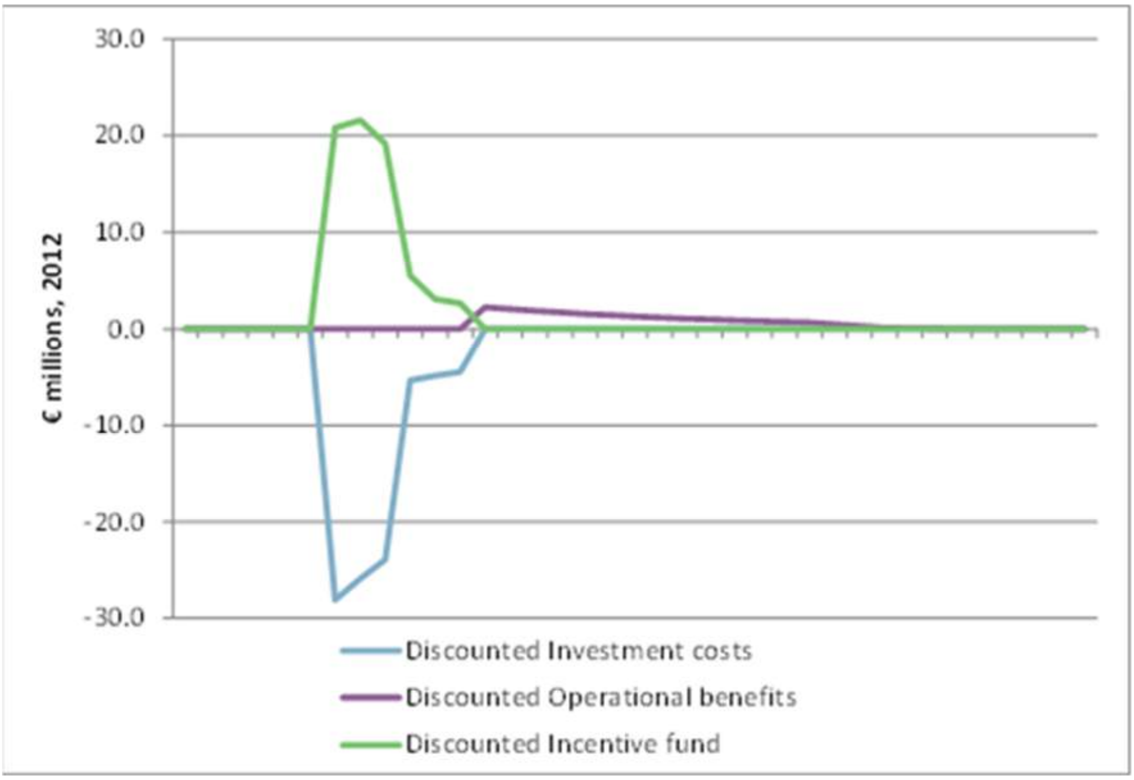
Scheme payments
Our estimate of the total value of incentive payments (equivalent under both Option A and B) is shown in the table below. Note that we have also estimated the impact on this value if the deployment of AF6 were to be delayed.

Assumption	NPV value in 2012 real terms (discounted to 2014)
ANSPs Deployment happens as required: fuel and CO_2 benefits from 2026	72.9 million €
Delayed ANSP deployment plan for AF6: no fuel and CO_2 benefits until 2039	92.4 million €

Source: Steer Davies Gleave analysis

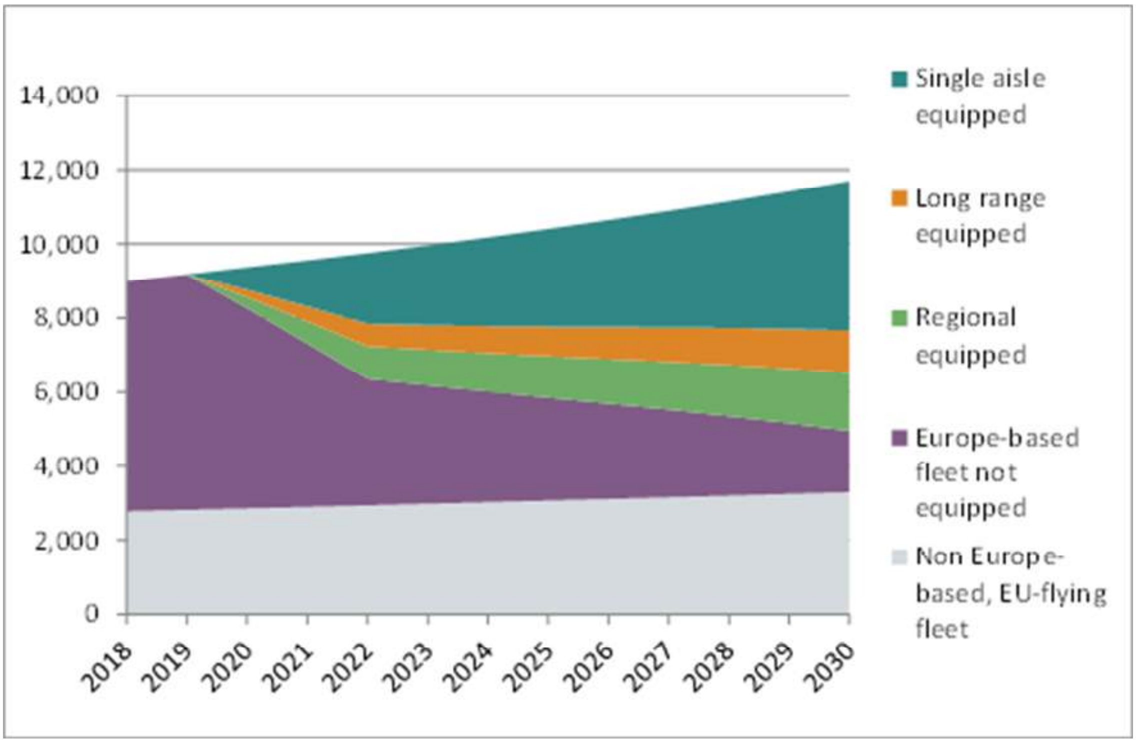
The figure below shows the profile of the discounted total annual cash flows, from the airspace users' perspective. The incentive scheme cash flows closely mirror the cost profile, as equipped aircraft become eligible for discounted ANS charges. The level of discount to the ANS charges is set at a level that allows equipped aircraft to recover their investment costs over years 1 and 2, and there is therefore a slight lag between the cost and funding profiles. Once airspace users have recovered their equipping costs, they no longer receive an ANS charge discount.

The total area under the cost (blue) line is equal to the total area under the operational benefits (purple) line plus the area under the incentive fund (green) line. Over the first three years of the scheme, newly delivered aircraft are being equipped and the existing fleet is being retrofitted, resulting in relatively high total annual costs. After the first three years only newly delivered aircraft need to be equipped and costs are consequently lower. Costs fall to zero once critical mass has been achieved and scheme ends.



Source: Steer Davies Gleave analysis

We have also estimated the profile of fitted and non-fitted aircraft fleets operating with European airspace, as shown in the figure below.



Under Option A, the reduction in ANSP revenues is compensated for by external funding and there is therefore no impact on charges incurred by unequipped flights. The levy rate paid by airspace users operating non-fitted aircraft under Option B is shown in the table below. The levy reaches a maximum of 2.3% in 2023, three years after the start of the scheme. In early years, there is a large pool of airspace users operating non-fitted flights that can compensate the early adopters of AF6. After three years, the retrofitted fleet has been fitted, increasing the burden on non-fitted flights (particularly as the number of non-fitted users is reduced compared to 2020). However, by 2023 the first aircraft fitted have already been compensated, reducing the size of the required levy.

Year	2020	2021	2022	2023	2024	2025	2026
Levy	1.3%	1.8%	2.3%	0.8%	0.5%	0.6%	0%

Source: Steer Davies Gleave analysis

Under the modified version of option A, in which all ANSP productivity gains are passed on to airspace users, there is a significant difference in the timing of the profile of investment costs and that for the realisation of benefits in the form of reduced ANS charges. This means that there would need to be a bridging mechanism whereby support for on-board investment could be secured against an expected ‘revenue’ stream in the form of future discounts on charges (possibly paid directly to a provider of loan finance). In our view, airspace users are unlikely to make the necessary investment unless they can be confident of full remuneration in the short term. We also question whether it would possible secure financing of this kind, as discussed further below in the context of a wider consideration of SESAR funding.

Scheme administration

We suggest that a single organisation should be primarily responsible for the administration of the scheme, including management of the one-off activities enabling implementation. Moreover, we have concluded that the CRCO is best placed to undertake the administrative role for a number of reasons:

- **Technical capability:** CRCO has a thorough understanding of the current charging system and would therefore be well placed to manage any changes required in support of the modulation of charges scheme.
- **Implementation of control procedures:** we consider that the internal and external control procedures would be similar regardless of the identity of the administrator, although we note that there may be synergies with any existing arrangements for auditing current payments (with which CRCO would be familiar).
- **Transparency:** CRCO is highly experienced in operating the charging system and is well placed to ensure an appropriate level of transparency.
- **Cost efficiency:** by definition, a modulation of charges incentive scheme would build on the existing charging arrangements and the scheme administrator would require access to, or at least be able to interface with, the systems operated by CRCO.
- **Management across the relevant geographical area:** CRCO already manages a charging framework extending beyond the EU-28 and has established relationships with ANSPs and other stakeholders in a number of non-EU countries.

Scheme financing

The largest source of financing available for SESAR is the Connecting Europe Facility (CEF), introduced under Regulation (EC 1316/2013). Recital 55 of the Regulation earmarks €3 billion for SESAR, although this allocation is not binding. Funding under CEF will be provided through three mechanisms, namely grants (managed through calls for proposals for projects), procurement of studies and financial instruments in support of private sector investment.

In practice, it is uncertain whether airspace users will be able to take advantage of the available grant funding for several reasons. In particular, we note that the co-funding rate for airspace users has been set at 20%, with users expected to bear the cost of the remaining 80% of the investment. In addition, applying for CEF funding requires considerable administrative effort, and there is little flexibility in terms of the scope of investment activity supported (e.g. the number of aircraft to be equipped). We also note that the financial instruments provided under CEF are designed for large capital projects with clearly identifiable associated revenue streams, and that they are consequently not well suited to investment in support of SESAR. The EIB has nevertheless expressed a willingness to work with the Commission to develop a specific application of financial instruments tailored to such investment.

Recommendations

Our recommendations relating the implementation of a modulation of charges scheme for incentivising the equipping of aircraft with SESAR technology are set out in the table below. In our view, the availability of SESAR technologies expected to deliver significant benefits merits the adoption of our recommendations and implementation of an incentive scheme within the current Reference Period.

Recommendation		Suggested prioritisation	Rationale
C1	We recommend the preparation of a statement of principles to underpin the design of a modulation of charges scheme, explicitly drawing on the lessons of Data Link.	Within next 2 years	Would reassure stakeholders in advance of the further development of an incentive scheme. Stakeholder support is essential if the scheme is to be progressed rapidly.
C2	We recommend that AF6 is subject to an independent review, commissioned as appropriate, in order to validate the associated costs and benefits.	Within next 2 years	This would establish the case for an incentive scheme prior to any substantial development work.
C3	We recommend that through the incentive scheme airspace users should not receive any more in incentive payments than is necessary to ensure that they equip their aircraft with the required technology. We also recommend that appropriate compensation is considered to airspace users in the event that they are unable to derive material benefits from equipping of aircraft due a failure on the part of ANSPs to undertake sufficient investment on the ground.	Within next 2 years	Early confirmation of this would help to establish the credibility of the scheme.
C4	We recommend that any scheme for incentivising the adoption of SESAR technology should be a discount only scheme.	Within next 2 years	Early confirmation of this would help to establish the credibility of the scheme.
C5	We recommend that the Commission investigates other funding sources.	Within next 2 years	Suitable funding sources need to be established as a matter of urgency.

Common charging zones

Background

Across the EU, currently, most Member States operate one charging zone for their en-route services territory. This leads to a range of unit rates associated with routings that cross European airspace. These differences have sometimes provided an incentive for airlines to change route to optimise ANS costs (if the savings more than outweigh the additional fuel costs incurred), leading to an extension of flight distance and an adverse effect on measures of flight efficiency and the environmental impact. Against this background, Preamble (15) and Article 15(2) of the Charging Regulation set out an approach to developing common charging zones at the FAB level. More specifically, Preamble (15) states that "*Member States should be able to set their unit rates collectively, in particular when charging zones extend across the airspace of more than one Member State or when they are parties to a joint route charges system.*"

In principle, movement towards common en-route charging zones could be expected to result in a number of benefits for different stakeholders. In the case of airspace users, these include:

- Increased potential for Free Route Airspace (currently flights may take a suboptimal route, driven by requirements to use particular entry and exit points on national boundaries);
- Potential avoidance of the incentive towards route extension (which may have arisen previously due to the application of airline flight efficiency software);
- A simpler system, with fewer charging zones; and
- Facilitation of greater modulation of charges (within a FAB zone), for example simplifying the introduction of congestion charging as discussed above.

In addition, ANSPs could benefit through planning and coordination of segregated areas such as military zones, and more efficient allocation of staff.

Key issues

A number of FABs, notably FABEC, BlueMed and FAB CE, have already considered the implications of common charging zones. In addition, we have engaged with these and other stakeholders in order to discuss the approach to, and effects of, implementation. This exercise highlighted a number of issues, in particular:

- **Revenue distribution effects:** the creation of a common charging zone is expected to have a positive impact on operations as re-routing of major traffic flows will be easier to implement within a FAB, but such re-routing is likely to lead to a reduction of revenue for some ANSPs. Any reduction in traffic will not necessarily result in a commensurate reduction in the costs of providing ANS for the ANSP concerned.
- **Impact on ANSPs:** one method of introducing a common charging zone previously considered involves pooling the cost base of member ANSPs and redistribution of revenues to ensure that the revenue each receives is independent of the traffic attracted to its airspace. In practice, Member States have been unwilling to countenance any pooling of costs and decoupling of costs and revenues as these measures are considered inconsistent with national sovereignty.
- **Impact of airspace users:** previous studies have indicated that the introduction of common charging zones and associated averaging of national rates is likely to have redistributive effects among airspace users, with some gaining from lower charges and others losing from higher charges.
- **Other issues:** the total number of service units (a measure of the output of the ANS industry) is likely to reduce since it is determined by the great circle distance between the entry and exit points of a charging zone. Previous analysis suggests that the number of units under a common charging zone could be some 1.5% less than under current national boundaries, resulting in a corresponding increase in the unit rate in order to ensure a given level of revenue. In addition, the administration of the charging framework could be complicated by the application of different VAT rules to ANS by different Member States, although the CRCO has indicated that this issue could be resolved by identifying the proportion of each flight arising in each country's airspace using data already collected.

More generally, the introduction of common charging zones is conditional on the development of broader governance and financial frameworks for FABs. The development of such frameworks is generally regarded as challenging, with at least one FAB suggesting that full implementation could take up to eight years.

Revenue distribution impacts

We have identified two options for redistributing revenue between the ANSP members of FABs, as summarised in the table below. We have undertaken more detailed analysis of Option CZ2, as described further below, as it would have major financial implications for ANSPs, at least in the short to medium term. CRCO considers that both options could be implemented with relatively little change to current charging systems. There would, however, need to be a "wash-up" mechanism under either approach as the allocation in each case might be different ex-ante and ex-post.

Option	Summary
CZ1: Cost-based distribution	Revenues collected according to common unit rate and number of service units within the FAB, preserving revenue neutrality. Revenues distributed in proportion to the underlying cost base of each member ANSP.
CZ2: Service unit-based distribution	Revenues collected according to common unit rate and number of service units within the FAB, preserving revenue neutrality. Revenues distributed according to the number of service units within each FAB.

Source: Steer Davies Gleave analysis

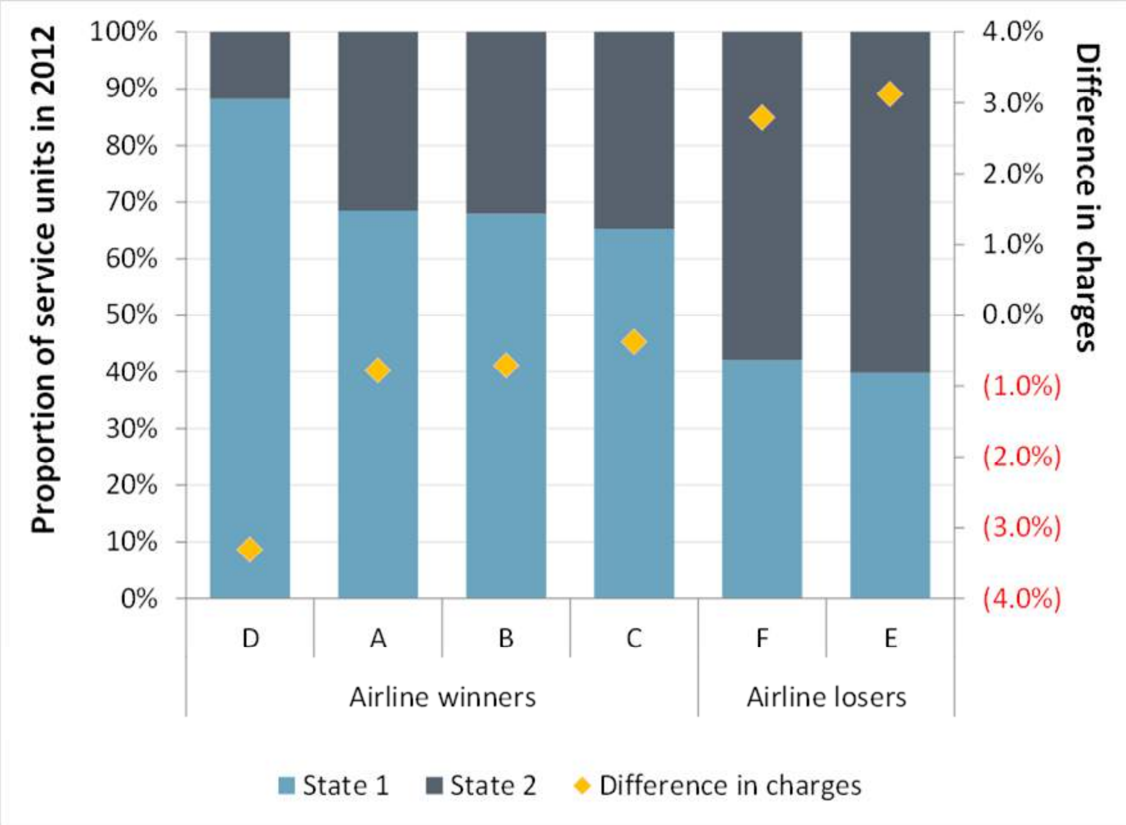
Our investigation of the revenue distribution impacts of common charging zones is based on a comparison of the distribution of revenues between the Member States of selected FABs under common charging with the distribution under national charging zones (using 2012 cost and revenue data as the basis for analysis). In each case, we have undertaken the analysis for two different scenarios, one in which the distribution of traffic between Member States remains constant and one in which it changes. The table below shows the results for Danube FAB, a relatively simple FAB including only Romania and Bulgaria.

		Romania	Bulgaria	FAB level
	Unit rate (€)	€41.84	€36.42	€39.93
	Service units (millions)	3.6	2.0	5.6
Scenario 1: National charging zone rates:				
	Charges recovered (€ millions)	€151m	€72m	€223m
Scenario 2: FAB level unit rate, assuming no change in traffic:				
	Charges recovered (€ millions)	€144m	€79m	€223m
	% change from using charging zone rates	(5%)	10%	-
Scenario 3: FAB level unit rate, assuming 10% increase in traffic for Romania:				
	New service units (millions)	4.0	1.6	5.6
	Charges recovered (€ millions)	€159m	€64m	€223m
	% change from using charging zone rates	5%	(11%)	-

Source: Steer Davies Gleave analysis of CRCO data

In scenario 3, in which 10% of traffic switches from Bulgarian to Romanian airspace, the revenues of the Romanian ANSP, ROMATSA, increase by 5% while those of its Bulgarian counterpart, Bulatsa, fall by 11%. In these circumstances, each organisation could be expected to adjust the scale of its operations to reflect changed traffic levels, but such adjustment would take time and in the interim Bulatsa's financial performance would suffer.

We have also estimated the impact on airspace users by calculating the change in charges faced by airlines operating in the airspace of selected FABs, again based on analysis of 2012 cost and revenue data. The results of this exercise have been anonymised for reasons of confidentiality. The figure below illustrates the outcome for one FAB, assuming no change in the number of service units for each airline, and demonstrates that whether an airline benefits from the introduction of a common charging zone depends on how its traffic is distributed between the higher and lower cost ANSPs within the FAB.



Source: Steer Davies Gleave analysis

Benefits of reduced flight extensions

A move towards common charging zones may result in economic benefits related to increased flight efficiency as a result of fuel savings and a reduction in the environmental impact of aviation. There is some evidence that airlines choose to fly further where there are economic benefits in doing so due to the differential in ANS charges between two en-route charging zones. For example, Thomas Cook state that "*When you have a very cheap country that sits next to a very expensive country you will fly a lot longer to save a lot of money. That's not efficient. If something was done about that at a European level we would see a big change in the way we operate.*"[3]

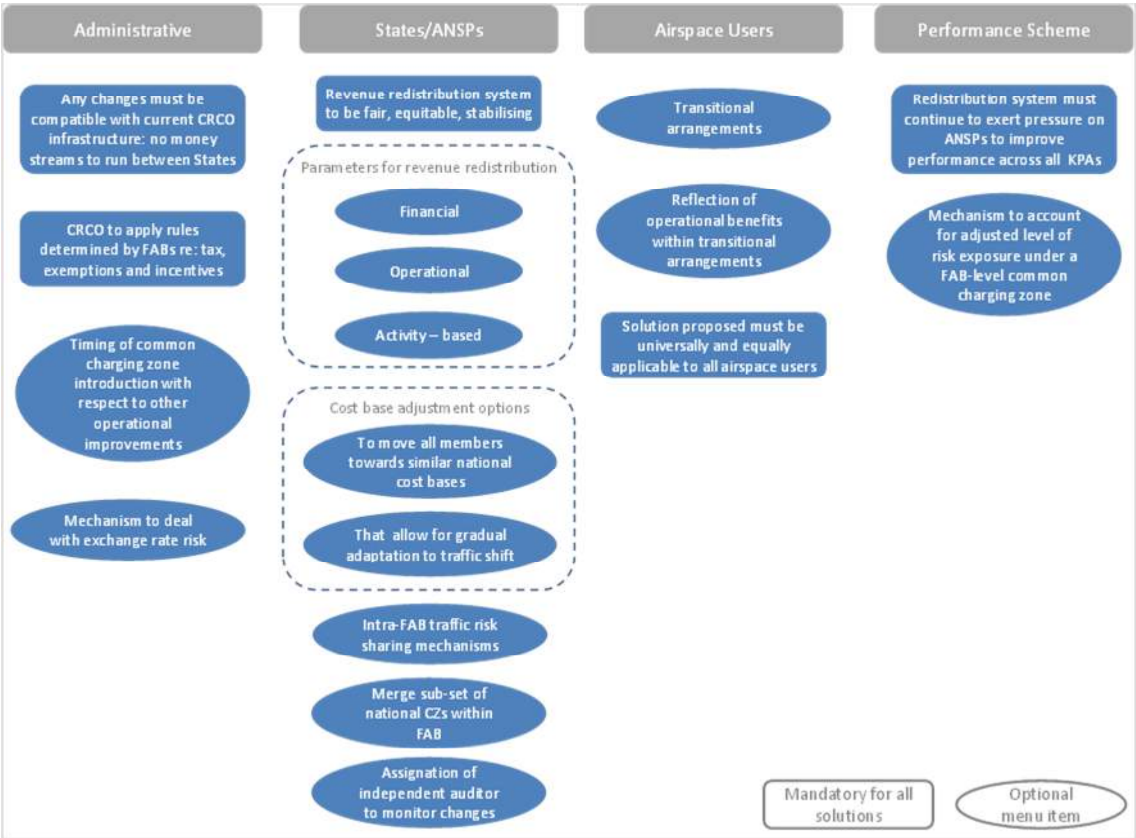
Using data and analysis available from the Performance Review Commission's (PRC's) 2010 Performance Review Report[4], we have sought to estimate the benefits of common charging zones in terms of greater flight efficiency. The PRC data imply a possible 0.17% improvement in efficiency, equivalent to a saving of 1,498 minutes of en-route flight time, 71,000 tonnes of fuel and 225,000 tonnes of CO_2 (using 2010 and 2013 as baseline years). However, to reflect the uncertainties surrounding this estimate and perceived changes in airline behaviour since 2010, we have also calculated the savings from of 0.34% efficiency improvement, double the previous estimate, as a sensitivity test. Based on these values, cost savings would be in the range of €68-136 million per annum (in 2009 Euros) by 2020, rising in line with traffic thereafter. Given the flexibility that airspace users have in filing flight plans, we anticipate that any cost savings could be realised almost immediately.

[3] Skyway 61 Summer 2014, Eurocontrol
[4] PRR 2010 Performance Review Report, Performance Review Commission, 2011

Potential implementation measures

Any proposals for implementing common charging zones must aim to meet the objectives set out in the introductory section above. One of the biggest challenges will be to obtain universal stakeholder support given that, following current discussions at FAB level, there is widespread opposition to the introduction of common charging from both airspace users and other stakeholders. In practice, there is unlikely to be a single solution that will address every issue facing the various stakeholders. Rather, we suggest that a menu of solutions that could then be tailored to suit the particular circumstances of each FAB would need to be developed.

Our proposals are summarised in the figure below, which identifies a number of measures for implementation by different decision makers within the industry. The figure distinguishes between mandatory measures and optional proposals to be developed and implemented by individual or groups of stakeholders. For example, we suggest that it should be mandatory that all solutions should be implemented within the current CRCO charging arrangements, whereas FABs could be free to consider a range of incentives to their members to reduce cost bases within a revenue redistribution scheme.



Recommendations

Our recommendations relating to the implementation of common charging zones are set out below. We consider that implementation is conditional on resolving broader issues relating to the governance and financial management of FABs, and that adoption of the main recommendations is therefore not an immediate priority.

Recommendation		Suggested prioritisation	Rationale
D1	Support should be provided for the independent estimate of the likely benefits to airspace users of a movement to common charging at a FAB level. The analysis would need to be seen to be independent and unbiased to be acceptable to airspace users.	Within next 2 years	Early progress on this issue would determine whether there was a case for progressing further work on common charging zones.
D2	To encourage the introduction of common charging schemes, transitional arrangements for airspace users and ANSPs may be considered.	5-10 years	May be considered as part of an implementation programme. Would need to take account of ANSP and FAB economics, including relative levels of efficiency and differences in unit rates, at the time.
D3	We suggest that the system implications of common charging zones should be investigated further through a shadow running process. In particular, the ability to calculate two sets of charges, one based at a State level and one at a FAB level, and to phase such an impact over a five year period should be the subject of a real time test.	3-5 years	The systems implications of common charging zones should be thoroughly investigated prior to the start of any implementation programme. However, there would be a need to make some system changes to enable shadow running, and time should be allowed to enable this.

1 Introduction

Background

1.1 The Single European Sky (SES) has introduced a common charging scheme for air navigation services (ANS) in the European Union (EU). This scheme is based on Articles 14, 15 and 16 of Regulation (EC) No 550/2004 (the "Service Provision Regulation") and detailed in the recently revised Commission Implementing Regulation (EU) No 391/2013 adopted on 3 May 2013 (the Charging Regulation). The charging scheme covers the list of services that can be financed by air navigation charges (both en-route and terminal services), the means by which the costs of these services must be established and made transparent to airspace users, and the calculation of unit rates and charges for each charging zone using a common formula. According to Article 16 of the Charging Regulation, Member States may decide to modulate air navigation charges to increase the efficiency of ANS and to promote their optimal use. Article 16 also describes the possible types of modulation scheme, as well as some principles to be applied in their development (in particular, consultation and ANSP revenue neutrality).

1.2 The charging scheme is closely linked to a key pillar of the SES, namely the Performance Scheme[5], which seeks to enhance the performance of ANS in Europe by adopting EU-wide performance targets for fixed reference periods of 3-5 years for the Key Performance Areas (KPAs) of safety, cost-efficiency, capacity and the environment. More specifically, it requires EU Member States to adopt binding performance plans that are consistent with EU-wide targets before each reference period, to monitor achieved performance against agreed targets, and to take corrective action as required. The EU Performance Scheme is implemented by the European Commission (the Commission) with the assistance of a designated Performance Review Body (PRB). The Commission is also assessing the compliance of the unit rate of charges with the requirements of the Charging Regulation.

1.3 En-route and terminal navigation charges in Europe amount to some €8 billion each year, and a 2011 study for Eurocontrol estimated the cost of Air Traffic Flow Management (ATFM) delays to amount to more than € 1.25 billion or €1.66 per ATFM delayed flight. It is therefore

[5] Commission Implementing Regulation (EU) No 390/2013 laying down a performance scheme for air navigation services and network functions and Commission Implementing Regulation (EU) No 391/2013 laying down a common charging scheme for air navigation services.

important for the Commission and ANS stakeholders to investigate, on a regular basis, potential actions that may lead to better use of resources and result in improved cost-efficiency. During Reference Period 2 (RP2), there are likely to be some changes in the approach to charging, linked to the mandatory requirement to introduce a financial incentive for the capacity target and an optional financial incentive for measures aimed at environmental protection, as well as a move towards targets and incentives being set at a Functional Airspace Block (FAB) rather than Member State level. In principle, the framework of charging could be further developed to encourage greater flight efficiency and a reduction in delay using various mechanisms for modulating charges, some of which have been discussed over a number of years.

1.4 The Commission requested Steer Davies Gleave to investigate a number of these mechanisms and make recommendations on their potential application. The study has focused on four specific modulation of charges schemes, each with potential interdependencies and affecting other SES policy objectives:

- Workstream A - the introduction of congestion pricing;
- Workstream B - harmonising the allocation of costs between terminal and en-route services;
- Workstream C - the modulation of charges to incentivise early on-board equipage of aircraft with SESAR technology; and
- Workstream D - a move towards common charging zones.

1.5 In each case, the focus of the study has been on the assessment of the technical feasibility of revising the charging system, the analysis of possible interdependencies and spill-over effects on other policy objectives, the impact on different categories of airspace users, development of incentive mechanisms and the analysis of changes to revenue streams for ANSPs.

Objectives of modulation of charges

1.6 The objective of the SES is reducing delays, improving safety standards and increasing flight efficiency in order to reduce the aviation environmental footprint and the costs of service provision. SES is supported by the Single European Sky Air Traffic Management Research Programme (SESAR), which will provide advanced technologies and procedures with a view to modernising and optimising the future European Air Traffic Management (ATM) network. Against this background, and based on our broader understanding of the principles of economic regulation as applied in transport and other sectors, a review of the legislative framework for ANS and discussions with the Commission, Eurocontrol and other stakeholders, we have identified the following general objectives for modulation of charges in EU airspace:

- **Economic efficiency:** a scheme should incentivise economically efficient decisions in the planning and use of airspace, for example by encouraging airlines to route flights in order to minimise overall economic and social costs (including delays and environmental impacts as well as operating costs) and by incentivising them to adopt technology that can help to further improve the allocation of airspace. It should also encourage Air Navigation Service Providers (ANSPs) to manage existing airspace capacity in order to optimise overall flight efficiency, minimising delays as far as possible, and to encourage efficient expansion of capacity through appropriate capital investment and changes to operating procedures.
- **Complementarity:** a scheme should complement other aspects of SES policy and should not duplicate or undermine policy measures that have already been put in place. More specifically, it should not seek to achieve outcomes that can be achieved more effectively

by introducing other initiatives, for example those designed to encourage investment in airspace capacity. Moreover, it should work alongside the SES Performance Scheme in incentivising improvements across the KPAs of cost efficiency, environment, capacity and safety.

- **Intelligibility:** the scheme must be capable of being understood by airspace users, ANSPs and other industry stakeholders, such that they can take the price signals that it provides into account in flight and capacity planning. The changes to the current arrangements will need to be fully explained and the consequences understood where possible.
- **Revenue/cost neutrality neutrality:** the scheme should not have the effect of increasing or decreasing ANSP or FAB revenues or costs for airspace users overall.
- **Minimal administration costs:** the costs of administering the scheme, including gathering the information required to calculate charges and the operation of systems supporting billing of airlines, should be proportionate to the benefits of the scheme and ideally not significantly greater than at present.
- **Credibility:** the scheme must be workable from the perspective of all stakeholders, and it should be possible to implement it without any serious dislocation of industry planning and operations, for example because of sudden, substantial and unforeseen changes in air navigation charges.

1.7 We discuss the interpretation of these objectives in more detail in the context of each workstream. The objectives also provide a broad framework against which each of the options for implementing the various modulation of charges schemes can be evaluated. We present the results of an evaluation in setting out our conclusions and recommendations for each workstream at the end of each of the following chapters.

Organisation of the report

1.8 This Final Report covers all workstreams and sets out the results of our analysis as well as conclusions and recommendations in each case. The remainder of the report is structured as follows:

- Chapter 2 examines options for the introduction of congestion pricing;
- Chapter 3 presents our findings on harmonisation of cost allocation;
- Chapter 4 considers a modulation of charges scheme to incentivise early equipage of aircraft with on-board SESAR technology;
- Chapter 5 describes our analysis of common charging zones; and
- Chapter 6 sets out a number of conclusions and recommendations relating to all workstreams.

1.9 In addition, we have included two appendices. Appendix A provides a list of the organisations with which we have consulted in the course of the various workstreams. Appendix B provides additional information relating to Workstream B on harmonisation of cost allocation.

2 Congestion pricing

Introduction

2.1 Airspace congestion is a significant problem across the Single European Sky (SES). According to the Performance Review Report for 2012, average delay to en-route flights due to Air Traffic Flow Management (ATFM) was 0.63 minutes[6]. While this level of delay was the lowest recorded to date, some 17% of flights were nevertheless delayed by more than 15 minutes for reasons attributed to ATFM. Flight delay, in turn, results in a number of costs to users of air transport as well as to wider society, including:

- Additional, unplanned journey time, which represents an economic cost to travellers and can reduce business efficiency;
- Increased fuel consumption due to aircraft being held in holding patterns in the air and on taxi-ways prior to take-off, and hence increased emissions of CO_2 and other gases harmful to the environment[7]; and
- Greater inconvenience for delayed passengers which, while it may be difficult to value, nevertheless represents a significant social cost.

2.2 While it is not possible to quantify all of these costs accurately, various estimates of the costs to airspace users of delay due to ATFM have been made. Most recently, these have been based on work undertaken by the University of Westminster, discussed further below, which valued ATFM delay at €81 per minute in 2010. Accordingly, the Performance Review Body (PRB) of the SES valued the costs of total ATFM delay in 2011 at €1.4 billion, including en-route delay costs of €0.9 billion and airport delay costs of €0.5 billion[8]. Although delay is projected to decrease in line with targets set for Reference Period 2 (RP2), with the costs of en-route delay falling to €0.27 billion by 2019, it is nevertheless expected to have a significant impact on the overall costs of airspace users over the medium term. Hence, RP2 targets

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[6] An Assessment of Air Traffic Management in Europe during the Calendar Year 2012, Performance Review Commission May 2013.
[7] We note, however, that ATFM delays often affect aircraft waiting at gates with their engines turned off, and the impact on fuel burn and carbon emissions may therefore be limited.
[8] These costs relate to tactical delays arising from operational impacts on the day rather than strategic delays arising from the flight planning process.

notwithstanding, there is a case for investigating whether delay might be further reduced through the modulation of air navigation charges.

2.3 In principle, there are two broad approaches to reducing delays by means of modulating charges:

- Differentiating charges for access to different volumes of airspace at different times such that more congested volumes attract a higher, and less congested volumes a lower, charge; and
- Introducing performance incentives, for example by applying a discount to charges for flights experiencing delay, with the level of the discount related to the extent of the delay.

2.4 The term congestion or scarcity pricing, as conventionally defined and as applied in other transport sectors, refers to the first approach, and provides the focus for much of the analysis and discussion in this report. However, the second is also a potential means of addressing the costs of congestion through pricing, and we have therefore also considered how such an approach might operate in the case of ANS. In our view, both could operate in parallel, although each would affect the structure of ANS charges in different ways.

2.5 Under Part A of our Terms of Reference, we are required to investigate the practical issues surrounding the implementation of congestion pricing as a means of encouraging the more efficient use of air space. More specifically, this part of the study involves analysis of the technical issues and investment requirements relating to congestion pricing, the development of at least three options for introducing it, focusing in particular on addressing congestion within known 'hot-spots' within the SES, and an assessment of the impacts on flight efficiency, planning and other aspects of air navigation. This chapter includes:

- A review of previous studies of the case for congestion charging in air navigation and of recent experience of congestion charging schemes in other transport sectors;
- The definition of a number of objectives for congestion charging against which the various options for implementation can be assessed;
- A description of the organisation and management of European airspace, and an analysis of the levels of congestion observed;
- The definition of a number of options for the level, structure and process for setting charges;
- Analysis to determine possible levels of congestion charges under different options;
- Discussion of a number of issues relating to the practical implementation of a congestion charging scheme; and
- An evaluation of options against the objectives, followed by conclusions and recommendations.

Previous studies of congestion pricing

2.6 There have been several studies of airspace congestion and the implications of introducing congestion pricing over a number of years. These have covered various aspects of the issue, including:

- The impact of congestion on both airlines and passengers;
- The possible design of a congestion pricing scheme;
- The price elasticity of demand for airspace and its implications for congestion pricing in terms of the likely airline reaction to an increase in air navigation costs;

- The possible impact of congestion pricing on levels of congestion and the efficient use of airspace; and
- The programme for implementation of congestion pricing.

2.7 The following summary of a number of key contributions to the literature is not intended to be exhaustive, but illustrates how the discussion of the surrounding issues has progressed to date.

2.8 The impact of congestion on airlines and passengers has been studied on a number of occasions, and the substantial costs associated with flight delays are well established. A study of the *Costs of air transport delay in Europe*, undertaken by the Institut du Transport Aérien (ITA) and published in 2000[9], found that the relationship between delay and cost is complex because of the interaction of delays on the operation of hub and spoke networks and the need to distinguish between primary and reactionary delay at different stages of a flight. Airline schedules typically include a buffer to enable the accommodation of some delay, increasing aircraft and crew requirements and therefore adding to overall operating costs. In addition, unscheduled delays carry costs for both passengers, in terms of time lost, and communities, in the form of additional noise and emissions. The study estimated that the cost burden for airlines in 1999 was €3.0 - 5.1 billion and the corresponding burden for passengers was €3.6 – 6.4 billion. More recent work by the University of Westminster, which focused on delay costs affecting an airline's business (including the costs of delays to passengers), found that total delay costs due to ATFM management in 2010 were some €1.25 billion, giving a value of €81 per minute of delay[10].

2.9 Studies of this kind highlighted both the need for a European-wide policy response and helped to inform the development of Commission policy towards the reduction of delays. They also encouraged further investigation of the potential for air navigation charging to be modified in order to provide incentives for the more efficient use of airspace. The Possible Pricing Mechanisms Task Force set up by Eurocontrol to identify ways of improving the efficiency of airspace use reviewed a number of options for congestion pricing against various criteria, scoring each on a scale of 1 to 5[11]. Options included differentiating charges according to both airspace geography and time of day[12]. The resulting scores are shown in the table below.

2.10 This exercise usefully highlighted the trade-off between the more economics-focused criteria (cost reflectiveness, efficient resource use and better use of airspace) and those more concerned with practicality (transparency, simplicity and ease of implementation). Nevertheless, we suggest that scoring exercises of this kind are of limited value since the average score is generally not an appropriate basis for selecting between approaches, even for the purposes of shortlisting them for further investigation. For example, the overall score given to charging by ACC, which is not significantly different from the current approach, is relatively high despite the fact that this would arguably do little to address the problem of congestion.

[9] ITA, November 2000. Costs of Air Transport Delay in Europe
[10] Note that the costs of delays to passengers estimated in the study concern only those costs incurred by airspace users, for example the costs of passenger rebooking, the provision of passenger care during disruption and compensation. The overall estimate of delay costs does not include additional societal costs, for example resulting from unplanned increases in passenger journey times. The inclusion of such costs could be expected to increase the estimate of delay costs substantially.
[11] Possible Pricing Mechanisms Task Force, 63rd Session, 26-27 June 2001. Agenda Item B.2: Report from the Possible Pricing Mechanisms Tasks Force (PPM/TF)
[12] Air navigation terminology relating to airspace geography is defined in paragraph 2.39 below.

Table 2.1: Scoring of options for airspace congestion charging

Objective/ assessment criterion	Basic structure of charges						
	Upper v lower airspace	Overflight v landing	Air Control Centre	Airspace sector	Peak v off-peak	Service level	Current formulae
Transparency	4.0	5.0	4.5	3.5	3.0	4.0	4.0
Simplicity	3.5	4.5	4.0	3.0	2.5	2.5	5.0
Ease of implementation	3.5	4.5	3.5	2.5	2.5	2.0	5.0
Predictability	4.0	5.0	4.0	2.5	3.0	4.0	5.0
Cost reflectiveness	4.0	3.5	4.5	5.0	4.0	4.0	1.5
Efficient resource use	3.5	3.0	3.5	4.0	3.5	4.0	1.5
Better use of airspace	3.0	3.0	3.5	4.5	4.0	4.0	1.5
Average	**3.6**	**4.0**	**3.9**	**3.5**	**3.2**	**3.5**	**3.3**

Source: 2001 Report from the Possible Pricing Mechanisms Task Force

2.11 A subsequent study by Marianne Raffarin, published in 2004, concluded that the congestion issue could be addressed by introducing a congestion element to the charging formula and making charges inversely proportional to aircraft size in order to discourage higher frequencies using smaller aircraft (charges are currently positively related to maximum take-off weight)[13]. However, the author also noted that such changes would not be well received by the airline community, and that further research would be needed to determine the appropriate approach to congestion pricing.

2.12 A critical issue for the calibration of efficient congestion prices is the likely reaction of airlines to changes in air navigation charges in terms of their use of particular volumes of en-route and terminal airspace. This was investigated in a *Study of ATS demand elasticity of airspace users* undertaken on behalf of Eurocontrol in 2003 as part of its Innovative Route Charging Scheme project[14]. The authors found that both airlines and passengers were relatively unresponsive to changes in route charges, a reflection of the fact that charges typically account for less than 30% of marginal flight costs. More specifically, they estimated that a 10% increase in route costs would induce a reduction in flights of no more than 4.8%. The impact of an increase in other costs, notably fuel, could be expected to be considerably greater.

2.13 This evidence raises the question of whether, in practice, congestion charging would provide sufficiently strong incentives to materially change the distribution of airline traffic across European airspace (on the assumption that very substantial increases in route charges would be strongly resisted and could not be realistically introduced without risking serious industry dislocation). This issue can only be investigated by simulating the redistribution of traffic across a large area of airspace under a given congestion pricing scenario, an exercise which requires the application of relatively sophisticated software. We are not aware of any study that has sought to undertake this analysis for the whole of European airspace, but recent research at the University of Belgrade provided an assessment of the impact of differential charges on the use of airspace over Poland[15]. The authors concluded that the benefits in

[13] M. Raffarin, January 2004. Congestion in European Airspace A Pricing Solution? Journal of Transport Economics and Policy Volume 38 Part 1 pp.109-126

[14] Padova Ricerche, December 2003.Work Package 5 Study of ATS demand elasticity of airspace users Final Report. Eurocontrol Care Innovative Action Project "Innovative Route Charging Scheme!

[15] Jovanovic et al. 2014. Anticipatory modulation of air navigation charged to balance the use of airspace network capacity, Transportation Research Part A.

terms of efficient capacity utilisation could be substantial provided there was spare capacity adjacent to the more congested sectors.

2.14 Studies of the kind already described have tended to conclude that more research is required before a robust congestion pricing scheme can be introduced, and few have considered the practical issues surrounding implementation. The *Study of the terminal charges for air traffic control services* undertaken by PwC on behalf of the European Commission, while it is now relatively dated, is an important exception since it took account of a number of practical issues that would need to be addressed prior to scheme implementation[16]. In particular, it noted the difficulty of establishing the level of delay caused by terminal air navigation and the lack of any information on the relationship between incremental delay and the number of flights. The implications for accounting and billing systems were also considered, at least at a high level. In view of the issues highlighted, PwC recommended a two stage implementation process, including a first stage designed to ensure non-discriminatory pricing as a first step towards congestion pricing as well as further data gathering and analysis to support the calibration of charges.

2.15 However, none of the studies included in our review has investigated how congestion charges might influence airline decisions given the constraints of flight planning and operations. The implicit assumption is that efficient price signals can be provided at appropriate points in the planning process such that flights will be rerouted or rescheduled to give a more optimal distribution of traffic with less congestion and less delay. The extent to which timely price signals could be provided, and the ability to predict airline reactions to them, has been a key issue for investigation in the course of our work.

Congestion pricing in other transport sectors

2.16 Congestion pricing has been implemented in a number of other transport sectors, notably in road and rail transport. Our review focused on road congestion pricing as there are a number of international examples, but also included a specific example of congestion charging in the rail sector in Great Britain, which we consider relevant in view of the fact that rail services, like air services, operate according to pre-planned schedules. In addition, we have briefly reviewed the approach to allocating scarce capacity at airports given the possible interaction with any scheme for charging for the use of congested airspace.

Road schemes

2.17 We investigated the experience of the road congestion charging schemes introduced in London, Milan and Stockholm and reviewed the broader academic literature relating to congestion charging more generally. These schemes operate on the basis of charging vehicles when they pass particular points or cross a boundary defining the most congested area of the city within a particular time interval. They have the advantage that they are relatively simple for road users to understand, but the incentives that they create are correspondingly blunt as compared with, say, charging according to distance travelled along congested routes. In principle, distance-based systems could be implemented using global positioning systems technology, but the cost of implementation coupled with public concerns about the impact on privacy has meant that they have received little support in practice.

[16] PWC, March 2001. Study of the Terminal Charges for Air Traffic Control Sevices. Commission of the European Communities

2.18 There are a number of important differences between road and air transport that must be taken into account in considering the implications of road charging schemes, in particular:

- Road schemes are typically aimed at reducing the level of car traffic by encouraging the use of competing public transport and, in some cases, the introduction of congestion charging has been preceded by substantial investment in enhanced public transport in order to provide capacity to accommodate additional demand. In general, the objective has not been to provide incentives for private car traffic to use alternative roads that are not subject to a charge, although this has sometimes been the effect.
- Private road traffic is not constrained by a planned schedule or timetable, and road users typically determine the timing of their journey and the route that they take according to a number of factors including, inter alia, convenience, journey time, fuel consumption and the level of any congestion charge. Public transport services operating to a published timetable are usually exempt from the charge.
- The implementation of congestion charging has invariably involved substantial investment in systems to enable the enforcement and administration of payment. The costs of initial setup and on-going administration have been significant, although the schemes we reviewed generate positive revenues for the relevant transport authority in the cities concerned.

2.19 Nevertheless, we consider that there are a number of important lessons to be drawn from the experience of road congestion pricing that have more general application, not least the potential for the effects to change over time, the possibility of perverse incentives and the need to trial charging schemes before implementing them in full. We also note that the most successful schemes have been developed and implemented with a high degree of stakeholder involvement, including careful communication of the purpose and benefits of the scheme in order to build consensus and support. These issues are particularly important in any consideration of the objectives of congestion pricing, to which we return below, and we therefore discuss them in more detail in the following paragraphs.

2.20 It is generally accepted that road congestion charging schemes had the effect of substantially reducing road traffic within the charging zone following their implementation, with traffic volumes falling by more than 20% in some cases. It is also recognised that the full effects may take time to emerge as road users must learn how best to respond to a charge. In the short term (for example, within a year) they may choose to change the timing of their journey, alter their route or possibly use an alternative mode of transport. In the longer term, the charge may affect other decisions such as whether to own a car and even where to live and work. It may also affect the decisions of businesses located within, or supplying, the charging zone, for example the configuration of their distribution networks and the choice of inventory levels. The results are further complicated by the tendency, observed in a number of cases, for road users to become acclimatised to the charge such that it no longer has the same effect on their decisions. In general, the long term impact of road congestion pricing on behaviour is difficult to predict, and this is likely to be equally true of charging for the use of congested airspace.

2.21 At the same time, the effects of congestion pricing can be negative from an economic and social perspective because of a lack of efficient price signals elsewhere in the economy. By way of example, some road congestion pricing schemes have encouraged traffic to travel around, rather than through, the area covered by the charge, resulting in an increase in vehicle mileage as well as in the associated carbon and other emissions. Since emissions are not priced, or at least not in a way that accurately reflects their economic and social cost, road users fail to take account of them in their travel decisions and the level of emissions is therefore economically inefficient[17]. In the case of air transport we note that, while air travel within the European Union (EU) is included in the EU Emissions Trading System (ETS), the traded price of carbon will not necessarily reflect the marginal social cost of all aviation emissions and any impact of congestion charging in terms of longer flights would therefore need to be considered.

2.22 Partly for these reasons, the designers of some road congestion charging schemes have understood the need to trial them through the introduction of pilot studies. In Stockholm, for example, the scheme was trialled for a period of six months prior to holding a referendum on whether it should be established on a permanent basis. This provided an opportunity to assess whether the actual impact of the scheme matched expectations, at least in the short term, and to demonstrate the benefits of congestion pricing to sceptical road users. In the event, users were persuaded of the merits of the scheme, with a majority voting in favour of it in the referendum, although this result was no doubt partly due to the enhancement of public transport services delivered in parallel.

2.23 The more successful schemes, including those implemented in London and Stockholm, also demonstrate the value of extensive stakeholder consultation during development and implementation. Opposition to the London scheme fell from 40% prior to implementation to 25% thereafter, while that in Stockholm fell from 55% to 41% over the equivalent period. In both cases, a well-designed communications strategy and consultation exercise helped to correct misunderstandings and provide reassurance in response to particular concerns. Any development of a scheme for airspace congestion charging would require extensive industry consultation through established forums, and it would be important to draw on these at an early stage in order to identify key issues and inform the design of charging structures for trial running.

Rail congestion charging in Great Britain

2.24 As noted above, we have also reviewed rail sector congestion charging in Great Britain, whereby train operators pay a capacity charge for access to a route section that reflects average capacity utilisation on that section over a defined period. The charge is differentiated according to whether access is provided on a weekday or at the weekend but does not vary within a day. It is calibrated to compensate the infrastructure manager, Network Rail, for the additional performance payments it is likely to make as a result of accommodating an additional train on the route section concerned.

2.25 The evidence suggests that the charge is not sufficiently disaggregated to encourage train operators to differentiate between periods of congestion and periods when traffic volumes are less capacity constrained, and it is generally agreed that the Capacity Utilisation Index used as the basis for the calibration of the charge is a poor measure of network congestion. More importantly however, there is also little evidence that the charge actually influences decisions about when to operate a train and the route it should take. This is partly because the majority of passenger services operate under franchise or concession agreements with a transport authority such as the national Department for Transport or Transport for London, and the service level commitment underpinning the timetable is a contractual requirement. In

[17] Fuel taxation may be regarded as a proxy for pricing emissions since the level of emissions produced by a vehicle is directly related to its fuel consumption. However, levels of taxation are determined according to a range of criteria, including their potential to raise revenue as well as political considerations, and are not generally intended to reflect the marginal social cost of emissions.

addition, rail infrastructure, by its nature, is a highly constrained environment in which to operate, typically providing only limited opportunities for rerouting services. Hence, in practice, train operators have little flexibility to respond to the price signals provided by infrastructure charges, however sophisticated the design of the charging structure.

2.26 Airlines operate according to commercially driven schedules rather than timetables that are effectively mandated by government and, notwithstanding capacity constrained air navigation infrastructure, have greater freedom to change the routes taken by their services. They therefore have greater flexibility than passenger train operators to respond to the incentives provided by air navigation charges. At the same time, the need to operate according to schedules on which their passengers can rely, and that are aligned with the needs of the market (e.g. in terms of offering competitive journey times to destinations within and beyond the EU), clearly limits their ability to substantially modify timings and routes. This, coupled with the commercial need to minimise fuel and other flight costs, will tend to reduce the elasticity of demand for access to a given volume of airspace.

Airport congestion

2.27 A number of Europe's airports, including London Heathrow and Paris Orly, are capacity constrained and EU legislation provides for a mechanism to allocate scarce capacity when a Member State designates an airport as congested[18]. In these circumstances, the demand and supply of take-off and landing slots are balanced by a slot co-ordinator, according to non-discriminatory and transparent procedures largely based on the International Air Transport Association (IATA) World Scheduling Guidelines. Where demand exceeds supply, slots are allocated according to defined criteria, primarily historic preference (sometimes known as 'grandfather rights') although some slots are made available to new entrants. Airlines have also been known to trade slots and while the legal basis for trades has been open to challenge in the past, the Better Airports Package of draft legislation adopted in 2011 includes proposals to facilitate slot trading across the EU.

2.28 The existence of airport slot constraints has important implications for congestion pricing in air navigation, since limited capacity on the ground may reduce an airline's ability to respond to price signals in the air. For example, where a flight is constrained to take-off or land within a particular time interval because of a lack of availability of alternative slots, it may not be possible to retime or reroute it in a way that materially changes its departure and arrival time. Higher air navigation charges resulting from the need to fly through congested airspace may therefore simply be absorbed. More generally, slot constraints are an important factor that many airlines need to take into account when planning flight schedules, and could have the effect of blunting incentives to modify flight plans created by an airspace congestion pricing scheme, although the expansion of slot trading could be expected to increase the flexibility of schedules to some degree.

2.29 Moreover, runway capacity at slot constrained airports may itself be subject to congestion pricing designed to reduce the demand for slots at particular times. Any reduction in the demand to take off or land at a particular airport within a given time interval could be expected to result in a corresponding reduction in demand to fly through the associated terminal airspace, and it is therefore possible that airport congestion pricing can help to alleviate airspace congestion (and vice-versa). This interaction highlights the potential need

[18] Regulation (EC) 793/2004 amending Council Regulation (EEC) 95/93.

for airport and terminal airspace charges to be co-ordinated in order to avoid inefficient outcomes, an issue discussed further below.

Objectives of congestion pricing for air navigation

2.30 In Chapter 1, we defined a number of general objectives for a modulation of charges scheme, namely:

- Economic efficiency;
- Complementarity;
- Intelligibility;
- Revenue/cost neutrality;
- Minimal administration costs; and
- Credibility.

2.31 The interpretation of some of these objectives is self-evident. In particular, in view of the estimated costs of delay arising from ATFM discussed above, it is clear that economic efficiency would be improved if delay costs could be reduced by alleviating airspace congestion. As noted above, while ANSPs are anyway expected to reduce delay in line with RP2 targets, it is possible that congestion pricing could usefully supplement their efforts by encouraging airlines to avoid capacity constrained airspace. In addition, as already noted, ANSPs could be encouraged to optimise the use of available airspace through the introduction of performance incentives whereby air navigation charges were reduced according to the level of delay experienced by airspace users.

2.32 However, a number of the objectives require further elaboration and definition if they are to properly inform the design of a congestion pricing scheme. For example, we note that economic efficiency can imply different approaches to pricing depending on whether the objective is focused on the use of existing air space capacity or its enhancement over the longer term. In economic parlance, there is a choice between a pricing scheme based on Short Run Marginal Cost (SRMC), which provides an incentive to allocate existing capacity to the highest value use, and Long Run Marginal Cost (LRMC), which provides for the recovery of the efficient costs of investment to enhance capacity. While economic theory demonstrates that in certain circumstances, specifically where capacity can be increased in small increments, SRMC and LRMC are equivalent, we consider that this condition is unlikely to hold in the air navigation industry. By its nature, investment in additional air navigation capacity tends to be ‘lumpy’, leading to a step-change in capacity provision, and there is no reason why prices set in order to recover the costs of future investment should also result in an efficient allocation of existing capacity.

2.33 While there has been extensive debate about the relative merits of SRMC and LRMC pricing in the academic literature, we note that a number of commentators have argued that meaningful definitions of LRMC are difficult to determine in circumstances where capacity cannot be increased incrementally. Moreover, the European Commission has provided guidance to the effect that the focus of this study should be on the development of a congestion charging scheme to encourage the efficient use of existing capacity. Our interpretation of the economic efficiency objective in paragraph 1.6 above is therefore consistent with an SRMC approach in the sense that we focus on short term capacity allocation. We envisage that the case for enhancement of air navigation capacity will continue to be evaluated in established industry forums at the national and European level.

2.34 We also note that this focus on a SRMC-based approach is in line with the objective of complementarity. Recent modifications to the SES legislation, in particular Commission Implementing Regulations 390/2013 and 391/2013 mentioned in Chapter 1 above, already provide for the introduction of mandatory financial incentives for Air Navigation Service Providers (ANSPs) to meet capacity targets defined in their performance plans. The details of individual incentive schemes have yet to be determined, but the Performance Review Body (PRB) responsible for overseeing the development of the SES has already set out a number of requirements and principles to be taken into account in their design. These include the application of financial penalties and bonuses capped at one per cent of air navigation service revenues in a given year (with the cap applying across all capacity and environmental incentive payments). Such schemes are intended to be a significant driver of investment in new capacity during the SES Second Review Period (RP2) and beyond, and it is therefore not clear what purpose the introduction of congestion pricing based on LRMC would serve. At the same time, we note that the level of capacity enhancement delivered as a result of the new incentive schemes requires further investigation, and we return to this issue in paragraphs 2.134 to 2.138.

2.35 The concept of revenue neutrality also requires some clarification, not least because of potential concerns that the introduction of congestion pricing would inevitably lead to an overall increase in the level of air navigation charges across Europe. Such concerns could be reinforced by economic theory, which suggests that monopoly service providers able to charge a price equal to SRMC have an incentive to deliberately restrict capacity in order increase price and profits. Notwithstanding the on-going regulation of ANSPs under the SES legislation, it is important to explain how such an outcome could be avoided in the case of air navigation.

2.36 In summary, the rationale for the revenue neutrality objective is to ensure that the desired incentive effects of differential charging are realised through a recalibration around the average rather than an overall increase in charges. The recalibration should ensure that, overall, ANSPs receive no more revenue and airspace users pay no more in charges than they would have done in the absence of congestion pricing. There are a number of ways of achieving this, for example by calibrating charges such that the average revenue of an ANSP (measured according to revenue per flight or another appropriate unit of output) remains constant. Regardless of the approach taken, we note that revenue neutrality is likely to require some form of ex-post reconciliation process, possibly involving some modification to the existing revenue risk sharing arrangements, since the forecasts on which ANSPs base their charges will need to take account of the balance of traffic flying through relatively congested and uncongested sectors as well as its overall volume. This could add some complexity to the congestion pricing scheme and might lead to increased administrative costs.

2.37 Finally, we note that while the interpretation of the objective of credibility requires judgement, the need for the scheme to be credible argues for ruling out a particular approach to congestion pricing without further analysis. In principle, it is possible to conceive of a scheme in which charges are modified in real time to reflect levels of congestion in different parts of European airspace as they emerge, with flight crews (or other decision makers within an airline) responding by modifying the flight plan during the flight. We consider that such an approach, analogous to the real time pricing of road access to manage capacity on some US toll roads, is unrealistic given current technology and likely to remain so for the foreseeable future. Therefore, the options for congestion pricing to be investigated in the course of this study are concerned with the introduction of incentives for efficient planning of capacity utilisation rather than the efficient matching of demand to capacity minute-by-minute.

The structure and management of European airspace

Organisation of airspace

2.38 Consideration of how best to achieve an efficient use of airspace requires an analysis of how air traffic can be distributed across four dimensions, namely the three dimensions defining physical location and time. In principle, a flight seeking to avoid congested airspace can be rerouted around it, maintaining the same flight level, or above or below it (except where it is required to take a given route, for example to avoid adverse weather or to land at the destination airport). It can also be retimed such that the aircraft enters a given volume of airspace before or after the congestion arises. Any airspace congestion pricing scheme should be designed to encourage such rerouting and/or retiming and should also be aligned with the way in which the flow of air traffic is planned and managed.

2.39 The organisation and management of airspace can be understood in terms of different levels defined according to both geographical and operational factors, in particular:

- Elementary sectors (generally referred to as sectors in the remainder of this report), generally representing the smallest units of managed airspace, which vary considerably in terms of their geographical size and the number of flights that they can accommodate;
- Collapsed sectors consisting of different combinations of elementary sectors, with combinations varying according to traffic demand and the number of Air Traffic Controllers (ATCOs) required to manage traffic flows within a given time interval;
- Flow Management Positions (FMPs) with responsibility for controlling traffic flows over a number of sectors;
- Air Control Centres (ACCs) controlling a number of FMPs within a defined area, usually covering a major part or even all of the airspace of a Member State;
- Air Navigation Service Providers (ANSPs), entities responsible for the management of airspace at the national level, typically including a number of ACCs, as well as the management of the associated air navigation costs and revenues; and
- Functional Airspace Blocks (FABs), introduced through the SES legislation[19] and including a number of ANSPs with the aim of optimising the management of airspace through better co-ordination or integration of air navigation services across national boundaries.

2.40 It is also necessary to distinguish between en-route and terminal air navigation as the issues surrounding implementation of congestion charging are different in each case. The distinction is discussed in more detail from a cost allocation perspective in Chapter 3. For the purposes of this chapter, we use the term terminal air navigation to refer to air navigation services provided to aircraft in the vicinity of an airport before landing or after take-off and subject to a terminal charge, and en-route air navigation to refer to other air navigation services provided between a flight's origin and destination and subject to an en-route charge[20].

2.41 The configuration of airspace at the sector level can be complex, with sector boundaries determined according to the location of air navigation equipment and the characteristics of the network of flight paths within a given geography. The figure below provides an illustration of 8 sectors located around the border between France and Italy (located in the Marseille and Roma ACCs) at a similar flight level. The figure indicates significant variation between sectors

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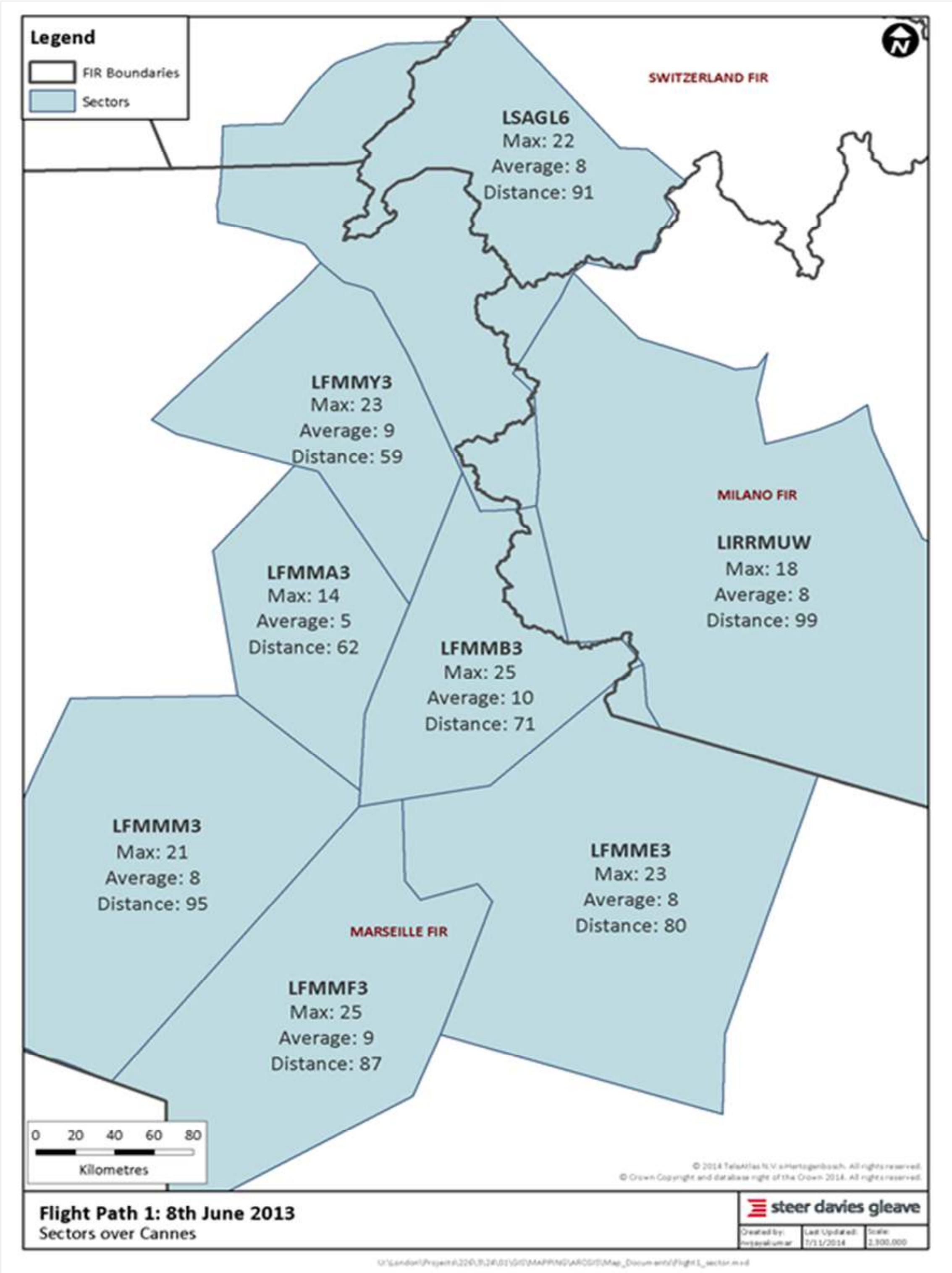
[19] Regulation (EC) No 1070/2009 amending Regulation (EC) No 549/2004 in order to improve the performance and sustainability of the European aviation system.

[20] Terminal and en-route charges are subject to different charging formulae, as illustrated in Table 2.2 below.

in terms of the number of flights per hour accommodated and the distances travelled by aircraft flying through them (illustrated with values for a given day in June 2013). For clarity, we have not included the various flight paths taken within each sector, which vary considerably in terms of position and direction.

Figure 2.1: Illustration of sector configuration



Source: NMOC flight data 2013, EUROCONTROL Regional Charts 2013, Steer Davies Gleave analysis

2.42 In principle, each sector is subject to a defined capacity, measured in terms of the number of flights that can be safely managed within the sector during a given time interval[21]. In practice, this capacity can change according to, inter alia:

- The complexity of flight paths within the sector (with flights changing altitude and direction requiring more management resource than flights travelling through the sector in one direction and at a constant altitude); and
- The deployment of ATCOs within the ACC (which can change through the day according to the volume of flights entering different sectors, and through the week according to established working patterns).

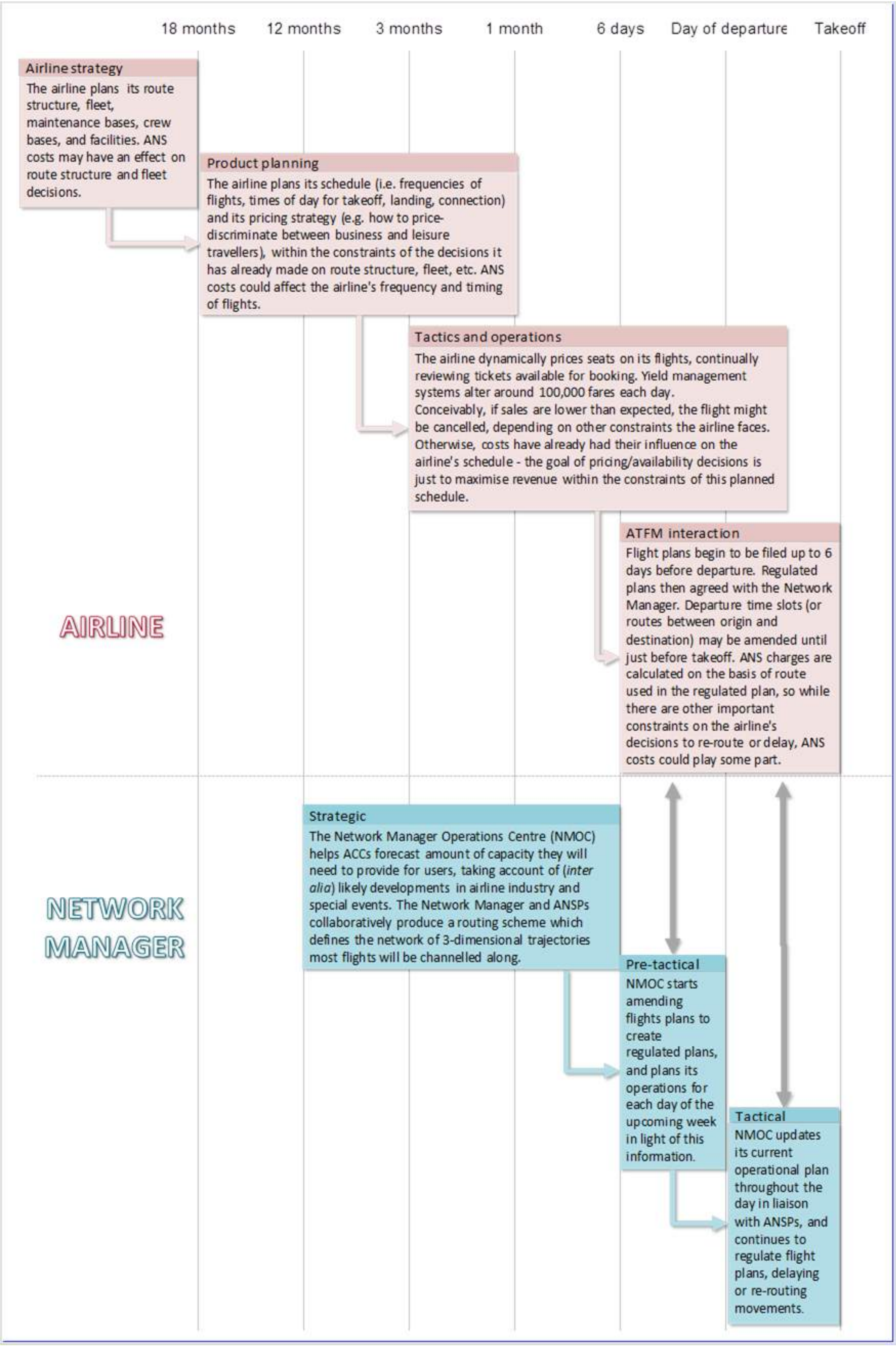
2.43 Note also that a number of elementary sectors can be combined into a collapsed sector depending on the volume of traffic seeking access to a given volume of airspace and the number of ATCOs required to manage it safely and efficiently. The configuration of collapsed sectors can also change, with different elementary sectors combined according to anticipated traffic patterns. The results of the flight planning process, discussed below, are therefore a critical determinant of the way in which airspace is organised and managed over time.

Flight planning and regulation

2.44 Airlines and other parties wishing to operate flights within and through European airspace must submit a flight plan to the Network Manager Operations Centre (NMOC). These are submitted up to six days before the flight, but the preparatory planning work may begin more than a year in advance as the airline develops its route structure and schedule and determines fare levels. In parallel, the NMOC works with ACCs to plan capacity and produce a routing scheme for flights operating on a given day, based on the capacity declared by ACCs. As flight plans are submitted, the NMOC modifies them in the light of emerging information on capacity and develops operational plans for the coming week. Note that even after final flight plans have been agreed, they may be modified before or during the flight as circumstances, including the availability of capacity, change. The figure below describes these processes in more detail and indicates how air navigation charges might influence airline decisions at each planning stage.

[21] We understand that in standard industry terminology, capacity limits apply to traffic volume reference locations rather than sectors. However, as traffic volumes are geographically coincident with sectors and in order to avoid confusion, in this report we have taken the term sector to mean a unit of airspace for which a capacity can, in principle, be defined.

Figure 2.2: Flight and capacity planning process



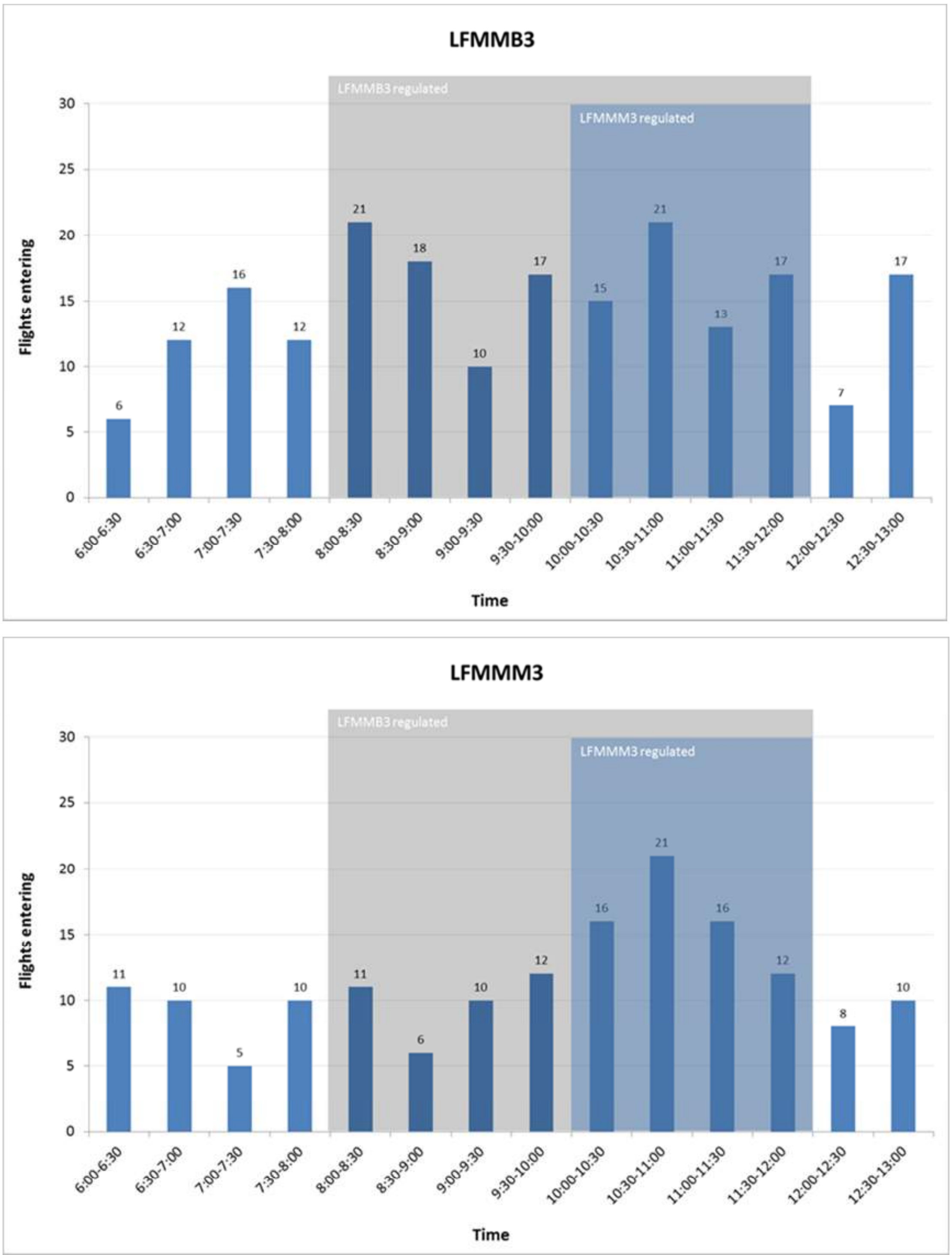
Source: Steer Davies Gleave analysis

2.45 Airspace congestion is managed through a process of regulation, whereby the NMOC designates sectors in which expected flight volumes exceed capacity as regulated sectors for a defined period. Where a flight is planned to operate through a regulated sector, the flight crew may be instructed to change the plan in a number of ways, for example by delaying take-off or rerouting through other sectors. In practice, relatively few sectors are regulated on any given day. Sample data provided by the NMOC indicated that only 38 en-route sectors, less than 2% of the total, were regulated for ATC Capacity reasons on 8th June 2013 (a day with a relatively large number of summer flights) and only 15, significantly less than 1%, on 12th January in the same year[22]. The number of terminal sectors regulated on these days was considerably less. The NMOC does not keep data on all the regulations affecting each flight, only on the number of regulations and the reason for the most penalising regulation. The sample data indicates less than 20% of regulated flights encounter more than one regulation.

2.46 Regulations are generally applied for a relatively short period of time, and their implementation and management is a dynamic process. Figure 2.3 shows flight volumes by half hour period on 8th June 2013 within two adjacent sectors within Marseille ACC, LFMMB3 which was regulated for four hours and LFMMM3 which was regulated for two. In the first case, flight volumes vary between 10 and 21 flights per half hour during the period of the regulation and are not substantially higher than in the two hour period immediately preceding it. In the second case, volumes peak at 21 flights while the regulation is in place but quickly return to more moderate levels. In both cases, observed flight volumes during the period of regulation are likely to be at least partly the result of changes to flight plans made after the sector was designated as regulated, and do not necessarily indicate the level of demand implied by the plans before the changes were implemented. Nevertheless, the figure demonstrates the need to regulate airspace in close to real time as traffic demand emerges rather than on the basis of stable and predictable forecasts.

[22] It is not possible to give a precise percentage because of the change in configuration of collapsed sectors hour-by-hour, and the fact that regulation can apply to either elementary or collapsed sectors. We understand that there are 2,336 elementary sectors and 3,358 collapsed sectors in European airspace.

Figure 2.3: Flight volumes during a period of sector regulation on 8th June 2013



Source: NMOC flight data 2013, Steer Davies Gleave analysis

2.47 We discuss the frequency of sector regulation and the implications of regulation for flight routing further below.

Charging for the use of airspace

2.48 Under current SES legislation, charges paid by airspace users are set in order to recover specified categories of ANSPs’ costs, with the revenue risk arising from variations in traffic shared according to a defined mechanism[23]. The basic charging formulae for en-route and terminal air navigation services have, however, been in place for a number of years, with the payment made for a given flight intended to reflect both the costs of serving it (approximated by distance travelled within the relevant volume of airspace in the case of en-route charges) and its value to the airline (approximated by Maximum Take-off Weight (MTOW), which is related the number of passengers carried). The formulae are set out in the table below. The individual unit rates vary by charging zone, with zones largely corresponding to regions of airspace managed by individual ANSPs.

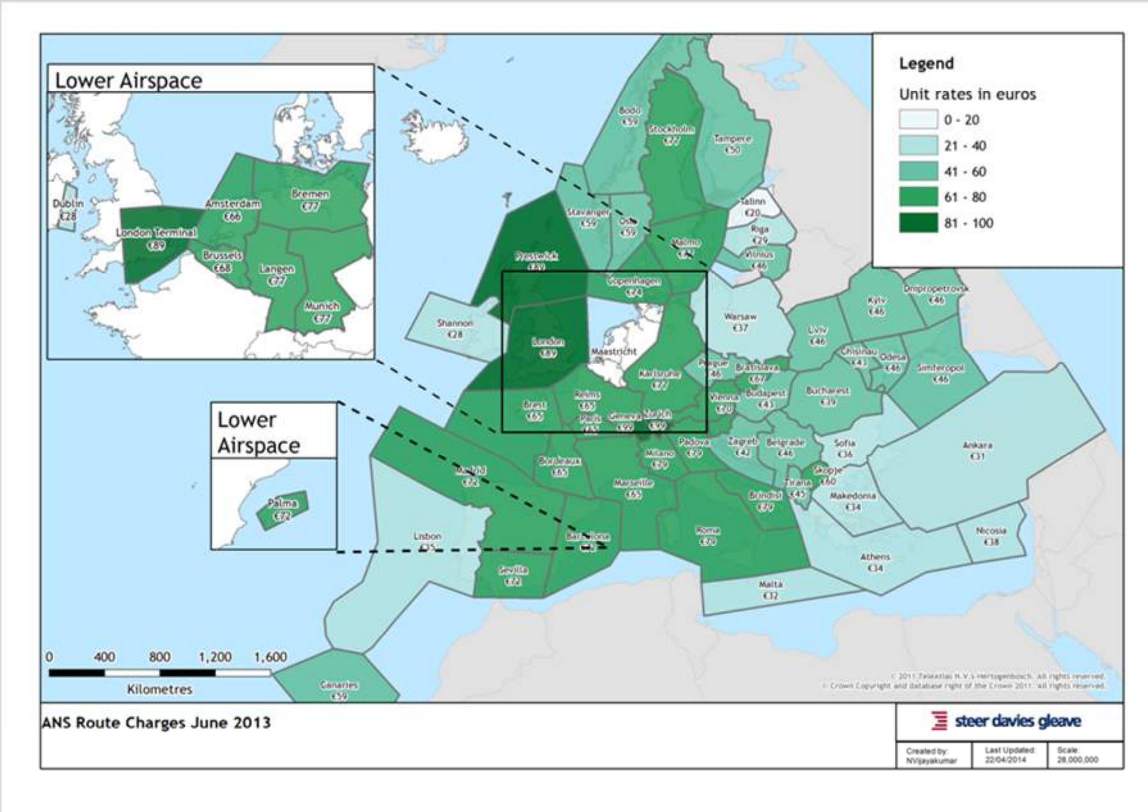
Table 2.2: Air navigation charging formulae

	En-route	Terminal
Formula	$\text{Unit rate}_i \times \text{Distance factor}_i \times \left(\frac{\text{MTOW}}{50}\right)^{0.5}$	$\text{Unit rate} \times \left(\frac{\text{MTOW}}{50}\right)^{x}$
Notes	Distance factor = length in km of great circle within ACC i, minus 20km for each take-off or landing within i MTOW = Maximum Take-off Weight	Value of *x* varies by ANSP (within a range 0.7 - 0.9)

2.49 The figure below shows the en-route unit rates for individual ACCs across Europe, with the ACCs shaded according to the relative level of the charge (darker shading indicates a higher charge). This illustrates the wide variation in unit rates, with ACCs in western and northern Europe tending to charge higher rates. Note that the upper airspace in Maastricht ACC is managed by Eurocontrol and does not have its own direct charging scheme. The costs are distributed between the four participating Member States according to an operational sharing parameter (number of controllers manning each sector). These redistributed costs are added to each national cost-base and recovered through route charges levied for each national charging area[24].

[23] Regulation (EC) No 391/2013 laying down a common charging scheme for air navigation services – the Charging Regulation.
[24] Final Report on mandate to support the establishment of FABs, Eurocontrol, 2005.

Figure 2.4: En-route air navigation unit rates (2013)



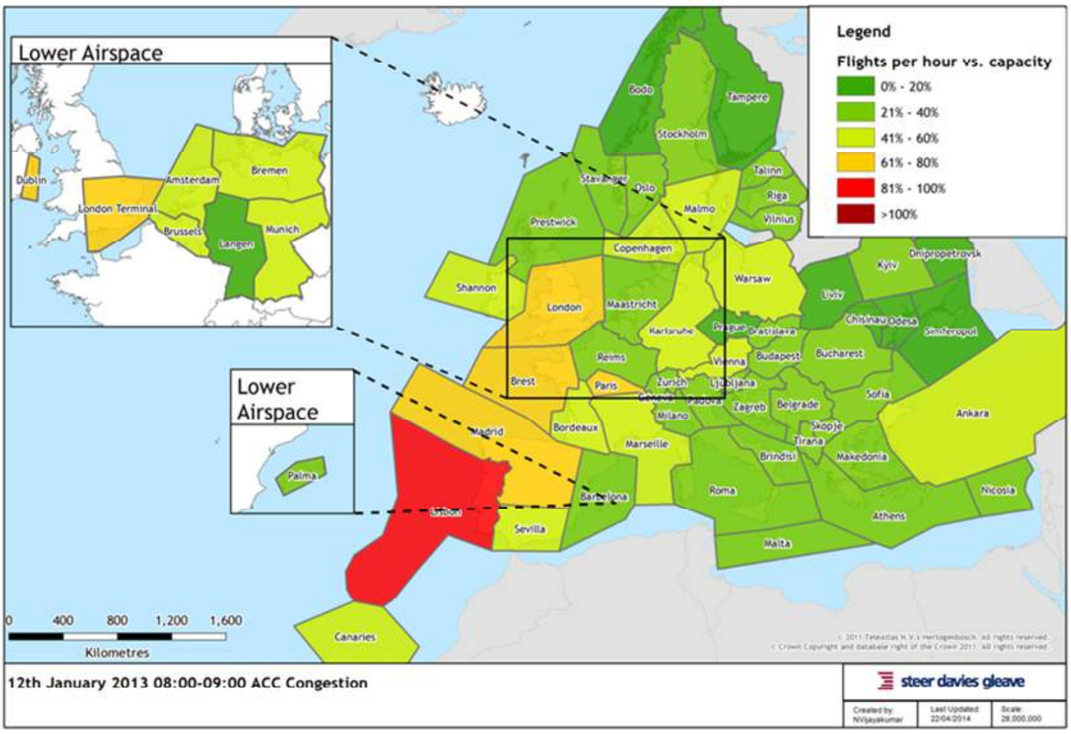
Source: Steer Davies Gleave

The extent of congestion in European airspace

ACC capacity utilisation

2.50 In order to identify "hot-spots", we have investigated the extent and location of airspace congestion across the SES, beginning with an analysis of ACC capacity constraints and then investigating congestion at the sector level. Figure 2.5 and Figure 2.6, which are based on data on flights per hour provided by the NMOC and corresponding capacity targets published in the Network Operations Plan 2013 – 2015, show relative levels of ACC capacity utilisation for a given hour on 12th January and 8th June (both dates being Saturdays) as well as for different hours on 8th June. Note that the dates were deliberately selected by the NMOC, at our request, to illustrate how congestion can vary over time.

Figure 2.5: Comparison of congestion through the year (winter/summer seasons)



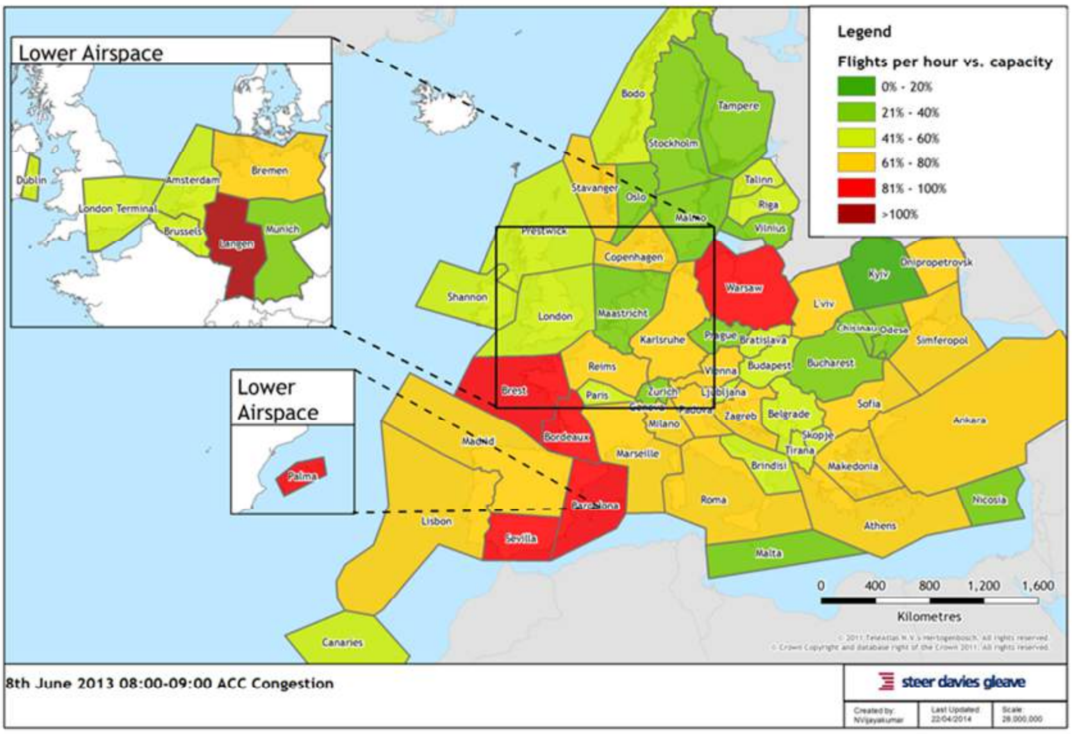
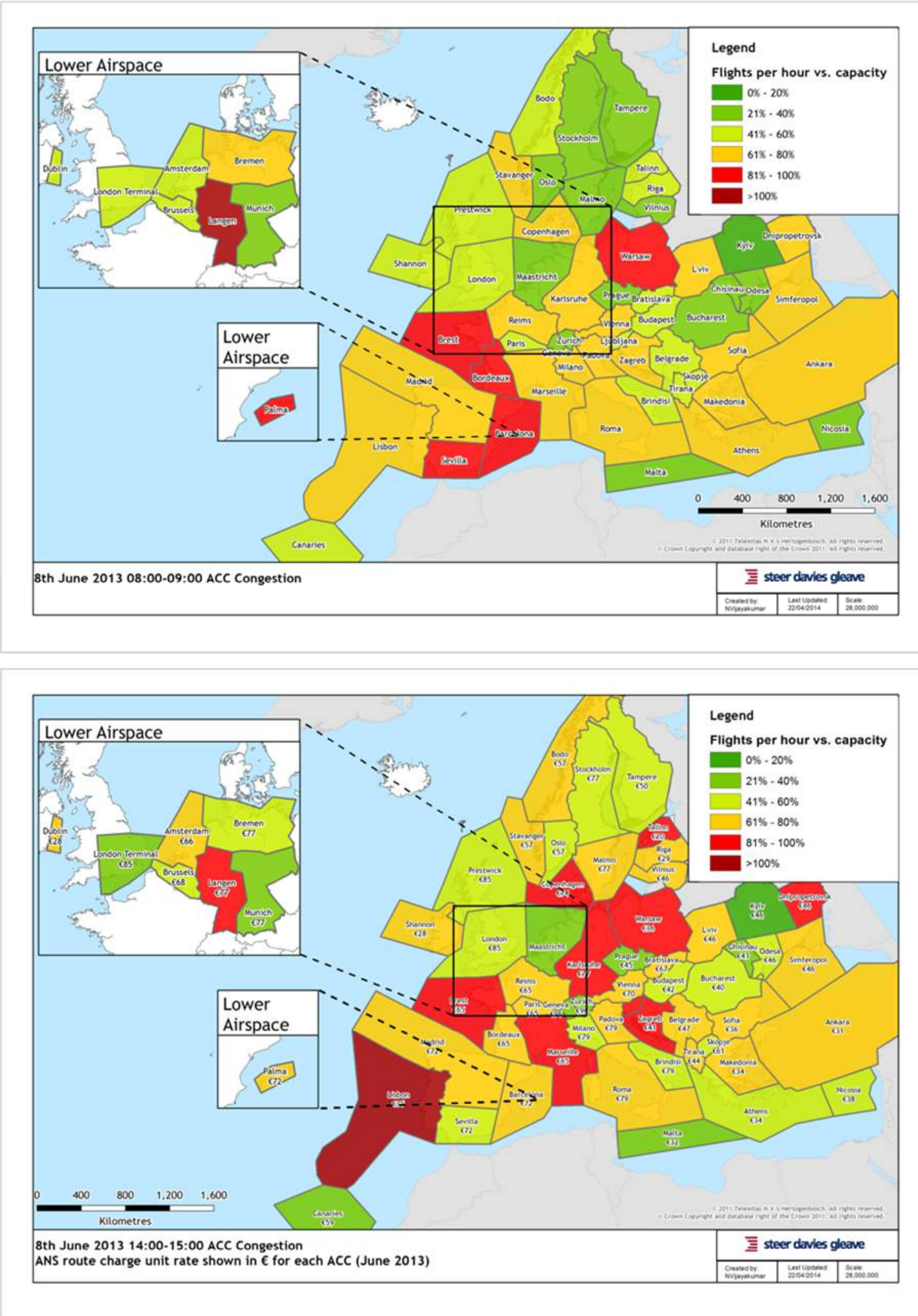


Figure 2.6: Comparison of congestion through the day (8 June 2013)

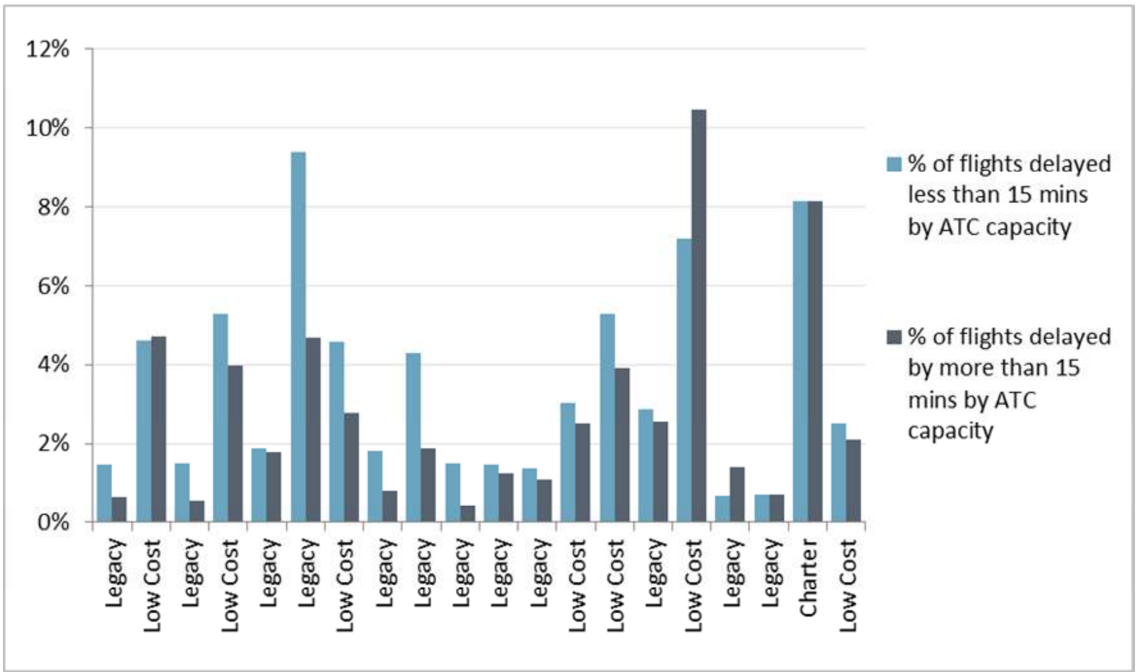


2.51 Figure 2.5 suggests that levels of congestion are significantly greater in the summer than in the winter, as might be expected given the much higher volume of leisure travel and associated air traffic during the summer months. The data for June demonstrate that capacity constraints were particularly acute over western France and eastern and southern Spain as well as over Poland, but congestion was also relatively high over much of southern and eastern Europe, at least for the hour shown. There is little, if any, correspondence with congestion levels during the equivalent hour in January, when capacity constraints were confined to the Lisbon, Madrid, Brest, London and Paris sectors in upper airspace. By contrast, lower airspace in northern Europe appears to have been more constrained in January than in June.

2.52 There is much greater similarity between levels of congestion experienced over the day in June, as shown in Figure 2.6. Capacity utilisation was at least 61% for the majority of ACCs during both the morning and afternoon hours shown, and Brest, Marseille and Warsaw appear to have experienced utilisation in excess of 80% for much of the day. At the same time, airspace over the UK and parts of Scandinavia was relatively uncongested in both the morning and afternoon.

2.53 The impact of congestion on flight times on 8th June is illustrated in Figure 2.7. This shows the percentage of flights delayed by the top 20 airlines (ranked according to flight volumes) on all their flights because of air traffic control capacity within and through European airspace on that day. We have anonymised the data but distinguished between legacy, low cost and charter airlines for the purposes of illustration. The figure shows wide variation, with a number of legacy and low cost carriers as well as one charter airline experiencing substantial delay.

Figure 2.7: Delay due to air traffic control capacity on 8th June 2013



Source: NMOC flight data 2013, Steer Davies Gleave analysis

2.54 This analysis demonstrates the broad magnitude of the congestion problem experienced by individual ACCs and airlines and the extent to which the level of congestion can vary over time. However, it does not provide any indication of precisely where, within the overall European air transport network, the most significant capacity constraints arise. We therefore requested data on sector regulation throughout the year from the NMOC in order to determine the location and frequency of congestion at a more granular level.

Analysis of sector congestion

2.55 The NMOC provided a record of all sector regulations imposed on European airspace during 2013. The data provided included an indication of the reason for the regulation, and we selected all regulations imposed for capacity reasons (categorised as aerodrome capacity or ATC (en-route) capacity regulations in the data set) for further analysis. In the description of the analysis below, we use the term capacity-related regulation to refer to any instance of regulation falling into either of these two categories.

2.56 Analysis of the regulation data confirmed that congestion is considerably greater in the summer as compared with the winter, as shown in the table below. Total delay arising from congestion during the period April to September was more than three and a half times that during October to March, and the proportion of summer flights subject to congestion-related regulation was more than two and half times the equivalent proportion over the winter.

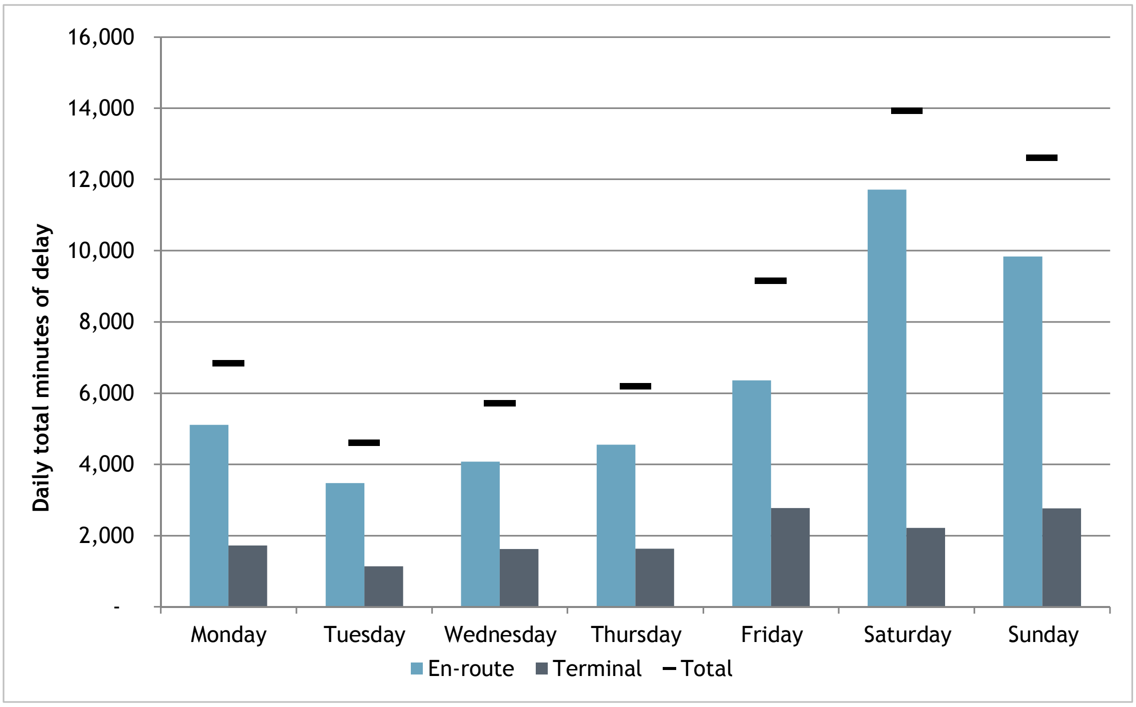
Table 2.3: Regulation and delay in summer and winter 2013

	Traffic regulated due to congestion (flights)	Proportion of traffic regulated due to congestion	Congestion-related delay (minutes)	Congestion-related delay per flight (minutes)
April - September	315,989	5.98%	13,193	0.46
January – March and October - December	79,343	1.85%	3,661	0.16

Source: NMOC regulation data 2013, Network Manager Monthly Network Operations Report December 2013

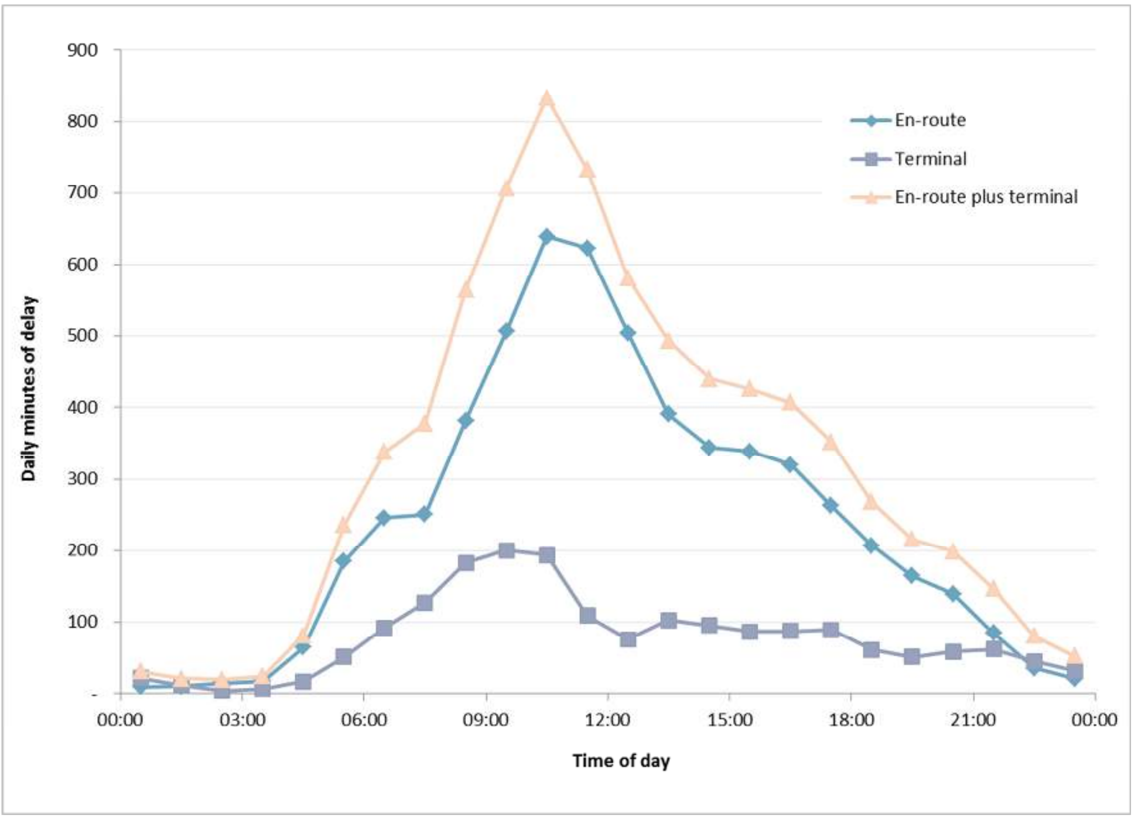
2.57 At the network level, the data also indicated substantial variations in congestion over the week and through the day, as indicated in Figure 2.8 and Figure 2.9. From discussions with Eurocontrol and other stakeholders, we understand that the higher level of delay at weekends is the result of a reduction in capacity due to reduced availability of ATCOs rather than the level of demand. The substantial increase in congestion-related delay from around 06:00 and low levels during the late evening and early hours reflect restrictions on the operation of airports at night as well as underlying patterns of flight demand. Both en-route and terminal delay are particularly high during 09:00 to 11:00, with en-route delay peaking later and persisting at higher levels for longer.

Figure 2.8: Capacity-related delay during an average week in 2013



Source: NMOC regulation data 2013, Steer Davies Gleave analysis

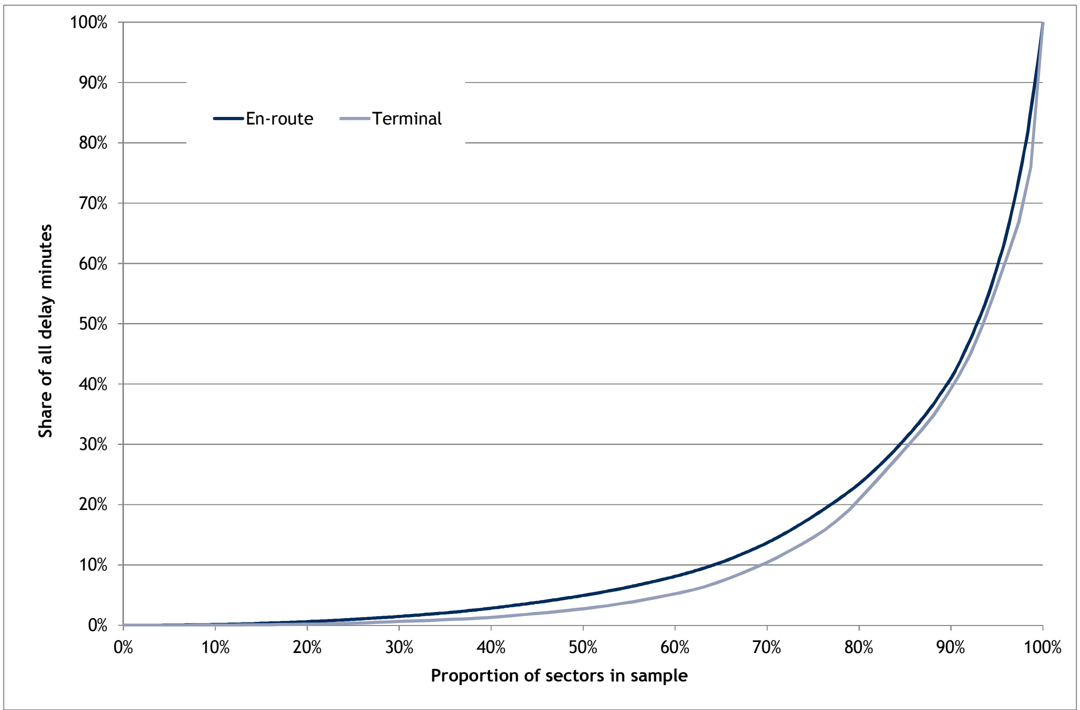
Figure 2.9: Capacity related delay on an average day in 2013



Source: NMOC regulation data 2013, Steer Davies Gleave analysis

2.58 However, these patterns of delay are not characteristics of all, or even most, sectors. As already noted, relatively few sectors are subject to regulation at any point in time, even during peak periods of airline traffic. In addition, the majority of delay is accounted for by a relatively small number of sectors. The figure below shows the cumulative distribution of delay across both en-route and terminal sectors, and indicates that the most congested 20% of sectors account for approximately 80% of recorded delay minutes.

Figure 2.10: Cumulative distribution of delay minutes across en-route and terminal sectors



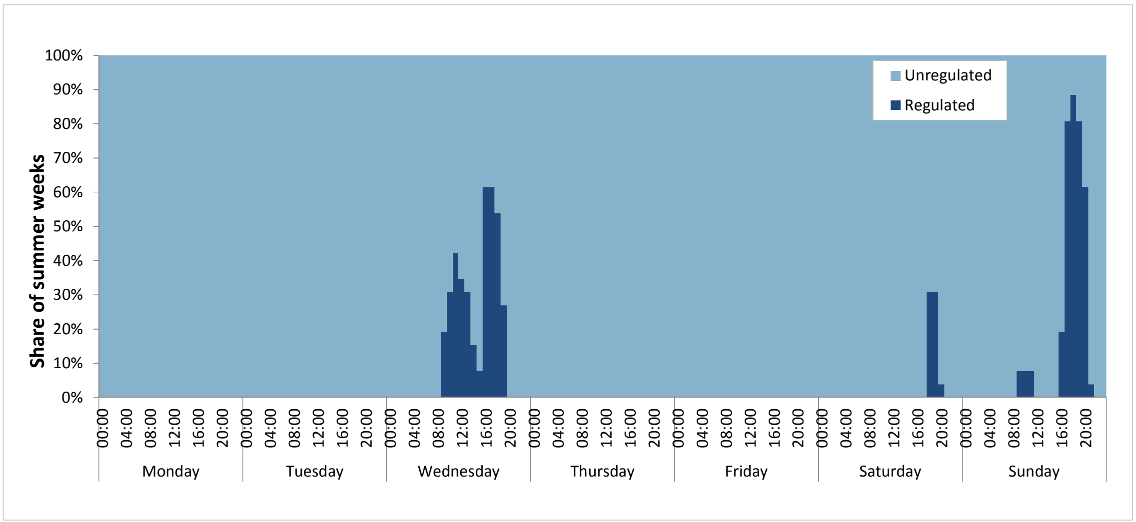
Source: NMOC regulation data 2013, Steer Davies Gleave analysis

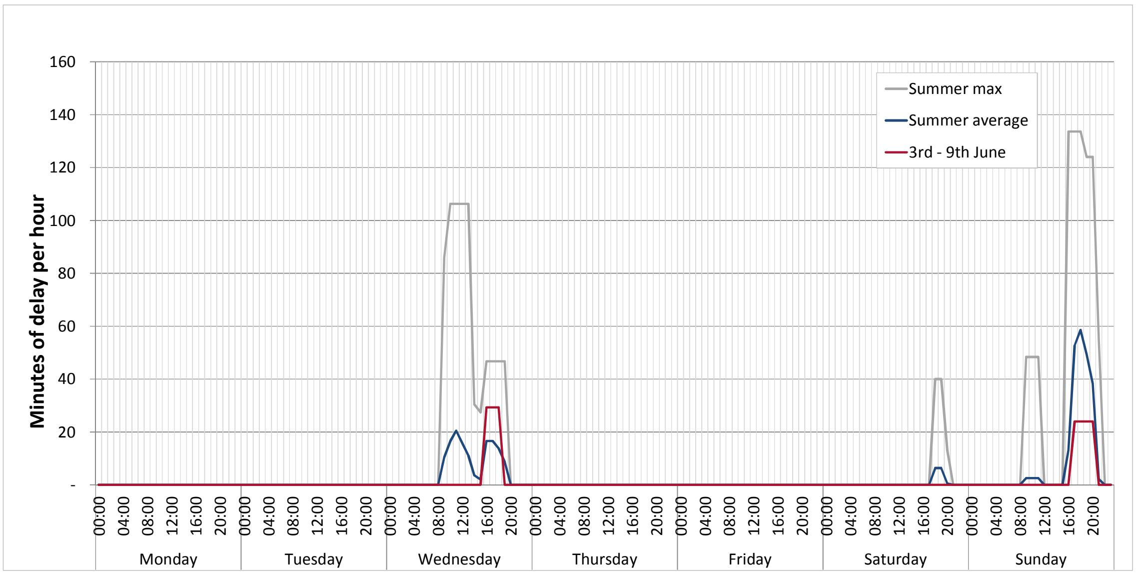
2.59 Moreover, our analysis also suggests that patterns of congestion vary significantly even between the more congested sectors, and that defining 'hot spots' at the sector level for the purposes of congestion charging is consequently challenging. In order to illustrate the issue, we present below the results of our analysis of relative levels of congestion in two terminal and two en-route sectors, selected to demonstrate the range of traffic patterns and levels observed within relatively congested sectors across the SES. The sectors are as follows:

- The terminal sector for Heraklion airport (LCPH): Heraklion is Crete's main airport and the second busiest airport in Greece. It is heavily used during the summer months by both scheduled and charter airlines.
- The terminal sector for Zurich airport (LSZH): Zurich is Switzerland's busiest airport, handling some 25 million passengers in 2013. Although the runway is not capacity constrained, the terminal sector is subject to more frequent regulation for capacity reasons than any in Europe.
- An en-route sector in the vicinity of Marseille airport (LFMMB3): this sector is used by flights operating on a North East/South West axis along the Mediterranean coast and by aircraft overflying Corsica and Sardinia on a North West/South East axis.
- An en-route sector above Krakow airport (EPWWJ): within this sector, flights operate on routes to and from all points of the compass. It is relatively large, covering approximately one eighth of the surface area of Poland.

2.60 We have undertaken analysis of the frequency of regulation and the predictability of congestion for each sector, as shown in Figure 2.11 to Figure 2.14 below. In each case, the first chart shows the proportion of summer weeks in 2013 in which the sector was regulated during each hour of the week. The second chart shows the maximum and average delay per hour recorded over the same summer period, as well as the delay per hour during a randomly selected week (3rd to 9th June), again by hour through the week.

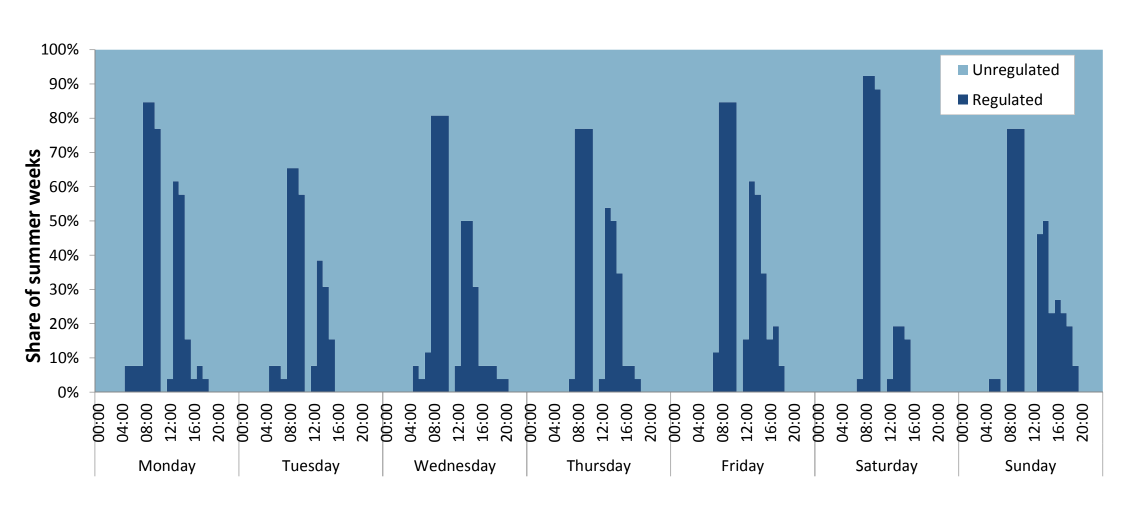
Figure 2.11: Changes in regulation and delay – Heraklion terminal sector (LCPH)

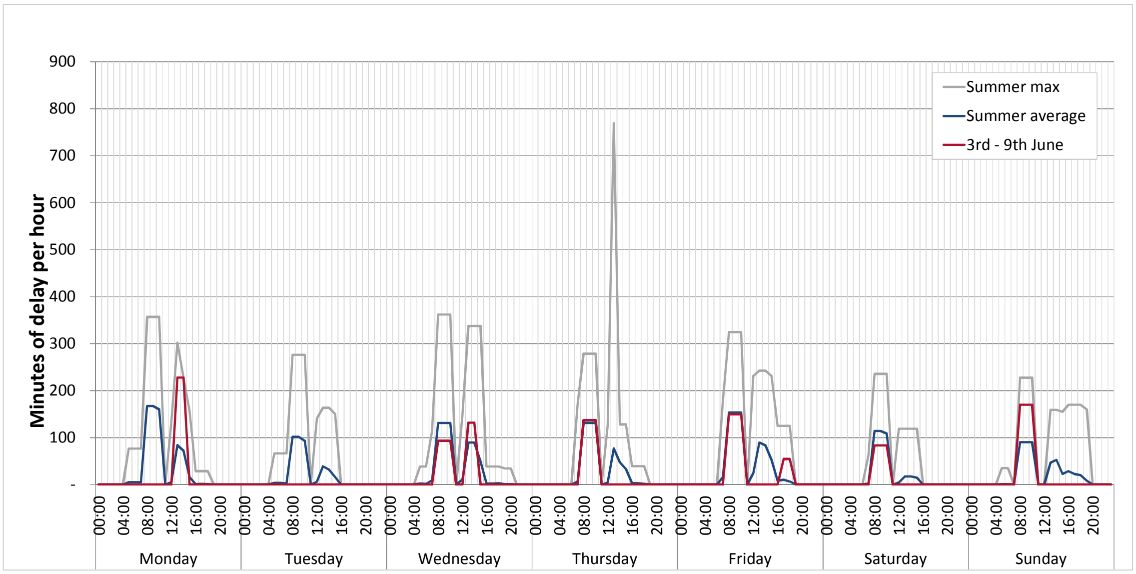




Source: Steer Davies Gleave analysis of NMOC regulation data 2013

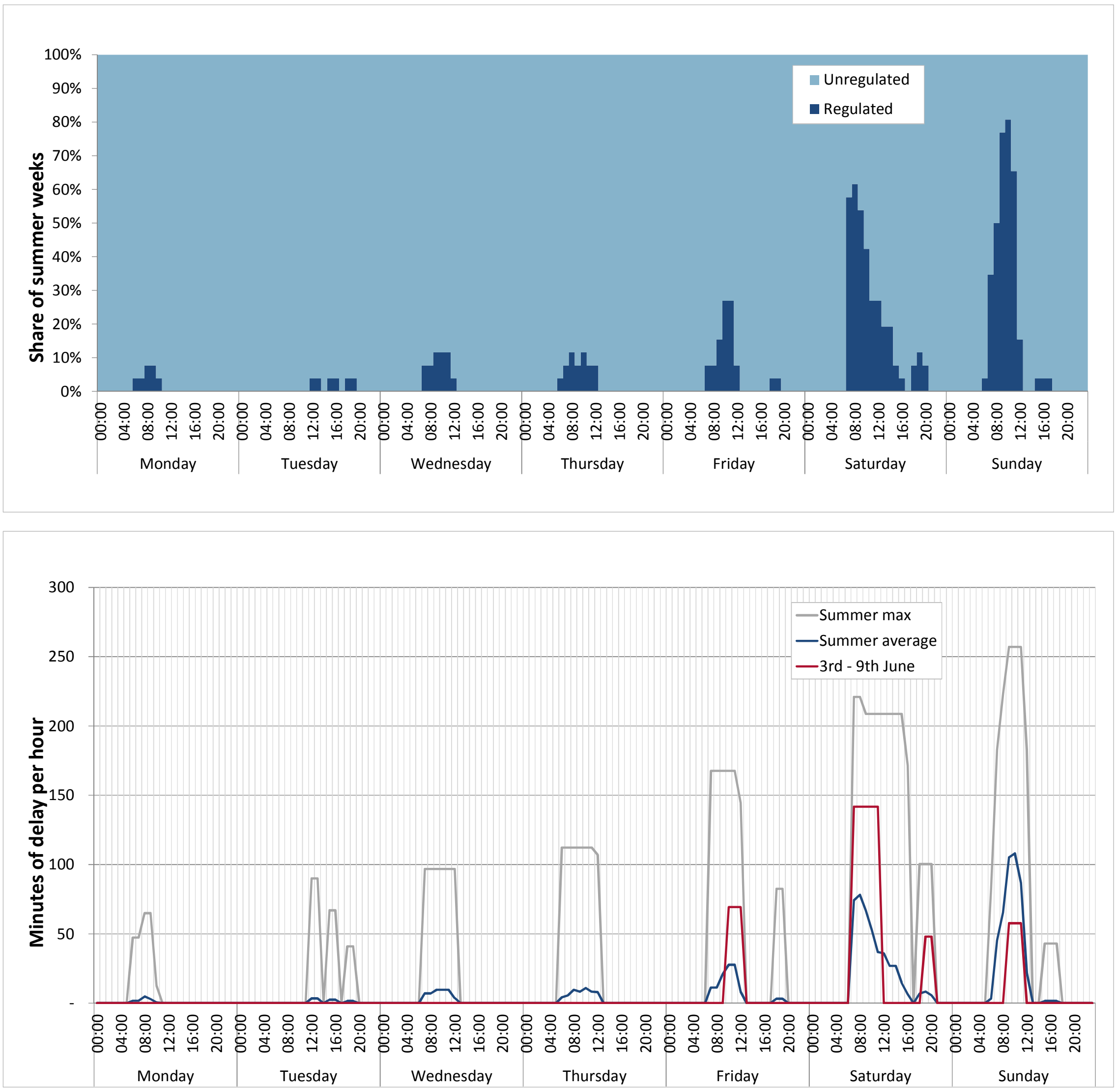
Figure 2.12: Changes in regulation and delay – Zurich terminal sector (LSZH)





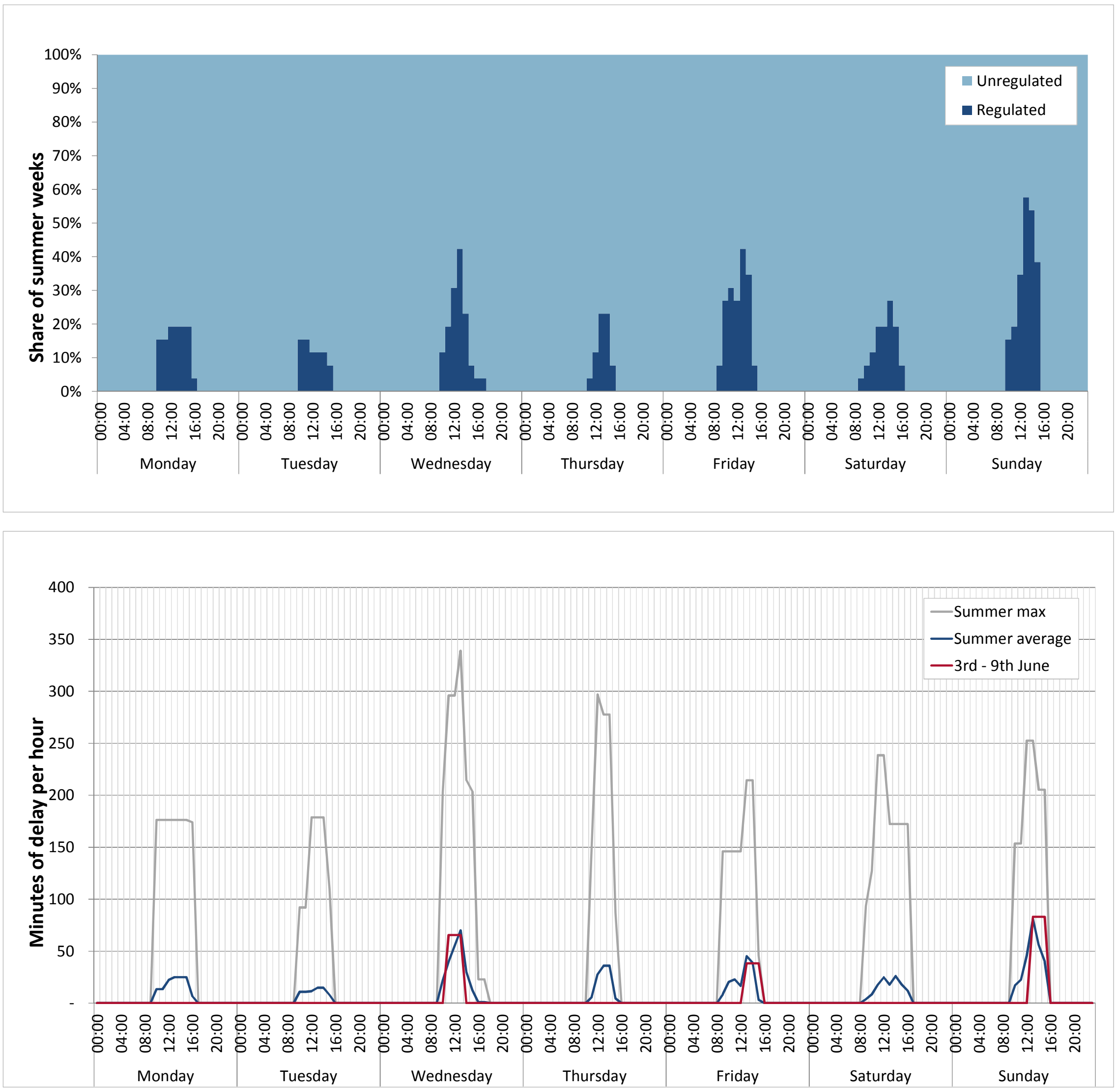
Source: Steer Davies Gleave analysis of NMOC regulation data 2013

Figure 2.13: Changes in regulation and delay – en-route sector in Marseille ACC (LFMMB3)



Source: Steer Davies Gleave analysis of NMOC regulation data 2013

Figure 2.14: Changes in regulation and delay – en-route sector in Warsaw ACC (EPWWJ)



Source: Steer Davies Gleave analysis of NMOC regulation data 2013

2.61 This analysis demonstrates that even the most congested sectors are not regulated most of the time, and that the need for regulation typically varies considerably from hour-to-hour, day-to-day and week-to-week. Even Zurich terminal sector, the most congested of those included in our analysis, was not consistently regulated throughout the summer period, although regulation was applied between 08:00 and 11:00 each day for at least 60% of summer weeks (and on most days for at least 75%). In most cases, regulation of particular hours during the week was applied for less than 50% of weeks.

2.62 In addition, the analysis of delay indicates that the pattern of delay for the average week is not a reliable guide to the pattern for any particular week and that the calculated average level of delay during the summer is typically substantially below the maximum observed. The results for EPWWJ shown above demonstrate that in any particular week there may be no delay during days when there is normally some while on other days the delay may approach the maximum for the summer as a whole. Given these variations, it will generally not be possible to predict levels of congestion substantially before the times at which they arise.

2.63 Nevertheless, these results provide some evidence that terminal congestion tends to be more stable and predictable than en-route congestion, at least when the terminal sector serves an airport that is heavily used during particular periods. We have already noted that Zurich terminal sector is subject to regulation through the week on a relatively consistent basis. In addition the sector serving Heraklion, which experiences peak demand on Wednesdays and Sundays over the summer, is also subject to regulation during specific hours for a relatively high proportion of summer weeks. These observations, while specific to the airports in question, are consistent with the expectation that airlines will be less willing to avoid or retime entry into particular terminal sectors given that flight origins and destinations are clearly determined by the decision to serve a particular market. By contrast, airlines can and do reroute flight operations through different en-route sectors in response to a range of considerations, notably weather conditions which can have a substantial effect on fuel burn and hence on the overall cost of a flight. The differences between terminal and en-route congestion in terms of the ability to reduce them by changing airlines' flight planning decisions are discussed further below in our assessment of congestion pricing options.

Options for congestion pricing

Elements of the charging scheme

2.64 We have considered the following key elements of any charging scheme in developing options for airspace congestion pricing:

- The structure of charges;
- The level of charges and charging differentials; and
- The process for setting charges.

2.65 We briefly discuss the main issues relating to each of these in turn before setting out the options investigated.

The structure of charges

2.66 The basic structure of air navigation charges, as shown in Table 2.2 above, has been subject to review and discussion since its introduction but is now well established within the industry. In our view, it would not be appropriate to introduce a fundamental change to the structure since this would involve significant modification to various industry systems, including those used by Eurocontrol's Central Route Charges Office (CRCO) and those used by airlines to optimise flight plans. We also note that fundamental changes would be likely to meet strong resistance from airlines and other stakeholders and detract from a balanced discussion of the case for congestion pricing. However, within the parameters of the existing structure, it would be possible to provide for some variation in the calculation to reflect relative levels of congestion in the sectors covered by a flight path. This could be achieved either by varying the unit rate, by sector and over time, or by including a fixed supplement to the main charge in the event that a flight passes through one or more congested sectors at some point between its origin and destination.

2.67 Varying the unit rate would arguably result in more effective incentives, since the premium paid for travelling through a sector would depend on the distance travelled within it. In the case of a fixed supplement, a flight would be subject to a premium charge simply because it entered congested airspace, regardless of the distance travelled, but charging on this basis would be simpler and might therefore enable airlines to estimate air navigation costs more easily. The modifications to the existing charging formulae that would be needed to implement each of these structural options are shown in the table below.

Table 2.4: Options for the structure of charges

Option	En-route	Terminal
Current formulae	$\text{Unit rate}_i \times \text{Distance factor}_i \times \left(\frac{\text{MTOW}}{50}\right)^{0.5}$	$\text{Unit rate} \times \left(\frac{\text{MTOW}}{50}\right)^{x}$
	Unit rate varies by ACC i Distance factor = length in km of great circle within ACC i, minus 20km for each take-off or landing within i	Value of *x* varies by ANSP (within a range 0.7 - 0.9)
C1: variation in unit rate by sector and time	$\sum_{j \text{ in } i \text{ and } p} \text{Unit rate}_{jt} \times \text{Distance factor}_{jt} \times \left(\frac{\text{MTOW}}{50}\right)^{0.5}$	$\text{Unit rate}_t \times \left(\frac{\text{MTOW}}{50}\right)^{x}$
	Unit rate varies by sector j and time interval t Distance factor = length in km of great circle within sector j located in ACC i included in flight plan p during time interval t	Unit rate for relevant terminal area varies by time interval t
C2: fixed congestion supplement	$\text{Unit rate}_i \times \text{Distance factor}_i \times \left(\frac{\text{MTOW}}{50}\right)^{0.5} + S_c$	$\text{Unit rate} \times \left(\frac{\text{MTOW}}{50}\right)^{x} + S_c$
	Unit rate varies by ACC i Distance factor = length in km of great circle within ACC i, minus 20km for each take-off or landing within i S_c = supplementary charge included in the calculation if the flight passes through at least one congested sector within the ACC	Value of *x* varies by ANSP (within a range 0.7 - 0.9) S_c = supplementary charge included in the calculation if the relevant terminal area is congested when the flight enters it

Source: Steer Davies Gleave analysis

2.68 The implementation of either option would require a definition of congested airspace in order to identify those sectors and times of the day attracting either a higher unit rate or a supplementary charge. We have already noted the difficulty in determining sector capacity with precision. However, we understand that individual ACCs, in collaboration with the NMOC, do undertake an assessment of the capacity limits of the sectors under their control in order to determine whether there is a need for regulation. We consider that this assessment, given that it provides a basis for operational decisions, could be used in principle to determine whether a sector should attract a higher charge. The designation of a sector as congested for the purposes of charging could even be linked to an assessment of whether it was likely to be regulated over a given period.

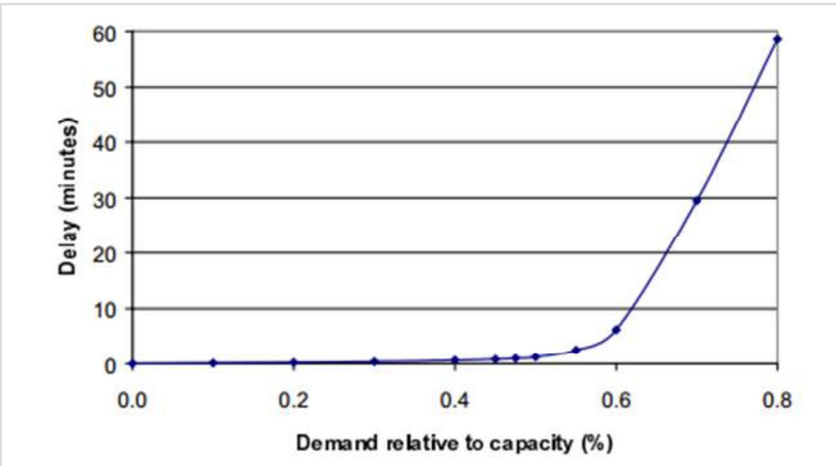
2.69 Once sector capacities have been determined, it is possible to define any number of incremental charges according to the level of capacity utilisation anticipated at a particular time. For example, each sector or group of sectors could be subject to only two charges, with the charge paid depending on whether capacity utilisation in the sector concerned was above or below a defined threshold level. Alternatively, charges could be subject to a more graduated scale corresponding to the range of congestion levels potentially arising (for example, the intervals of capacity utilisation underpinning the presentation of relative congestion levels in Figure 2.5). The latter approach has some merit in that it could provide incentives for airlines to avoid sectors that were heavily utilised as well as those operating at or near capacity. However, charging by reference to a single capacity utilisation threshold would probably be simpler to administer and easier for airlines to factor into flight planning.

The level of charging differentials

2.70 The objective of revenue neutrality necessarily requires that the overall level of charges is similar to that already prevailing and calibrated in order to enable ANSPs to recover their costs. Hence, charges set in line with this objective cannot also cover the economic and social costs of congested airspace, as measured by the cost of delay to which it gives rise. Nevertheless, the differential between charges applied to congested and uncongested airspace could be determined in order reflect the cost of delay, notwithstanding that the average level of charges remained the same. Other things being equal, this would result in charges for the use of uncongested airspace being somewhat lower than those currently in place, balancing higher charges in the more congested sectors.

2.71 The calibration of the associated differential would require an investigation of the relationship between congestion and delay as well as estimation of a value for the cost of delay. We note that previous research has already been undertaken in this area, for example in the course of the study undertaken by PwC into charging for terminal air navigation services[25]. The figure below shows PwC's estimated relationship between the demand for airspace relative to capacity and delay in Marseille ACC, which indicates that delay costs increase sharply once capacity utilisation reaches 60%, although we note that the relationship is likely to vary by ACC and sector. Estimates of the cost of delay per flight are also available, for example from the study by the University of Westminster estimating the hard costs due to passenger rebooking, compensation and care and the soft costs including passengers' perceptions of unpunctual airlines[26] and from the ITA report demonstrating the multiplicative nature of delay costs[27].

Figure 2.15: Relationship between congestion and delay for Marseille ACC



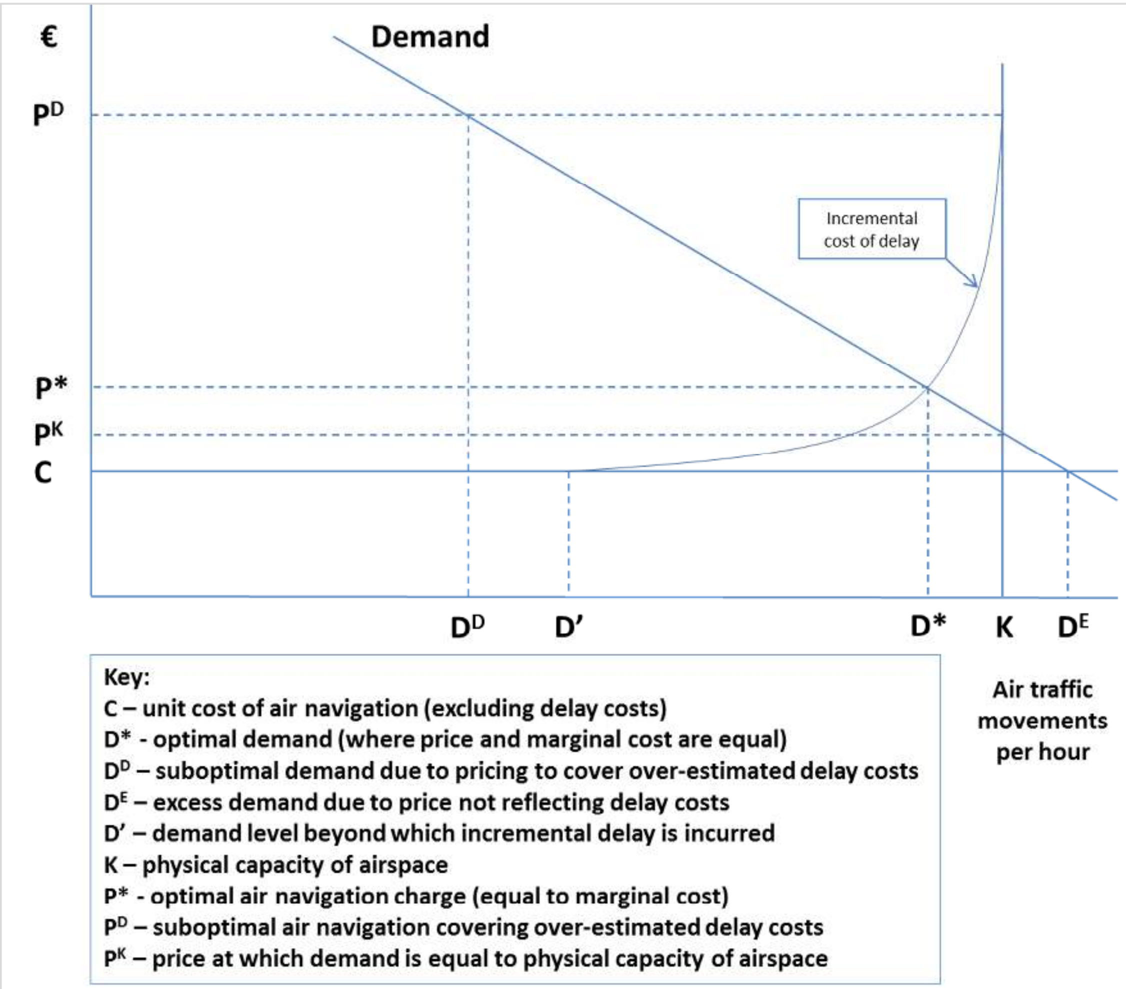
Source: PwC, 2001

2.72 Alternatively, the level of the differential could be set in order to reduce the demand to fly through congested sectors by a given amount in order to bring flight volumes more into line

[25] PwC, 2001, Study of the Terminal Charges for Air Traffic Control Services, Commission of the European Communities.
[26] Cook et al. 2009, The cost of delay to air transport in Europe – quantification and management, 13th Air Transport Research Society.
[27] ITA, 2000, Costs of air transport delay in Europe.

with available capacity, potentially significantly below the level reflecting the economic and social cost of delay. The difference between the two approaches is shown in Figure 2.16, which represents a situation in which the capacity of a sector, measured in terms of air traffic movements per hour, is limited to K and the unit cost of accommodating movements up to capacity is C. If the charge for the service is set at C with the aim of recovering total ANSP costs, the notional demand of D^E cannot be accommodated and the sector must be regulated. In addition, as the number of movements increases above a defined level, D' in the diagram, flights are increasingly disrupted and there is an economic and social cost of delay over and above the cost of providing the air navigation service. With traffic regulated to K movements per hour, the charge is sufficient to cover ANSP costs but does not cover external delay costs.

Figure 2.16: Illustration of different approaches to pricing of a congested sector



Source: Steer Davies Gleave analysis

2.73 The diagram demonstrates how different approaches to congestion charging address different aspects of the problem. Increasing the charge to P^K eliminates excess demand, with traffic reducing to K without the need for regulation, but does not eliminate the substantial cost of delay arising when the sector is at capacity. Increasing it further to P*, defined by the point at which the demand curve intersects the incremental cost of delay curve, reduces demand to the economically efficient level. At this point, airspace users pay a price that is just sufficient to cover both the ANSP's costs and the cost of delay caused by the marginal user. Note, however, that the determination of this optimum for all sectors would require broader consideration of the redistribution of flights and resulting levels of demand relative to capacity across airspace as a whole.

2.74 The diagram also highlights the need to investigate the relationship between changing demand for airspace and changing levels of delay. For the purposes of illustration, it assumes a non-linear relationship whereby incremental delay rises exponentially as congestion within the sector increases. Incremental delay at capacity is therefore substantially above that at lower levels of airspace utilisation. Given the demand conditions shown, calibration of a charge to cover the costs of delay at capacity (P^D in the diagram) would give rise to an inefficient outcome, with a substantial number of flights rerouting to avoid the sector and demand falling to D^D. In these circumstances, capacity would be substantially underutilised, with the possible implication that other sectors would be more congested than previously and/or that the total number of flights would be significantly reduced.

2.75 The two basic options for determining the appropriate charging differential are summarised in the table below. The key difference between them is that whereas D1 involves setting air navigation charges to fully reflect economic and social costs at the optimum level, with the airline response being the dependent variable, D2 involves setting demand in line with capacity (or another appropriate operational objective) and determining the charges needed to achieve this result.

Table 2.5: Options for charging differential

Option	Summary
D1: Calibration by reference to economic and social costs of delay	Would require analysis of the relationship between congestion and delay as well as the estimation of an economic value of delay. The difference between the charges for flying through congested and uncongested airspace would reflect the higher economic and social cost of choosing the former.
D2: Calibration by reference to relative route operating costs	Would require investigation of the commercial incentives to use alternatives routes created by imposing differentiated charges. The resulting charging differential could be expected to influence behaviour in order to achieve either an economically optimum outcome or, perhaps more realistically, a defined operational objective.

Source: Steer Davies Gleave analysis

2.76 We provide illustrative examples of the calculation of a congestion charge under each option in paragraphs 2.82 to 2.112 below, noting that a more comprehensive assessment would involve the use of simulation software to estimate all airline routing choices across European airspace under different pricing scenarios.

The process for setting charges

2.77 We have already noted that we do not consider that a charging scheme in which charges for the use of airspace change in real time is realistic, and that we have focused on the development of a scheme whereby charges are set with the aim of influencing decision-making at the planning stage. This could involve flight and capacity planners responding to a set of charges, however determined, posted at a single point during the overall planning process illustrated in Figure 2.2. In this scenario, the process for setting charges would be similar to that already in place, although their calibration would be more complex.

2.78 The difficulty with this approach is that it would not allow for the possibility that any given set of charges could result in unpredicted and even perverse outcomes, since there would be no opportunity to modify charges in response to emerging patterns of demand for airspace. For example, airlines could be incentivised to route a substantial number of flights through airspace that was expected to be relatively uncongested with the result that the demand for flight paths through these sectors exceeded their capacity. In that event, the implementation of congestion pricing would shift, rather than resolve, the problem, and the resulting allocation of airspace might be no more (and possibly even less) efficient than previously. In principle, this issue could be addressed to some extent by extensive simulation as well as trialling in limited areas of real airspace prior to full implementation, following established practice in implementing road congestion charging schemes reported above. However, there could be no guarantee that simulation and trialling would eliminate, or even substantially reduce, the risk of a perverse outcome following the introduction of a full set of congestion charges.

2.79 This risk suggests a need for a more dynamic approach to the setting of charges, with initial charges posted and then modified according to emerging demand indicated by submitted flight plans. Final charges would be determined through an iterative process, possibly changed several times before the appropriate charging differentials were established. By extension, flight plans would also need to be revised and resubmitted following each posted change in charges, with major implications for the flight planning process. At the very least, it is likely that airlines would need to submit detailed flight plans well before the day of the flight in order to allow time for one or more iterations.

2.80 At first sight, the costs of implementing such a process, in terms of changes to established systems and procedures as well as the associated industry dislocation, would appear to be prohibitive. However, given the importance of minimising the risk of perverse outcomes following the introduction of a congestion pricing schemes outlined above, we nevertheless suggest that a more dynamic approach to the setting of charges is worth some further consideration. A summary comparison of this approach and the simple posted charges option is provided in the table below.

Table 2.6: Options for the process of setting charges

Option	Summary
P1: Dynamic, iterative process for setting charges	Charges for air navigation modified one or more times through an iterative process, taking account of the demand response at each stage. Airlines would need to revise and resubmit flight plans at each stage to allow the NMOC and ACCs to gauge the demand response to a given set of charges.
P2: Simple posted charges	Charges calibrated under one of the options discussed above, and posted at a single point in time during the flight planning process.

Source: Steer Davies Gleave analysis

Summary of options investigated

2.81 In the light of the above discussion, we have subjected the combinations of options set out in the table below to further investigation and assessment. Note that P1 has not been subject to a detailed quantitative assessment in combination with other options. In principle, it could be combined with any structure and level of differentiated charges in order to minimise the risk of an undesirable allocation of airspace, and it can therefore be considered as a method of implementation rather than a fundamentally different form of congestion pricing. Accordingly, our assessment of P1 has focused on the practical issues raised by the introduction of a more dynamic process for setting charges, including the challenges in terms of flight planning and any related implications for procedures and systems.

Table 2.7: Congestion charging options investigated

Option combination	Description	Rationale for inclusion in the study
C1:D2:P2	Differentiated unit rates, with higher rate for specific sectors during periods in which capacity utilisation is expected to exceed a defined threshold. Differential determined empirically in order to generate incentives to reroute flights. Charges posted at a single point in time.	Allows investigation of a relatively sophisticated structure of charges, providing an incentive to minimise distance travelled within a congested sector rather than to simply avoid the sector completely.
C2:D1:P2	Introduction of fixed supplement, payable when a flight passes through specific sectors during periods in which capacity utilisation is expected to exceed a defined threshold. Differential determined according to economic and social cost of delay. Charges posted at a single point in time.	Allows investigation of the impacts of a simpler charging structure and, through comparison with the previous combination of options, an understanding of the trade-off between economic efficiency and greater simplicity.
C2:D2:P2	Introduction of fixed supplement, payable when a flight passes through specific sectors during periods in which capacity utilisation is expected to exceed a defined threshold. Differential determined empirically in order to generate incentives to reroute flights. Charges posted at a single point in time.	Allows investigation of the impacts of a simpler charging structure and a better understanding of how underlying operating costs determine incentives.
P1	Dynamic, iterative process for setting charges.	Allows qualitative investigation of the scope for improving the allocation of airspace through progressive modification of charges.

Source: Steer Davies Gleave analysis

An illustration of congestion pricing

Overview of analysis

2.82 We have already noted that an airline's ability to retime or reroute a flight through en-route sectors is likely to be greater than its ability to avoid terminal sectors during congested periods. The choice of en-route flight path is generally determined by identifying the lowest cost option among the different routes available, taking account of factors such as wind direction, overall journey time and restrictions identified in Eurocontrol's Route Availability Document. The need to enter a specific terminal sector is driven by the decision to serve a particular airline market, except where an airline has a choice of airports at a given origin or destination. Note, however, that even where a city is served by more than one airport, the choice of airport will typically be constrained by market factors (e.g. catchment area), operational considerations and/or levels of runway congestion.

2.83 In assessing the options for congestion pricing described above, we have therefore undertaken separate analysis of charging for en-route and terminal airspace. More specifically:

- In the case of en-route sectors, we have estimated the congestion charge needed to incentivise the rerouting of a flight on a number of sample routes (options C1:D2:P2 and C2:D2:P2 above), and compared this with the fixed supplement representing the economic and social cost of delay in the sectors concerned (option C2:D1:P2).
- In the case of terminal sectors, we have calculated the congestion charge that would be needed to reduce the estimated margin (i.e. operating profit) for a number of sample flights to a level at which they were no longer regarded as commercially attractive, and hence incentivise an airline to withdraw or retime them (option C2:D2:P2), again comparing this with the fixed supplement implied by estimating the economic and social cost of delay (option C2:D1:P2).

2.84 The results give an indication of the levels of charges needed to influence airline flight planning decisions for a range of en-route and terminal sectors. In our view this approach, based on illustrative calculations for sample cases, is more transparent and enables a better understanding of how congestion charges might be taken into account by airlines in the course of a commercially driven flight planning process. This is of particular value for the purposes of this study, which is focused on the practical issues relating to the development of a congestion pricing scheme. At the same time, we note that an understanding of how flights might be redistributed across European airspace in response to such a scheme would require an extensive simulation exercise covering a much larger sample (and possibly the entire population) of flights.

En-route congestion pricing

Estimation of charges based on economic and social cost of delay (option D1)

2.85 We have estimated the impact of congestion on delay by investigating the statistical relationship between demand for airspace during periods of regulation and the associated delay to flights attributed to capacity constraints recorded over the same period. Again, in order to undertake the analysis we drew on data covering all capacity-related regulations in 2013 obtained from the NMOC. The dataset included information on both flight numbers and delay incurred during regulation events in more than 200 sectors. As most of the sectors were regulated on many occasions, the data allowed us to investigate both the general relationship between flight numbers and delay and the specific relationship within individual volumes of airspace.

2.86 The statistical model estimated was a hierarchical linear model in which both intercept and slope parameters are allowed to vary by volume of airspace. The form of the model and the definition of the various parameters are shown in the table below.

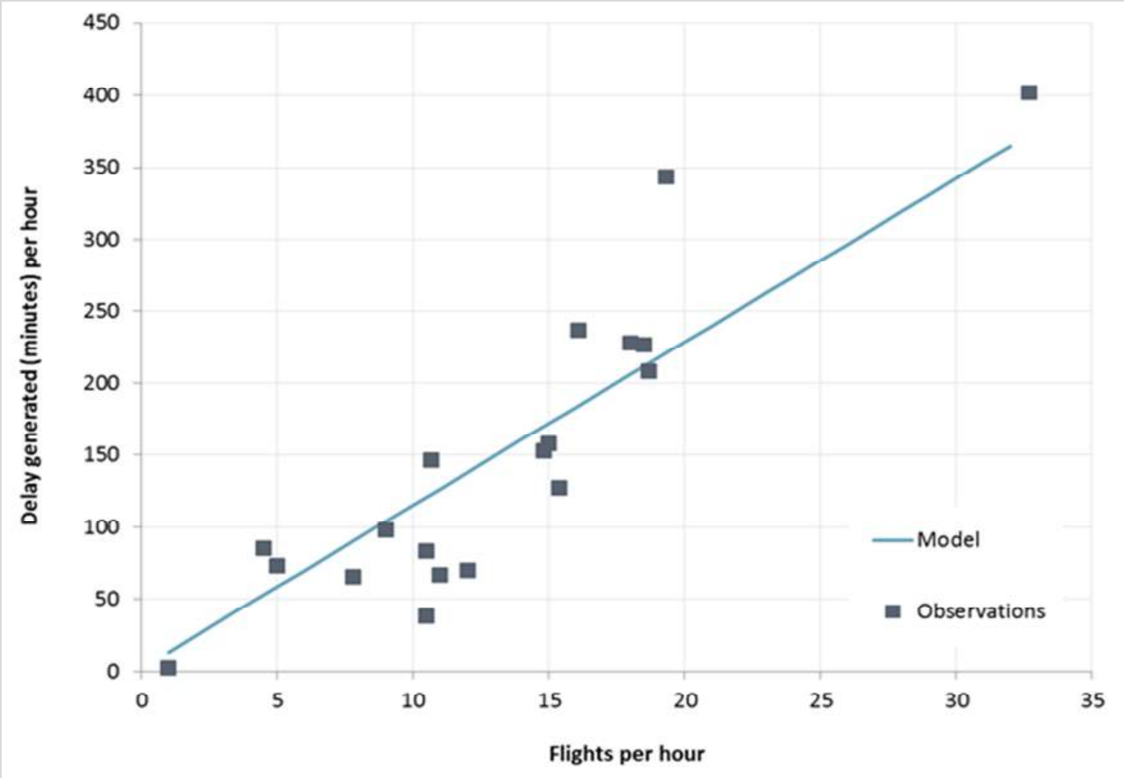
Table 2.8: Hierarchical linear model of the demand-delay relationship

Model specification	
$Y_{ij} = y_{00} + u_{0j} + (y_{10} + u_{1j})\, X_{ij} + e_{ij}$	
Parameter	Definition
Y_{ij}	Delay generated during regulation event *i* in airspace volume *j* Expressed in terms of total minutes of delay generated per hour
X_{ij}	Demand for airspace volume *j* during regulation event *i* Expressed in terms of the total number of regulated flights per hour
y_{00}	The overall intercept of the model
y_{10}	The overall slope of the model
u_{0j}	Deviation of the intercept parameter for an individual airspace volume *j* from the overall intercept A random (normally distributed) variable which varies between different *j*
u_{1j}	Deviation of the slope parameter for individual airspace volume *j* from the overall slope A random (normally distributed) variable which varies between different *j*
e_{ij}	The random errors of prediction at the level of the individual airspace volume A random (normally distributed) variable which varies between different *ij*

Source: Steer Davies Gleave analysis

2.87 By estimating the model parameters, we were able to derive values for the change in delay resulting from a given change in the number of flights per hour for all of the sectors in the sample. Figure 2.17 shows the estimated demand-delay relationship for sector LCCCS12, located in Nicosia ACC. Note that the model assumes a linear relationship between total flights per hour and total delay generated, resulting in a constant value of incremental delay for each flight added. In the example shown below, an additional flight generates approximately 11 minutes of incremental delay across existing airspace users. This is a simpler relationship than that illustrated in Figure 2.16 but is generally supported by the results of the statistical analysis.

Figure 2.17: Estimated and observed demand-delay relationship for LCCCS12



Source: Source: Steer Davies Gleave analysis of NMOC regulation data 2013

2.88 The delay impact of the marginal flight can be used to derive a value of delay by multiplying it by an estimate of the average cost of a minute's delay for airspace users. We have used a value of €89 per minute obtained from the University of Westminster Study cited in the Performance Review Board's proposed principles for incentive mechanisms Draft Paper[28].

Estimation of charges based on relative route operating costs (option D2)

2.89 We have also estimated congestion charge values based on a comparison of the costs of flying between an origin and destination using two different routes. By estimating the total operating costs of a flight routed through a congested sector and comparing these with the costs of an alternative route that avoids the congestion, it is possible to determine the level of congestion charge needed to incentivise the desired change in route. This is likely to vary substantially depending on route and flight characteristics, but in order to illustrate the broad levels of congestion charge implied we have undertaken an analysis of the operating costs of three separate flights made on June 8th 2013. A summary of the main characteristics of each flight is provided in the table below.

[28] Cook et al 2009, The Cost of Delay to Air Transport in Europe – Quantification and Management Paper for the 13th Air Transport Research Society (ATRS) World Conference, Abu Dhabi, June 27-30 2009. Performance Review Board's proposed principles for incentive mechanism Draft Paper 16/10/13. Note this figure has been uplifted for inflation to 2013 prices using the EU28 inflation rate from Eurostat.

Table 2.9: Congestion charge analysis – sample flight characteristics

	Fuerteventura to Friedrichshafen	Budapest to Madrid	Bucharest to Berlin
Aircraft	Airbus A319	Boeing 737-800	Boeing 737-800
MTOW (tonnes)	68	79	79
Fuel consumption (kg/km)	4.1	3.0	3.0
Fuel price ($/tonne)[29]	949	949	949
Great circle distance for calculation of charge (km)	2,035	1,951	1,265

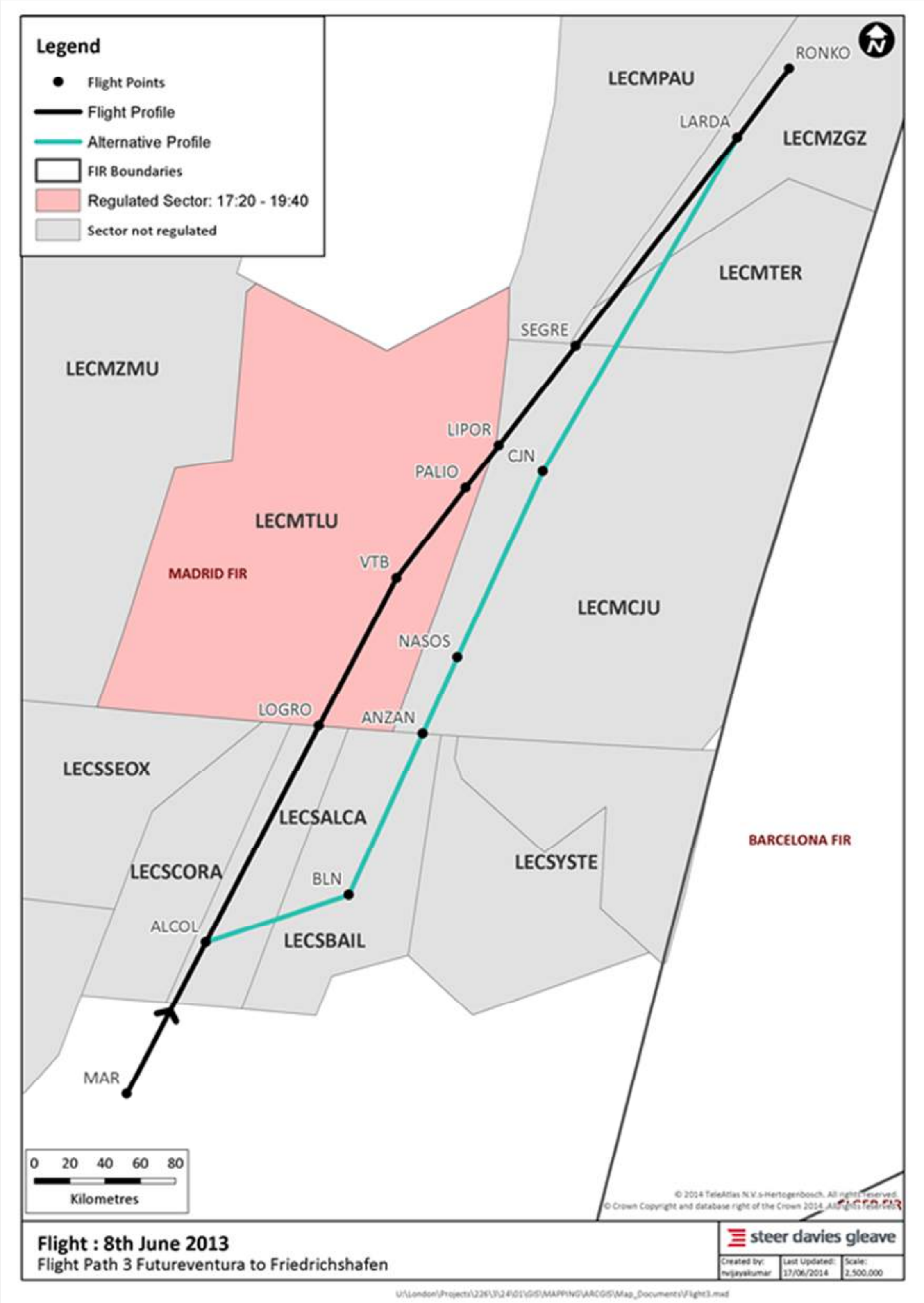
Source: NMOC flight data, Air Berlin website, German Wings website, Central Route Charges Office

2.90 These examples were selected by examining the flight data provided by NMOC and identifying flights operating through regulated sectors and considered capable of being rerouted through adjacent sectors with relatively little impact on the overall distance travelled by the aircraft. In each case, we also identified an alternative route by referring to the route structure operating on the day in question and selecting a flight path avoiding the congested sector. Given that the analysis was for the purposes of illustration, we did not confirm that the alternative routes were permitted by the Route Availability Document or that they represented the shortest possible route extension. Nevertheless, the route selection process was broadly analogous to that underpinning route optimisation software such as LIDO, which is used by a number of airlines in flight planning. Figure 2.18 to Figure 2.20 show the path of the actual flight and the alternative route on which the comparison of costs was based.

2.91 In the first example shown, the flight enters Madrid ACC close to the Strait of Gibraltar and travels north, crossing the regulated sector LECMTLU located over the centre of Spain and then continuing into Bordeaux ACC. The alternative route takes the aircraft through LECMCJU and LECSYSTE, both of which are also located in Madrid ACC, and the points of entry to and exit from the ACC therefore do not change. Consequently, in the absence of congestion charging the alternative route does not result in a change to air navigation charges, although it does result in additional fuel consumption due to the longer distance flown.

[29] Fuel price on 14the April 2014, sourced from **http://www.iata.org/publications/economics/fuel-monitor/Pages/price-analysis.aspx**. Converted to Euros at $1=€0.72.

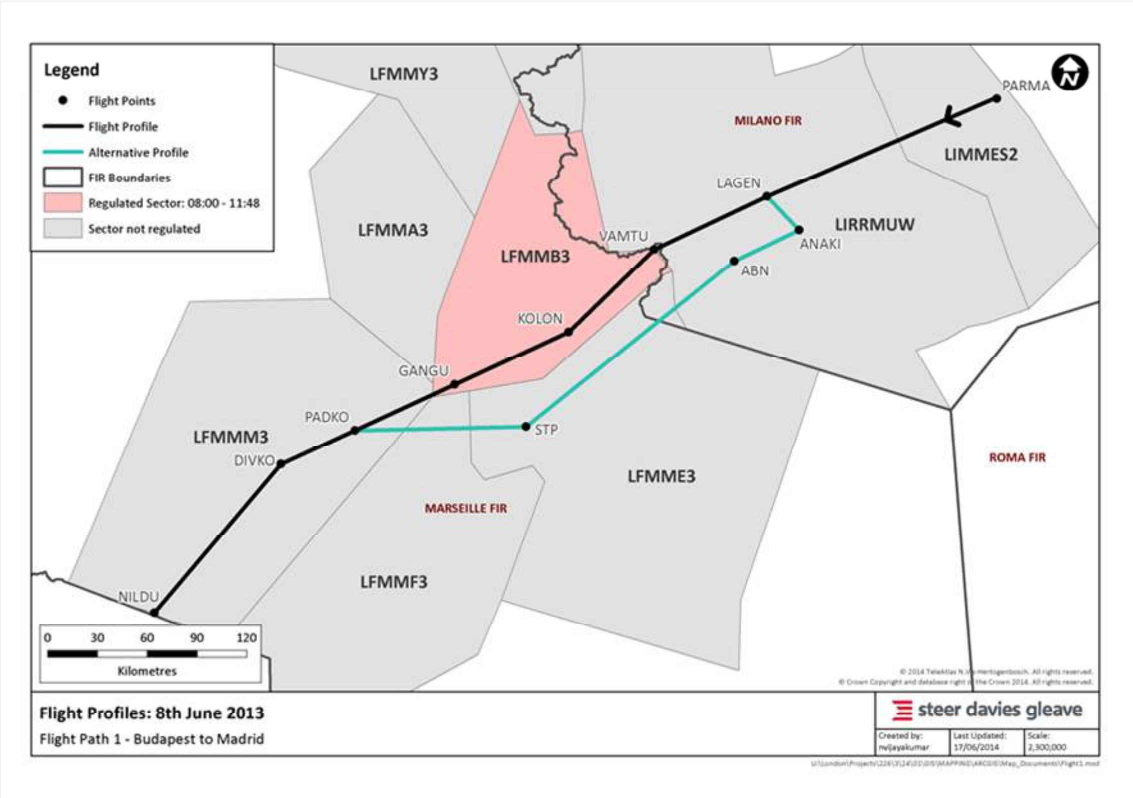
Figure 2.18: Fuerteventura to Friedrichshafen



Source: NMOC flight data 2013, EUROCONTROL Regional Charts 2013, Steer Davies Gleave analysis

2.92 In the second example shown below, the flight enters French airspace along the Mediterranean coast between Nice and Gerona and crosses into LFMMB3, a frequently congested sector in the vicinity of Marseille airport. In the alternative routing, it crosses into Marseille airspace at a point further east, and consequently occupies Milan airspace for longer. The changes are, however, relatively small, and the difference between the relevant unit rates for air navigation is limited, and there is therefore little impact on air navigation charges (again, absent congestion charging). The alternative route does add 47km to the flight length however.

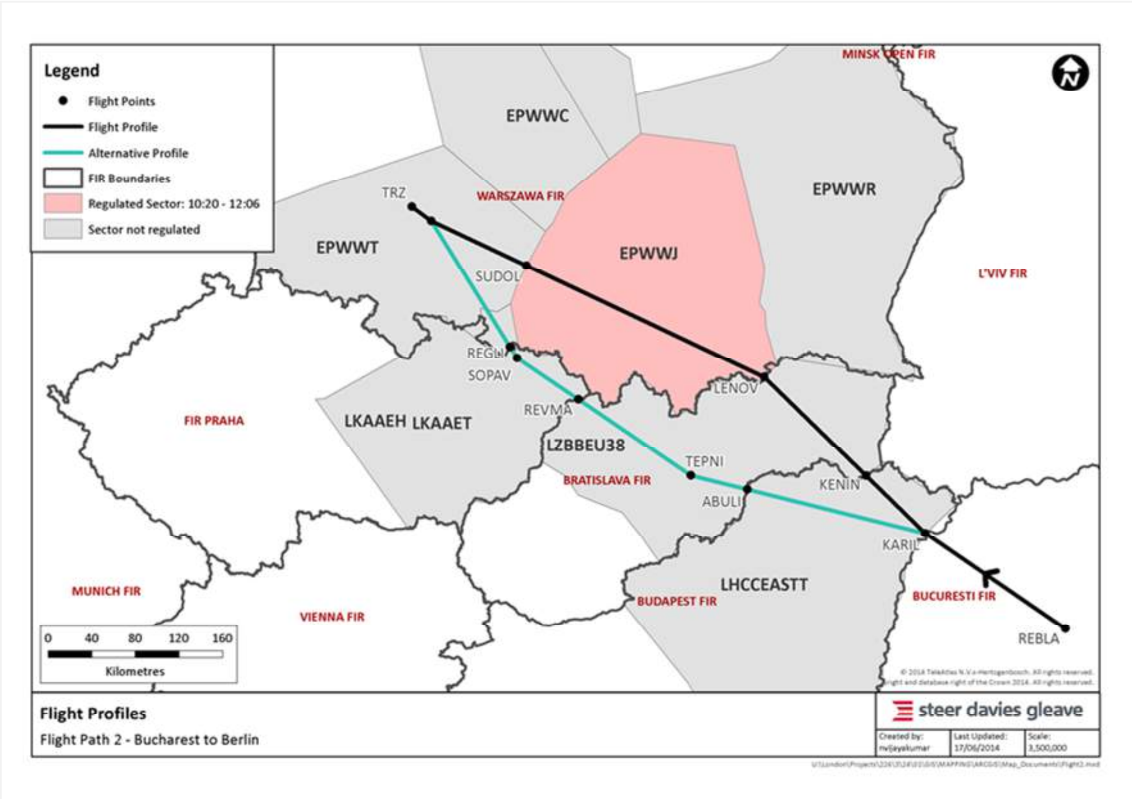
Figure 2.19: Budapest to Madrid



Source: NMOC flight data 2013, EUROCONTROL Regional Charts 2013, Steer Davies Gleave analysis

2.93 In the final example, the flight enters the regulated sector EPWWJ at around the halfway point, immediately after leaving Bratislava airspace. The alternative route requires it to travel further through Budapest and Bratislava ACCs and to enter Prague airspace for a short time. Air navigation costs increase due to the substantial reduction in the use of Warsaw airspace (which is subject to the lowest unit rate of the four ACCs covered by the revised route). The flight extension is 21km.

Figure 2.20: Bucharest to Berlin



Source: NMOC flight data 2013, EUROCONTROL Regional Charts 2013, Steer Davies Gleave analysis

2.94 Table 2.10 compares the distances travelled and costs incurred for the original and alternative routes for each of the three examples. We have assumed that cost differences are entirely due to differences in the distance travelled, driving changes in fuel consumption, and any changes in air navigation costs arising from the use of different paths through different charging zones[30]. Given that the route extension is relatively short in each case, we have assumed no impact on crew and other operating costs.

Table 2.10: Comparison of flight distances and costs (2013 prices)

	Fuerteventura - Friedrichshafen			Budapest - Madrid			Bucharest - Berlin		
	Original	Revised	Change	Original	Revised	Change	Original	Revised	Change
Actual length of divergent route (km)	548	565	17	287	334	47	554	575	21
Number of charging zones along divergent route	1	1	0	2	2	0	3	4	1
Fuel consumption (kg)	2,223	2,265	42	863	1,004	141	1,665	1,729	164
Air navigation costs along divergent route (€)	771	771	0	805	807	2	379	417	39
Fuel costs (€)	1,518	1,547	28	590	686	96	1,137	1,181	44
Total costs subject to change (€)	2,289	2,318	28	1,395	1,493	98	1,516	1,598	83

Source: Source: Steer Davies Gleave analysis based on NMOC flight data

30 Air navigation charges have been calculated using the formula applied by the CRCO, with the distance factor given by the great circle distance between the points of entry to and exit from the charging zone.

2.95 Note also that this analysis does not take into account the costs of the additional carbon and other emissions arising from aircraft flying longer distances. In principle, such costs could be taken into account, at least in part, through the pricing of carbon emissions under the ETS. Airspace users paying to emit carbon would take account of the associated costs in responding to congestion price signals in the same way that they took account of the additional fuel costs resulting from flying along the divergent route. However, the inclusion of emissions costs in the trade-off between additional operating costs and the congestion charge would only give rise to an economically efficient outcome if carbon was priced correctly by the ETS.

2.96 In practice, there is evidence that the ETS may be substantially under-pricing carbon because of the volume of Emissions Allowance Units in circulation. We also note that the inclusion of aviation within the ETS has been achieved partly through the introduction of derogations for certain types of traffic. The current traded price of carbon is therefore unlikely to provide a realistic indication of the environmental impact of emissions. This is illustrated in the table below, which compares the additional carbon costs for each of the three routes valued on the basis of the maximum carbon price prevailing in 2014 (€7.54 per tonne) with those valued on the basis of the carbon price used by the UK Department for Transport for the purposes of investment appraisal (€73.61 per tonne).

Table 2.11: Comparison of additional costs of carbon emmissions on diverted routes (2014 prices)

	Fuerteventura - Friedrichshafen	Budapest - Madrid	Bucharest - Berlin
Carbon costs valued at ETS price	€0.14	€0.50	€0.23
Carbon costs valued at Department for Transport (mid-range) price	€7.84	€26.97	€12.24

Source: Source: Steer Davies Gleave analysis

2.97 These comparisons demonstrate that the environmental impacts of congestion pricing could not be taken into account simply through the inclusion of ETS emissions prices in the calibration of charges. Instead, such impacts would need to be calculated separately, using a carbon price more reflective of estimated emissions costs, and compared with the estimated benefits of congestion pricing as part of the calibration process. In practice, an iterative process might be required in order determine the optimal balance between reduced delay costs, on the one hand, and additional environmental impacts on the other.

Estimated en-route congestion charges

2.98 Our estimated congestion charges under each of the options described in Table 2.7 are set out in the table below. The fixed supplement option C2:D2:P2 is derived directly from the difference in estimated operating costs for each of the example flights described above. We have also estimated unit rates (option C1:D2:P2) by calculating sector specific distance factors and using these in combination with the MTOW to determine the unit rates giving the same overall congestion charge as the fixed supplement. We have assumed that these distance factors would continue to be based on great circle distances and calculated according to the following formula:

$$D_i = \frac{\text{Length of flight plan inside sector i}}{\text{Length of flight plan inside charging zone}} \times \text{Great circle distance inside charging zone} \div 100$$

2.99 This formula has the effect of leaving the total great circle distance within a charging zone unchanged while allowing distance factors to vary by sector and reflect the point profile described by an aircraft's flight plan.

Table 2.12: Estimated en-route congestion charges (2013 prices)

		Fuerteventura - Friedrichshafen	Budapest - Madrid	Bucharest - Berlin
Congested sector		LECMTLU	LFMMB3	EPWWJ
Additional delay caused by additional flight (mins)		4.5	4.1	9.7
C2:D1:P2	Fixed supplement based on economic and social cost of delay (€)	400	367	859
C2:D2:P2	Fixed supplement based on operating cost comparison (€)	28	98	82
C1:D2:P2	Additional unit rate based on operating cost comparison (€)	13	53	38
Total unit rate (existing rate plus C1:D2:P2) (€)		85	118	74

Source: Source: Steer Davies Gleave analysis

2.100 These results indicate a wide range between estimates of the congestion charge based on the economic and social cost of delay and those calibrated according to differences in operating costs incurred on alternative routes. The introduction of charges calculated according to the first approach would result in substantial increases in the air navigation costs for an individual flight and could be expected to deter a high proportion of flights from entering the congested sector. In the case of the Bucharest – Berlin flight, the estimated supplement of €859 would represent a 353% increase on air navigation costs of travelling through Warsaw airspace.

2.101 However, while such charges would generate strong incentives, they might not represent an optimum level for the purposes of efficient congestion pricing. We noted above that the model used in the estimation assumed a simple relationship between demand and delay, effectively resulting in a constant level of incremental delay for each additional flight entering a sector. While the model results appear robust, they are based on an estimation of the relationship using data for regulated sectors which, by definition, are highly congested. Estimation of the relationship over a wider range of sector utilisation values is likely to give different results, with individual flights at lower levels of demand resulting in less delay than is suggested by the figures in Table 2.12. The values estimated for option C2:D1:P2 may therefore tend to approximate the price level represented by P^D in Figure 2.16 above rather than that represented by P*. If so, the imposition of charges at this level would lead to a significant reduction in air traffic operating through some sectors and inefficient underutilisation of the capacity available.

2.102 The charges estimated by reference to operating costs are, however, substantially lower and create the required incentives without substantially increasing overall air navigation costs. In the case of the Budapest Madrid flight, the fixed supplement under option C2:D2:P2 represents an increase of some 32% on the air navigation costs of flying through Marseille airspace. The equivalent increase in the unit rate under option C1:D2:P2 is 82%. While these increases are significant, they represent a more manageable change to the overall operating costs of the flight than those resulting from air navigation charges reflecting the full economic and social cost of delay.

2.103 Nevertheless, our analysis of both options indicates that charges for flying through congested sectors would be substantially higher than at present. Given the objective of revenue neutrality, this would mean that charges for uncongested sectors would need to fall. Overall, the structure of charges would be calibrated in order to preserve the charging differentials underpinning the incentive to reroute or reschedule flights while maintaining the same level of revenue as would otherwise be collected by ANSPs (sufficient to cover their efficient costs, including a return on capital).

2.104 Note, however, that preserving revenue neutrality for an individual ANSP through charging alone would probably prevent the calibration of an efficient structure of charges for European airspace as a whole. For example, a situation could arise whereby the charge for access to a congested sector was lower than that for adjacent uncongested airspace because it was controlled by a low cost ANSP, an issued considered further in paragraphs 2.143 to 2.146.

Terminal congestion pricing

Estimation of charges based on flight economics

2.105 Encouraging airlines to avoid congested terminal airspace is likely to require stronger commercial incentives, since a carrier wishing to serve a particular airport during a given day of the week and hour of the day must have access to the associated terminal sector within the relevant time window. In order to incentivise a reduction in terminal sector traffic, congestion charges would need to be set at a level that reduced the profitability of a number of flights such that airlines were willing to retime them or even redeploy the aircraft on to more profitable routes. We have therefore undertaken an investigation of flight economics on a number of routes to estimate the range of possible operating margins earned and calibrated congestion charges by determining the charging level needed to significantly reduce them.

2.106 This approach is subject to qualification as information on flight operating margins is confidential and not generally available. In particular:

- Airlines do not publish profitability route-by-route; and
- Nor do they publicise margin thresholds underpinning commercial decisions about which routes to serve.

2.107 Costs and margins must therefore be estimated based on available information about route characteristics, aircraft operated and published data on the overall profitability of individual airlines. Drawing on this information, SDG has developed a model of flight operating economics, and we have used this to estimate flight costs and margins on a range of routes. The model takes account of a number of factors affecting route margins, notably:

- Route characteristics: distance flown will affect fuel burn as well as crew and maintenance costs, while the route itself will determine the level of air navigation charges;
- Type of aircraft: in general, the larger the aircraft the higher the capital and operating costs (including fuel and air navigation costs); and
- Carrier business model: low cost airlines generally earn higher margins than traditional carriers, and different versions of the low cost model can also give rise to different levels of profitability.

2.108 We have used the model to estimate operating costs and margins for a traditional carrier and two different types of low cost carrier. Note that the results obtained are not intended to represent the flight economics of particular carriers, although they have been calibrated using published information for airlines within each category of operation. In particular, in the absence of detailed data on route profitability, we have assumed that the operating margin for each route is in line with the average profitability of an airline within the relevant category (as indicated by airline financial accounts published within the last two years.

2.109 In practice, operating margins vary substantially by route as well as by airline. Moreover, they may provide only limited information about the contribution of a route to overall profitability, depending on the operating model adopted by the airline. For example, a traditional carrier may choose to continue operating on a short haul route despite earning an apparently low margin from the traffic carried as the flight feeds a more profitable medium or long haul route. More generally, individual route margins earned by network carriers, to the extent that they can be meaningfully calculated at all, typically provide little or no guide to how an airline will react to an increase in route operating costs whether this results from the imposition of a congestion charge or some other cause.

2.110 Notwithstanding the limitations of the analysis described above, the results of our modelling provide a guide to the levels of congestion charge needed to reduce terminal sector congestion for a range of routes and airline types. Key characteristics of the routes modelled are summarised in Table 2.13 and the assumptions underpinning the representation of the different airline business models are shown in Table 2.14.

Table 2.13: Routes selected for modelling of operating costs

Route	Distance (km)	Regulated terminal sector	Airport served by congested sector
London – Amsterdam	360	EHAM	Amsterdam Schiphol
London – Edinburgh	575	EGKK	London Gatwick
London – Milan	900	EGKK	London Gatwick
Frankfurt – Istanbul	1,900	EDDF	Frankfurt

Source: NMOC regulation data 2013

Table 2.14: Airline business models – key assumptions

Business model	Key characteristics	Aircraft operated		Route margin
		Short haul	Medium/long haul	
Traditional carrier	Mid-range national carrier	Airbus A320	Airbus A330	2.5%
Low cost 1	Large low cost operation	Airbus A320	-	7.5%
Low cost 2	Ultra low cost carrier	Boeing 737-800	-	12.5%

Source: Route margins based on Source: Steer Davies Gleave analysis of published airline accounts

Estimated terminal congestion charges

2.111 The results of our analysis, including estimated congestion charges for a number of terminal sectors, are shown in the table below. Congestion charges reflecting economic and social costs of delay have been determined using the methodology described in paragraphs 2.85 to 2.88. Those implied by route margins have been calibrated on the assumption that they would need to be set to reduce the estimated route margin to 25% of its previous value in order to modify airline decisions about whether and when to operate into the associated airport. In practice, it may be possible to set charges at a lower level, sufficient to reduce margins below an alternative threshold. The estimated values nevertheless provide an indication of the level of charges needed to provide the required commercial incentive.

Table 2.15: Estimated terminal congestion charges (2013 prices)

Route[31]	Route costs (€)[32]		Airline business model		
			Traditional carrier	Low cost 1	Low cost 2
London - Amsterdam	Existing terminal charges	Arrival	227	227	196
		Departure	-	-	-
	Total operating costs		13,000	12,000	9,100
	Estimated margin		325	900	1,138
	Congestion charge (economic and social cost)	Fixed supplement (C2:D1:P2)	654	654	654
	Implied congestion charge (75% of margin)	Fixed supplement (C2:D2:P2)	244	675	854
		Unit rate (C1:D2:P2)	81	486	711
London – Edinburgh	Existing terminal charges	Arrival	-	-	-
		Departure	-	-	-
	Total operating costs		12,900	11,600	8,400
	Estimated margin		323	870	1050
	Congestion charge (economic and social cost)	Fixed supplement (C2:D1:P2)	1,120	1,120	1,120
	Implied congestion charge (75% of margin)	Fixed supplement (C2:D2:P2)	242	653	788
		Unit rate[33] (C1:D2:P2)	-	-	-
London – Milan	Existing terminal charges	Arrival	353	353	306
		Departure	-	-	-
	Total operating costs		16,000	14,000	10,700
	Estimated margin		400	1,050	1,338
	Congestion charge (economic and social cost)	Fixed supplement (C2:D1:P2)	1,120	1,120	1,120
	Implied congestion charge (75% of margin)	Fixed supplement (C2:D2:P2)	300	788	1,004
		Unit rate (C1:D2:P2)	100	567	836
[illegible]	Existing terminal charges	Arrival	-	-	-
		Departure	514	-	-

[31] Note that London airports charge directly for terminal air navigation services rather than through Eurocontrol.
[32] Fixed supplements based on economic and social cost have been calculated for airport with regulated terminal airspace in 2013 data sample.
[33] Unit rate is not applicable as the charge is made by the airport rather than via Eurocontrol using the standard formula.

	Route costs (€)[32]		Airline business model		
	Total operating costs		22,900	-	-
	Estimated margin		573	-	-
	Congestion charge (economic and social cost)	Fixed supplement (C1:D2:P2)	1,791	-	-
	Implied congestion charge (75% of margin)	Fixed supplement (C2:D2:P2)	430	-	-
		Unit rate (C1:D2:P2)	143	-	-

Source: Source: Steer Davies Gleave analysis

2.112 These results suggest that terminal congestion charges would need to be set at relatively high levels if they were to materially influence airline decisions about whether to serve a particular airport at a given time. As in the case of en-route charges, calibration on the basis of airline operating costs appears to yield lower charges than calculation based on an estimate of the economic and social cost of delay for the relevant sector. In most cases, however, estimated congestion charges imply at least a doubling of existing terminal air navigation costs.

Implementation issues

Overview

2.113 The discussion above focused on the level of congestion charges required to influence airline decisions about the markets served and routes flown. It assumed that it would be possible to provide signals to airlines at appropriate points in the planning process illustrated in Figure 2.2 such that they could react in a way that changes the ultimate distribution of traffic across European airspace. It also assumed that these reactions could be anticipated with sufficient confidence to allow congestion charges to be posted at a single point in time (as in option P2 in Table 2.6), and that air navigation monitoring and billing systems would have the capability to enable charges to be calculated efficiently and accurately notwithstanding the greater complexity of the charging structure.

2.114 As already noted, in practice the process of setting congestion charges would probably need to be more dynamic as levels and patterns of congestion are not stable and predictable and airline reactions to a given structure of congestion charges cannot be known in advance. In addition, we consider that a different process would be needed for setting en-route charges from that for setting terminal charges since the decisions that each set of prices are intended to influence are made at different times. More specifically:

- The route taken by a flight is decided in near or actual real time, often based on an optimisation exercise using route planning software a few hours before the aircraft takes off, and it would be necessary to provide pricing information within the same time frame if charges were to reflect and influence emerging levels of congestion; and
- The demand for terminal airspace is determined by the markets an airline wishes to serve, as reflected in its schedule, and congestion charges would therefore need to be available to airspace users as early as at the schedule planning stage.

2.115 In both cases, it might be necessary to modify charges in response to changes in airline plans, as under option P1, as there could be no guarantee that any set of charges initially posted were optimal (resulting in an efficient distribution of traffic across the available airspace). It is not clear how many iterations would be needed to achieve an optimal outcome, although it is possible that the number would reduce over time as airlines, ANSPs and Eurocontrol became more familiar with the process and the available data on the relationship between demand and charges increased.

2.116 Implementation would be further complicated by the need to ensure that congestion charging was consistent with the broader framework of regulated charges affecting the commercial decisions of airlines and ANSPs. For example, it would be important to co-ordinate the introduction of terminal congestion charges with the imposition of analogous charges designed to reduce the demand for congested runway capacity at the associated airport. At the same time, charging for congested airspace more generally would need to be consistent with incentive mechanisms for improving the availability of capacity, for example incentives on ANSPs to meet targets through investment and other means.

2.117 We consider these issues in more detail below before evaluating the various options investigated, drawing conclusions and making recommendations. In each case, we distinguish between en-route and terminal congestion charging as the practical issues surrounding the implementation of each are different.

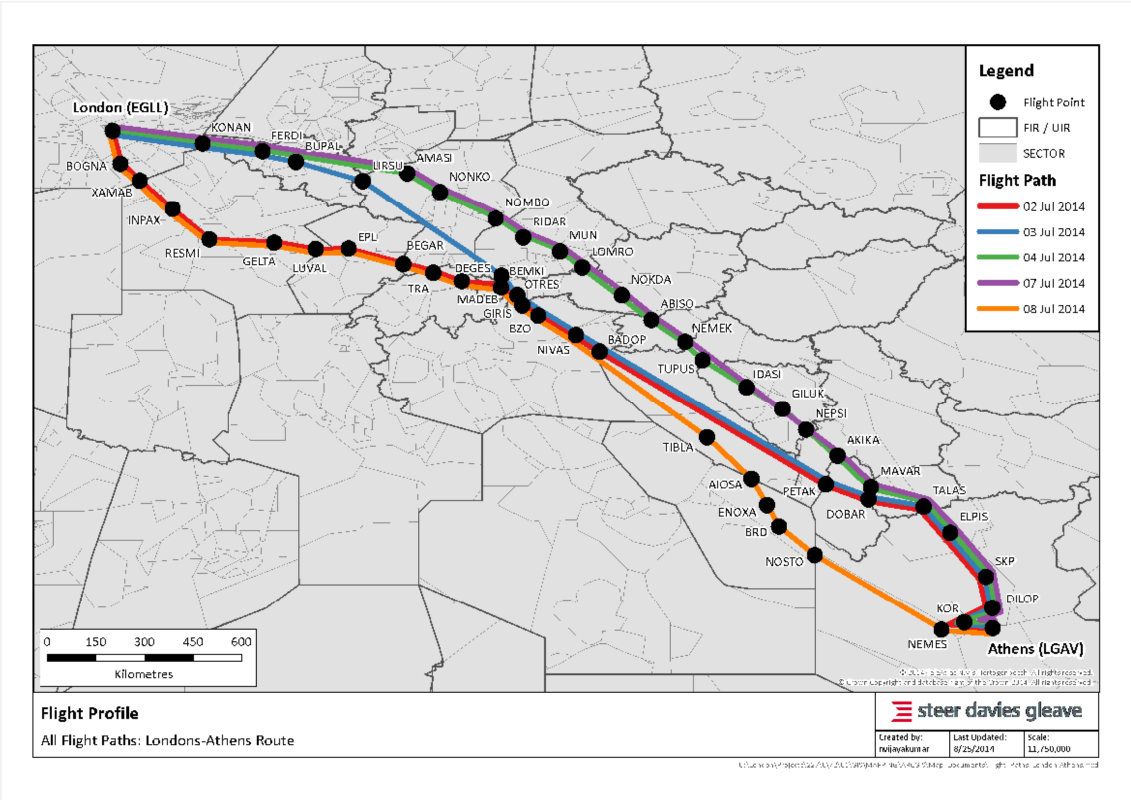
The process for setting charges

En-route congestion charging

2.118 From our discussions with airline and ANSP stakeholders as well as with Eurocontrol, we understand that airlines typically review route plans several times in the 24 hours preceding the flight time, and that the route taken may not be finalised until a short time before take-off. Moreover, flight plans that have already been filed may be amended in response to regulations or new information about the availability of routes. Planned routes can be subject to substantial change, particularly as a result of changing weather patterns affecting the safety of a route and the expected fuel burn.

2.119 Figure 2.21 shows the flight profiles on five successive days in July 2014 for a service between London and Athens operated by a major airline. The difference between the flight paths 4 and 5 in terms of distance flown is 350km, equivalent to a difference in fuel burn of 1,053kg and in fuel costs of €719 (based on the assumption that the route is operated by a Boeing 737-800). This demonstrates the potential for the demand to operate through particular en-route sectors to change significantly from day to day, as well as the difficulty of anticipating airline reactions to a given congestion charge with confidence.

Figure 2.21: Variation in flight paths on London – Athens service



Source: Steer Davies Gleave analysis

2.120 Setting efficient congestion charges would require knowledge of the price sensitivity of airline decisions about choice of route. If, for example, the demand to fly through a given volume of airspace was highly price sensitive, setting the premium too high or too low could lead to major, sub-optimal changes in the distribution of traffic between sectors. This is illustrated in Figure 2.22 below, which shows three possible demand scenarios.

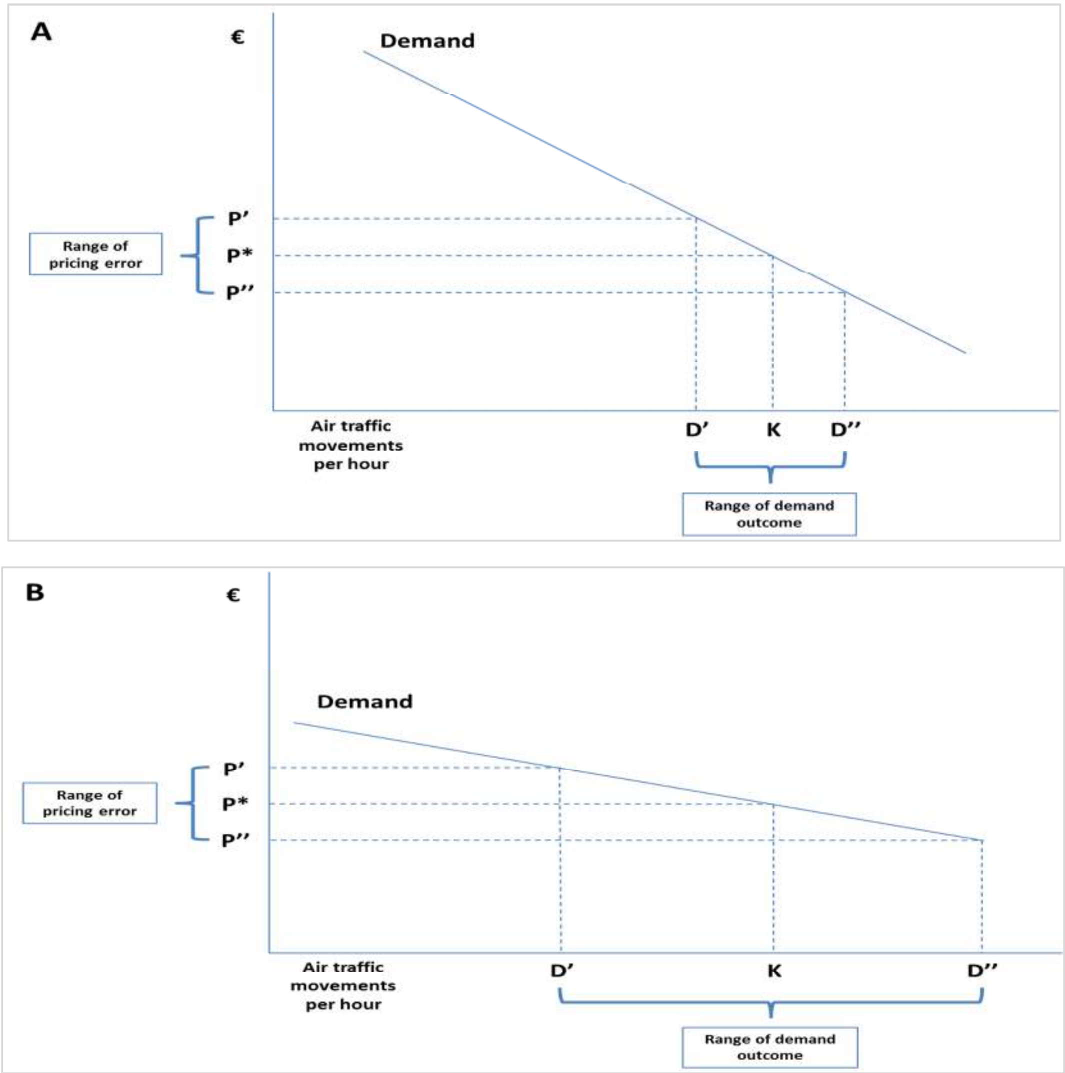
2.121 In all three scenarios, the price at which demand is equal to the capacity of the sector K is represented by P*[34]. In practice, determining this price with precision is likely to be challenging, particularly given the dynamic and time constrained nature of route planning, and the price actually set will be subject to error (represented by the price range P' – P'' in the diagram). The impact of this error on demand depends critically on the elasticity of demand to fly through the sector, which is likely to vary significantly from one sector to another.

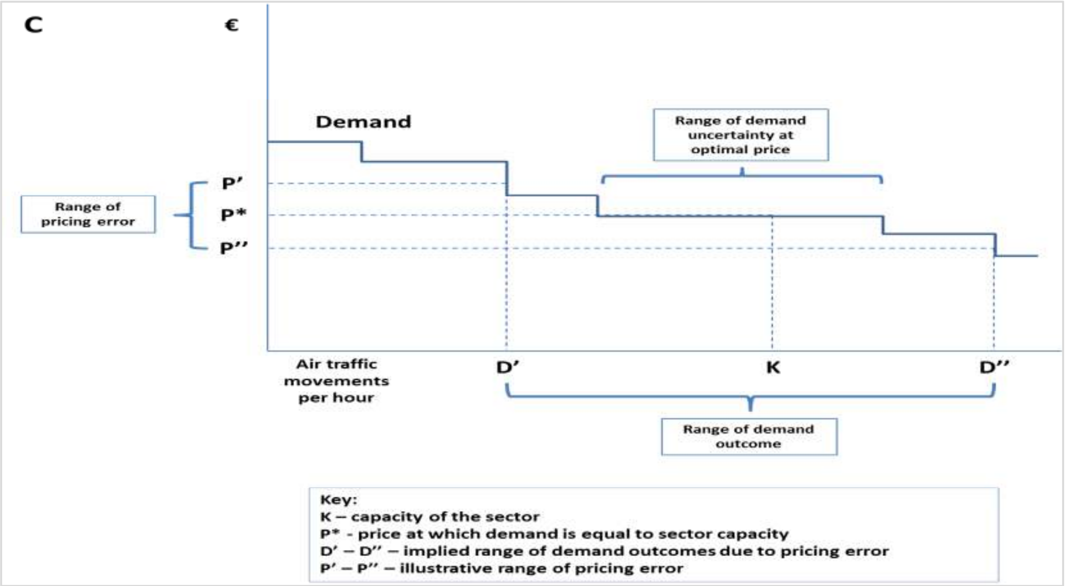
2.122 In Scenario A, demand is relatively inelastic and setting the congestion price within the error range indicated in the diagram therefore results in only limited deviations of demand from capacity. By contrast, in Scenario B the same pricing error range implies a much wider range of possible demand outcomes with, for example, a price of P' resulting in a substantial reduction of demand and sub-optimal use of the available capacity. Moreover, it is possible that the diversion of traffic in these circumstances would lead to a commensurate increase in the demand to fly through an adjacent sector, effectively switching the location of, rather than alleviating, the congestion problem.

[34] As previously discussed, the optimal price P* should also cover the costs of delay at the margin. Here, we have defined P* as the price at which demand is equal to physical capacity in order to simplify the analysis. In any event, there is no clear basis for allocating delay costs to individual sectors ex ante.

2.123 Scenario C illustrates a further possibility, in which the demand curve takes the form of a series of steps rather than a continuous line. This represents a situation in which flights operate along a number of standard corridors within a sector, with flights along a given corridor facing similar costs if they reroute. As in Scenario B, the range of demand outcomes implied by the indicated pricing error range is relatively wide, with over-pricing resulting in substantial under-utilisation of capacity. In addition, the vertical line indicating the maximum capacity of the sector intersects the demand curve at point on a horizontal section. As a result, the level of demand at the theoretically optimum price of P* is indeterminate, since this represents the threshold at which a number of flights might choose to either reroute or continue to operate through the congested sector. The associated range of demand uncertainty includes levels of demand significantly above and below the available capacity.

Figure 2.22: Different airspace demand scenarios

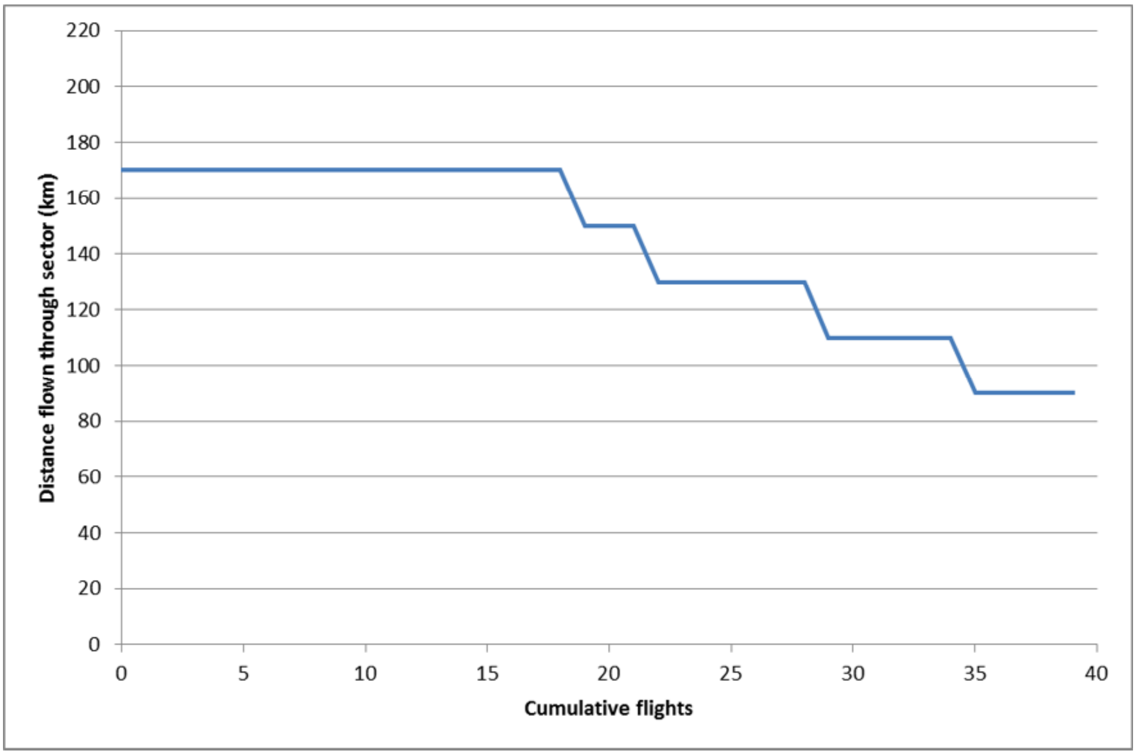




Source: Steer Davies Gleave analysis

2.124 In order to assess the potential price sensitivity of demand for a given volume of airspace, we have investigated the number and routing of flights through LFMMB3 (the sector in Marseille ACC used to illustrate flight profiles in Figure 2.3) over a single hour during the period of regulation on 8th June 2013. Figure 2.23 shows cumulative flights within defined distance bands, ranked in descending order of distance flown; the cumulative values on the horizontal axis give the number of flights travelling further than the lower limit of a given distance band (for example, a total of 34 flights flew more than 100km and all 39 flights flew more than 80km). While the line shown is not equivalent to a demand curve, it does provide an indication of the sensitivity of demand in so far as distance flown through the sector is related to the cost rerouting through adjacent airspace. If such a relationship holds, then the distance travelled by an individual flight can be regarded as a proxy for the price that would need to be charged in order to cause it to divert.

Figure 2.23: Flights entering LFMMB3 between 08:00 and 09:00 on 8th June 2013



Source: Steer Davies Gleave analysis

2.125 A review of the flight profile for LFMMB3 both before and after the regulation was imposed, as shown in Figure 2.3, suggests that the capacity threshold triggering regulation was approximately 30 aircraft per hour. A congestion charge sufficient to divert the last 10 flights, flying between 80km and 120km, would have been sufficient to reduce demand to a level just below this threshold. However, an over-pricing error sufficient to divert flights in the next distance band would have led to a further reduction in demand of 7 flights, equivalent to almost 25% of the estimated value of the capacity threshold. While it is not possible to generalise on the basis of data for a single regulated hour in one sector, this analysis suggests that congestion prices would need to be set with some precision in order to avoid significant and sub-optimal diversion of traffic.

2.126 Given these results, and recognising the dynamics of the flight planning process noted above, we suggest that the process of setting congestion charges would need to allow them to be modified in response to observed changes in airline demand. One approach would be to provide airlines with congestion charges at a number of defined points prior to the finalisation of flight plans due to be operated within a given time window. For example, defining the time at which flight plans for flights taking off within a given hour are finalised as T, the process for setting congestion prices (in the form of either a fixed supplement or an increased unit rate) could be as follows:

- T-9 hours – initial prices issued to airlines whose flight plans include travel through congested sectors, giving an indication to airlines of where significant congestion is likely to arise and inviting them to investigate other routes;
- T-7 hours – deadline by which airlines must respond if they wish to file an alternative route;

- T-5 hours – a further set of prices is issued on the basis of revised flight plans submitted at T-7, inviting airlines to either "lock in" to their preferred route at the new prices or respond with further revisions to the route;
- T-3 hours – deadline for next set of revised flight plans;
- T-2 hours – final set of prices issued;
- T-1 hours – deadline for final submission of revised plans;
- T – flight plans finalised and final prices confirmed.

2.127 At each of the stages T-9, T-5 and T-2, the NMOC would need to review changes to plans made in the light of the congestion charges provided and modify the price signals depending on the change in expected levels of congestion. At the same time, the process would need to provide incentives to lock in flights to relatively uncongested paths to avoid unstable swings in demand for particular sectors and reduce the number of revised flight plans submitted at each stage. As already noted, without a dynamic process of this kind, it is possible that congestion charging could simply shift the congestion problem to different sectors rather than redistribute traffic more efficiently and reduce the overall level of delay.

2.128 The illustrative process outlined above assumes that an optimal level of prices and distribution of traffic could be established through three iterations. In practice, there could be no guarantee that this number would be sufficient, or even that a stable equilibrium existed. Possible airline behaviour in different scenarios could be investigated through simulation exercises, and reactions could become more predictable over time, as noted above. However, it is likely that the NMOC would need the option of reverting to the current system, including the imposition of regulations, to be available alongside any system of congestion pricing.

Terminal congestion charging

2.129 In the case of terminal air navigation, congestion prices would need to be made available to airlines in time to influence strategic route planning, possibly a year or even 18 months in advance of the operation of the schedule. This raises the question of whether terminal congestion is sufficiently stable to enable it to be predicted with reasonable confidence so far in advance. As discussed above, we have identified some evidence that terminal congestion tends to be more stable than en-route, at least in certain locations, providing a firmer foundation for congestion pricing. However, airline reaction to congestion charging would need to be tested through route planning simulation exercises in order to determine the appropriate level of charges case-by-case. The results of the analysis reported in Table 2.15 indicate that charges could be expected to vary substantially between airports.

2.130 As in the case of en-route charges, it is possible that an iterative process for setting charges would need to be established, although this could operate over the longer time scales of the route planning process. We note, however, that such a process could be interrupted or distorted by a wide variety of changes affecting strategic route planning decisions, for example changes in demand for flights to a particular location, swings in fuel prices, airport congestion and developments in the political situation influencing the ability of airlines to serve a given country or city. Hence, a charging differential initially set with a view to encouraging, say, the retiming of flights from an airport from the peak to the off-peak might therefore be wholly inappropriate 12 months later. In general, predicting the impact of a charge on demand for congested terminal airspace over relatively long timescales is likely to be challenging.

Consistency with other regulated charges and incentives

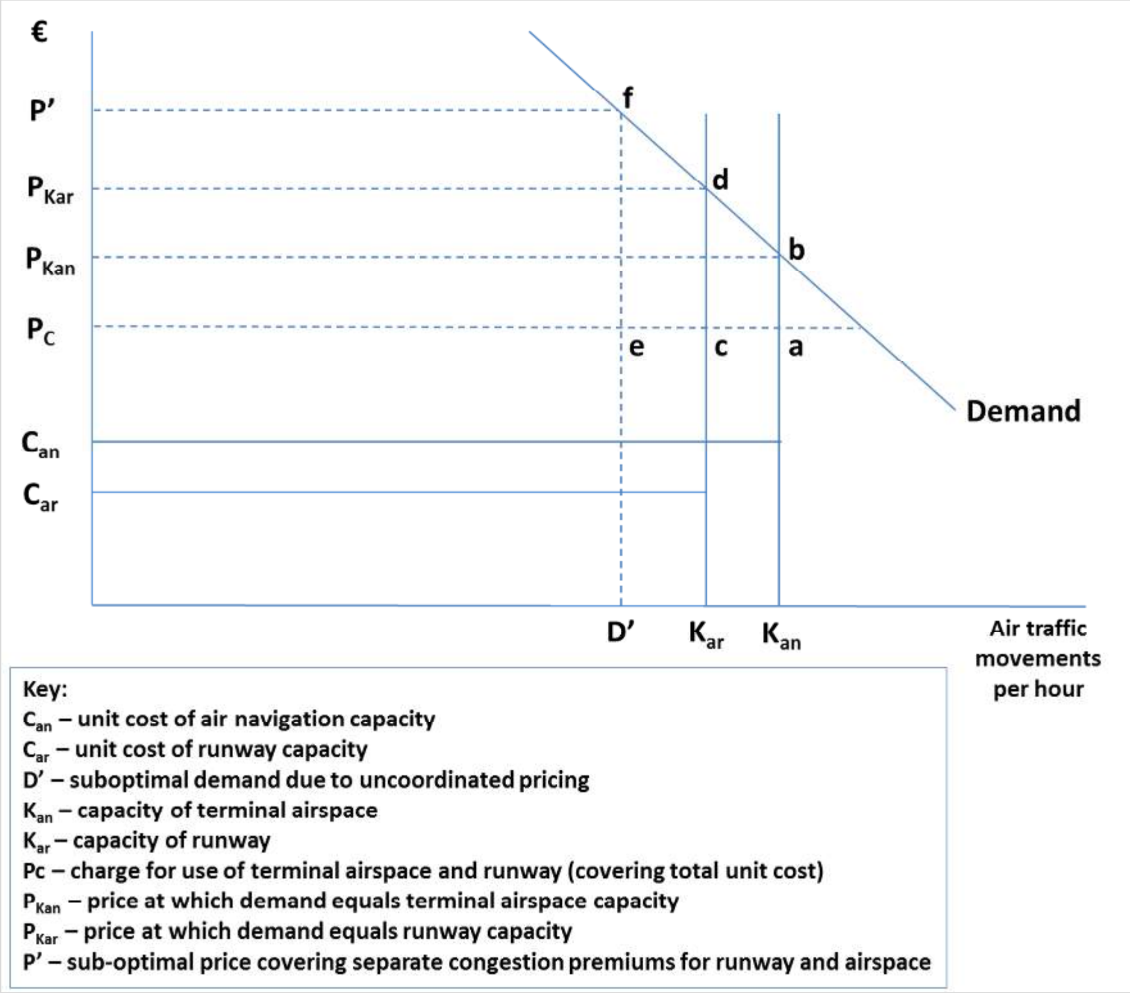
Consistency with airport charging

2.131 It is not necessarily the case that congested terminal capacity goes hand-in-hand with congested runway capacity since the level of capacity in each case is independently determined (i.e. capacity decisions are made by different parties, although they will generally be co-ordinated to avoid, for example, substantial investment in runway capacity that cannot be used because of air navigation constraints). Our review of the NMOC regulation data for 2013 demonstrates that terminal airspace can be congested although the airport itself is not subject to significant capacity constraints (as in the case of Zurich) and vice versa. At the same time, the demand for each service is strongly related and, to a first approximation, they are used in fixed proportions (each landing or take-off involves a movement through the associated terminal airspace and each movement through terminal airspace is preceded by a take-off or followed by a landing).

2.132 Given this relationship, congestion charges for air navigation would need to take account of any runway congestion pricing planned or in place at the airport concerned. The need for effective coordination of charges is illustrated in the figure below, which shows the demand for air traffic movements (landings and take-offs) at a hypothetical airport. In the situation shown, both runway and air navigation capacity are constrained at K_{ar} and K_{an} respectively and unit costs are given by C_{ar} and C_{an}. If both the airport and the terminal services provider each charges sufficient to cover costs, the overall price faced by an airline wishing to use the airport is P_c (equal to C_{ar} + C_{an}) and there is excess demand for both runway and air navigation services.

2.133 In order to achieve the optimum outcome (in the absence of further investment), both service providers must coordinate their respective charging policies, since if each tries to introduce a congestion supplement sufficient to reduce demand to capacity (an amount equivalent to ab in the case of the terminal services provider and cd in the case of the airport) the resulting overall price is P', demand falls to D' and capacity is underutilised. If, however, the airport (or the terminal services provider) introduces a single supplement equal to cd, demand is reduced to the level of the runway capacity (the binding constraint) and can be accommodated within the available terminal airspace. While this outcome is specific to the situation depicted, the figure nevertheless highlights the risk of inefficient outcomes if airport and air navigation congestion charges are set independently of one another.

Figure 2.24: Coordination of airport and air navigation congestion charging



Source: Steer Davies Gleave analysis

Coordination with ANSP performance incentives

2.134 As noted in the discussion of objectives above, absent regulation congestion charging would provide an incentive for ANSPs acting commercially to restrict capacity in order to raise prices and profits. This can be avoided through the application of a regulatory framework that ensures revenue neutrality. Under such a framework, any increase in charges for access to congested volumes of airspace would need to be balanced by a reduction in charges elsewhere, as discussed further below.

2.135 Nevertheless, the introduction of congestion charges designed to encourage efficient use of existing capacity would not provide any incentive for ANSPs to invest to relieve capacity constraints over the long term. It would therefore be essential to provide such incentives in parallel with the operation of any congestion charging scheme. As part of our work, we have reviewed the key incentive mechanism already in place, namely the financial incentives provided to ANSPs to meet defined targets as provided for under SES legislation.

2.136 The Performance and Charging Regulations adopted in May 2013 required Member States to introduce mandatory financial incentive mechanisms to encourage ANSPs to meet capacity targets at the FAB level in their performance plans[35]. Under the principles for the operation of

[35] Commission Implementing Regulation (EU) No 390/2013 and 391/2013.

incentive mechanisms, issued by the Performance Review Body in October 2013, incentives are capped at one per cent of ANSP revenues during Review Period 2 (RP2, 2015 - 19). By way of illustration, this cap is equivalent to some £6 million per annum in the case of the UK (based on an apportionment of total en-route revenue of £630m in 2012).

2.137 In order to assess the effectiveness of this incentive, we have investigated plans for investment to increase capacity set out in the RP2 Performance Plan for the UK-Ireland FAB. These are summarised in the table below. Note that, in accordance with the legislation, the plans address a number of the Key Performance Areas of safety, the environment, capacity and cost efficiency and are not solely driven by the need to address capacity constraints.

Table 2.16: Planned UK-Ireland FAB investment

Investment	Summary	Reduction risk index	Annual reduction in CO_2 (kT)*	Additional capacity (flights per busy hour)	Annual operating cost savings (£m)*	Capital cost (£m)
Airspace development	Revision of route network structures	7 points	220	13	0.5	53
Centre systems software development	Enhancements to the Swanwick, Prestwick and Corporate and Technical Centres	1 point	125	5	0.2	191
ITEC FDP/NCW	Advanced systems and tools providing platform for SESAR-based operations	15 points	-	5	-	205

Source: FAB Performance Plan UK-Ireland FAB, Second Reference Period (2015-2019)

* The timescale of the reductions is not specified in the report, but they are assumed to be annual

2.138 From the FAB's perspective, the business case for these investments will not depend entirely on the mandated financial incentive mechanism. The airspace development and centre systems software development initiatives, in particular, are expected to generate substantial savings in operating costs over a number of years. Indeed, the level of capital expenditure required, ranging from £53mto £205m, gives a useful indication of the investment needed to increase capacity significantly, and suggests that any associated financial rewards provided by the incentive mechanism as currently defined are likely to be regarded as marginal by ANSPs. We also note that a return to the mechanism in place in the UK during RP1 (2012 – 14), which limited incentives for meeting both capacity and flight efficiency targets to 5% of revenue (£30 million in 2012), would substantially strengthen the business case for investments such as the ITEC FDP/NCW initiative that are not expected to deliver operating cost reductions or other financial benefits.

2.139 At the same time, we note that it may be possible to increase the capacity of air navigation services in the short term without substantial investment. We have already highlighted, in paragraph 2.57 and Figure 2.8, the impact of limited availability of ATCOs at weekends on effective capacity. In principle, capacity constraints of this kind could, and arguably should, be addressed through a change in working practices rather than through the introduction of new capital equipment and technology. One option for providing the required incentives would be the introduction of rebates on air navigation charges in the event that delay was caused by a temporary reduction in capacity, analogous to the performance penalties applied in the UK rail industry and elsewhere. Such rebates would underpin the business case for implementing the necessary changes to working arrangements, with avoided rebates offsetting and possibly covering any implementation costs (for example, the payment of higher rates to ATCOs for weekend shifts).

2.140 The introduction of rebates would clearly have the opposite effect on charges to congestion pricing, with airlines receiving compensation for delay rather than paying a premium for the use of capacity constrained airspace. In principle, the two approaches are not necessarily mutually exclusive, since congestion charging could be applied to sectors that were subject to fundamental capacity constraints and rebates to temporary congestion relating to fluctuating levels of ATCO availability and other short term factors. Implementation of both would nevertheless require careful co-ordination to avoid sending complex, mixed and potentially confusing price signals to airspace users, as well as the introduction of supporting processes and systems.

2.141 Regardless of whether it was introduced alongside, or instead of, congestion pricing, the operation of a performance regime would require a process for delay attribution, whereby the reasons for delay were determined and recorded. This would enable ANSPs and airspace users to determine whether a delay had been caused by short term constraints on ATFM activity, such as lack of ATCO availability, or more fundamental constraints on airspace capacity. Lessons from the operation of similar processes established in other sectors, for example the performance regime for the national railway in Great Britain, demonstrate the importance of defining agreed protocols and thresholds that simplify delay attribution and reduce the likelihood of frequent and protracted disputes over the causes of delay.

2.142 For example, we consider that it would be necessary to establish a decision rule to determine whether delays were the result of short term operational failings or limits on capacity that could only be addressed through capital investment. One option would be to determine the maximum number of aircraft able to fly through a given volume of airspace within a defined time period assuming full ATCO resourcing of the relevant ACCs. Any delays incurred by flights using the capacity at a time when the number of aircraft was below the threshold would result in penalty payments in the form of discounted air navigation charges. Conversely, delays arising when the number of aircraft was at or above the threshold (possibly triggering regulation or the imposition of a congestion charge) would not attract penalties. In principle, appropriate thresholds would need to be established for all sectors, although these could be derived using the same processes underpinning the need for regulation under current arrangements (recognising that they would need to be based on maximum ATCO availability rather than actual availability observed at a point in time).

Achieving revenue/cost neutrality

2.143 In order to meet the objective of revenue neutrality, congestion charges would need to be calibrated against the regulated revenue requirements of ANSPs as well as according to the demand responses of airlines. As already noted, this could be addressed in principle by regulating average revenue and allowing EU Member States to set congestion charges for access to some sectors on condition that these were offset by lower charges for others. The calibration would ensure that, in aggregate, airspace users paid no more for air navigation services than they would have done in the absence of congestion charging. For any given ANSP, the resulting charges would establish the appropriate incentives while ensuring that the revenue collected was just sufficient to cover efficient costs (including a reasonable rate of return). Moreover, on the assumption that relatively few sectors would be subject to congestion charging, the adjustment to charges across the majority of airspace would be limited (significant increases in the case of a few sectors would be balanced by limited reductions for the majority).

2.144 However, we consider that achieving revenue neutrality by this means would be challenging in practice, partly because of the difficulty in taking account of a set of revenue constraints while administering the iterative price setting process described above, but also because it could lead to distorted incentives at the boundaries between ANSPs. For example, as already noted it might not be possible to identify a congestion charge for access to a sector within one ANSP's airspace that simultaneously gave the appropriate incentive to airlines to reroute through a sector controlled by another, while ensuring that total revenue raised did not exceed costs. At the very least, the determination of revenue neutral charges would be a challenging constrained optimisation problem adding significant complexity to the process of price setting.

2.145 An alternative, simpler approach would involve charging a premium for congested airspace while leaving charges in uncongested sectors unchanged (with premiums again calculated in order to ensure appropriate price differentials and encourage airlines to divert flights through sectors with available capacity). Any additional payments generated would be redistributed back to airlines through a defined mechanism administered by CRCO. Redistribution could be on the basis of a percentage discount on all air navigation charges paid by airlines within the relevant period (for example, a month or a year). The percentage would be equivalent for all airlines in order to simplify administration and preserve the incentives generated by the congestion charging scheme[36], and calculated ex-post with a view to redistributing all additional payments arising from the continued use by some airlines of congested airspace.

2.146 In our view, such a mechanism would anyway be needed in view of the difficulty in predicting demand levels associated with a given set of charges, and might also address the problem of charging anomalies at the boundaries between ANSPs by effectively decoupling the level of charges on a given day from the level of revenue needed to recover efficient costs. We also note that resolution of this issue could be facilitated by the introduction of uniform charging arrangements at the level of the FAB, permitting greater freedom to develop an appropriate set of congestion charges across a wider area of airspace and potentially providing for some reallocation of revenue between ANSPs. The broader issue of uniform charging by FABs is discussed further in Chapter 5.

2.147 It is nevertheless important to recognise that revenue neutrality, while ensuring that ANSPs could not earn monopoly profits as a result of the introduction of congestion prices, would not prevent individual airlines from facing an overall increase in air navigation charges. Airlines tending to require greater access to congested airspace could be expected to experience an average rise in air navigation costs and those requiring less access a fall. It is therefore likely that at least some airlines would resist the introduction of congestion pricing on cost grounds alone, even if the practical implementation issues could be addressed.

Implications for planning, monitoring and billing systems

2.148 We have considered the implications for planning, monitoring and billing systems used by the NMOC and CRCO and the flight planning systems used by airlines. Within the scope of this study, we have not sought to develop a specification of system requirements in each case.

[36] Redistribution of payments to the airlines making them (as a result of continuing to route flights through congested airspace) would effectively neutralise the incentives since the discount would simply offset the initial premium.

However, we have discussed system implications with stakeholders who are familiar with current planning, monitoring and billing processes and their limitations.

Planning systems

2.149 In our view, the implementation of congestion charging would require substantial changes to the existing systems, in particular those supporting flight planning. We have already described an illustrative iterative process for establishing optimal en-route congestion charges and traffic distribution. In order to support such a process, there is a need to:

- Communicate air navigation charges, differentiated at the sector level, to all airlines submitting flight plans a number of times within a constrained time window (typically a few hours before the finalisation of plans and take-off);
- Following each communication of a set of charges, review revised flight plans to determine the impact of airline route choices and an appropriate modification of charges in the light of this; and
- Integrate this process with parallel processes for communicating other information, including restrictions on the use of airspace for reasons other than capacity.

2.150 System requirements for terminal congestion charging would arguably be less demanding, since initial prices would be provided several months in advance of their finalisation in order to influence airline strategic planning decisions about the markets they wished to serve and the airports and associated terminal airspace to which they needed access. Nevertheless, we envisage that the process for setting charges would also need to be iterative, possibly involving airlines submitting planned schedules rather than detailed flight plans in order to indicate their reaction to a given set of terminal congestion prices. As with en-route charging, the aim would be to determine optimal prices resulting in efficient use of terminal airspace, with the NMOC working in collaboration with ANSPs to determine airline reactions to price signals at a number of different stages.

2.151 There are already mechanisms for supporting communications between airlines and the NMOC at various stages of the planning process, including channels for communicating necessary changes to flight plans in close to real time (for example, in order to communicate the application of a regulation to a particular sector and associated requests for airlines to modify their flight plans). However, there is currently no facility for determining optimum charges through an iterative process on a routine basis. Discussions with representatives of both the CRCO and the NMOC have confirmed that the costs of implementation of such a process, while they would need further investigation, would be likely to be substantial.

2.152 We also consider that the various planning tools are not sufficient to support flight planning under congestion pricing. At present, such tools include:

- The Demand Data Repository, which generates future and past samples of traffic to support capacity planning and other activities;
- The Capacity Analyser, a methodology for calculating sector capacity through simulation, which can be used to estimate the benefits of a change in the structure of airspace and routes;
- NEST, an airspace design and capacity planning tool used for scenario simulations and other capacity planning activities;
- PREDICT, the main network operations tool used to support pre-tactical planning for daily operations; and
- SIMEX, which allows operational staff to simulate the impact of different ATFM measures, including tactical measures, before they are applied in real operations.

2.153 None of these tools currently enables planners to simulate the effects of changes in air navigation charges at the sector level on the distribution of air traffic across European airspace. Implementation of congestion pricing would therefore require modifications to one or more of them or the construction of a new tool designed to simulate the effects of price signals on route choices. In our view, such a capability would also be useful to support the further investigation of the benefits of congestion pricing prior to any decision to implement it.

NMOC monitoring and CRCO billing systems

2.154 We consider that the monitoring information currently collected by the NMOC would be sufficient to support charging by sector, notwithstanding that this would involve a much greater disaggregation of flight information than is currently required for billing purposes. The sample data provided to us by the NMOC provides confirmation that there is sufficient information to determine not only the sectors through which a flight has travelled but also the distances travelled in each case. Hence, we are confident that the data is available to calculate charges under all the various options investigated above, including the introduction of congestion charges based on a fixed supplement and those requiring the calculation of the great circle distance (or an approximation of this) through an individual sector. We also note that it would be possible to identify divergences between the actual route taken and the final flight plan submitted, which might be required in order to adjust invoiced charges in particular circumstances[37].

2.155 However, while the CRCO has access to the data required to calculate congestion charges, its billing systems are not currently configured to perform the more complex calculation that would be necessary to invoice airlines on this basis routinely. The costs of reconfiguration or system enhancement, whilst probably not prohibitive, would be likely to be significant, particularly in the case of the more sophisticated charging options. For example, an option based on modified unit rates would require calculations incorporating the formula in paragraph 2.98, whereas those based on a fixed supplement would only require the inclusion of appropriate supplements in the final bill according to the record of sectors covered by the flight. Again, the costs of modifying existing systems would need to be investigated, although discussions with the CRCO suggest that calculations could be supported by existing capability within the NMOC.

2.156 We have also considered the systems implications of implementing a performance regime of the kind discussed above. We understand that, while the NMOC can identify the delay incurred on individual flights, it is not currently possible to adjust air navigation charges according to the level of delay experienced by the flights to which such charges relate. This is a key requirement for the operation of any performance regime, and the current limitation on the billing system would therefore need to be addressed as part of a programme of implementation of the performance regime. However, we consider that that the costs would be significantly less than those incurred in making the changes need to support congestion pricing.

[37] For example, an aircraft might be diverted through a congested sector for reasons outside its control. In the event that the airline submitted a flight plan involving a route through uncongested airspace but was subsequently redirected through one or more congested sectors for safety or other reasons, there would be a case for charging according to the flight plan rather than the route actually taken.

Airline flight planning

2.157 Airlines already routinely investigate the costs of different flight plans several times in the hours before take-off, typically using LIDO software or an equivalent. Their systems are also updated on a regular basis to take account of changing wind and other conditions, which affect flight time and fuel burn, and changes to airspace restrictions. In principle therefore, they could investigate the impact of new congestion charges in the same way, although some modification to the software would be required to enable more frequent changes to air navigation charges (currently treated as fixed parameters for the purposes of route optimisation as they may only change once a year).

2.158 However, while the implications for airline flight planning systems appear more limited than those for the NMOC (since airlines are only required to react to price signals rather than determine optimal prices), it is likely that the introduction of en-route congestion charging in close to real time would require a more prescriptive process than at present. Currently, airlines may choose when and how often to investigate optimum routes, although they must submit a final flight plan by a given time prior to take-off. Under an iterative optimisation process of the kind described in paragraph 2.120, it would be necessary to provide price information and for airlines to respond with revised flight plans within defined time windows. This would enable the NMOC to determine the overall demand for access to congested airspace at each stage in the process, an essential element in the process for setting optimal prices.

2.159 We have not discussed the implications of such a process in detail with airline representatives. Nevertheless, on the basis of our observations of current practice adopted by a major European airline, we consider that it would require significant changes to established procedures with potential implications for staff resourcing within the flight planning organisation. We also note that the implementation of the process in a way that recognised the progression of take-offs and landings according to established schedules would be challenging.

Stakeholders' views

2.160 We discussed the principles and practical implications of congestion pricing with a number of organisations representing airspace users as well as CANSO. Our discussions highlighted several issues meriting further consultation and investigation prior to any implementation programme:

- The mechanisms by which revenue neutrality is ensured, such that airspace users are not subject to an overall increase in air navigation charges;
- The sensitivity and predictability of demand for airspace at the sector level, which will determine the extent to which it is possible to establish a stable and more efficient distribution of traffic through congestion pricing;
- The implications of more dynamic and granular price setting for planning and billing systems;
- The potential to distinguish between long term and short term capacity constraints; and
- The scope for introducing a congestion pricing scheme in a way that was consistent with other industry and policy objectives, including a reduction in carbon emissions from air transport and initiatives designed to encourage collaborative approaches to resource optimisation.

2.161

Conclusions and recommendations

Evaluation of options

2.162 We have evaluated each of the options for congestion charging set out in Table 2.7 against the objectives described in Chapter 1. The results of this exercise are summarised in Table 2.17 below.

Table 2.17: Evaluation of options for congestion charging

	Option combination			
	C1:D2:P2	C2:D1:P2	C2:D2:P2	P1
Summary of option combination	Differentiated unit rates, with higher rate for specific sectors during periods in which capacity utilisation expected to exceed a defined threshold. Differential determined empirically in order to generate incentives to reroute flights. Charges posted at a single point in time.	Introduction of fixed supplement, payable when a flight passes through specific sectors during periods in which capacity utilisation expected to exceed a defined threshold. Differential determined according to economic and social cost of delay. Charges posted at a single point in time.	Introduction of fixed supplement, payable when a flight passes through specific sectors during periods in which capacity utilisation expected to exceed a defined threshold. Differential determined empirically in order to generate incentives to reroute flights. Charges posted at a single point in time.	Dynamic, iterative process for setting charges. In the case of en-route charges the process would need to be applied in close to real time as part of the finalisation of flight plans. In the case of terminal charges, it would apply at the strategic planning stage with the aim of influencing airline schedules rather than detailed flight plans.
Economic efficiency	High level of granularity, enabling better alignment of charging structure with variations in levels of congestion. Takes account of distance travelled within congested sector, although this is arguably less important as a determinant oc capcity utilisation than the complexity/variability of a flight path within a given sector. However, a high risk that prices posted at a single point will not reflect rapidly changing demand for airspace, leading to an inefficient allocation of capacity.	High level of granularity, enabling better alignment of charging structure with variations in levels of congestion. Flights subject to the same charge regardless of how far they travel within a congested sector, although distance may not be a primary driver of capacity utilisation. Estimates of economic and social cost of delay imply a substantial increase in charges applying to congested airspace as compared with the current position. However, these estimates reflect delay costs when capacity is fully utilised and may overstate economic and social cost under optimal distribution of traffic. A high risk that prices posted at a single point will not reflect rapidly changing demand for airspace, leading to an inefficient allocation of airspace.	High level of granularity, enabling better alignment of charging structure with variations in levels of congestion. Flights subject to the same charge regardless of how far they travel within a congested sector, although distance may not be a primary driver of capacity utilisation. A high risk that prices posted at a single point will not reflect rapidly changing demand for airspace, leading to an inefficient allocation of airspace.	Allows iteration of charges towards the optimum. Likely to give a more efficient outcome in terms of airspace use. However, it is not clear whether the optimum set of prices and associated allocation of traffic could be achieved within the timescales governing flight planning. Achieving an efficient outcome would be particularly challenging in the case of en-route charges, since the routing of flights can change immediately before and after take-off. It might be more realistic in the case of terminal charges, since the aim would be to influence airline schedules rather than detailed flight plans.

	Option combination			
Intelligibility	Potentially difficult for airlines to investigate the full implications of the structure of charges within the constraints of the planning process.	Potentially difficult for airlines to investigate the full implications of the structure of charges within the constraints of the planning process, although possibly easier than in the case of C1:D2:P2.	Potentially difficult for airlines to investigate the full implications of the structure of charges within the constraints of the planning process, although possibly easier than in the case of C1:D2:P2.	Likely to be difficult for airlines to investigate the full implications of a number of different sets of charges within the constraints of the planning process. This would be particularly true in the case of en-route charges given that flight plans are changed in close to real time. The impact of changes in terminal charges could be investigated as part of the strategic planning of schedules.
Revenue/cost neutrality	Possible to maintain revenue neutrality but calibration of charges likely to be complex. Charging anomalies likely to arise at boundaries between ANSPs if charges must reflect individual ANSP costs as well as congestion. (although this could be addressed to some extent by FAB-based charging zones coupled with ex-post reallocation of revenue). Revenue neutrality could also be achieved by redistributing additional payments from congestion charging to airlines according to a pre-defined formula.	Possible to maintain revenue neutrality but calibration of charges likely to be complex (although less complex than for C1:D2:P2). Charging anomalies likely to arise at boundaries between ANSPs if charges must reflect individual ANSP costs as well as congestion. (although this could be addressed to some extent by FAB-based charging zones coupled with ex-post reallocation of revenue). Revenue neutrality could also be achieved by redistributing additional payments from congestion charging to airlines according to a pre-defined formula.	Possible to maintain revenue neutrality but calibration of charges likely to be complex (although less complex than for C1:D2:P2). Charging anomalies likely to arise at boundaries between ANSPs if charges must reflect individual ANSP costs as well as congestion. (although this could be addressed to some extent by FAB-based charging zones coupled with ex-post reallocation of revenue). Revenue neutrality could also be achieved by redistributing additional payments from congestion charging to airlines according to a pre-defined formula.	Maintaining revenue neutrality and ensuring cost recovery for each ANSP would further complicate the process. At each stage of the iteration, Eurocontrol would need to identify prices that improved congestion levels and recovered efficient costs (although the need for imposing a revenue neutrality constraint at this stage could be avoided through the implementation of an ex-post reallocation mechanism).

	Option combination			
Minimal administration costs	Information required to support calculation of charge already collected. CRCO billing systems would require modification to enable calculation of great circle distances at the sector level. Airline planning systems would also require modification to take account of more disaggregated structure of charges.	Information required to support calculation of charge already collected. CRCO billing systems would require modification to enable calculation of charges at the sector level, but this would be less onerous than for C1:D2:P2. Airline planning systems would also require modification to take account of more disaggregated structure of charges.	Information required to support calculation of charge already collected. CRCO billing systems would require modification to enable calculation of charges at the sector level, but this would be less onerous than for C1:D2:P2. Airline planning systems would also require modification to take account of more disaggregated structure of charges.	The costs of implementation could be substantial in the case of en-route charges. There is a need for the facility to determine optimal charges on the basis of modified flight planning data. There would also be significant system modification costs for airlines. Implementation costs would probably be more limited in the case of terminal charges, since the aim would be to establish a more balanced distribution of traffic across terminal airspace through a schedule planning process lasting months rather than hours.
Credibility	Unlikely to receive stakeholder support, with resistance from airlines likely to be strong. Some ANSP stakeholders have indicated that congestion pricing would not improve the efficiency of airspace use unless it could be introduced in close to real time (which anyway would not be possible in the foreseeable future).	Unlikely to receive stakeholder support, with resistance from airlines likely to be particularly strong in view of the potential impact on some charges (notwithstanding revenue neutrality). Some ANSP stakeholders have indicated that congestion pricing would not improve the efficiency of airspace use unless it could be introduced in close to real time (which anyway would not be possible in the foreseeable future).	Unlikely to receive stakeholder support, with resistance from airlines likely to be particularly strong in view of the potential impact on some charges (notwithstanding revenue neutrality). Some ANSP stakeholders have indicated that congestion pricing would not improve the efficiency of airspace use unless it could be introduced in close to real time (which anyway would not be possible in the foreseeable future).	The implementation of P1 in the case of en-route charges would represent a radical change to current practice and would probably be regarded as impractical by both airlines and ANSPs. A more dynamic approach to setting terminal charges, integrated with the schedule planning process, could be regarded as more realistic, but would probably still be subject to airline resistance.

Source: Steer Davies Gleave analysis

Conclusions and recommendations

2.163 The results of our review of previous studies on congestion pricing in air navigation and congestion charging schemes already applied in other transport sectors suggest that, in principle, such pricing could play an effective role in encouraging more efficient utilisation of existing airspace. Previous experience of congestion charging demonstrates that it can provide strong incentives to change behaviour and hence the utilisation of transport capacity at different times. In particular, by rewarding users of capacity who are prepared to modify the route or timing of their journey, it can lead to significant reductions in the demand for congested road and other infrastructure.

2.164 However, our review has also highlighted some important differences between air navigation and, say, road use, which have implications for implementation. We note, for example, that road pricing has typically been applied in circumstances where the profile of demand is relatively stable (e.g. travel into city centres at well-established peak times), and that the aim has often been to encourage a switch from use of private vehicles to alternative public transport services rather than to incentivise road users to take different routes. In addition, private road users will generally be able to respond more flexibly to incentives resulting from congestion pricing than will airlines operating to a published schedule.

2.165 Moreover, we consider that previous studies of congestion pricing for air navigation have tended to focus on issues of economic principle rather than on practical considerations relating to the planning and operation of air transport services. Such considerations must be taken into account in any assessment of whether and how a congestion charging scheme for airspace should be implemented. In particular, we consider that a full assessment of the case for introducing congestion charging must take account of the following:

- Patterns of congestion across European airspace and the extent to which these are geographically and temporally stable;
- The difficulty of establishing robust measures of airspace capacity at a sufficiently granular level, recognising factors such as the potential for ATCO resources to vary over the week and different combinations of elementary sectors to be reconfigured into collapsed sectors; and
- The need to integrate the process for setting charges with established or modified flight planning processes at both the strategic and operational levels.

2.166 These factors will determine the extent to which units of capacity can be priced in a way that both reflects the level of congestion arising at a point in time and enables airlines to react by modifying the timing or routing of flight plans.

2.167 We have therefore assessed a number of different options for the design of a congestion charging scheme against a range of objectives, taking account of the need for any scheme to be practical in terms of implementation and beneficial in terms of economic efficiency. These options covered different definitions of both the structure and level of congestion charges, as follows:

- Differentiated unit rates determined empirically in order to generate incentives to reroute flights, with a higher rate for specific sectors during periods in which capacity utilisation is expected to exceed a defined threshold;

- The introduction of a fixed supplement, payable when a flight passes through specific sectors during periods in which capacity utilisation is expected to exceed a defined threshold, with the level of the supplement determined according to the economic and social cost of delay; and
- The introduction of a fixed supplement, payable as above but with the level determined empirically in order to generate incentives to reroute flights.

2.168 We have also investigated whether, in each case, it would be possible to determine congestion prices dynamically in response to airline reactions rather than simply posting them at a point in time.

2.169 Overall, we have concluded that the introduction of a workable scheme would be challenging given the range of issues that would need to be addressed. In particular we consider that dynamic price setting, while necessary given the potential for demand for airspace at a sector level to vary considerably within the hour, would require substantial changes to current protocols and systems supporting flight planning. Our analysis of airspace congestion also suggests that it is relatively unstable, with the result that prices reflecting levels of capacity utilisation at a specific time on a given day are unlikely to be appropriate at the equivalent time and day in the following week, month or year.

2.170 Against this background, we have developed an illustrative programme for the further development and implementation of congestion charging, as shown in the table below. Note that the programme would commence with preliminary work, including the development and application of simulation tools (as discussed further below) and culminating in a recommendation as to whether to proceed further on the basis of the results obtained. In addition, the operation of the charging mechanism at selected locations as well as the case for applying charges elsewhere would need to be kept under review to ensure that changing patterns of demand and congestion were taken into account in the evolution of the charging framework.

Table 2.18: Illustrative programme for implementation of congestion charging

Stage	Element
Preliminary work	Consultation on proposed options Investigation of legislative implications Recommendation of whether to proceed to design and trialling
Design	Design of charging formula Simulation of outcomes, supported by software development Development of integrated processes and procedures for charge setting Specification of system requirements (NMOC, CRCO, ANSPs and airlines)
Trialling	Introduction of shadow congestion charges at a limited number of locations Limited implementation of system changes to support trials Monitoring of “wooden dollar” money flows to check billing and other systems
Further development	Consultation on lessons from trialling Implementation of any necessary legislative changes Full development and implementation of integrated processes and procedures Full development and implementation of required changes in systems

Stage	Element
Staged implementation	Introduction of congestion charges at a limited number of locations, followed by gradual roll-out across the SES Consultation on lessons learned at each stage
Ongoing review	Review of operation of charges Review of patterns of congestion arising across SES Development of charging scheme in response to new data and lessons learned.

Source: Steer Davies Gleave analysis

2.171 Our findings have particular implications for the design of a congestion pricing scheme. More specifically, our analysis of terminal airspace congestion suggests that it is more stable than en-route congestion but also less sensitive to changes in air navigation charges, consistent with the observation that airlines have little or no choice over access to a given terminal sector once they have decided to serve the associated airport. Nevertheless, levels of congestion can vary significantly between airports and over time, and not all airports experiencing terminal airspace congestion do so on a consistent basis through the week or over the year. In addition, at some locations it is airport rather than terminal airspace capacity that acts as the binding constraint, and congestion charging would need to be introduced in a co-ordinated way that recognised the interaction between terminal airspace and runway capacity utilisation.

Recommendation A1:

We therefore recommend that the focus of further development work should be on en-route rather than terminal congestion charging. In our view, terminal congestion is likely to be limited to a number of specific locations and, given the potential interaction with airport capacity, would be better addressed through airport charging or other location-specific measures, following agreed principles at EU level.

2.172 Our findings also demonstrate the case for a relatively simple structure for congestion charges. While there would be some merit in modifying unit rates in order to reflect levels of congestion, we consider that intelligible and transparent price signals could be provided through the introduction of a fixed congestion supplement. In practice, it is the complexity of a flight path rather than distance travelled through a sector that determines how much ACC capacity it uses (an aircraft changing direction and/or altitude requires more attention from an ATCO than an aircraft flying in one direction at cruising height). Hence, modifying the unit rate such that the level of the congestion charge paid depended on distance travelled would not necessarily result in more cost reflective prices; an aircraft travelling a long distance through a sector would pay a higher charge than one travelling a shorter distance even though it required less oversight and instruction from the ATCO. Moreover, a fixed supplement would make for a simpler charging structure, allowing the cost implications of flying through congested airspace to be calculated more easily.

Recommendation A2:

We recommend that the structure of a congestion charge should be based on the option of introducing a fixed supplement into the existing charging formula (option C2 in Table 2.4).

2.173 As part of the process of defining the structure of a congestion pricing scheme and calibrating individual charges, it would be necessary to undertake detailed simulation work to determine the impact of different pricing scenarios on the distribution of traffic. Such an exercise has not been possible in the course of this study, not least because existing simulation tools such as NEST, PREDICT and SIMEX do not allow simulation of how demand at the sector level might vary if relative prices of sector access were to change to reflect different levels of congestion. This capability would also be needed to support future flight planning under a congestion pricing framework.

2.174 In paragraphs 2.134 to 2.138, we highlighted the importance of establishing effective incentives for capacity enhancements since congestion charging designed to encourage efficient use of existing capacity would not incentivise the necessary investment. In our view, the performance incentives on ANSPs during RP2, which are limited to one per cent of revenue under Regulations 390/2013 and 391/2013, appear relatively weak given the reported costs of investment already planned, for example, by the UK – Ireland FAB. At the same time, we note that some capacity constraints are the result of short term factors such as ATCO working practices and availability, and can in principle be addressed without the need for substantial capital investment.

Recommendation A3:

We recommend that the current wording of the Regulations 390/2013 and 391/2013, relating to incentive schemes for ANSPs is reviewed with the aim of determining whether an increase in the value of incentives, above the value of one per cent of revenue permitted under current legislation, could provide an effective impetus to enhance capacity. This review, which could form part of a wider, forthcoming review of legislation, should include an examination of the business case for actual investment schemes planned or rejected by ANSPs, and the determination of incentive levels required to materially improve investment returns. Subject to the outcome of the review, existing legislation may need to be amended to provide for a higher cap on the allowable level of incentive payments.

Recommendation A4:

We further recommend that an operational performance regime, based on the payment of rebates determined according to the level of delay incurred, be introduced. Such a regime would need to distinguish between delay caused by temporary unavailability of capacity and that resulting from more fundamental, long term capacity constraints, as described in paragraph 2.141. This would enable discounts to be applied in the event that an ANSP took operational decisions resulting in a short term capacity constraint and consequential delay. For example, flights incurring delay as a result of a reduction in the number of ATCOs available over a weekend would benefit from performance related discounts on air navigation charges, providing ANSPs with an incentive to avoid capacity shortfalls of this kind through recruitment or changes to working arrangements.

2.175 The introduction of a performance regime alongside congestion charging would require careful co-ordination to avoid sending complex and confusing price signals to airlines. At the same time, we suggest that the implementation of performance discounts would be considerably less challenging than the introduction of congestion charging as conventionally defined, and that a scheme could be in place by RP3.

2.176 As noted in our discussion of the application of congestion charging in other transport sectors, it is essential that industry stakeholders are fully involved in the development of any scheme. It also is clear that any implementation of congestion pricing for air navigation must draw heavily on industry expertise, with all stakeholders contributing to the design and delivery of a number of necessary tools and mechanisms needed to establish the required charging formula and supporting processes and systems. However, we recognise that it may not be appropriate to place additional obligations on stakeholders at a time when they are already focused on a range of industry initiatives as well as other activities supporting the regulation of air navigation charges and required by legislation. The implications of all our recommendations relating to the various workstreams covered by this report are considered further in Chapter 6.

3 Cost allocation harmonisation

Introduction

3.1 The Terms of Reference for Workstream B require us to undertake the following tasks:

- "To provide an overview on the modalities of cost allocation between en-route and terminal services in the EU Member States";
- "To provide at least two options for a harmonisation of cost allocation between terminal and en-route services"; and
- "To assess the impact of the current divergence in cost allocation modalities between en-route and terminal services and the expected benefits of a harmonised system for cost allocation on other policy objectives and other key performance areas. To assess how differences contribute to the divergences in en route user charges, the move towards common en-route charging zones, as well as on congestion pricing and the modulation of charges to incentivise SESAR."

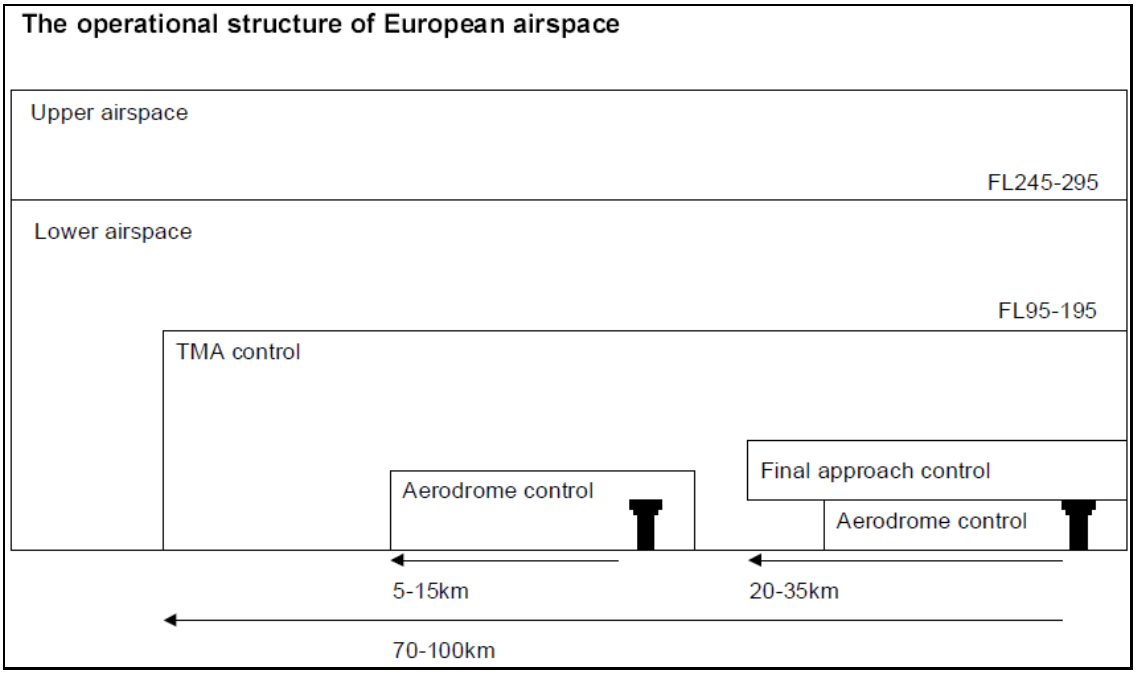
3.2 In addition, following stakeholder feedback, the Commission asked Steer Davies Gleave to consider the cost allocation issues associated with the joint provision of airport (passenger terminal, apron and runway services) and air navigation services (en-route and terminal). This is discussed in Appendix B, together with the results of an analysis of the standalone costs of en-route service provision and other supporting information relating to our investigation of cost allocation harmonisation.

3.3 This chapter includes a review of the current cost allocation situation, followed by a discussion of possible options for cost allocation harmonisation and an overview of the views of stakeholders.

The organisation of Air Navigation Services

3.4 In Europe, Air Navigation Services (ANS) are provided by Air Navigation Service Providers (ANSPs) responsible for controlling the airspace above defined territories, in most cases following national boundaries. They employ a number of Air Traffic Control Officers (ATCOs), and other staff, who are in direct contact with the pilots of aircraft using the airspace. Figure 3.1 below illustrates the variety of operational structures used in European airspace.

Figure 3.1: The operational structure of European airspace



Source: "Study of the terminal charges for Air Traffic Control services", PwC, 2001

3.5 Departing aircraft are controlled by the airport tower until airborne. In relatively empty airspace they may be either controlled from the tower for up to 80 kilometres, or handed directly to an en-route controller, supervising their climb to cruising altitude in upper airspace. From cruising altitude they descend to final approach, at which point they are controlled by the airport tower. As airspace becomes more complex, however, it becomes necessary to subdivide it into sectors controlling smaller elements of the flight:

- Final approach control, controlling separation between potentially conflicting aircraft descending towards the same airport or runway;
- In some cases, approach control of arriving aircraft at up to 100 kilometres from the airport, routing their descent until they are on final approach at the correct speed and separation; and
- In others, a Terminal Manoeuvring Area (TMA), in which all aircraft leaving or arriving at an airport, or group of airports, are controlled.

3.6 Figure 3.1 also illustrates how different ANSPs may take different approaches to operations depending on local circumstances:

- Where there are many airports in close proximity in busy airspace, it may be necessary to have separate controllers for relatively small volumes of airspace around each airport. In these circumstances, the airspace may be subdivided as shown.
- Where a single airport is surrounded by quiet airspace, it may be possible for all aircraft to be controlled from an en-route centre except for a short distance controlled by the tower.

In these circumstances, all except the areas immediately around airports may be controlled by en-route controllers.

- Alternatively, where a single airport is surrounded by quiet airspace, it may be more cost-effective for the tower to control aircraft throughout descent and climb to distances of 100 kilometres or more from the airport. In these circumstances, all lower airspace, and even some upper airspace, may be controlled from the tower.

Air Navigation Services charging organisation

Charging zones

3.7 Article 5 of Regulation (EU) 391/2013 (the Charging Regulation) recognises that Member States establish charging zones in the airspace falling under their responsibility, and that these are defined in a manner consistent with air traffic control operations and services. Article 2 of the Charging Regulation defines two types of charging zone:

- An en-route charging zone: a volume of en-route airspace for which a single cost base and a single unit rate are established; and
- A terminal charging zone: an airport or group of airports for which a single cost base and a single unit rate are established.

3.8 Thus, a terminal charging zone might, depending on operational requirements, relate to final approach control over a relatively small distance or an entire TMA covering a number of airports. Approach services, where provided, may extend outside the terminal charging zone and therefore involve of mixture of en-route and terminal services. ANSPs will change the structure of airspace during the working day so as to ensure that no controller is responsible for more aircraft than he or she can safely control. This means that airspace may be finely divided, with many layers of service, at busy times, and less finely divided, with fewer layers of service, at quieter times.

Service charges

3.9 Each provider of ANS is entitled to recover the costs of providing services from the airlines and aircraft operators served, subject to the Performance Scheme requirements (as defined in the Charging Regulation). The Charging Regulation distinguishes between:

- En-route charges, for each unit of en-route service provided; and
- Terminal charges, for each unit of terminal service provided.

It also clarifies that en-route and terminal service charges should be calculated according to the formulae set out in Table 2.2, with each charge levied on a per-flight basis. The unit rates are calculated according to the formulae provided in Annexes IV and V on the basis of determined costs (after allocation to en-route and terminal services), plus a number of adjustments for inflation, risk sharing, and any restructuring costs, divided by forecast service units. This calculation must be performed before the beginning of each year of the Reference Period.

3.10 Annex IV of the Charging Regulation specifies that:

- When assessing the distance for calculating the en-route service units, "the distance to be taken into account shall be reduced by 20 kilometres for each take-off and for each landing on the territory of a Member State"; but

- In calculating terminal charges, there is no analogous requirement that the charges relate only to services provided within 20 kilometres of an airport and not controlled by the tower.

En-route and terminal cost allocation principles

3.11 Article 8(2) of the Charging Regulation requires that "…Member States shall, before the start of each reference period, define the criteria used to allocate costs between terminal and en-route services for each airport and inform the Commission accordingly." The same Article 8(2) defines terminal services as comprising:

- "Aerodrome control services, aerodrome flight information services including air traffic advisory services and alerting services;
- Air traffic services related to the approach and departure of aircraft within a certain distance of an airport on the basis of operational requirements;
- An appropriate allocation of all other air navigation services components, reflecting a proportionate distribution between en route and terminal services."

3.12 Article 8(3) defines the cost of en-route services as the eligible costs defined in Article 8(1), less the costs of providing terminal services defined in Article 8(2). Article 8(4) requires that a separate cost base is established for air navigation services provided to VFR flights if exemptions are granted to such flights. Such costs may be established through a marginal cost methodology, taking into account the benefits to IFR[38] flights stemming from the services granted to VFR flights.

3.13 CRCO document 11.60.01 Principles for Establishing the Cost-Base for En Route Charges and the Calculation of the Unit Rates further provides that *"where the utilisation of ATS facilities between en route services on the one hand and terminal services on the other cannot be allocated on a statistical basis, the said facilities shall be classified as follows:*

- *Facilities provided mainly for en route services (allocation of 75% of the corresponding costs to route services);*
- *Facilities provided virtually to the same extent for en route and terminal services (allocation of 50% of the corresponding costs to route services);*
- *Facilities provided mainly for terminal services (allocation of 25% of the corresponding costs to route services)."*

3.14 We understand that, unlike the Charging Regulation, CRCO guidance is not binding. This means that:

- ANSPs have significant freedom in defining the basis for cost allocation between provision of terminal and en-route services; and
- While the regulation requires that the costs of approach service provision are allocated to terminal services, ANSPs have significant freedom in defining the scope of approach services. This is necessarily the case as operational requirements vary among airports.

3.15 These two factors lead to significant variation in methods of cost allocation among Member States, with consequent variations in en-route and terminal charges levied.

3.16 The implication of Article 8(2c) is that a proportion of joint or indirect costs (e.g. administrative costs, buildings, utilities, and engineering support) should be allocated to terminal services

[38] IFR = Instrumental Flight Rules. VFR = Visual Flight Rules

consistent with the method used to establish the direct terminal costs described at 8(2a) and 8(2b).

Allocation and apportionment of costs

3.17 ANSPs typically operate an internal cost management system that allocates the costs of staff, operations and assets to particular business units, operational centres or activities. Table 3.1 summarises categories of cost incurred by an ANSP that need to be allocated or apportioned to en-route or terminal activities for charging purposes.

Table 3.1: The types of costs to be allocated to activities

Type of cost	Elements	Comments
Staff	Salaries and overtime	Individual staff may divide their time between a number of services and activities (depending, inter alia, on licensing conditions
	Benefits and allowances	
	Pensions	Current pension payments cannot be related to current staff activities
Other operating costs	Maintenance	
	Utilities	May be related to relative use of space or equipment
	Consumables	
	Contractors	The extent to which work is specific to one activity may vary
	Indirect costs	Head office and support services
Assets	Depreciation	Different accounting conventions, and many assets such as buildings, radars and equipment may be shared between activities
Equity and debt	Cost of capital	
Exceptional items		

Source: Steer Davies Gleave analysis

3.18 However, recovery of these costs from airlines means that all must ultimately be correctly allocated to either en-route or terminal activities, as required by the Charging Regulation. In particular, two distinct processes are likely to be needed:

- Allocation of costs that are clearly only related to a specific cost centre, activity or charging zone, as envisaged in Article 8; and
- Apportionment of costs that are joint or common between two or more cost centres, activities and charging zones and must therefore be apportioned between them on the basis of one or more auditable metrics.

3.19 Any harmonisation of charges would require consistent rules for both allocation and apportionment of costs.

3.20 If en-route and terminal activities were wholly independent businesses, there would be no need to allocate or apportion costs between them. In practice, most ANSPs have chosen to provide these services jointly, and in some cases their provision may be carried out from the same room or by the same controller. There is therefore a need:

- To allocate, to en-route or terminal activities, the direct costs unambiguously attributable to one or the other;

- To apportion, between en-route and terminal activities:
  - In almost all ANSPs, the indirect or central costs relating to both activities (such as head office functions like Finance or Human Resources), engineering support for systems and hardware used by both businesses and/or building used by both businesses; and
  - In ANSPs where a single controller is qualified and able to handle both en-route and approach phases, the costs of providing the controller and associated facilities and equipment.

3.21 Different approaches to the allocation of costs can result in different charges to different airlines and hence to distortions or cross-subsidy. A 2001 report[39] identified for instance that in many Member States a large proportion of the costs of terminal ANS was recovered through en-route charges. If this was still the case, it could mean unfair cross-subsidies from overflying aircraft to those taking off and landing, in turn resulting in a cross-subsidy from long-haul flights to short-haul, regional and domestic flights. If some users were not being charged the full costs they imposed, this could lead to sub-optimal behaviour among airspace users, and inefficient use of airspace.

The current situation

Gaps in reporting requirements

3.22 During Reference Period 1 (RP1), ANSPs were required to provide details of *determined* costs for en-route services but not for terminal services. However, they were required to provide *actual* costs for both en-route and terminal activities. In RP2, they will be required to provide *determined* and *actual* costs for both services. The table below summarises these reporting requirements.

Table 3.2: Current reporting requirements

Reporting Period	Status	En-route	Terminal
RP 1 (2012-2014)	Historic incumbent ANSP	Determined costs Actual costs	× Actual costs
	Other ANSPs (if relevant)	Not able to provide en-route services	× Actual costs
RP 2 (2015-2019)	Historic incumbent ANSP	Determined costs Actual costs	Determined costs Actual costs
	Other ANSPs (if relevant)	Not able to provide en-route services	Determined costs Actual costs

Source: Steer Davies Gleave analysis

3.23 Some States were also unable to provide *actual* costs in June 2014 for 2012. In this case they provided *forecasted* costs for 2012 in June 2014.

3.24 The structure of the Reporting Tables requires costs to be broken down between five categories (staff, other operating costs, depreciation, cost of capital and exceptional items) and total. No additional breakdowns, such as ATCOs and non-ATCOs staff costs, were required to be reported.

[39] Study of the terminal charges for air traffic control services, PwC, 2001, paragraph 2.5.2

3.25 In addition, some ANSPs were unable to report terminal costs. This is the case for HungaroControl where the organisation of the ANS does not include terminal service provision. For the Maltese ANSP (MATS), although en-route and terminal costs are available, there is no terminal unit rate and terminal service units are not reported because the terminal charging zone comprises only one airport, which is less than 50,000 movements per year, meaning that MATS is not required to provide this data. There is also no reporting requirement for approach services or even for how approach services are organised within ANSPs.

3.26 Therefore, we have based our analysis on:

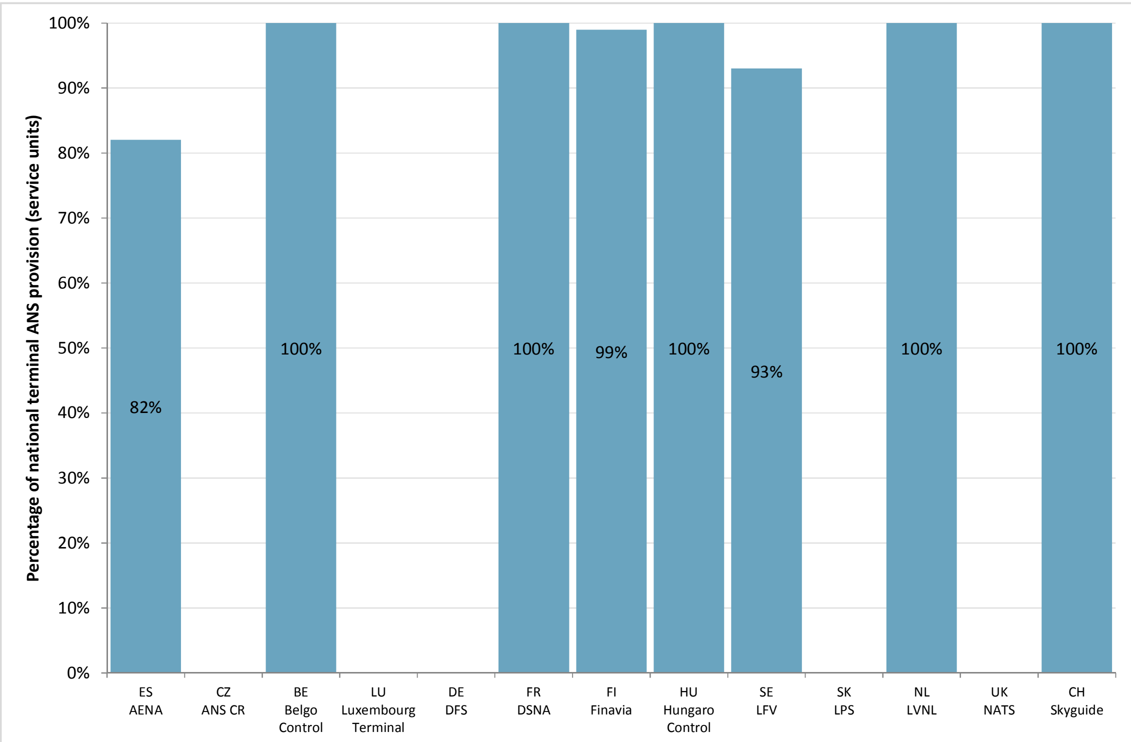
- 2012 *actual* costs as reported in June 2014 for both en-route and terminal services; and
- Additional information received directly from ANSPs and National Supervisory Authorities (NSAs) through our questionnaires and further clarification provided subsequently.

3.27 In the absence of mandatory 100% reporting, estimates of the impacts of different options for harmonising charges can only be indicative.

Current cost allocation

3.28 Most of the ANSPs included in the sample are the dominant or only provider of terminal ANS within their Member State. Figure 3.2, based on the ANSPs' responses to our questionnaire, shows their reported estimates of share of the market for national terminal ANS provision measured in terms of service units.

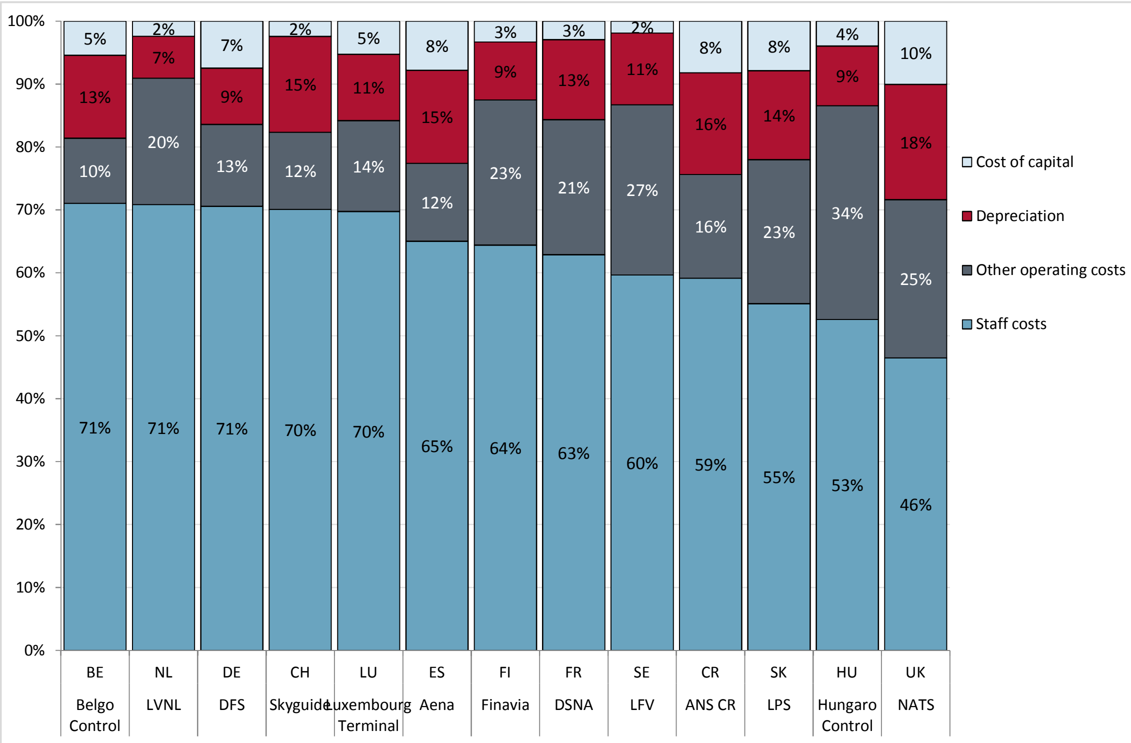
Figure 3.2 : ANSPs' share of national terminal ANS



Source: Stakeholder questionnaire responses

3.29 Figure 3.3, based on the ANSPs' reported total (terminal and en-route) actual costs for 2012, shows the relative importance of different categories of cost. It indicates that the largest category is staff costs, ranging from almost half of costs in some ANSPs to over 70% of costs in others. We discussed the varying proportion of staff costs with one ANSP, who suggested that this might be caused principally by variations in local wage rates and employment benefits.

Figure 3.3: Cost segmentation of ANSPs sample



Source: Steer Davies Gleave analysis of 2012 actual costs (apart from HungaroControl, which reported determined costs)

3.30 Table 3.3: summarises the sample of ANSPs' reported methodology and results obtained.

Table 3.3: Summary of ANSP sample

ANSP	State	Cost allocation basis	Costs allocated to Terminal	Allocation basis for approach sector
Aena	Spain	Activity-based costing	21%	10% of final approach phase is allocated to terminal, 90% to en-route
ANS CR	Czech Republic	Indirect-joint costs (such as training and administration) are allocated based on “composite flight hours”	19%	Performance Plan does not mention it and no response received
Belgo Control	Belgium, Luxembourg	Activity-based costing	26%	Proportion of approach airspace within cylinder radius 20 kilometres around airport
Luxembourg Terminal	Luxembourg, Belgium	Not stated	15%	Not stated
DFS	Germany	Operational, financial and organisational responsibilities	22%	Operational, financial and organisational responsibilities
DSNA	France	Allocation of activities, but no sub-allocation of staff time	20%	Varies by cost centre. No detailed rule provided.
Finavia	Finland	Based on flight-kilometres controlled	26%	Share of distance controlled by approach which is within kilometres within 20 kilometres of airfield. This results in 80% of approach being allocated to en-route
Hungaro Control	Hungary	Activity-based costing	17%	50% of distance flown in approach is taken into account in en-route
LFV	Sweden	All costs allocated 75% en-route , 18.5% approach and 6.5% terminal	12%	100% of approach costs are allocated to en-route
LPS	Slovakia	Allocation keys include proportion of IFR movements which are en-route and terminal	11%	Distance controlled, include the 20 kilometre rule
LVNL	Netherlands	Stated not to be activity-based costing, but appears to be based on extensive allocation and apportionment	33%	Costs incurred above FL 30 or more than 18 kilometres from a controlled airport are allocated to en-route
NATS	UK	Activity-based costing	20%	Any approach services that are provided under contracts agreed with airport operator customers are 100% terminal.

ANSP	State	Cost allocation basis	Costs allocated to Terminal	Allocation basis for approach sector
Skyguide	Switzerland	Based on organisational structure, ATCO staff numbers and territory controlled	40%	Based on operational shifts

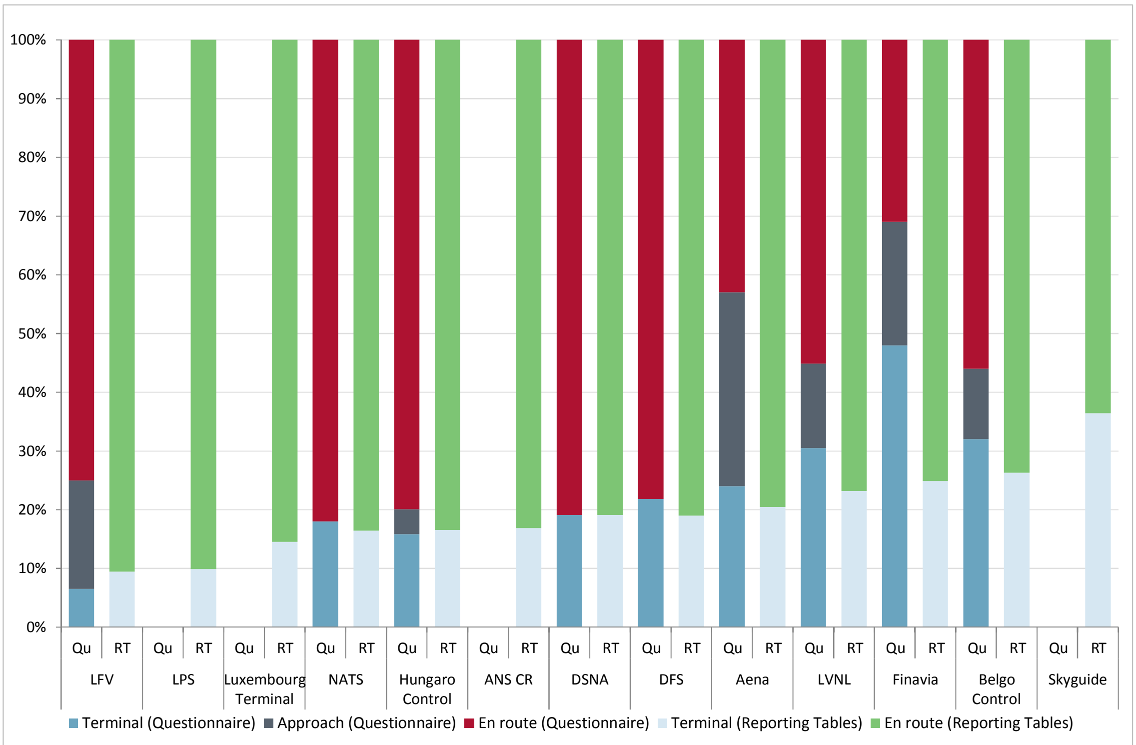
Source: ANS CR, Finavia and LPS allocations based on RP2 Performance Plans, all others based on stakeholder questionnaire responses, 2012 determined costs as reported in October 2011 Reporting Tables

3.31 In the Reporting Tables, the proportion of total costs allocated and apportioned to terminal ANS varies from 10% for LPS in the Slovak Republic to 41% for Skyguide in Switzerland. Only some of the ANSPs provided a more detailed apportionment identifying costs associated with approach ANS. In the cases of Aena, BelgoControl, Finavia and LVNL, the reported proportions of costs differ considerably between the Reporting Tables and the stakeholder questionnaire.

3.32 As explained above, the Reporting Tables do not provide any information on the allocation of costs for approach services. Figure 3.4 shows the selected sample of ANSPs and the proportions of their determined costs for 2012 expressed in two ways:

- As allocated to activities such as en-route, approach and terminal services as reported in the stakeholder questionnaire (Qu); and
- After apportionment of approach costs to en-route and terminal, as reported in the June 2014 Reporting Tables (RT).

Figure 3.4: The sample of ANSPs consulted



Key: Qu = questionnaire response, RT = reporting table.
Source: stakeholder questionnaire responses, 2012 actual costs.

Explanation of terminal costs

3.33 We observed in Table 3.3 above that the proportion of costs allocated to terminal services varies between 10% and 40% across ANSPs. We note that this range is quite wide and have considered what may drive the range of costs allocated to terminal activities. We have examined more than 12 possible explanatory variables and report our findings in Table 3.4 below.

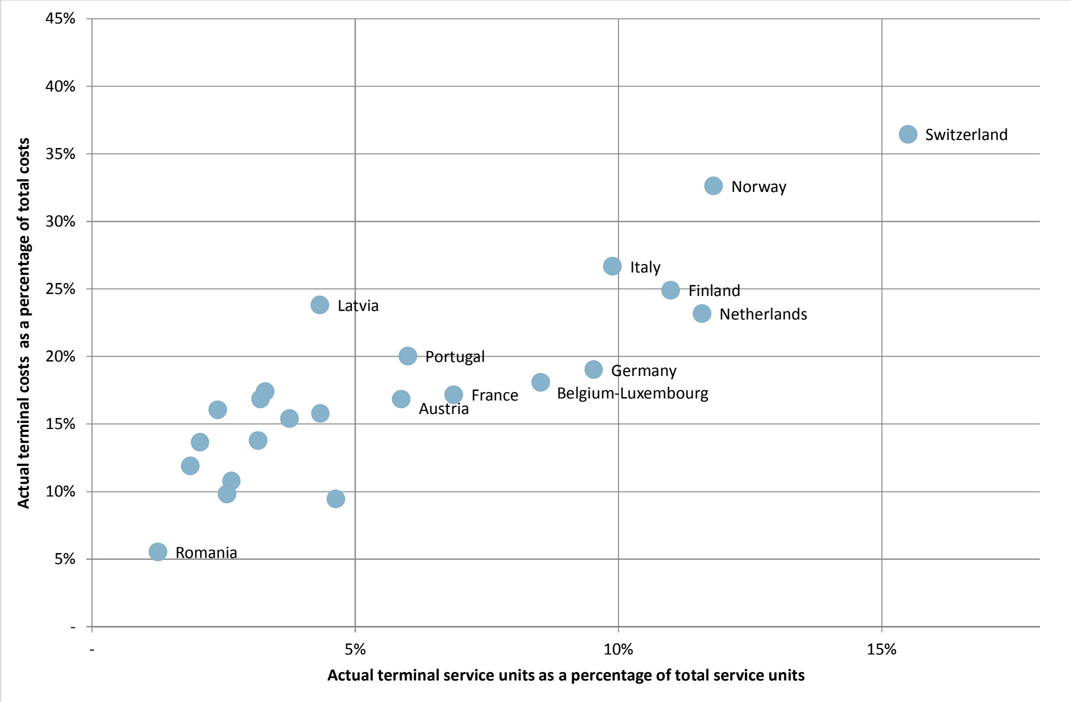
Table 3.4: Explanatory variables for cost allocation

Variable	Result
Proportion of terminal traffic	There was a distinct trend – the higher the proportion of terminal service units, the higher the terminal cost allocation.
Traffic complexity	There are two elements that define overall traffic complexity: adjusted density (concentration of traffic in a given volume of airspace) and structural complexity. The higher the overall complexity score, the higher the terminal cost allocation. However, this variable cannot be split into en-route and terminal so it cannot be used directly to reallocate costs.
Size of airspace	There was no clear trend between the size of the airspace controlled and the terminal cost allocation, as some ANSPs that allocated a relatively higher proportion of costs to terminal have a relatively small airspace.
Number of composite flight-hours	There was no clear trend.
Number of ATCO staff	There was no clear trend.
Number of Approach and Tower ATCO staff	There was no clear trend.
Proportion of Approach and Tower ATCO staff	There was no clear trend.
Proportion of Approach and Tower ATCO-hours on duty	There was no clear trend.
Number of Tower operational units	There was no clear trend.
Proportion of Tower operational units	There was no clear trend.
Number of IFR flights controlled by the ANSP	There was no clear trend.
Number of IFR km controlled by the ANSP	There was no clear trend.

Source: Steer Davies Gleave analysis

3.34 The only explaining variable that we found for the allocation of costs to terminal was the proportion of terminal traffic in the Member State. We have plotted this relationship in the figure below.

Figure 3.5: Relation between terminal service units and terminal charges (ANSP sample)



Source: Steer Davies Gleave analysis of 2012 actual terminal costs and service units as reported in June 2014

3.35 Figure 3.5 shows that:

- The proportion of service units related to terminal services varies from less than 2% to over 15% of the total;
- The proportion of charges related to terminal services ranges from around 5% to 35% of the total; and
- In general, the proportion of charges grows with the proportion of service units, suggesting that the proportion of charges is typically between 2 and 3 times the proportion of service units.

3.36 There is no obvious case of an outlier where the proportion of terminal charges is unusually low (or high), as might be the case if terminating flights were systematically subsidised at the expense of en-route or overflying flights.

Allocation of costs to activities

3.37 Stakeholders provided detailed responses regarding their processes of allocation of costs to activities. These can be found in Appendix B, section B.1.

Summary of stakeholder responses

3.38 We note that all the metrics mentioned might be appropriate for the allocation of ATCOs, and possibly other staff, whose costs are largely time-based, but are likely to be less appropriate for other costs, depreciation, cost of capital and extraordinary items. Table 3.5 summarises the ANSPs' responses (where a response has been received) to the cost allocation approach and the driver used. We note that:

- LFV allocate fixed proportions of each in-scope cost to en-route, approach and terminal charges. We have not identified how these proportions have been determined or whether there is a process for their review and revision.
- All the other ANSPs allocate costs between en-route and terminal at least partly on the basis of the operational, financial and organisational responsibilities.
- Many of the ANSPs claim to have used Activity Based Costing (ABC), a specific approach to cost allocation, although adoption of a common broad approach does not necessarily mean that each has applied exactly the same detailed methodology. For example, allocation models require some subjectivity in the rules for spreading company overheads, as Skyguide pointed out.
- A number of ANSPs appear to apportion at least some costs on the basis of the ATCO sectors/positions/shifts worked. This could be based on a system of ATCO timesheets, but might be based on automated recording of when controller positions were opened and closed to deal with emerging and varying workload.

Table 3.5 Summary of ANSPs approaches to cost allocation

ANSP	Cost allocation approach				Driver mentioned					
	Activity-based costing (ABC)	Other management accounting	Organisational structure	Any other method	ATCO staff numbers	ATCO staff hours	ATCO sectors / positions / shifts	Composite Flight Hours (CFH)	Flight-kilometres controlled	Territory controlled
AENA	✓						✓			
ANS CR		✓						✓		
BelgoControl	✓		✓		✓					✓
DFS	Part	✓	✓	✓			✓			
DSNA		✓	Part	✓	✓				✓	
Finavia				✓					✓	
HungaroControl	✓								✓	
LFV									✓	
LVNL		✓			Part	Part				
NATS	✓		✓	✓						
Skyguide			✓	✓	✓		✓			✓

Source: Steer Davies Gleave interpretation of stakeholder questionnaire responses

3.39 Most ANSPs use more than one driver to allocate costs, as shown in Table 3.5. In most cases, ANSPs stated that they use a variety of drivers, consistent with the need to be as realistic in their approach as possible. Some provided examples or illustrations but no explanation covering the whole of the cost allocation process, and none provided detailed lists of costs and the associated drivers. In particular, there was little suggestion that a driver could be identified for any costs other than staff costs, although one ANSP apportioned at least some other costs on the basis of distance flown. We note that any apportionment purely on the basis of distance flown might understate the relative costs of providing approach and terminal services, and hence misallocate costs between overflight and terminal movements.

Detailed allocation of costs to activities

3.40 We examined the allocation and apportionment of each of the types of costs in more detail, considering in turn staff costs, other operating costs, depreciation, cost of capital, and exceptional items and other costs (where relevant).

3.41 **Staff costs**: Table 3.6 and Table 3.7: below provide the breakdown of staff costs between ATCOs and non-ATCOs.

Table 3.6: Allocation of ATCO staff costs in 2012

ANSP	ATCOs, as reported in the stakeholder questionnaire			All staff, as reported in the Reporting Tables	
	En-route	Approach	Terminal	En-route	Terminal
Aena	41%	32%	27%	76%	24%
ANS CR	No response provided			77%	23%
BelgoControl	53%	13%	34%	74%	26%
Luxembourg Terminal	No response provided			0%	100%
DFS	77%	0%	23%	78%	22%
DSNA	No response provided			81%	19%
Finavia	30%	25%	45%	72%	28%
HungaroControl	55.2%	17.9%	26.9%	81%	19%
LFV	75%	18.5%	6.5%	86%	14%
LPS	No response provided			90%	10%
LVNL	No response provided			66%	34%
NATS	71%	0%	29%	78%	22%
Skyguide	No response provided			71%	29%

Source: Stakeholder questionnaire responses for 2012, where provided, 2012 determined costs from October 2011 Reporting Tables for other operating costs

Table 3.7: Allocation of other staff costs in 2012

ANSP	Other staff, as reported in the stakeholder questionnaire			All staff, as reported in the Reporting Tables	
	En-route	Approach	Terminal	En-route	Terminal
Aena	40.1%	29.9%	30%	76%	24%
ANS CR	No response provided			77%	23%
BelgoControl	53%	13%	34%	74%	26%
Luxembourg Terminal	No response provided			0%	100%
DFS	80%	0%	20%	78%	22%
DSNA	79.5%	0.%	20.5%	81%	19%
Finavia	24%	16%	59%	72%	28%
HungaroControl	88.2%	0%	11.2%	81%	19%
LFV	75%	18.5%	6.5%	86%	14%
LPS	No response provided			90%	10%
LVNL	No response provided			66%	34%
NATS	83%	0%	17%	78%	22%
Skyguide	No response provided			71%	29%

Source: Stakeholder questionnaire responses for 2012, 2012 determined costs from October 2011 Reporting Tables for all staff costs

3.42 **Operating costs**: Both AENA and BelgoControl's stakeholder questionnaire showed a higher proportion of both direct and indirect other costs allocated or apportioned to terminal costs than in the Reporting Tables; this does not appear to be consistent and we have sought, but not obtained, clarification.

Table 3.8: Allocation of other direct operating costs in 2012

ANSP	As reported in the stakeholder questionnaire			As reported in the Reporting Tables	
	En-route	Approach	Terminal	En-route	Terminal
Aena	39.3%	40.9%	19.8%	86%	14%
ANS CR	No response provided			83%	17%
BelgoControl	55%	12%	33%	73%	27%
Luxembourg Terminal	No response provided			0%	100%
DFS	90%	0%	10%	75%	25%
DSNA	82.1%	0%	17.9%	80%	20%
Finavia	35%	15%	50%	79%	21%
HungaroControl	85.9%	0%	14.1%	86%	14%
LFV	75%	18.5%	6.5%	88%	12%
LPS	No response provided			91%	9%
LVNL	No response provided			68%	32%
NATS	76%	0%	24%	74%	26%
Skyguide	No response provided			68%	32%

Source: Stakeholder questionnaire responses for 2012, 2012 determined costs from October 2011 Reporting Tables for other operating costs

Table 3.9: Allocation of other indirect operating costs in 2012

ANSP	As reported in the stakeholder questionnaire			As reported in the Reporting Tables	
	En-route	Approach	Terminal	En-route	Terminal
Aena	46.6%	30.2%	23.2%	86%	14%
ANS CR	No response provided			83%	17%
BelgoControl	55%	12%	33%	73%	27%
Luxembourg Terminal	No response provided			0%	100%
DFS	70%	0%	30%	75%	25%
DSNA	84.6%	0%	15.4%	80%	20%
Finavia	30%	22%	48%	79%	21%
HungaroControl	86%	0.2%	13.8%	86%	14%
LFV	75%	18.5%	6.5%	88%	12%
LPS	No response provided			91%	9%
LVNL	No response provided			68%	32%
NATS	0%	0%	100%	74%	26%
Skyguide	No response provided			68%	32%

Source: Stakeholder questionnaire responses for 2012, where provided, 2012 determined costs from October 2011 Reporting Tables for other operating costs

3.43 **Depreciation**: Aena, Finavia and HungaroControl all reported in the stakeholder questionnaire a higher proportion of depreciation allocated or apportioned to terminal costs than in the Reporting Tables. We have not identified the reason for these differences.

Table 3.10: Allocation of depreciation costs in 2012

ANSP	As reported in the stakeholder questionnaire			As reported in the Reporting Tables	
	En-route	Approach	Terminal	En-route	Terminal
Aena	50.8%	37%	12.2%	89%	11%
ANS CR	No response provided			84%	16%
BelgoControl	62%	11%	27%	67%	33%
Luxembourg Terminal	No response provided			0%	100%
DFS	80%	0%	20%	79%	21%
DSNA	78.3%	0%	21.7%	79%	21%
Finavia	33%	18%	49%	77%	23%
HungaroControl	84.9%	0.2%	14.9%	87%	13%
LFV	75%	18.5%	6.5%	94%	6%
LPS	No response provided			91%	9%
LVNL	No response provided			68%	32%
NATS	97%	0%	3%	97%	3%
Skyguide	No response provided			70%	30%

Source: Stakeholder questionnaire responses for 2012, 2012 determined costs from October 2011 Reporting Tables

3.44 **Cost of capital**: ANS CR and Luxembourg terminal allocated all the cost of capital to en-route activities in their Reporting Tables.

Table 3.11: Allocation of cost of capital in 2012

ANSP	As reported in the stakeholder questionnaire			As reported in the Reporting Tables	
	En-route	Approach	Terminal	En-route	Terminal
Aena	50.4%	36.7%	12.9%	87%	13%
ANS CR	No response provided			100%	0%
BelgoControl	80%	0%	20%	84%	16%
Luxembourg Terminal	No response provided			0%	100%
DFS	83%	0%	17%	81%	19%
DSNA	86.7%	0%	13.3%	85%	15%
Finavia	31%	19%	50%	74%	26%
HungaroControl	86.3%	0%	13.7%	88%	12%
LFV	75%	18.5%	6.5%	86%	14%
LPS	No response provided			90%	10%
LVNL	No response provided			64%	36%
NATS	94%	0%	6%	94%	6%
Skyguide	No response provided			73%	27%

Source: Stakeholder questionnaire responses for 2012, 2012 determined costs from October 2011 Reporting Tables

3.45 **Exceptional items**: in practice, given the nature of exceptional items, we would not expect to determine, in advance, whether they should be allocated to en-route or terminal or apportioned between them on some basis.

Table 3.12: Allocation of exceptional items in 2012

ANSP	As reported in the stakeholder questionnaire			As reported in the Reporting Tables	
	En-route	Approach	Terminal	En-route	Terminal
Aena	46.5%	32.7%	20.8%	92%	8%
BelgoControl	62%	8%	30%	85%	15%
DFS	77%	0%	23%	77%	23%
NATS	95%	0%	5%	94%	6%

Source: Stakeholder questionnaire responses for 2012, 2012 determined costs from October 2011 Reporting Tables

3.46 **Other costs**: we made provision in the stakeholder questionnaire for ANSPs to describe the treatment of any “other costs” not covered in the categories listed above. As shown in the table below, only two ANSPs identified other items of costs. HungaroControl allocated these entirely to en-route and LFV apportioned them in the same way as all other items.

Table 3.13: Allocation of other costs in 2012

ANSP	As reported in the stakeholder questionnaire			As reported in the Reporting Tables	
	En-route	Approach	Terminal	En-route	Terminal
HungaroControl	100%	0%	0%	Reporting Tables do not have a category of "other costs"	
LFV	75%	18.5%	6.5%		

Source: Stakeholder questionnaire responses for 2012

Total cost allocation

3.47 The table below summarises the overall allocation of costs as reported in the stakeholder questionnaire and in the Reporting Tables.

Table 3.14: Allocation of total costs in 2012

ANSP	As reported in the stakeholder questionnaire			As reported in the Reporting Tables	
	En-route	Approach	Terminal	En-route	Terminal
Aena	43%	33%	24%	80%	20%
ANS CR	No response provided			81%	19%
BelgoControl	56%	12%	32%	74%	26%
Luxembourg Terminal	No response provided			0%	100%
DFS	78%	0%	22%	78%	22%
DSNA	81%	0%	19%	80%	20%
Finavia	31%	21%	48%	74%	26%
HungaroControl	80%	4%	16%	83%	17%
LFV	75%	18%	7%	88%	12%
LPS	No response provided			90%	10%
LVNL	55%	14%	31%	67%	33%
NATS	82%	0%	18%	82%	18%
Skyguide	No response provided			59%	41%

Source: Stakeholder questionnaire responses for 2012, 2012 determined costs from October 2011 Reporting Tables

3.48 The principal findings of this analysis are as follows:

- Stakeholders' reporting of their 2012 costs by activity in the stakeholder questionnaires was not always consistent with those provided in the corresponding Reporting Tables.
- The proportion of staff costs allocated to en-route ANS varies between 90% and 66%, that of other costs varies between 91% and 61%, whilst the depreciation allocated to en-route ANS varies between 98% and 67%. The proportion of the cost of capital allocated to en-route ANS varies from 100% to 64%.
- Whilst these ranges seem broadly consistent across cost categories, the range in each case is wide. However, it remains difficult to determine how far it reflects underlying differences in extent of terminal activity rather than differences in allocation methodologies.

Allocation of approach costs to en-route and terminal costs

3.49 The Charging Regulation provides for approach services to be defined differently on the basis of operational requirements. It also states that en-route charging zones shall extend "from the ground up to, and including, upper airspace". In complex terminal areas, Member States may establish a specific zone within a charging zone.

3.50 In practice, many ANSPs provide "approach ANS" which, in the case of Finavia, can begin as much as 100 kilometres from the airport. All the ANSPs stated that approach ANS costs were divided between en-route and terminal costs, with the exception of LFV from Sweden who explained that their system was created when the market was still regulated. Table 3.15 summarises the reported approaches to apportioning the cost of approach services between en-route and terminal.

Table 3.15: Allocation of approach to en-route or terminal in the sample chosen

ANSP	All en route	Mixture of en-route and terminal
AENA	No	90% en route charge, 10% terminal charge
BelgoControl	No	The allocation of approach varies from 22% to 81% depending on the tower in charge of providing the service
DFS	No	Approach services provided by Control Centres (CC) are allocated to en-route, final approach services provided by control towers are allocated to terminal. Approach sectors are part of the business unit CC, which is 100% related to en route.
DSNA	No	The allocation of approach varies depending on local parameters (such as number of aerodromes controlled from a same approach control room) and other parameters (flight-kilometres and 20 km rule, etc)
Finavia	No	Share of distance controlled by approach which is within kilometres within 20 kilometres of airfield. This results in 80% of approach being allocated to en-route.
HungaroControl	No	Approach related direct costs are allocated on the basis of average distance flown - where 50% of distance flown in approach is taken into account in en route, and the other half is calculated for terminal services. This results in 85.94% of approach being allocated to en-route.
LFV	Yes	No
LVNL	Unclear. LVNL stated that 100% of its approach costs were allocated to en-route charges. However it also declared that 21% of approach costs were also allocated to en-route charges.	
NATS	No	Any approach services (excluding London) that are provided under contracts agreed with airport operator customers are 100% terminal. For the London approach, the allocation of costs is currently based on a separate Terminal Charge with the current allocation of costs. The UK CAA has indicated that it will be inclined to move towards a separate Terminal Charge with full allocation of costs over time in line with a common approach that could be adopted for the EU.
Skyguide	No	Approach costs are allocated between en-route and terminal according to operational shifts. The metrics used are numerous including radio frequencies, volume of airspace, sectorization, etc

Source: Stakeholder questionnaire responses for 2012

3.51 Our review of the ACE submissions also revealed a wide variations in the methods for apportioning approach sector costs between terminal and en-route services:

- To terminal by distance from aerodrome, as described by Finavia and HungaroControl including:
  - Undefined distances, such as at "controller handover point", which varies
  - 13 kilometres from the aerodrome
  - 20 kilometres from the aerodrome (consistent with the en-route charging formula)
- "By volume of controlled airspace"
- "On an accounting basis"
- Percentage shares, with en-route shares of 100%, 75%, 64%, 50% and 0% all mentioned
- Finavia clearly stated that the split was based on the share of distance controlled by approach which is within kilometres within 20 kilometres of airfield, and provided an illustrative worked example.
- HungaroControl stated that it does not have a separate terminal sector, but that approach costs are allocated on the basis of average distance flown: this appears to be consistent with Finavia's approach.
- Aena estimated "the proportion of final approach in relation to the total approach distance": this appears to be consistent with Finavia's approach.
- DSNA stated that the allocation of approach costs to en-route and terminal is carried out for each combination of approach and tower control, using flight kilometres and the 20 kilometre rule: this appears to be consistent with Finavia's approach.

3.52 While only Finavia and HungaroControl stated unambiguously that the apportionment was based on the proportions of the notional or average distance over which an aircraft was under approach control pro rata within or outside 20 kilometres from the airport, we concluded that AENA and DSNA had probably used this approach. Distance is a reasonable basis on which to subdivide approach costs, although we note that:

- The distance measure is likely to understate the time spent within 20 kilometres of the airport, as ground speed declines with altitude; and
- Even if the distance measure were replaced with a time measure, it might be argued that this did not reflect actual costs if, for example, approach controllers' workload in controlling aircraft was not evenly distributed over the distance under approach control. At busy airports there might be a high workload to space aircraft correctly in the approach pattern at around 20 kilometres from landing, but relatively little workload while subsequently descending at constraint airspeed and spacing.

3.53 In contrast:

- BelgoControl referred to the Charging Regulation requirement that, in the calculation of en-route service units "The distance to be taken into account shall be reduced by 20 kilometres for each take-off from and for each landing on the territory of a Member State." However, it stated that costs were based on the share of airspace volume within 20 kilometres of the airport, not the share of approach distance within 20 kilometres of the airport, and conceded that this might be a disadvantage of the current approach.
- DFS said that approach services provided by Control Centres are allocated to en-route and Final Approach Services provided by Control Towers are allocated to "TNC". This would appear to be consistent with the Charging Regulation only if the handover between Control Centres and Control Towers, both inbound and outbound, is always at 20 kilometres.

- NATS referred us to CAA paper CAP 1158, which refers to the principles of a number of approaches but does not quantify their effect.

Summary

3.54 Annex 4 of the Charging Regulation requires that, in calculating en-route charges, "the distance to be taken into account shall be reduced by 20 kilometres for each take-off from and each landing on the territory of a Member State". If aircraft were handed between "en-route control centres" and "terminal control centres" at points 20 kilometres from their origin and destination airports, there would be little need to allocate costs to en-route and terminal services, except for overhead activities and functions shared between both types of centre. A variety of operational practicalities, however, dictate that handover takes place at a wide range of distances from airports, in some cases with the airport tower controlling the entire descent and climb phases into upper airspace.

3.55 Many ANSPs identify an "approach" activity and, to comply with their interpretation of the Charging Regulation, a number apportion costs allocated to approach between en-route and terminal pro rata with the notional distance less than or more than 20 kilometres from the airport. This method of apportionment appears sensible, but depends on the definition of the points at which approach control starts and ends.

3.56 Aircraft fly more slowly at lower altitudes, and it could be argued that apportionment should be on the basis of the relative time, rather than the relative distance, spent in en-route and terminal phases. This would increase the proportion of approach costs apportioned to terminal charges. Conversely, aircraft within 20 kilometres of the airport may all have reached a consistent bearing, spacing, airspeed and rate of descent, and require less supervision than those still being guided to join the approach with the correct sequence and spacing. Without a clear view of the relative workload at different distances, which might be a function both of the airport and traffic conditions, it is not clear what basis for apportioning approach costs is most cost-reflective.

3.57 The handover point between en-route, approach and tower may vary with time of day, direction of approach, workload and other factors. This suggests that a "correct" apportionment of costs would need to record the times at which each aircraft was handed over between controllers.

3.58 Finavia provided a clear worked example of how it apportioned approach costs: assuming that an average aircraft was under approach control from 80 kilometres to 5 kilometres from landing, 60 kilometres, or four-fifths of costs, were treated as en-route and 15 kilometres, or one-fifth of costs, were treated as terminal.

3.59 Use of any of these methods, unless subject to rigorous data collection and analysis, could be open to manipulation if ANSPs were motivated to do so. In Finavia's example, if approach control was assumed to be from 95 kilometres to 5 kilometres, or 80 kilometres to 8 kilometres, terminal charges would be based on one-sixth, rather than one-fifth, of the total.

Objectives of cost allocation harmonisation

3.60 The general objectives for modulation of charges described in Chapter 1 require some elaboration in the context of harmonisation of cost allocation. The rationale for harmonisation is driven to a large extent by a desire to improve economic efficiency and ensure that costs are allocated "to the charging zones in respect of which they are actually incurred", as required in Article 8 (1) of the Charging Regulation.

3.61 There are three main reasons why costs are allocated, encompassing planning and control, price setting and cost of services sold[40]:

- *"To obtain desired motivation. Cost allocations are sometimes made to influence management behaviour and thus promote goal congruence and managerial effort. Consequently, in some organizations there is no cost allocation for legal or internal auditing services or internal management consulting services because top management wants to encourage their use. In other organizations there is a cost allocation for such items to spur managers to make sure the benefits of the specified services exceed the costs;*
- *To compute income and asset valuations. Costs are allocated to products and projects to measure inventory costs and cost of goods and services sold. These allocations frequently service financial accounting purposes. However, the resulting costs are also often used by managers in planning, performance evaluation, and to motivate managers, as described above;*
- *To justify costs or obtain reimbursement. Sometimes prices are based directly on costs, or it may be necessary to justify an accepted bid. For example, government contracts often specify a price that includes reimbursement for costs plus some profit margin. In these instances, cost allocations become substitutes for the usual working of the marketplace in setting prices".*

3.62 It is important to note that different cost allocations can be made for different purposes and that, as discussed above in paragraph 3.21, there is some potential for distortion or cross-subsidy. Ideally all three cost allocation objectives above should be met at the same time, but this is sometimes difficult to achieve. Hence, in practice, the allocation of costs can distort the charges paid by airspace users significantly, leading to winners and losers. If, for example, costs were disproportionately allocated to en-route, the following groups of users would benefit:

- Low cost EU based carriers flying short-haul routes and using a mix of terminal and en-route services;
- Full service carriers based in the EU flying short-haul routes and using a mix of terminal and en-route services; and
- General aviation services flying short routes and using predominantly terminal ANS services.

3.63 By contrast, non-EU carriers only flying long-haul and using predominantly en-route services and EU based long-haul carriers flying over EU airspace and using mainly en-route services would lose since the charges that they paid would more than recover the costs of the services that they used.

[40] "Cost Allocation and Activity-Based Costing Systems"

3.64 At the same time we note that full cost-reflectiveness, even if it could be achieved in principle, might be difficult to reconcile with a number of the other objectives described in Chapter 1. For example, a rebalancing of the cost allocation towards terminal activity, while it could be made consistent with revenue neutrality, might require a more thorough and administratively onerous analysis and reporting of costs. This, in turn, might be considered impractical by ANSPs and other stakeholders. We return to these issues in the evaluation of the options considered against the various objectives at the end of this chapter.

Key cost allocation issues

3.65 Table 3.1 lists some of the types of cost incurred by an ANSP that need to be allocated or apportioned to route or terminal activities for charging purposes. Article 8 of the Charging Regulation requires that “the costs of eligible services, facilities and activities shall be allocated in a transparent way to the charging zones in respect of which they are actually incurred”. However, unless the methodology to be used for charging is specified in considerable detail, ANSPs can take a number of different approaches to allocating costs based on the structure of their activities or any other decisions. Any business will face similar issues and not all would make the same choices even in the same circumstances.

3.66 We illustrate below some of the practical issues that may have been addressed by ASNPs:

- Costs related to former employees or to activities not organised in the same way today as previously: staff pension costs relating to retired ANS staff, who may have worked in roles which no longer exist, cannot readily be allocated to the activities of current ANS staff.
- The costs of servicing debt, part of the cost of capital, are likely to be joint across all activities, and cannot normally be readily attributed or allocated to activities. They must therefore be apportioned between them on some basis.
- Maintenance costs related to how they are provided: costs of management and maintenance of buildings and facilities might, for instance, be provided by any of:
  - In-house staff dedicated to each location;
  - A centralised team whose costs are allocated on a basis such as the floor area dedicated to each service, or the labour and materials expended on space occupied by each service; and
  - Subcontractors, with the contract cost of work covering both en-route and terminal facilities allocated to each on some basis.
- Other administrative costs: the cost of telephone systems serving all the ANSP’s activities might plausibly be allocated pro rata with the variable call charges, the number of call minutes, the number of calls, the number of staff, or the number of telephone extensions provided in locations used by each service. When call charges were high, it might have been appropriate to prorate other costs with call charges. Where call charges are low or zero (such as if calls are made over virtual private networks or using Internet Protocol (IP)), it may be necessary to express all costs as a cost per staff member or per extension. In either case, procedures are needed for updating the cost allocation as the number of staff or extensions changes.

3.67 In addition, the calculation required may also change if the ANSP’s organisation changes. If an ANSP has a single centre staffed by controllers trained in both en-route and terminal work, it may need to allocate their costs to these activities based on timesheets recording how they spend each working shift. If en-route activities are moved to a new centre, it may only be necessary to identify the location at which the staff are employed.

3.68 This means that a number of different approaches could be transparent, and therefore compliant with Article 8, but still result in different allocations of charges. In addition, our analysis suggests that it would not be desirable to adopt an apportionment measure which could result in a different allocation of costs depending on the ANSPs' approach to outsourcing and subcontracting, particularly if changes in procurement strategy resulted in sudden changes in the allocation of costs. As we noted above:

- Depreciation charges might change depending on whether an asset was on the ANSP's balance sheet or provided as a service by an outside contractor; and
- Staff costs might change depending on whether staff were employed directly by the ANSP, subcontracted or outsourced.

Possible approaches to harmonising cost allocation

Bottom-up approach

3.69 A bottom-up approach would prescribe the allocation driver by cost category for any direct, indirect or joint/common cost to be allocated. Such an approach, while recognising that the majority of ANSPs use some form of ABC process to allocated costs, would provide for a transition towards the use of prescribed drivers in order to increase transparency. The option could be applied according to the following guidelines:

- ANSPs with ABC type systems in place could continue to use them, provided they were transparently reported and consistent with the Principles;
- ANSPs without ABC systems would be required to adopt "Lite" versions of ABC using basic metrics adopted at a high level as follows:
  - All staff costs and direct operating costs split by an ATCO measure (to be defined);
  - Indirect operating costs split by Composite-Flight Hour or possibly Service Units;
  - Depreciation and Cost of Capital to be split by asset bases; and
  - Exceptional items split on a case-by-case basis.

3.70 The benefits of a bottom-up approach are that it would enable an incremental approach to cost allocation, building from the current situation.

3.71 Adoption of such an approach would require development of, and agreement on, a large number of accounting, allocation and apportionment conventions to ensure that any ANSP, no matter how organised or reorganised, could be shown to have applied the same approach in the same way. These rules would need to be sufficiently comprehensive to deal with a wide range of arrangements, including subcontracting (which we noted in paragraph 3.68 may transform staff costs and depreciation costs into other operating costs), reorganisation, or subdivision into independent companies. Effectively, such rules would need to be capable of consistent application to all the ANSP models currently used, but also allow for any changes which Member States might reasonably introduce from time to time.

3.72 In the absence of a consistent and detailed set of accounting conventions, it is not yet clear whether and how it would eliminate all ambiguity in how costs were to be allocated, especially in relation to issues such as the recording of ATCO hours (see 3.90) or the allocation of workstations to services (see paragraph 3.91). Neither is it clear whether ANSPs, NSAs and other stakeholders would accept that any such set of conventions was "correct", and in particular cost-reflective.

3.73 An additional challenge in providing harmonisation through a bottom-up approach would be overseeing and enforcing the mandated approach. In principle, this would require more cost and other information to be provided by Member States and ANSPs. Moreover, the ability of NSAs to oversee the implementation of accounting requirements has been shown to be limited in RP1, while recent discussions on pensions and the cost of capital demonstrates the need for a pooling of NSA resources to address these issues.

Top-down approach

3.74 Under this option, there would be a standard metric for the allocation of total costs or costs by category between en-route and terminal activity. The approach would recognise the difficulties of allocating the costs using bottom-up ABC processes, and that there would be some trade-off between certainty and transparency to airspace users and accuracy. It could be applied as follows:

- Use a top-down metric or number of metrics, applied to all ANSPs in the same way; and
- Consider standardising treatment of approach services (for charging purposes only), possibly to 20km from terminal, consistent with the calculation of en-route service units.

3.75 The top-down approach would therefore be simpler to oversee and enforce and could be applied using data that is already collected. However, it would not result in the most accurate allocation of costs and ANSPs already applying a more detailed methodology would be likely to challenge its value.

3.76 As noted above, as the current allocation of costs between businesses is not fully transparent, it is difficult to estimate the size of the impact using a detailed bottom-up approach. By contrast, it is relatively straightforward to quantify the impact of a harmonised top-down approach and compare the resulting allocation to that arising under current allocation methods. After discussion with the Commission, we have focused on two possible top-down options:

- A simple cost allocation, for example related to ATCO numbers or ATCO hours, that would be applied to all cost categories; and
- A more detailed cost allocation based on different metrics that may vary depending on the cost categories.

3.77 A number of metrics are already reported that could be used to support either top-down approach, and other metrics not currently available could, in principle, be developed. The choice of metric(s) depends on the appropriate balance between the objectives described in Chapter 1, recognising that there is likely to be a trade-off between economic efficiency or cost-reflectiveness on the one hand and practicality and costs of implementation on the other.

Summary of options

3.78 The options for cost harmonisation that we have considered are summarised in the table below. Having noted the difficulties of adopting a bottom-up approach, we review the implications of using different metrics in support of a simpler top-down approach in the following paragraphs.

Table 3.16: Options for harmonisation of cost allocation

Option	Summary
CH1: Bottom-up approach	Would require prescriptive identification of drivers for different categories of cost at a detailed level, based on ABC principles. This, in turn, would involve extensive stakeholder consultation and discussion in order to reach consensus and detailed monitoring to ensure consistent application of agreed conventions.
CH2a: Top-down approach – single metric	Application of a single metric to apportion relevant cost categories between en-route and terminal activity. The choice of metric would similarly need to be established through consultation and discussion, taking account of an appropriate balance of objectives. Monitoring of the application of this approach would be considerably less onerous than in the case of CH1.
CH2b: Top-down approach – multiple metrics	Application of multiple metrics, selected after determining the main drivers of different categories of cost and similarly agreed through consultation and discussion. Monitoring would be less demanding than under CH1 but potentially somewhat more onerous than under CH2a (depending on the number of metrics and their application).

Source: Steer Davies Gleave analysis

Apportioning costs on the basis of a single metric

3.79 Apportioning costs between en-route and terminal ANS on the basis of the single measure of ATCO hours could be undertaken in respect of all cost categories, including approach costs. However, this would result in all costs other than ATCO staff costs being apportioned between these activities even if they were directly attributable to a specific activity.

3.80 An ATCO staff-hours metric could be derived from timesheets, with each ATCO recording the number of hours spent on en-route and terminal activity. However, as each ANSP operates differently, we were unable to obtain this data for all ANSPs. The ATM Cost-Effectiveness (ACE) 2011 Benchmarking Report, Annex 7 Table 0.5, provides ATCO hours on duty split by en-route and 'APP+TWR', (with approach activity grouped with tower or terminal activity). We have been unable to use this data as we have been unable to determine how approach activity is split between en-route and terminal in each case.

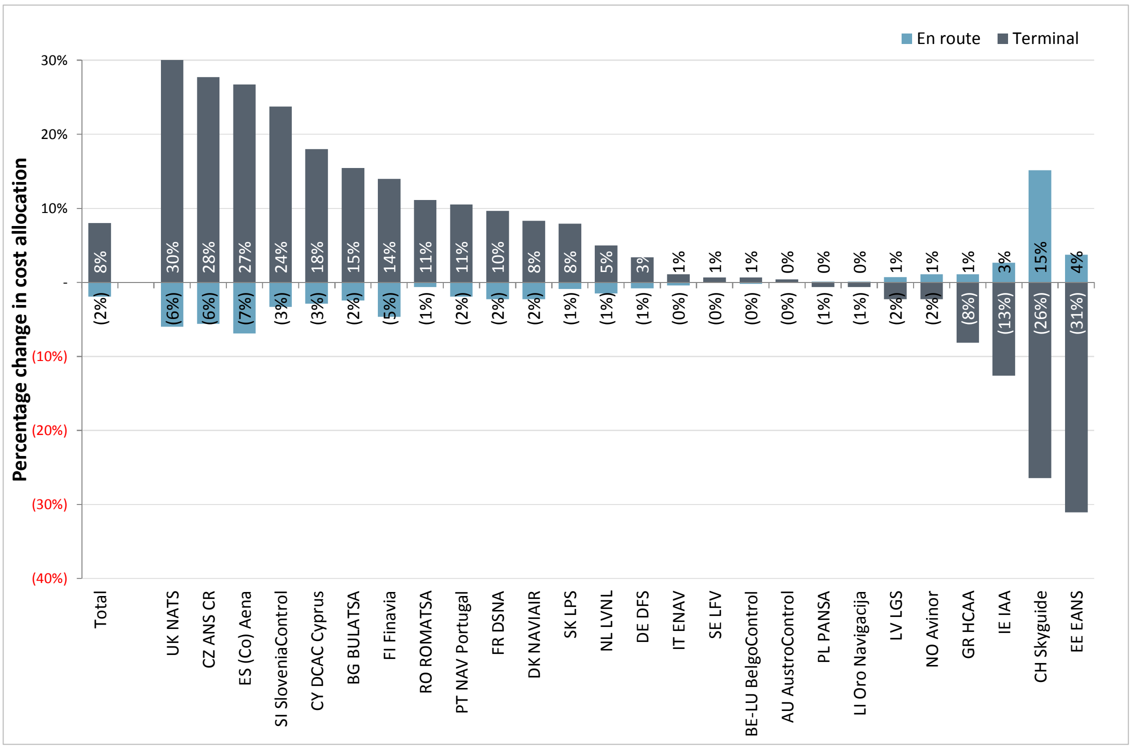
3.81 ATCO staff costs split by en-route and terminal activity could also be used to derive a possible metric, as hours spent by ATCOs on duty should correspond to staff costs. However, only total staff costs are readily available from the Reporting Tables, and reporting of further disaggregation by staff type is not required by the Regulations. We also note that:

- Staff costs, as reported by ANSPs, are themselves an outcome of a process of allocation and apportionment, which might not be consistent between ANSPs.
- The incidence of staff costs may change if activities are contracted out. It might not be sensible, for example, for en-route charges to increase if maintenance of an en-route control centre was no longer contracted out and instead provided by ANSP-employed staff.

3.82 By way of illustration, we have reallocated costs between en-route and terminal using total staff costs as a proxy for ATCO staff costs and ATCO hours. In this scenario, terminal cost allocation increases for more than half the Member States, by up to 28%, as shown in Figure 3.6. En-route costs therefore decrease in those States but by a smaller percentage as en-route costs are much higher than terminal costs. The overall effect on the allocations modelled for the different States is an 8% increase in terminal costs and a 2% fall in en-route costs.

However it must be noted that the data used has limitations and some Member States with incomplete data have been excluded from the analysis.

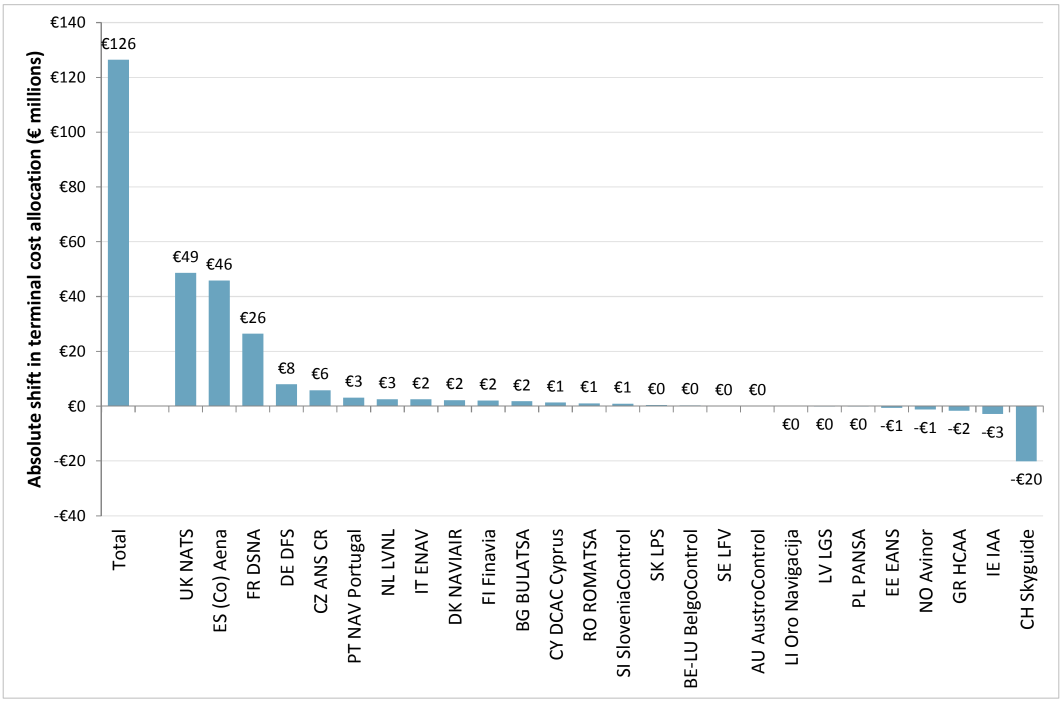
Figure 3.6: Apportionment on ATCO costs: indicative en-route/terminal charges



Source: Steer Davies Gleave analysis

3.83 As the figure below shows, the absolute impact in the case of some States is considerably larger than in others. Costs allocated to terminal increase in more than half the States by between €1m and €46m (2012 prices), although for most the absolute change is less than €3m. In the case of one State, the allocation falls by €20m. The overall effect is to redistribute €126m from en-route to terminal charges.

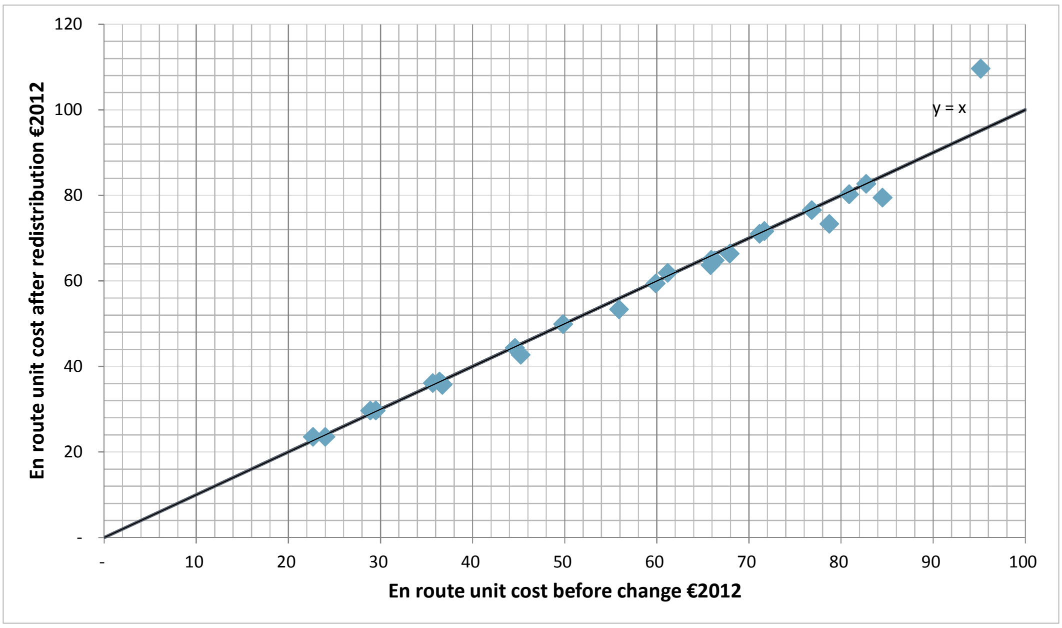
Figure 3.7: Apportionment on ATCO costs: indicative terminal revenue



Source: Steer Davies Gleave analysis

3.84 The new en-route unit cost after redistribution is plotted against the original cost charged in 2012 in Figure 3.8. There is little change in the costs for most States, although one experiences an increase of more than 15%. Note that the range of unit costs has not reduced, demonstrating that “harmonisation” will not eliminate variation in costs.

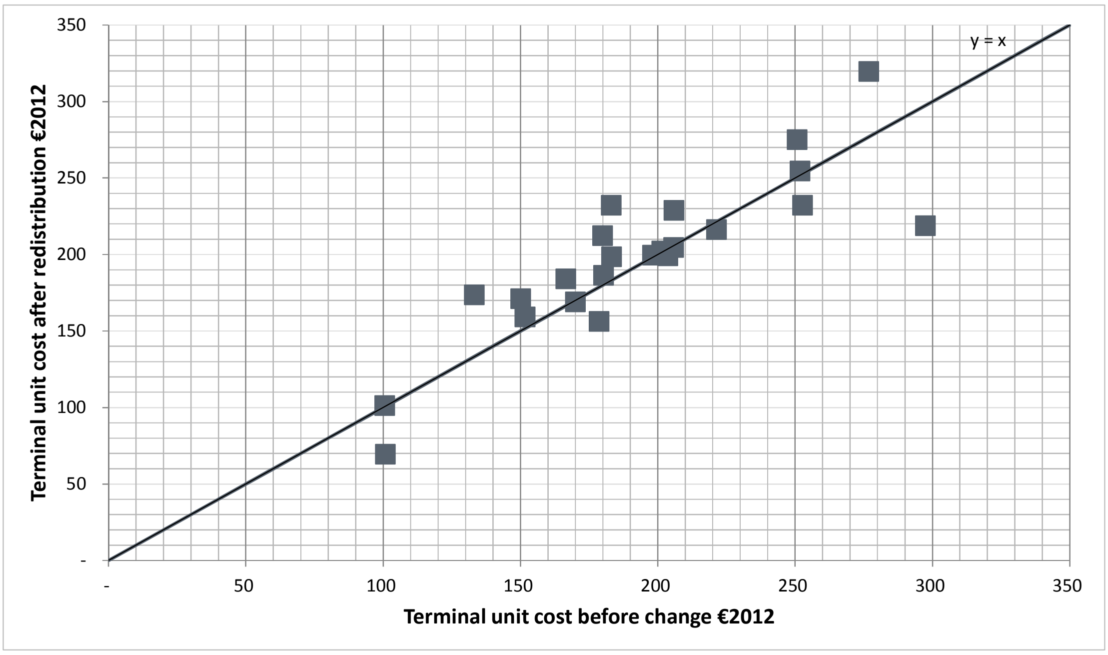
Figure 3.8: Apportionment on ATCO costs: indicative en-route unit costs



Source: Steer Davies Gleave analysis

3.85 Figure 3.9 shows the change in terminal unit costs before and after redistribution, where the effects are bigger than for en-route, particularly in the case of States that have rates at the higher end of the range (above €250).

Figure 3.9: Apportionment on ATCO costs: indicative terminal unit costs



Source: Steer Davies Gleave analysis

3.86 While in principle, apportionment on the basis of ATCO costs seems appropriate, it might need to be based on different approaches in different ANSPs. For example:

- An ANSP with separate en-route and terminal control centres might have clearly separate groups of en-route and terminal staff, and find it easier to base apportionment on their headcount, rather than the more complex calculation of their salary costs and benefits, including pensions for former staff.
- An ANSP without a distinct terminal sector, with some or all ATCOs providing both en-route and terminal services, would need to base ATCO costs on an apportionment of ATCO hours, probably based on timesheets or records of work performed on each shift.
- Where approach services were provided, it might still be necessary to apportion the costs of some ATCOs working on some shifts on the basis of a measure such as flight hours or flight kilometres.

3.87 We note that the potential impact of requiring ANSPs to apportion all costs on the basis of ATCO costs might have a similar effect to apportionment on the basis of staff costs. However, we also note that ATCO costs are themselves likely to be based on apportionment using other metrics.

3.88 Headcount, although a simpler metric as already noted, also has a number of potential disadvantages:

- It may vary in the short term with factors such as staff departures, leave of absence, and numbers of staff who are not yet fully trained or can only cover limited numbers of sectors, and a sample or annual average headcount may not reflect the underlying mix of workload

between en-route and terminal activities. This is particularly likely to be the case if en-route and terminal control centres are remote from each other and have fundamentally different recruitment and training processes.
- As noted above, many ATCOs provide both en-route and terminal services and any measure of headcount would therefore be based on a further level of apportionment such as ATCO hours by activity or flight kilometres.

3.89 A further potential apportionment measure is ATCO hours. However, we note that where individual ATCOs are specific to en-route or terminal activities, or these services are provided at different centres, they may not record their actual hours worked and this may need to be estimated, in at least some circumstances, by headcount.

3.90 The stakeholder consultation also indicated that an apportionment based on ATCO hours could be distorted by factors such as sector opening hours and productivity. For example, by opening en-route sectors for longer than was strictly necessary, subdividing en-route airspace by more than was strictly necessary, or recording that ATCOs on duty but not working were providing cover for one service or another, it would be possible to manipulate the relative number of ATCO hours and hence the charges for each service. One ANSP stated that metrics giving rise to incentives of this kind would almost certainly begin to affect ANSP behaviour and hence the apportionment of costs. Unlike measures such as costs and headcount, which cannot be directly influenced by individual ATCOs, ATCO hours can be manipulated by systematic distortions in the way in which ATCOs complete their timesheets, or are allocated to workstations or sectors controlled by their supervisors.

3.91 A number of ANSPs reported that they allocate some costs according to the "sectors/positions" operated in each operational cost centre, although one stated that workstations were only used as a metric for apportioning the costs of technical equipment between the various buildings it served. Workstations could form the basis of different metrics such as:

- The number of workstations or working positions provided for en-route and terminal control, which would be fixed and easily measurable. It might, however, prove open to manipulation if workstations were shared between en-route and terminal activities, in circumstances where they were only required for short periods when a large number of sectors were operated, or if unused or surplus workstations were allocated to one activity rather than being declared out of use.
- The number of workstation hours, or sector hours, actually operated. This would remove the potentially distorting features described in the preceding bullet point, but would effectively become a measure of ATCO hours and hence introduce the potential for individual ATCOs or supervisors to influence the apportionment of costs between activities.

Assessment of potential metrics for application in a multiple metric approach

3.92 We set out the possible metrics that we considered for CH2b and our analysis of their suitability in terms of harmonisation of cost allocation in Table 3.17. The results of our assessment are illustrated below with the following legend:

✓ Metric that could probably be used to apportion the cost category;
✗ Metric not suitable to apportion the cost category; and
? Not clear whether or how the metric could be used to apportion the cost category.

Table 3.17: Possible metrics for cost apportionment

Type	Metric	Staff	Other	Depreciation	Cost of capital	Exceptional	Comments	Reported in RP2
Output	Composite Flight Hours (CFH)	✓	?	?	?	×	Circular definition based on previous apportionments	✓
	Flight hours	?	?	?	?	×	Standard measure	✓
	Flight kilometres	?	?	?	?	×	Can be obtained or calculated, used to apportion approach to en-route and terminal	×
	Service units	✓	?	?	?	×	Requires arbitrary weighting of en-route and terminal	✓
	Territory controlled	?	?	?	?	×	Not reported, open to manipulation	×
	CRCO guidance	×	?	✓	×	×	Applies to “facilities” and not staff or cost of capital	×
	Tons controlled	?	×	×	×	×	Not reported, not consistent with the weighting specified in the Charging Regulation	×
Input	Staff costs	✓	?	×	×	×	Reported, but broader than ATCO costs	✓
	ATCO costs	✓	?	×	×	×	Not reported, may not reflect efficient mix, some ATCOs may handle both en-route and terminal	×
	ATCO headcount	✓	?	×	×	×		×
	ATCO hours	✓	?	×	×	×	Not reported, not recorded if locations or ATCOs are dedicated	×
	ATCO workstations or ATCO working positions	✓	?	×	×	×	May be relevant for costs related to office space, not reported, lumpy, open to manipulation	×
	Sectors controlled	✓	?	×	×	×	Not reported, lumpy, open to manipulation	×
	Radio frequencies	×	?	?	×	×	Not reported, may be appropriate for some equipment costs	×
	Turnover	×	×	×	×	×	Reported, but only appropriate to overheads	✓
	Location of equipment	×	?	✓	×	×	Not reported, but depreciation (and other costs) for equipment such as radar and ILS could be based on a measure of distance from an airfield	×

Source: Steer Davies Gleave analysis

3.93 Not all of these potential metrics are currently reported, and any requirement to measure and report them in future might need to be supplemented by more detailed specification of supporting processes. Where the data were available, we have analysed and quantified the impact of a change in the allocation mechanisms, and otherwise we have subjected the metrics to a qualitative assessment.

Composite Flight-Hours

3.94 The ACE 2011 Benchmarking Report states that in ACE 2001 the concept of “composite flight-hours” was introduced, to reflect the fact that the service provided by ANSPs is “gate-to-gate” and that differences in the boundaries used by different ANSPs between terminal and en-route ANS could distort measured performance if they were considered individually. Composite gate-to-gate flight-hours were defined as en-route flight-hours plus IFR airport movements, weighted by a factor that reflected the relative (monetary) importance of terminal and en-route costs in the cost base:

Composite gate-to-gate flight-hours = (en-route flight-hours) + (0.27 x IFR airport movements)

3.95 According to this definition, the total number of Composite Flight Hours for the Pan-European system in 2011 was 18.5 million. The average weighting factor (0.27) was based on the total monetary value of the outputs over the period 2002-2011.

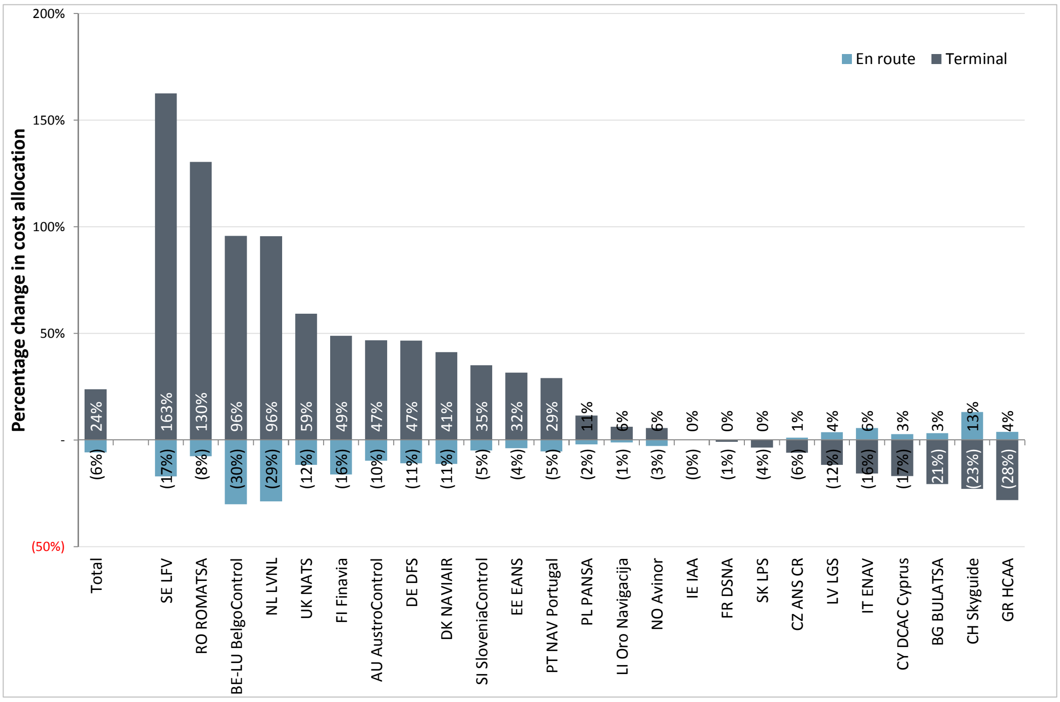
3.96 Therefore Composite Flight Hours would be a circular measure as it is based on a weighted average cost allocation from the past ten years. The weighting factor would need to be frozen at 0.27 or averaged across Member States over ten years. More specifically, Composite Flight Hours would require individual ANSPs to apportion their costs between en-route and terminal on the basis of a ten year, Europe-wide average of how costs had been allocated to en-route flight hours and IFR aircraft movements.

3.97 ANS CR reported that it used Composite Flight Hours to allocate "indirect-joint" costs, such as training and administration, between the two main cost bases. However, a number of stakeholders argued that basing cost allocation on Composite Flight Hours would lead to circularity, as it would effectively base determined costs on past averages of determined costs. It would, in principle, be possible to proceed on either of two bases:

- Fix the weighting of IFR airport movements at 0.27 in perpetuity, or at least for one or more reporting periods. This would have the effect of freezing the relative weighing of en-route and terminal charges, based on the levels of activity and cost in the period 2002-2011; or
- Continue to require ANSPs to allocate and apportion costs as at present, but require them to set unit rates for charges on the basis of a ten-year moving average of the results.

3.98 We estimate that under this approach, five States would experience a substantial increase in costs allocated to terminal, with three experiencing at least a doubling of the original costs, as shown in Figure 3.10. On the other hand, some States experience a decrease in costs allocated to terminal, of up to 28%. Costs allocated to en-route experience a smaller percentage change, as their absolute value tends to be much higher than the value of terminal costs. Overall the effect is a rise of 24% in costs allocated to terminal.

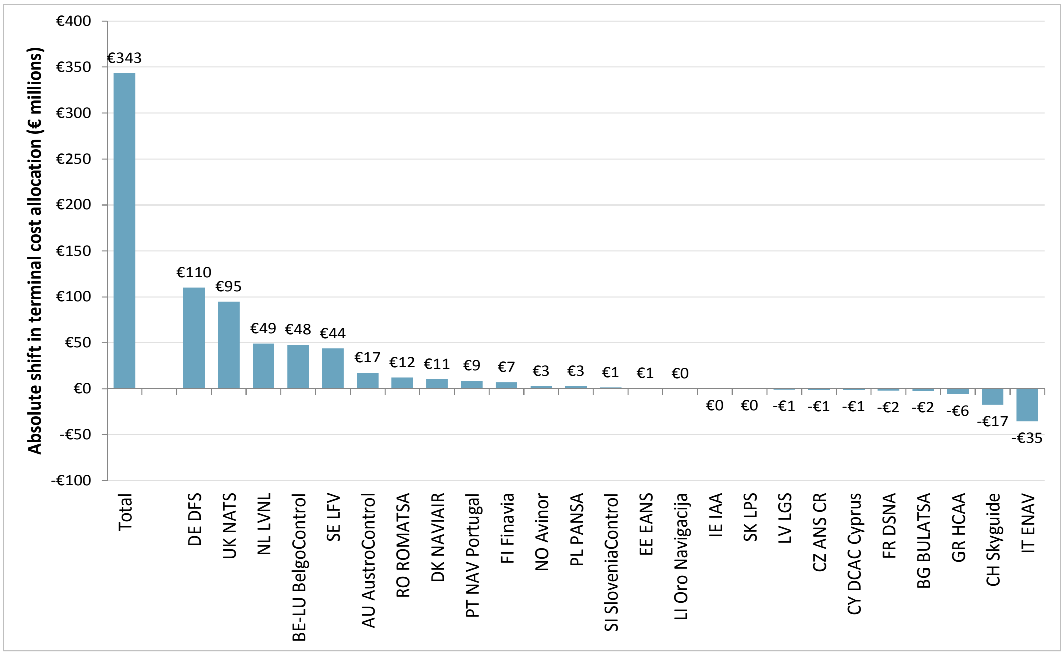
Figure 3.10: Apportionment on composite flight hours: indicative en-route/terminal charges



Source: Steer Davies Gleave analysis

3.99 Using Composite Flight Hours to allocate costs results in a €343m shift of costs from en-route to terminal, as shown in Figure 3.11, a substantial change. Moreover, the relative change is greater for some States and it is therefore likely that they would find this approach difficult to implement.

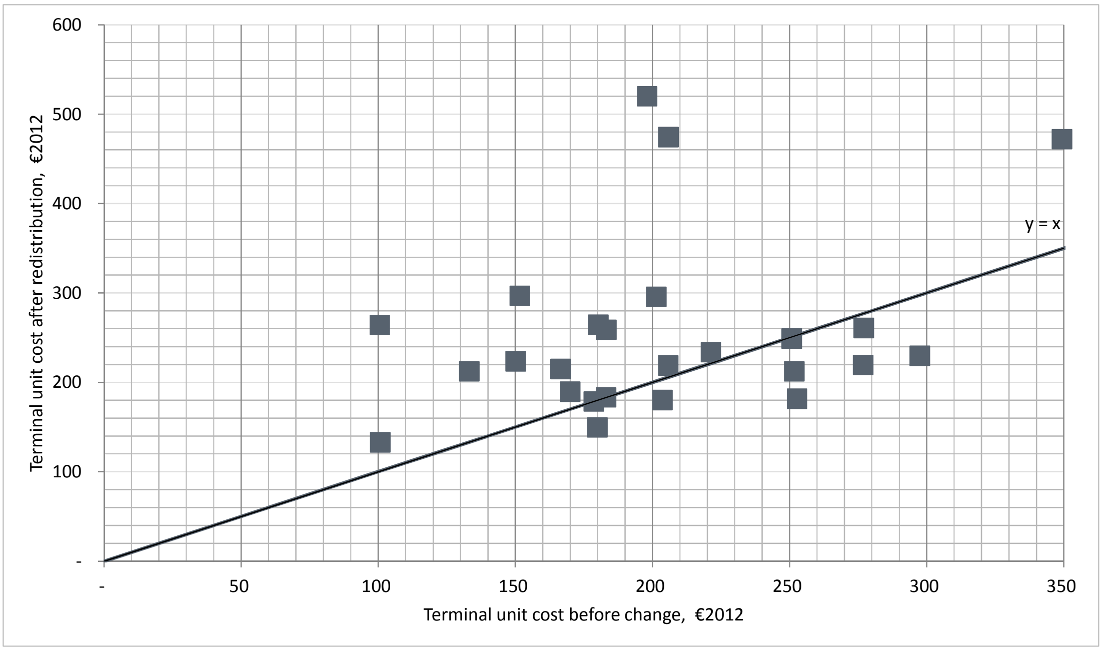
Figure 3.11: Apportionment on composite flight hours: indicative terminal revenue



Source: Steer Davies Gleave analysis

3.100 Figure 3.12 shows large changes in terminal unit costs, with those for Sweden Arlanda, Sweden Landvetter and Romania increasing by more than 100%. Most charging zones experience a smaller increase in unit costs, however, and there are relatively small decreases in seven of the charging zones.

Figure 3.12: Apportionment on Composite Flight Hours: indicative terminal unit costs



Source: Steer Davies Gleave analysis

Flight-Hours

3.101 ANSPs could be required to apportion costs on the basis of Flight-Hours, with terminal costs based on the estimated proportion of total hours spent within 20 kilometres of the airport but not controlled by the airport tower. In principle, this could be based on the approach already used by Finavia, which involves:

- Declaring, for each airport, assumed handover points to and from tower control for arriving and departing aircraft; and
- Identifying, in a table of assumed flight times in approach and departure, a standardised number of Flight-Hours spent between these handover points and the 20 kilometre charging boundary.

3.102 However, while unadjusted Flight-Hours could be used as a basis for apportionment, it would have a number of disadvantages:

- The lack of cost-reflectiveness, with all costs being apportioned on the basis of Flight-Hours even if they were clearly associated with only one activity or charging zone;
- The need for duplicate systems to enable costs to be allocated and apportioned as at present as well as charges to be set and recovered on the basis of Flight-Hours; and
- In the absence of a weighting to terminal activities, a major reduction in the proportion of charges apportioned to terminal activities, with a consequent shift in charges from arriving, departing and domestic aircraft to overflying and foreign aircraft.

Flight-Kilometres

3.103 A number of ANSPs suggested Flight-Kilometres as a basis for apportioning costs. Finavia, HungaroControl, Aena and DSNA already use Flight-Kilometres as a basis for apportioning approach control costs inside and outside the charging boundary 20 kilometres from the airport. Transportstyrelsen's questionnaire response also described its approach as being based on Flight-Kilometres controlled, but did not include details of the calculation method. Given these precedents, ANSPs could be required to apportion costs to terminal activity based on the estimated proportion of total Flight-Kilometres within 20 kilometres of the airport but not controlled by the airport tower. Under this approach, each ANSP would:

- Declare, for each airport, assumed handover points to and from tower control for arriving and departing aircraft - in some cases these might be based on the Final Approach Point (FAP); and
- Calculate the terminal Flight-Kilometres as the distance between these handover points and the 20 kilometre charging boundary.

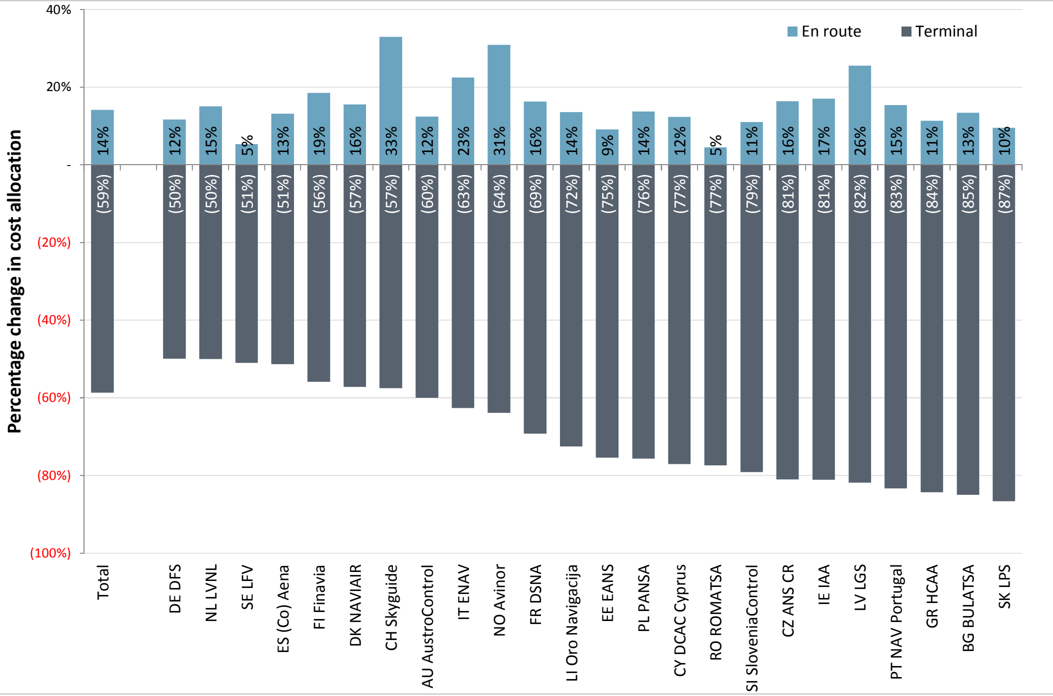
3.104 We note, however, that this method of apportionment would be subject to the same disadvantages as apportionment based on Flight-Hours.

Service units

3.105 We noted in paragraph 3.10 that Annexes IV and V of the Charging Regulation require that ANSPs subdivide total costs apportioned to en-route and terminal services equally among service units. However, as en-route and terminal service units cannot be regarded as equivalent in terms of the level of activity undertaken, this metric is subject to the same limitations as Flight-Hours and Flight-Kilometres as a basis for apportioning costs. We have nevertheless examined the potential impact of requiring ANSPs to apportion all costs on the basis of service units, as discussed below.

3.106 In this scenario, costs allocated to terminal activity are reduced in all the States included in our analysis by at least 50%, as shown in Figure 3.13. This is due to terminal service units not being defined in the same way as en-route service units. More specifically, terminal service units are measured by reference to a weighting factor and distance covered, and the chart suggests that they are underweighted as the approach leads to a reduction in terminal costs across all States. Moreover, a common definition of terminal service units has only recently been established, and our analysis is based on 2012 data reported prior to harmonisation.

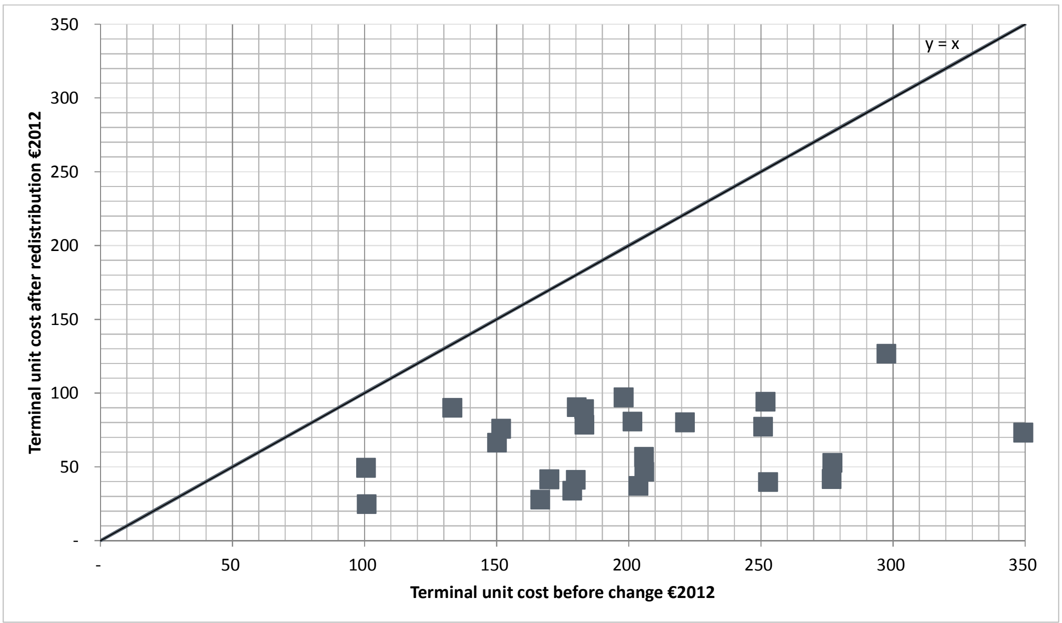
Figure 3.13:Apportionment on service units: indicative en-route/terminal charges



Source: Steer Davies Gleave analysis

3.107 The net effect is a reduction of over €890 million in costs allocated to terminal for the States included in the analysis. En-route unit costs increase significantly (particularly for DSNA, ENAV, DFS, AENA, NATS, Skyguide, Avinor and LVNL), balanced by a substantial fall in terminal unit costs.

Figure 3.14: Apportionment on service units: indicative terminal unit rates

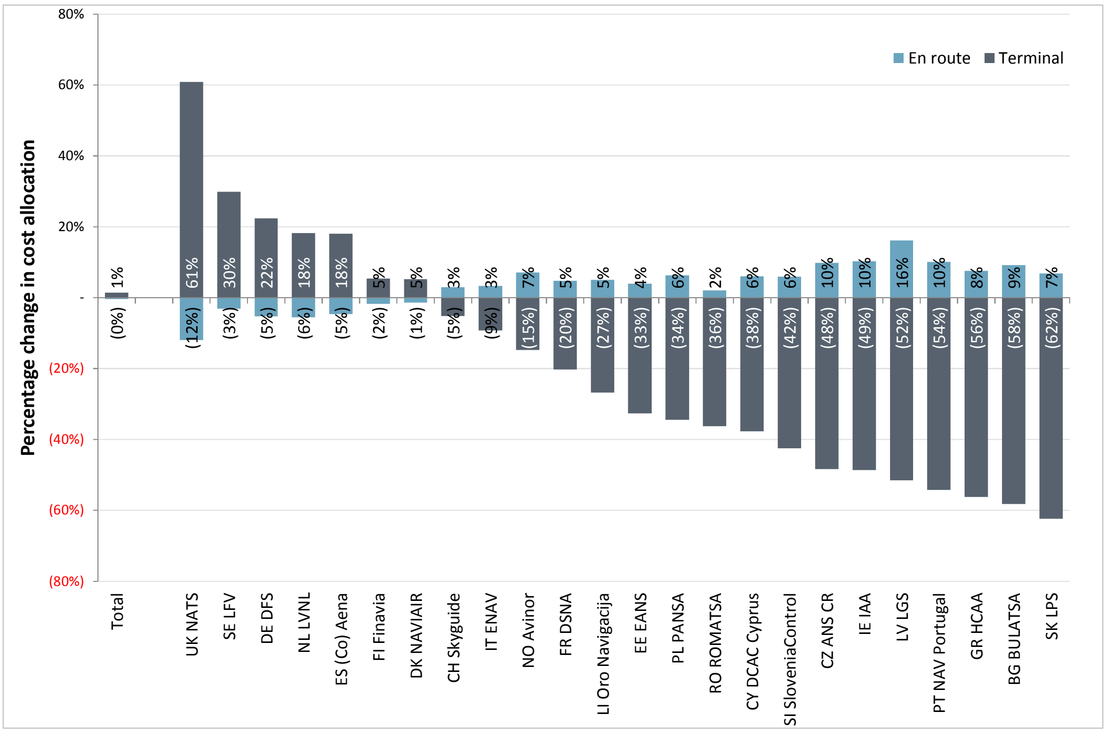


Source: Steer Davies Gleave analysis

Weighted service units

3.108 An alternative approach would be to weight terminal service units so that the net impact on costs across Member States is zero. Our analysis indicates a weighting factor of approximately 2.9 would achieve this outcome, but this has been derived using data for the subset of ANSPs included in the calculation and the value could be significantly different if an alternative subset were selected. As shown in Figure 3.15, the overall change for both en-route and terminal (indicated on the far left of the chart) is close to zero after the weighting is applied. Seven of the States experience an increase in costs allocated to terminal but most experience a significant decrease.

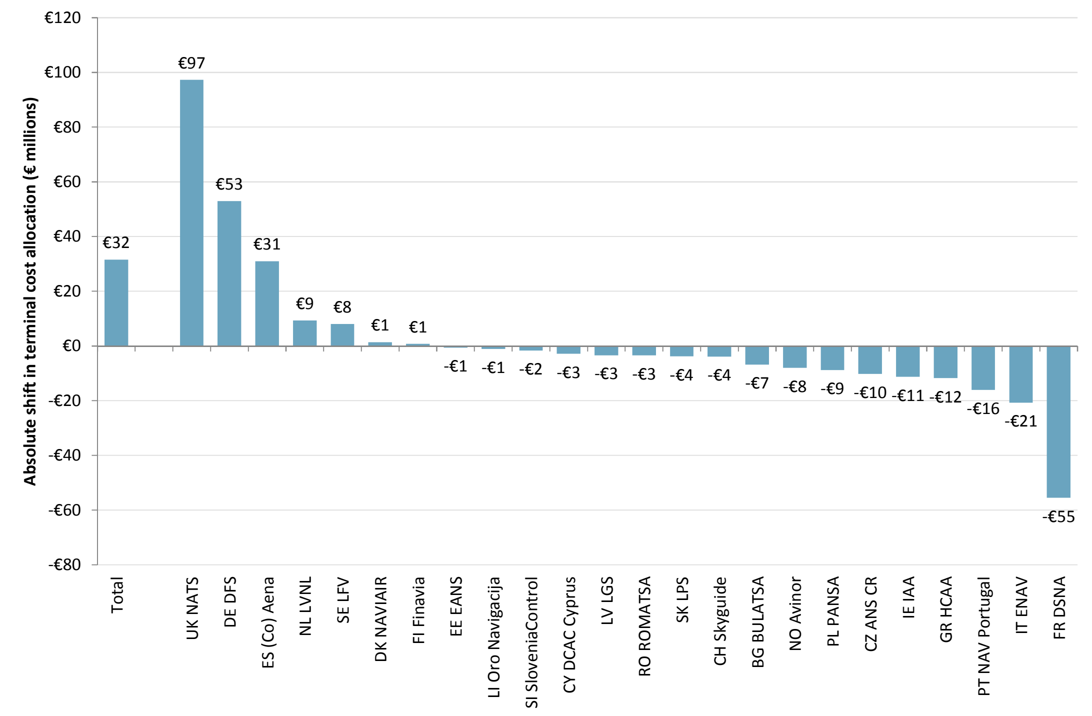
Figure 3.15: Apportionment on weighted service units: indicative en-route/terminal charges



Source: Steer Davies Gleave analysis

3.109 Changes in the absolute value of apportioned costs are shown below. There are large changes in terminal cost allocation for some States, including a €55m reduction for one State and a €97m increase for another.

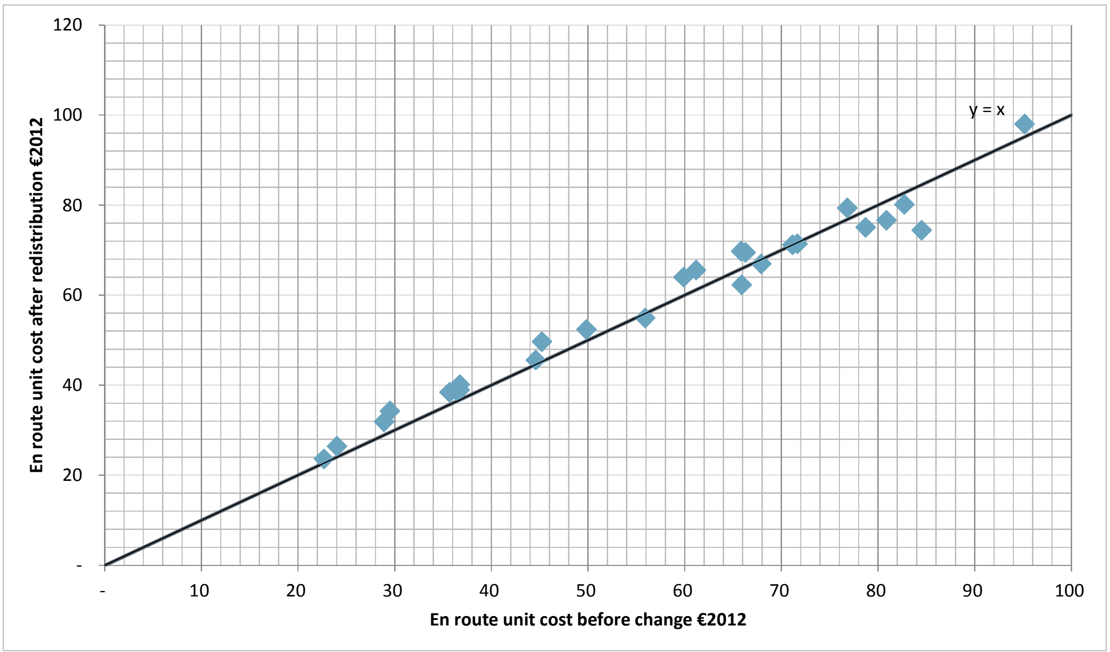
Figure 3.16: Apportionment on weighted service units: indicative terminal revenue



Source: Steer Davies Gleave analysis

3.110 There are only limited changes in en-route unit costs, but the changes in terminal unit costs are much greater given that they are determined relative to a lower overall cost base, as shown in Figure 3.17.

Figure 3.17: Apportionment on weighted service units: indicative terminal unit rates



Source: Steer Davies Gleave analysis

Territory controlled

3.111 A further measure used by ANSPs such as BelgoControl, DFS and Skyguide to apportion costs was “territory controlled”, although this term was variously applied to distance, area and volume. BelgoControl referred to the Charging Regulation requirement that, in the calculation of en-route service units “The distance to be taken into account shall be reduced by 20 kilometres for each take-off from and for each landing on the territory of a Member State.” However, it stated that costs were based on the share of airspace volume within 20 kilometres of the airport (by implication taking into account not only the (approximately) 1,250 square kilometres within 20 kilometres of an airport but also the different floor and ceiling altitudes controlled), not the share of approach distance within 20 kilometres of the airport. BelgoControl conceded that this might be a disadvantage of the current approach.

3.112 With the boundaries of airspace clearly defined, a measure of territory or airspace controlled could be used as a basis for cost apportionment, although a decision would be required on whether this should be based on volume (as reported by BelgoControl), area, or distance. If based on distance, which seems most likely to be related to workload, this measure would be similar to the measure of Flight-Kilometres discussed above, and subject to the same weaknesses and limitations.

CRCO guidance

3.113 A further approach, which could in principle be formalised and applied, is the CRCO guidance that costs of ATS facilities are apportioned as follows:

- 75% to en-route services if “mainly for en-route services”;
- 50% to en-route services if “virtually to the same extent for en-route and terminal services”; and
- 25% to en-route services if “mainly for terminal services”.

3.114 If supported by clear definitions of “mainly” and “virtually to the same extent”, the guidance could be extended to additional or all facilities and, in principle, applied to both depreciation and other operating costs related to specific assets. However, it is unlikely to be a suitable basis for the apportionment of staff costs.

Tons controlled

3.115 One ANSP referred to the use of tons controlled in cost allocation, but did not explain how this could be applied in apportioning costs between en-route and terminal. In principle, it would be possible to calculate total tonnage, or MTOW, of all aircraft controlled en-route and total tonnage, or MTOW, of all aircraft landing and taking off. The ratio of these values could then be used as a measure for the apportionment of costs. However, in the absence of any measure of en-route distance, it seems unlikely that this would support a realistic or credible apportionment of costs. In particular, the proportion of ANSP costs allocated to en-route charges would not vary with the size of the area controlled.

Sectors controlled

3.116 While this metric was mentioned by a number of ANSPs, we concluded that it was subject to the same disadvantages as ATCO workstations. In particular, the maximum number of sectors into which airspace was subdivided might be no indication of the average, there might be an incentive to define or open sectors when this was not operationally necessary, and charging would be based on the potential subdivision of airspace to deal with future growth rather than the average degree of subdivision currently needed.

Radio frequencies

3.117 One ANSP reported that some costs were apportioned on the basis of radio frequencies. We did not obtain any clarification but note that, as with our discussion of possible metrics for the allocation of telephone costs, this might be an appropriate basis for the allocation of the costs of depreciation, maintenance and operation of some equipment used for both en-route and terminal services, and that radio frequencies might also be a proxy for the number of sectors controlled. However, as in the case of workstations and sectors controlled, this metric would potentially be subject to manipulation by allocating frequencies which were rarely or never used.

Turnover

3.118 In the case of one ANSP, some overhead and headquarter costs are apportioned to activities or services on the basis of their turnover. Apportionment on the basis of turnover might be appropriate when the majority of costs have already been apportioned according to an objective measure of outputs or inputs. However, by definition a measure of turnover cannot be used to apportion costs if these are then used to calculate charges which determine turnover. As a metric for allocating costs in order to set charges, turnover would introduce circularity.

Location of equipment

3.119 One ANSP stated that the allocation of some asset-related costs was based on their location, with a "rule of thumb" (based on distance from airports) used to allocate assets such as VOR and ILS to terminal or en-route activity. Another indicated that its CNS support costs were all apportioned in a similar manner (except in the case of two long range en-route radars, the costs of which were all associated with en-route services). This approach might be applied more generally to the allocation of the costs of depreciation, maintenance and operation of physical assets such as VOR, ILS and radar equipment. However, we consider that it would not be appropriate as a basis for apportioning the majority of ANSP costs, up to 70% of which are staff-related.

A combination of metrics

3.120 The results of our investigation of the metrics discussed above suggest that, while a large proportion of ANSP costs relate to staff, and in particular to ATCOs, it may not be appropriate to allocate or apportion all costs on the basis of a single metric. For example:

- The costs of overheads might be apportioned on the basis of turnover; and
- The costs of some assets might be allocated on the basis of their location or, in the case of radio equipment, the frequencies at which they could be operated.

3.121 At our meeting with the Commission on 8 July 2014, we were asked to consider whether it might be appropriate to apportion staff costs on the basis of a metric related to ATCOs and their workload, and the remainder on the basis of one or more other metrics applied to some of the other operating costs, depreciation, cost of capital or exceptional items.

3.122 In the event, neither the responses of the stakeholders (and our more detailed discussions with them), nor our analysis support the use of any particular metric for these categories of cost. We consistently found that the most appropriate approach to allocating or apportioning costs would depend on the circumstances of the particular ASNP and the staff, operating cost or asset concerned. In principle, it would be possible to apportion a small percentage of overhead costs on the basis of a metric such as turnover, but if turnover had itself been calculated on the basis of a metric such as ATCO hours, this approach would not differ in practice from apportioning all costs on the basis of ATCO hours.

Airport and air navigation cost allocation

3.123 During stakeholder discussions on a previous study for the European Commission (covering the Cost of Capital and Pensions), airspace users raised the issue of cost allocation between single organisations providing both airport (runway, passenger terminal and apron services) and air navigation services (terminal navigation serves and en-route services). Across the SES, there are a small number of organisations that provide both air navigation services and also manage and operate airports:

- Hellenic CAA in Greece (however, changes are underway with the planned concession of two groups of regional airports in Greece due to conclude in 2014);
- Finavia in Finland;
- Avinor in Norway; and
- Aena in Spain (in June 2014 the government announced its intention to sell a 49% stake in Aena, with 28% sold through an Initial Public Offering (IPO) and 21% available to long term investors).

3.124 In addition, there are a number of organisations that have corporate governance structures encouraging close links with other government departments and subject to cost allocation as applied by a public sector body. These include DGAC Cyprus and Hellenic CAA. There are also additional public sector organisations with autonomous budgets, in particular in France (DSNA) and in Poland (PANSA). Oceanic services are also provided by Avinor (Norway), IAA (Ireland), NATS (United Kingdom) and NAV Portugal.

3.125 In Appendix B, we provide a review of these organisations, including trends in costs between 2010 and 2013. We are not in a position to draw any firm conclusions regarding the allocation of central function costs from any of the annual reports reviewed, due in part to the lack of transparency provided by the statutory accounts. However, as central function costs tend to be relatively low in comparison to the other direct operating costs of the airport and air navigation businesses unit as well as in comparison to businesses in other sectors, we consider that it is unlikely that they explain the changes in charges observed.

3.126 At the same time, as these shared costs are likely to be relatively low, the efficiencies to be gained from operating the ANSP as part of an airport operating group are likely to be comparatively low. In practice, the two activities have little in common and there are few synergies to be shared between them. This suggests that there is a case for separating the ANSP from the airport operator group, improving transparency and enabling both organisations to pursue their own strategic objectives with greater freedom. Against this background, we note that the alliance of North West European ANSPs (Borealis Alliance), including both Avinor and Finavia, while it has not been formed with the strategic intention of merging ANSPs, may deliver greater efficiency than the current organisational structures of the airport / ANSP groups reviewed.

3.127 We also understand that whilst there is a requirement for en-route charges to include only the cost of providing these services to aircraft, the Avinor 2011 report expressly states that in setting charges the group should consider the whole of its operations and use profits generated within one area of the business to subsidise unprofitable activities in others. As the demand for en-route air navigation services is likely to be inelastic relative to that for airport services, it could be economically beneficial for an airport / ANSP grouping to use en-route charges to subsidise airport charges.

3.128 From the information available, we consider that the recent increase in airport charges in Spain is likely to be the result of the following rather than cost allocation:

- Cross-subsidisation: changes to the level of cross-subsidisation between larger and smaller airports in Spain;
- Preparation for private sector participation: the Spanish Ministerio de Fomento has recently announced its intention to sell a 49% stake in Aena airports through a combination of IPO and financial investment, and the increase in charges might be in preparation for this;
- Reacting to a reduction in traffic throughput: at Madrid, in particular, traffic fell from 50 million passengers in 2012 to 40 million passengers in 2014 (a20% reduction); and
- A change in the approach to cost recovery: in 2010 and 2011, the AENA accounts reported that the airports business unit made large operating losses after finance costs were taken into consideration.

Policy options to improve transparency and confidence of users

3.129 To provide airspace users with a greater understanding of the costs of operations, a number of initiatives could be considered to provide greater confidence in the outcomes:

- A requirement for full accounting transparency of airport and ANSP costs: this would require the organisations to explain the level of costs that are allocated between the two businesses and the basis of the allocation. This might be addressed through a combination of SES2+ and the Airport Charges Directive, but would require significant oversight and enforcement from National Supervisory Authorities.
- Provision of separate accounts for each organisation: this would not prevent allocation of joint and common costs between the two organisations in circumstances where they continued to be under common ownership, but it would allow trends in costs to be monitored more easily. It would also require less oversight than full transparency, although there would still be a need for enforcement from NSAs.
- Mandatory corporate separation: the only way of ensuring that cost allocation is not distorting charges is to mandate enforced corporate separation. However, in the short term this may result in the separate organisations incurring some additional costs for corporate services, although as noted above we consider that the synergies to be gained in sharing central functions are likely to be limited. Moreover, as experience in the rail industry has shown, the separation of previously integrated businesses (Infrastructure Managers and Railway Undertakings in the case of the rail sector) can be difficult to enforce.
- Requiring full transparency of the extent of cross-subsidisation across airports: this would allow any changes in the level of cross-subsidisation to be made transparent over time, and could be implemented through the airport charges Directive

Stakeholder views

3.130 We discussed the principle of harmonisation of, and approaches to, cost allocation with a number of stakeholders, including individual ANSPs, CANSO, airspace user representative organisations and National Supervisory Authorities. Many doubted the need for harmonisation, and all stressed the practical difficulties of achieving greater harmonisation given the need to take account of different ways of organising the provision of approach, terminal and en-route control. The following observations were common to several stakeholders:

- There is already legislation requiring ANSPs to apply and report cost allocation transparently, and better enforcement of existing legislative provisions should be considered before adopting new requirements;
- Different market structures, operational organisation and services would make it difficult to apply a common approach across all ANSPs;
- Many ANSPs already apply rigorous ABC methods, and greater harmonisation based on a limited number of allocation metrics would be likely to lead to an allocation of costs that was less, rather than more, reflective of underlying activity;
- A common approach that did not allow sufficient flexibility could have the effect of discouraging organisational arrangements designed to improve efficiency, for example the colocation of approach and terminal services;
- The use of ATCO activity as the only or principal metric for allocating costs would be inappropriate since it is only a driver of some direct costs and is of little value in allocating indirect costs; and
- Cost harmonisation could be expected to lead to higher terminal charges, which would disadvantage European-based airspace users.

3.131 However, some stakeholders noted that there was a case for establishing clearer definitions of the different stages of a flight such that the boundaries between approach, terminal and en-route activities could be more easily established and costs allocated accordingly.

3.132

Conclusions and recommendations

Evaluation of options

3.133 We have undertaken a high-level evaluation of the main options summarised in Table 3.16, based on the analysis and assessment of individual metrics reported above. The results of this evaluation are shown in the table below.

Table 3.18: Evaluation of options for harmonisation of cost allocation

	Option		
	CH1	CH2a	CH2b
Summary of option combination	Comprehensive and prescriptive rules for allocating and apportioning costs at a highly disaggregated level. Application of agreed conventions would be monitored through appropriate auditing of annual returns.	Application of a single metric to apportion all, or a defined group of, costs between en-route and terminal ANS. Application of the agreed approach would be monitored through appropriate auditing of annual returns.	Application of a number of metrics to apportion different categories of cost between en-route and terminal ANS. Application of the agreed approach would be monitored through appropriate auditing of annual returns.
Economic efficiency	Would enable a robust allocation of costs and support more cost-reflective charges, based on a consistent application of ABC principles across ANSPs.	Would not result in an efficient allocation of costs. The resulting charges likely to be less cost reflective than at present, at least in the case of ANSPs already using relatively sophisticated ABC methods.	Would not result in an efficient allocation of costs. The resulting charges likely to be less cost reflective than at present, at least in the case of ANSPs already using relatively sophisticated ABC methods. Economic efficiency could be greater than under CH2a however.
Intelligibility	Likely to introduce complexity into the apportionment of costs, at least from some ANSPs, although intelligibility could improve as familiarity with agreed conventions increased.	Simple for stakeholders to understand and apply. Would enable simple comparisons between ANSPs, although these would be open to challenge on the grounds that they were based on a distorted allocation of costs.	Simple for stakeholders to understand and apply. Would enable simple comparisons between ANSPs, although these would be open to challenge on the grounds that they were based on a distorted allocation of costs.
Revenue/cost neutrality	Consistent with revenue/cost neutrality, although the balance between en-route and terminal ANS revenues could change.	Consistent with revenue neutrality, although the balance between en-route and terminal ANS revenues could change. Analysis suggests that terminal charges could increase significantly, depending on the choice of metric.	Consistent with revenue neutrality, although the balance between en-route and terminal ANS revenues could change. Analysis suggests that terminal charges could increase significantly, depending on the choice of metrics.
Minimal administration costs	Transition and reporting costs likely to be significant. Potentially disproportionate to the benefits. Monitoring costs likely to be onerous and even prohibitive.	Some transition and reporting costs, depending on the ANSP's current approach to cost apportionment. Monitoring costs considerably lower than under CH1.	Some transition and reporting costs, depending on the ANSP's current approach to cost apportionment. Monitoring costs considerably lower than under CH1.
Credibility	Likely to be subject to strong challenge from ANSPs and other stakeholders. Would probably be regarded as adding complexity without delivering significant benefits.	Likely to be subject to strong challenge from ANSPs and other stakeholders. Would probably be regarded as introducing new requirements without delivering significant benefits.	Likely to be subject to strong challenge from ANSPs and other stakeholders. Would probably be regarded as introducing new requirements without delivering significant benefits.

Source: Steer Davies Gleave analysis

Conclusions and recommendations

Choice of metric

3.134 We conclude that there is no single correct, or universally accepted, method of ensuring that the allocation of costs between en-route and terminal ANS is fully reflective of the distribution of underlying activity between these functions. Metrics such as Flight-Hours or Flight-Kilometres do not fully reflect the underlying workload of individual ATCOs, which may depend on the number of aircraft to be monitored simultaneously, the complexity of their movements (as determined by the number of changes of level and direction) or the number of times they are contacted by the ATCO. More generally, none of the metrics currently recorded, or that have been suggested by ANSPs, gives an accurate indication of the relative costs of provision of en-route and terminal ANS.

3.135 Given the availability of information, we have focused our quantitative analysis of the impact of harmonisation on allocation methods based on application of the following metrics:

- Staff costs, as a proxy for ATCO costs or headcount;
- Composite Flight-Hours; and
- Service units, with a weighting to reflect the different workload for each of en-route and terminal activity.

3.136 None of these metrics meets all the objectives set out in Chapter 1. Input measures, which in principle provide a more precise indication of when and why costs are incurred, are themselves the result of a range of allocation and apportionment rules that must ultimately be applied by ANSP staff and may be subject to manipulation. For example, measures such as staff costs, ATCO costs and ATCO hours may be derived from the apportionment of ATCOs' time on the basis of Flight-Hours or Flight-Kilometres. Composite Flight-Hours are based on information which is not under the control of the ANSP, are only indicators of the actual incidence of costs and are open to the objection that they would give rise to circularity if used to allocate costs. Service units, in the absence of arbitrary weighting, would result in a reallocation of costs to en-route activity and, while this could be addressed through a more robust definition of en-route and terminal service units, would give rise to the same circularity issues as Composite Flight-Hours.

Implications for data collection and reporting

3.137 We have also considered the implications of using different metrics for cost allocation for data collection and reporting. Ideally, any new metrics used for the harmonisation of charges would make use of systems already in place. As Table 3.17 shows, however, only a limited number of metrics are currently recorded and reported, and additional systems might be needed for new metrics to be introduced. All of the metrics listed in the table could, in principle, be measured and reported if they are not already:

- Some could be generated by ANSPs' existing operating and management systems (for example, workstations and terminals may already report the hours during which they have been logged on, the activity for which they have been used and, from keystroke or microphone activity, the times at which this activity took place).
- Other metrics, in particular the input measures, might require the introduction of additional recording systems, which would be more problematic. While the misallocation of the costs of entire control centres would be unlikely, more detailed metrics based on measures such as workstations, headcount or individual staff hours might require intrusive monitoring. Timesheet systems, in particular, are populated on a daily basis by individual

staff and extensive independent checking that this had been done correctly would be onerous.

3.138 In addition, rules and procedures would also need to be established for the definition of new metrics, the ways in which they were to be calculated and, where these were not inherently transparent, for internal checking and external audit. The net workload would depend on the extent to which the new reporting processes replaced, rather than added to, existing ones. A key factor might be the extent to which reporting was specified by any or all of ANSPs' management, shareholders, or the NSAs.

Progress towards harmonisation of cost allocation

3.139 It is therefore unclear what benefits would emerge from a harmonisation of the allocation of costs, not least because it is not possible to determine with confidence whether any of the methods of cost allocation considered would result in charges being more or less cost-reflective. At best, harmonisation would enable ANSPs to be compared more easily, but the level of transparency for airlines and NSAs would probably be reduced. At the same time, the costs of implementing a change would be significant, at least for some ANSPs, in view of the required modification of systems to support cost allocation and invoicing.

3.140 We have also established that there is no strong support among stakeholders to harmonise cost allocation. Most stakeholders were sceptical that harmonisation was either necessary or practical and stressed the potential detrimental effects, noting in particular that it would lead to a move away from cost-reflectiveness in many cases and raise significant transition issues. They also raised concerns about the resulting significant changes to the en-route and terminal service cost base, which would have implications for the established level of en-route and terminal charges.

3.141 However, notwithstanding these challenges, we consider that there is scope for moving towards greater harmonisation through the provision of more information on the approach that ANSPs use to allocate costs. We have found that understanding the basis of the allocation is difficult, notwithstanding the transparency requirements of Article 8 of the Charging Regulation. In particular, the amount of information provided does not enable a thorough understanding of the allocation mechanisms used. Moreover, enforcement is left to NSAs, which means that the information provided differs significantly among ANSPs. We suggest that information regarding cost allocation should be collected in a more standardised manner. Reporting files could include information including:

- A detailed description of the cost allocation approach used as well as a detailed justification of the use of this method; and
- For the most common categories of costs (ATCO staff costs, non-ATCO staff costs, direct operating costs, indirect operating costs, depreciation, cost of capital, exceptional items, and other costs), a list and description of the most used cost drivers.

Recommendation B1:

Transparency of cost allocation principles and metrics used, as required by the Charging Regulation, should be better enforced. Principles should also be developed to ensure more consistent enforcement by NSAs.

3.142 We also suggest that greater transparency could be achieved through the development of clearer definitions of the different elements of ANS. In particular, we note that differences in the approach to allocation of costs between en-route and terminal activity partly reflect the variety of local practices governing the activities themselves (e.g. whether or not ATCOs located in an airport tower undertake approach or even upper airspace control) and the scope for interpreting EU legislation in different ways. Against this background, there would be merit in reviewing the various definitions underpinning both legislative provisions and policy guidance in order to address gaps and inconsistencies.

Recommendation B2:

Consideration should be given to clarifying the definitions of terminal, approach and en-route services for the purposes of legislation and supporting policy guidance.

3.143 We recognise that the current definitions were the result of lengthy negotiations between all parties involved, and any move towards more precise definitions would be challenging given the need for some flexibility. However, we suggest that greater clarity in terms of the control activities undertaken at different stages of a flight would support a more consistent approach to cost allocation over time. In particular, in line with the comments of some stakeholders, we consider that the definitions of approach, terminal and en-route air navigation should be further developed and clarified with a view to achieving a consistent basis for identifying clear boundaries between these activities and allocating the associated costs accordingly.

3.144 The results of our investigation of the options for harmonisation suggest a trade-off between cost reflectiveness on the one hand and greater comparability and lower transition costs on the other. A bottom-up approach, while it would provide for much greater precision in the allocation of costs in principle, would be difficult to achieve in practice given the need for comprehensive agreement on detailed cost categorisation and extensive monitoring activity to ensure the application of common allocation methods.

Recommendation B3:

We recommend that the option of bottom-up cost allocation is not pursued. In our view, the difficulties of obtaining consensus on a consistent application of detailed rules governing cost allocation, and the likelihood of high and probably prohibitive transition costs render this approach impractical.

3.145 From our assessment of the top down options, we have concluded that there is no rationale for apportioning costs on the basis of Composite Flight-Hours or service units. Apportioning costs on the basis of ATCO hours appears to be a more appropriate approach if a single metric is to be used. However, this data is not publicly available and our assessment of the implications for cost allocation is therefore based on staff costs as a proxy for ATCO numbers and activity. As compared with the actual allocation in 2012, application of this metric results in an overall 8% increase in terminal costs and a 2% fall in en-route costs for those States included in the calculation, with a much higher change for some States/ANSPs.

3.146 Given the limitations of this analysis and the uncertainty over whether the approach would lead to a better or worse alignment of cost allocation with underlying activity, we consider that a move to harmonisation of allocation on the basis of staff costs would be premature. However, a better understanding of the costs of en-route and terminal services could be achieved if ATCO hours for en-route and terminal activity were systematically collected and reported.

Recommendation B4:

We recommend that information on ATCO hours, disaggregated by en-route and terminal activity, should be reported by ANSPs as part of their Reporting Tables requirements. The disaggregation of hours would need to be based on clear principles established in consultation with the ANSPs.

3.147 We have also considered the allocation of costs between ANS and airports where they are provided by the same corporate entity. Although our analysis did not show any marked changes over the past five years, we suggest that a policy of mandating separation of organisation and financial reporting should be considered. In our view, such a policy would give stakeholders greater confidence in the allocation of costs and allay concerns about cross-subsidy between two very different businesses.

Recommendation B5:

We recommend that consideration should be given to mandating the organisational and financial separation of ANS and airport businesses where these are currently undertaken by a single corporate entity. Given that, in our view, central function costs shared between the businesses are limited, such separation would not raise challenging allocation issues of the kind considered in the context of en-route and terminal ANS. Nevertheless, any legislative provisions mandating separation would need to allow adequate time for the introduction of separate governance, management and financial frameworks, and we suggest that full separation should not be required before the start of the next Regulatory Period.

4 Modulation of charges to incentivise early equipage of SESAR

Introduction

4.1 The objective of the Single European Sky Air Traffic Management Research Programme (SESAR) is to modernise and harmonise the technology and operations of the European Air Traffic Management (ATM) System. It forms part of the wider Single European Sky (SES) initiative, which aims to increase capacity and safety while reducing ATM costs and the environmental impact of the aviation sector. Under Part C of our Terms of Reference, we are required to analyse and make recommendations on how charges could be modulated to provide incentives for the early on-board equipage of SESAR technology.

4.2 Accordingly, after providing a brief overview of the SESAR project, this chapter includes:

- A review of modulation of charges schemes in other industries;
- A presentation of the case for incentivising early on-board adoption of SESAR;
- Options for a modulation of charges scheme;
- A review of the financial incentives available to SESAR;
- A summary of stakeholder's views; and
- Our conclusions and recommendations.

Overview of SESAR

4.3 SESAR has been divided into three phases, as follows:

- **Definition phase (2004-2008):** the first phase, which was completed in 2008, was to define the content, priorities, development plans and deployment plans for the next generation of ATM systems. This phase also delivered the European ATM Master Plan, which links the development and deployment plans for the new technology with the SES performance objectives, defining deadlines and the actions required of stakeholders. This definition phase was undertaken by a consortium of representatives of all air transport stakeholders and led by Eurocontrol. It was co-funded by the European Commission under the Trans-European Network Transport (TEN-T) programme.

- **Development phase (2009-2016):** the development phase is validating and producing the new generation of technological systems and components, as defined in the ATM Master Plan and SESAR Work Programme. A public-private partnership, the SESAR Joint Undertaking, was established specifically for this phase, merging funds from the EU, Eurocontrol, industry and third countries.
- **Deployment phase (2014-2020):** the deployment phase will result in the use of the new ATM infrastructure, with fully harmonised and interoperable components improving the performance of air transport services in Europe. This phase will, in due course, be delivered by the Deployment Manager. The first stage of the deployment phase is currently underway, with the adoption of the Pilot Common Project (PCP) in June 2014 (Regulation (EU) 716/2014). This regulation was supported by a global Cost Benefit Analysis of the six ATM functionalities selected for deployment and specifies target dates for their deployment.

4.4 The deployment of SESAR is supported by a detailed legislative framework, based on Implementing Regulation (EU) 409/2013, adopted in May 2013. This defines four main instruments to enable deployment:

- **Common projects:** these are intended to introduce ATM functionalities considered to be essential contributors to the improvement of ATM performance across the EU, particularly in relation to Key Performance Areas (KPAs) such as capacity, flight and cost efficiency, environmental sustainability and safety. Each project will be defined by specific legislation setting out actions and deadlines for the stakeholders concerned. Projects will group ATM functionalities defined in the ATM Master Plan that are sufficiently mature to enable implementation, have a demonstrably positive global business case, and require synchronised deployment.
- **The deployment programme:** this defines the detailed deployment activities underpinning implementation of common projects.
- **Governance mechanisms:** these ensure a timely, synchronised and coordinated deployment of SESAR involving all stakeholders and the relevant EU and SES bodies. The governance structures include high level steering through the existing SES framework - the European Commission (the Commission), the Single Sky Committee, the Industry Consultation Body (ICB), the consultative group of experts on the social dimension of the SES, the National Supervisory Authorities (NSAs) and the Performance Review Body (PRB) - and a Deployment Manager.
- **Targeted incentives and financial support:** these include grants, loans and schemes for the modulation of route charges to support the coordination and implementation of common projects.

4.5 Article 8(2)(d) of Regulation (EU) 409/2013 states that the “policy level” will be responsible for “identifying incentives for SESAR deployment and enforcing the framework partnership agreement concluded with the deployment manager”. Under Article 14(1) of the same Regulation, incentives for SESAR deployment may be identified when establishing “common projects” as defined in Article 15(a) of Regulation (EC) No 550/2004. In addition, Article 16(2) of the Regulation (EU) 391/2013 (the Charging Regulation) stipulates that Member States may modulate air navigation charges to accelerate the deployment of SESAR ATM capabilities, in particular to give incentives to equip aircraft with systems included in the common projects referred to in Article 15a of the Service Provision Regulation.

4.6 As part of its overall responsibility for oversight of the deployment of SESAR, the Commission initiated the development of the first common project, the PCP mentioned above, and introduced a Deployment Manager to plan and manage detailed deployment activities. The PCP identified ATM Functionalities (AFs) that are considered appropriate for deployment, based on the research, development and validation work undertaken by the SESAR Joint Undertaking.

4.7 As agreed by Member States, implementation of the PCP is subject to a legally binding Regulation requiring operational stakeholders to deploy the six most developed AFs. In the case of projects benefitting from EU funding, a range of measures are available to encourage deployment of the relevant technologies including reduction of the grant awarded for the implementation project and administrative and financial penalties (in the event of serious breach of obligations by the grant beneficiary). In the case of projects that are not co-funded by the EU, Member States will be responsible for enforcing the obligations of stakeholders through specific penalties. The Commission will also be able to enforce certain obligations through the performance and charging schemes, for example the performance targets in the performance plans of Air Navigation Service Providers (ANSPs).

Previous experience of incentivising the adoption of new technology

4.8 In this section we review previous experience of encouraging the adoption of new technology through modulation of charges. We have focused on experience from the deployment of the European Rail Traffic Management System (ERTMS), which in our view provides a useful example of incentivisation in a European context. However, we also sought to draw lessons from the deployment of Data Link in ATM, which is anyway related to the deployment of certain SESAR technologies, and from the incentivisation of ANS technology in Canada.

ERTMS

Background

4.9 In its 2011 White Paper, the Commission set out its vision to establish a genuine Single European Transport Area by 2050, including through the creation of a Single European Railway Area (SERA). A key condition for SERA is the removal of administrative, technical and regulatory obstacles in the rail sector in order to enable both market opening and interoperability. In particular, the White Paper calls for a more efficient use of transport infrastructure through use of improved traffic management and information systems such as ERTMS, thereby facilitating cross-border movements by rail and providing rail transport with a competitive advantage over long distances. Regulation (EU) 913/2010 for a European rail network for competitive freight is intended to support this vision by reinforcing cooperation at all levels to deliver high quality infrastructure along nine rail freight corridors.

4.10 The deployment of the signalling component of ERTMS, known as the European Train Control System (ETCS), is relatively well supported in terms of funding. However, the number of rail vehicles equipped with the required technology is still relatively low, and Directive 2012/34/EU (the “Recast” of previous EU rail sector legislation) seeks to address this through differentiation of infrastructure charges on ERTMS corridors to provide incentives to equip trains with on-board ETCS. The Directive also provides for the adoption of measures for achieving differentiation of charges according to a timescale consistent with the ERTMS European Deployment Plan established under Decision 2009/561/EC, and for ensuring that differentiation does not result in any overall change in the revenue of infrastructure managers. Member States may choose to extend differentiation outside the ERTMS corridors if they wish.

Benefits of ERTMS technology

4.11 There are currently more than 20 standalone train control systems across the EU, resulting in a significant barrier to trans-European interoperability. This, in turn, results in substantial additional costs, including:

- The cost of equipping trains regularly crossing borders with different systems capable of interfacing with national signalling infrastructure;
- The cost of train drivers to operate on different national systems;
- In some cases, the cost of changing rolling stock at a border; and
- The cost of undertaking tests to ensure that all the legacy systems can operate together.

4.12 ERTMS is intended to address these issues by establishing a single, EU-wide standard for train control and command systems while maintaining a minimum level of safety agreed by Member States. It also provides for better train service performance through higher speed and reliability and supports the development of a single market in signalling equipment.

4.13 ETCS, the signalling component of ERTMS, also has a number of benefits other than greater interoperability. The system has 3 levels:

- Level 1, which retains the existing fixed signalling system and fixed signals but complements this with radio beacons to transmit braking curves to trains to ensure safety;
- Level 2, which retains centralised signalling interlocking based upon block sections but no longer requires trackside signals or track circuits as movement authorities are transmitted to trains, which also report on their own positions; and
- Level 3, which does not require block sections but operates on 'moving block' principles to keep a safe distance between trains.

4.14 Levels 2 and 3 offer the prospect of significant cost savings by removing the need for installation and maintain of trackside equipment. They also enable a substantial increase in line capacity, potentially reducing the need for construction of new lines, while additional features (for example, the automatic application of train brakes in the event that a driver ignores a movement authority) improve safety. However, these benefits can only be achieved if every train operating over the relevant part of the network is equipped with the necessary systems and infrastructure.

Coordination of ERTMS

4.15 As the Commission recognised at an early stage in the development programme, efficient deployment of ERTMS relies on effective coordination of the various supporting projects across the EU. In the absence of such coordination, there is a risk that Member States would engage in a number of inconsistent projects that failed to deliver the anticipated interoperability benefits. Regulation (EU) 913/2010 therefore provided for the establishment of an Executive Board (comprising representatives of Member States) to supervise implementation and to make political, strategic and financing decisions, and Management Boards (comprising representatives of infrastructure managers) responsible for deployment on each of six different corridors. These governance arrangements are in place on most ERTMS corridors and draw, as far as possible, on existing structures.

4.16 A number of other measures have been taken to support the efficient deployment of ERTMS, some of which are analogous to measures taken in support of SESAR:

- The appointment of a European Coordinator for ERTMS (equivalent to the other TEN-T Coordinators appointed to assist in the implementation of TEN-T Priority Projects), whose role is to progress the project at a political level;
- The introduction of a European Deployment Plan (EDP) with legally binding dates for ERTMS deployment on core routes;
- Alignment of strategic rail freight corridors with the six ERTMS corridors and the provision of substantial funding for ERTMS deployment (including funding from the Connecting Europe Facility (CEF));
- The development of high quality technical specifications subject to European Railway Agency oversight and testing at accredited European testing laboratories for ERTMS equipment; and
- Establishing a platform of European Infrastructure Managers, co-chaired by the Commission, to support greater coordination, particularly on issues such as ERTMS deployment.

Funding of ERTMS

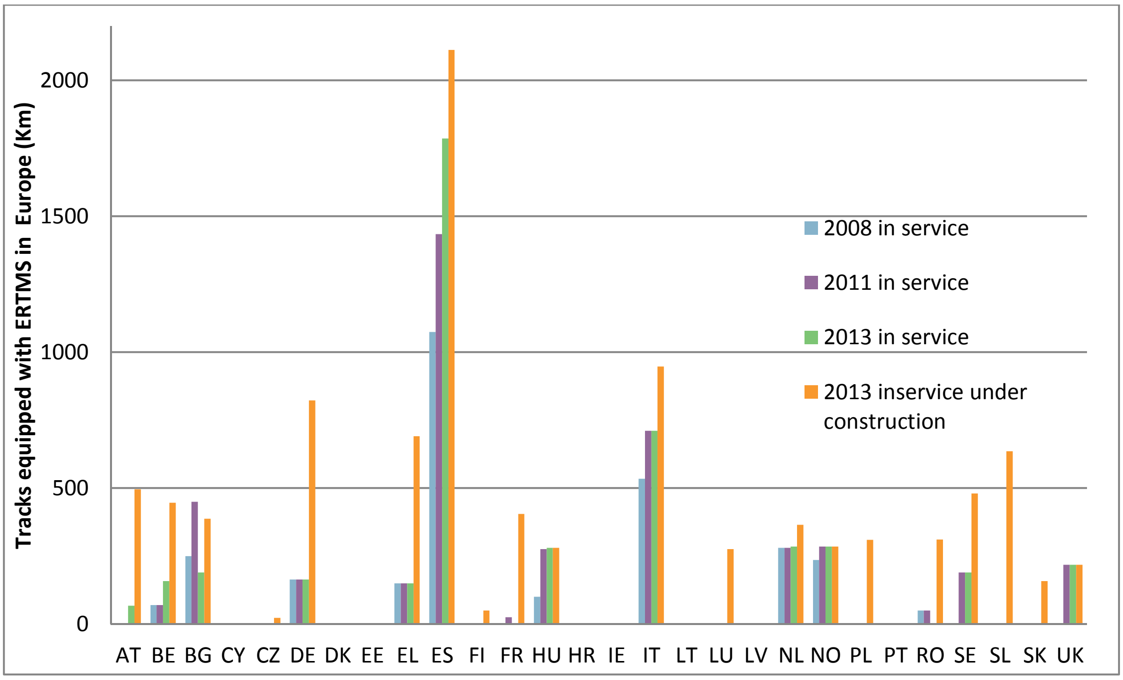
4.17 Under the 2007-2013 TEN-T Programme, the maximum amount of EU funding that could be awarded to individual activities was 50% of costs for both trackside and on board projects. Co-funding continues at the same rate under CEF, and will be focused on the TEN-T Core Network (as defined in the recently adopted TEN-T Guidelines of 2013) and specifically on Level 3 deployment. In addition, CEF will provide financial instruments for ERTMS, such as debt or equity guarantee schemes. The Cohesion Fund and the European Regional Development Fund (ERDF) will support the deployment of ERTMS on the Comprehensive Network (as also defined by the TEN-T Guidelines).

4.18 Substantial EU funds have already been used to support the deployment of ERTMS. Under the 2007-2013 TEN-T Financial Regulation, € 770 million has been distributed across five calls for tender, while Bulgaria, the Czech Republic, Greece, Spain, Lithuania, Poland and Slovenia have received more than €1.5 billion for ERTMS from the Cohesion Fund over the 2007-2013 Programming Period. However, only 50% of the activities earmarked for TEN-T co-funding have been, or will be, completed on time. The bulk of the funding is now focused towards the end of the TEN-T programme, which results in a major risk as funds cannot be transferred to another financing period in the event that the works are not completed on time. In addition, we understand that the majority of the TEN-T beneficiaries, accounting for some 70% of the €770 million, are tracks-side project promoters and only 30% is accounted for by on-board project promoters.

Current ERTMS deployment

4.19 Notwithstanding all of the measures taken to ensure effective deployment of ERTMS, the current level of deployment across the EU varies considerably. There has been substantial investment in ERTMS in a number of Member States, including in Italy and Spain where it has been deployed in the development of new high speed networks, as well as in Belgium, Denmark, Luxemburg, the Netherlands and Switzerland. However, some key Member States are significantly behind, including some of the largest in terms of the provision of rail transport such as Germany and France, as shown in the figure below.

Figure 4.1: ERTMS deployment by Member State



Source: European Commission

4.20 There are a number of reasons for this variation in the level of deployment:

- Technology "standards" have continued to evolve, with the result that earlier ERTMS technology was not necessarily compatible with newer versions, and that versions developed by different suppliers were not always interoperable.
- Some Member States have been reluctant to invest in a new, pan-EU technology when, in their view, the additional benefits have not been fully demonstrated and they have already undertaken substantial investment in national systems. While the European Coordinator for ERTMS has been instrumental in changing this perception but it persists in a number of countries.
- There is a misalignment of incentives to invest in ERTMS between infrastructure managers (responsible for track-side equipment and systems) and train operators (responsible for on-board equipment). This arises partly as a result of the asymmetry in the benefits for operators relative to those enjoyed by infrastructure managers – substantial capacity increases, for example, will enable them to operate additional services but the associated financial gain is considerably smaller than the cost savings accruing to the infrastructure manager from avoiding the construction of a new line.
- Progress in retro-fitting rolling stock has been particularly limited as a result of the high costs, financial constraints on train operators and a lack of clarity regarding the programme for installing track-side equipment. At the same time, infrastructure managers do not consider installation of the equipment to be urgent because the level of on-board deployment is low.

4.21 These issues have been addressed to some extent through requirements in the European Deployment Plan to equip corridors with on-track ETCS by defined dates, but the European Commission has nevertheless indicated that it may develop further measures to reinforce this policy.

The need for incentives

4.22 Article 32(4) of Directive 2012/34/EU states that ‘the infrastructure charges for the use of railway corridors shall be differentiated to give incentives to equip trains with the ETCS’, and the Commission is currently considering the scope for introducing incentives based on modulation of track charges. The impact assessment for this policy initiative is based on an investigation of three options:

- **Option A:** a special levy (separate to the access charges regime) would be collected each year from operators with non-equipped rolling stock operating on ERTMS Corridors. The levy would be set at a level covering the opportunity cost of not equipping trains (i.e. the costs avoided) in order to incentivise retro-fitting. The revenue generated by the levy would be used to fund the upgrading of existing rolling stock. The levy could be held constant or increase over time.
- **Option B:** all trains with the necessary equipment would attract a discount when operating on the ERTMS Corridors. This would have an impact on public finances as the Directive requires that any differentiation shall not have an impact on overall charges. As in the previous option, the incentive could remain constant or increase over time.
- **Option C:** this option includes elements of both the special levy and the discount schemes.

4.23 The impact assessment includes a qualitative assessment to identify whether each option represents an improvement or deterioration in respect of a range of criteria, as set out in the table below.

Table 4.1: Approach to qualitative assessment

Category	Criteria
Impact on intermodal competition	The options will be reviewed based on whether they have a positive or negative impact on intermodal competition. If an option increases net costs to the sector it will have a negative (High, Medium or Low) impact on intermodal competition and vice versa.
Impact on the competitiveness of small train operators (short term)	Competitiveness for small operators will be driven primarily by the effects of authorisation costs. The options will have different impacts on small operators as opposed to large operators given the authorisation costs associated with ETCS (Positive/Negative).
Impact on the competitiveness of large train operators (short term)	As above but for large operators.
Impact on the cost of converting infrastructure manager charging systems	This has been raised as an issue by a number of infrastructure managers. The assessment will be based on consideration of the complexity of the various charging systems (High/Medium/Low).
Impact on national funding	How the various options will affect national funding for the railways (Increase/Decrease/Neutral).
Impact on EU funding	How the various options will affect EU funding for the railways (Increase/Decrease/Neutral – Large/Small).
Will the options accelerate retrofitting?	Yes/No/Not applicable.

Category	Criteria
Impact on barriers to entry (costs of entry for train operators)	Whether each of the options increase or decrease barriers to entry.
Impact on signalling costs for infrastructure managers	How will the options affect the signalling costs incurred by infrastructure managers (speed of reduction of signalling costs) - (Large/Small Increase/Decrease)?
Implementation timescale	Short term (0-5 years), medium term (5-15 years), or long term (>15 years). Based on the acceleration of retro-fitting.

4.24 There is considerable variation in the level of access charges across Member States, and it would therefore not be possible to introduce consistent incentives to equip rolling stock with ETCS through a defined percentage levy or discount. Rather, incentives must be based on a supplementary payment, defined in absolute terms, that is separate from access charges (although administered through the same monitoring and invoicing arrangements in order to minimise administration costs). The impact assessment has also considered a number of options for the structure of the payment (e.g. a payment per unit of rolling stock equipped or per train-km operated by equipped trains on ERTMS enabled infrastructure).

4.25 We understand that the main conclusions and recommendations of the impact assessment include the following, all of which have some relevance for the incentivising the adoption of SESAR technology:

- The results of the qualitative assessment suggest that the discount option has the most favourable attributes overall;
- The introduction of the incentive scheme should be linked to the actual deployment of trackside ETCS, with incentives provided when 75 – 90% of trackside equipment is in place; and
- Exemption for certain trains, for example those used to provide regional services, has some justification but could significantly limit the level of retro-fitting.

Implications for SESAR

4.26 There are many differences between the ANS and the rail industries, and ERTMS is substantially different in scope from SESAR (with the latter embracing a wider range of technologies than the former). In addition, ERTMS is at a mature stage of development, with some equipment already in place and operational. However, some comparisons can be drawn between the two projects such that the experience of ERTMS deployment is useful in informing the incentivisation of SESAR technology:

- Both initiatives require extensive collaboration between infrastructure managers, transport operators and other stakeholders while the incentives that each group of stakeholders faces are not always aligned;
- The deployment of ERTMS has been subject to delay, notwithstanding the introduction of a legislative framework requiring delivery by defined dates;
- The recent economic recession has reduced both public and private sector expenditure and hence reduced the amount of funding available, making deployment more challenging than might otherwise have been the case;

- There are lengthy administrative processes relating to the release of TEN-T funding, with those responsible for deployment required to incur upfront costs and receiving funding only at a later stage;
- Various options for the design of an incentive scheme are available in principle, including levies, discounts and different metrics for the determination of payments.

4.27 However, there are important differences between ERTMS and SESAR relating to a range of different aspects of the projects:

- **Policy objectives:** one of the key objectives of ERTMS is the interoperability of the rail sector and the removal of incompatible legacy systems. Variations between Member States do not exist to the same extent in the aviation sector, where a number of operators are excluded from the scope of SESAR, and legacy systems may not be withdrawn (at least in the short-term).
- **Geographical focus:** ERTMS is a European project in the sense that the overwhelming majority of equipped rolling stock will only ever operate within Europe. By contrast, airspace users must operate according to international conventions and are generally more internationally-focused. Technological programmes similar to SESAR are being developed in other countries, for example NextGen in the USA, and airspace users must also take these into account in making investment decisions (for example, in relation to their long haul fleets). In addition, ERTMS is focused on six rail corridors, while SESAR is to be applied to the whole of European airspace.
- **Focus and level of incentives:** ERTMS will deliver considerable benefits in terms of interoperability, safety and cost reductions to train operators, although the benefits for infrastructure managers are likely to be greater. On the other hand, several SESAR technologies do not necessarily benefit the airspace users significantly, even though they must incur a substantial proportion of the costs if the benefits are to be realised. In addition, as all new rolling stock must be ETCS-equipped from the beginning of 2015, incentives for the deployment of ERTMS must encourage retro-fitting of existing rolling stock and infrastructure. In principle, it may be appropriate to deploy SESAR technology on both new and existing aircraft.
- **Governance and management:** a European Coordinator for ERTMS has been in place since 2005. The Deployment Manager for SESAR was appointed by the end of 2014, but will not have the same role as the ERTMS Coordinator in terms of progressing the initiative at the political level. The ERTMS Deployment Plans, which set out clear dates for implementation, have been agreed by Member States since 2009, while the PCP Regulation 716/2014 mandating the deployment of six AFs is more recent.
- **Technical standards:** ERTMS is subject to agreed technical standards, but it is not clear whether equivalent standards are being developed for SESAR and, if so, to what timescales.
- **Administration:** individual rail infrastructure managers are responsible for collecting track access charges, while charging for ANS is centrally administered by the Central Route Charges Office (CRCO).
- **Funding:** co-funding rates available under the CEF are 50% for train operators investing in ERTMS equipment as compared with 20% for airspace users investing in SESAR technology (although rail infrastructure managers and ANSPs both benefit from a 50% co-funding rate).

4.28 We have taken account of both the similarities and differences between ERTMS and SESAR in developing our recommendations under this workstream. In our view, the lessons in respect of funding, in particular the need for accessible funding in support of incentives, and the relative attraction of a discount rather than a levy-based scheme are particularly important.

Data Link

Background

4.29 Currently, the majority of communications between Air Traffic Controllers (ATCOs) and pilots are by means of voice communications. Link 2000, later called Data Link, was developed to enable Controller Pilot Data Link Communications (CPDLC) as a means of reducing voice channel congestion and supplementing voice communications. Data Link was also expected to improve safety while increasing ATM capacity by automating routine tasks including:

- ATC communications management, to handle repetitive frequency changes;
- ATC clearances, to provide standard clearance commands; and
- ATC microphone check, to enable communication in case of blocked frequencies.

4.30 Trials of the technology were undertaken by MUAC ANSP during the 1990s. These were followed by the establishment of Eurocontrol's Link2000+ Programme, which initially included work on standardisation and specifications as well as on the identification of exemptions. Eurocontrol also provided guidance material and established the DLS Implementation Group (DLISG).

4.31 The Link2000+ Programme identified three phases for the on-board deployment of Data Link as follows:

- **Pioneer Phase:** direct reimbursement of a maximum of €20,000 per aircraft from Eurocontrol for equipping aircraft with Data Link (with a maximum of 20 aircraft per airspace user), with the aim of demonstrating the technology;
- **Incentives Phase:** availability of TEN-T Funding for equipping aircraft with a co-funding rate of up to 20% per aircraft for airspace users; and
- **Mandate Phase:** adoption of Regulation 29/2009, which mandates deadlines for the equipage of ANSPs and airspace users with Data Link.

4.32 The Pioneer Phase began in 2003 and was expected to achieve the early equipping of approximately 100 aircraft. In the event, over 200 aircraft were equipped under this scheme, with all funding coming directly from Eurocontrol. Different options for the Incentives Phase were considered, including investment grants and differential charges as follows:

- **Investment grant:** the investment grant scheme involved the payment of a cash grant to operators for each aircraft that was to be equipped for CPDLC, subject to eligibility criteria. On presentation of appropriate documentation, the owner of an eligible aircraft that had been equipped with CPDLC would be entitled to receive a grant.
- **Route charge differentiation:** under a differential charge scheme, an equipped aircraft would pay lower route charges in the Link area than a similar unequipped aircraft. Reductions of route charges differed from direct grants as they would be awarded on a per flight basis. The more an eligible aircraft flew in the Link airspace, the more it would contribute to the overall ATM benefits/cost savings, and the more it would benefit from route charge reductions.

4.33 It is not clear who would have overseen any reduction in charges or whether the ANSPs were expected to receive funds from another source to compensate for the associated reduction in revenues. In practice, there was no agreement between airspace users and ANSPs on the design of the scheme and it was not taken forward.

Funding of Data Link

4.34 After consultation with the stakeholders, grants using TEN-T funding available under the European Economic Recovery Plan[41] were used as the basis for incentives. Over €7 million of EU funding was granted to airspace users for fitting Data Link, following calls for proposals with a co-funding rate of up to 20%.

4.35 Applying for TEN-T funding is a complex administrative process, and this is likely to have acted as a barrier to investment in Data Link for some airspace users. One stakeholder noted that they found it necessary to employ external advisors to support the bid for funding and project liaison activity, thereby lowering the funding available to support the adoption of the technology. In response to problems of this kind, Eurocontrol took responsibility for submitting a proposal for TEN-T funding and acted as the fund manager for the airlines under TEN-T project 2009-EU-40068 E. We understand that several airspace users nevertheless chose to leave the scheme due to the tight deadlines and relatively onerous administration involved.

4.36 Those obtaining funds through Eurocontrol were reimbursed for 20% of the actual costs upon submission of an auditable cost statement. Actual costs included the cost of the deployment of the technology as well as costs incurred for associated project management and required travel. The then TEN-T Agency (now known as INEA) pre-financed 50% of the estimated funding allocation upon signature of the contract between the airspace user and the technology supplier. There was no limit to the number of aircraft an airspace user could equip using the TEN-T funding.

4.37 A further issue was that avionics manufacturers and suppliers encountered difficulties in obtaining the required certificates from EASA within the required timescales. Three extensions to the project deadline were granted by the TEN-T Executive Agency in order to mitigate these problems, but any deadline extension as part of TEN-T must be within the timescales of the relevant programme (in this case 2007 to 2013, extended in some circumstances to 2015 but not beyond). One stakeholder also suggested that Eurocontrol underestimated the number of resources required to manage this project, and that while relatively successful it was more costly than originally estimated.

Implementation of Data Link

4.38 With the implementation of Regulation (EC) 29/2009, part of the SES legislation on interoperability, implementation of CPDLC in European airspace above FL285 became compulsory from 1 January 2013. The legislation originally set out binding requirements for the implementation of Data Link services within the EU, addressing both the airborne and ground environment with obligations for Airspace Users and ANSPs. These include:

- All newly delivered aircraft operating above FL285 to be equipped as of 2011;
- Core European ANSPs (Group A) to be operational by 7 February 2013;
- The rest of European ANSPs to be operational (Group B) by 5 February 2015; and
- All existing aircraft operating above FL295 to be retrofitted by 5 Feb 2015 (unless exempt).

[41] The European Economic Recovery Plan (EERP) was introduced in 2009 with a budget of €500 million. It had two objectives: to inject additional money into the market to boost European investment in transport infrastructure projects following the 2008 financial crisis, and to ensure that the bulk of the funding should be used for projects to be implemented in 2009-2010.

4.39 So far the progress in the implementation of both ground-based and on-board equipment has been rather limited:

- In the case of ground-based infrastructure, implementation has been completed in the Netherlands (MUAC), Germany, UK, Ireland and Switzerland with planned operational dates for the other countries ranging from 2014 to 2018[42]. However, only some 45% of committed Data Link ground investments had been made by September 2013.[43]
- Some progress has been achieved in relation to on-board equipment, with between 1,000 and 1,200 aircraft equipped, with less than 50% of planned fitted aircraft by February 2015.

4.40 Regulation (EC) No 29/2009 has in the meantime been amended by Implementing Regulation (EU) 2015/310, which effectively suspends the application of the Regulation until 5 February 2018 and differs airborne capability application date to 5 February 2020.

Factors hindering the implementation of Data Link

4.41 Some common problems have been identified by the stakeholders involved in the implementation of Regulation (EC) 29/2009, including technical problems which were not identified during the Pioneer Phase, budget restrictions and a lack of project management. In the course of our discussions with them, stakeholders generally agreed with the view that it is evident that the costs, complexity of implementation and possible difficulties were all underestimated. The following issues were identified by stakeholders attending a workshop on the implementation of the Regulation on 23 of September 2013.

Table 4.2: Issues hindering the implementation of Regulation (EC) 29/2009

Stakeholder Group	Issues faced
ANSPs	• Missing radio infrastructure (Link between SITA and ARINC , HW/SW) • No increase in traffic • Technical problems (unexpected disconnections) • Implementation was time consuming • Compliance demonstration was more complex than envisaged • Currently no operational benefits • Potential operational safety issues • Lack of validation of the technology undertaken • Implementation has been resource consuming
Airspace users	• Very limited usage – geographical coverage, technical issues and dwindling confidence • Interpretation of the Regulation has been difficult due to unclear Articles • Late availability of EASA Certification Specifications • Late availability of avionics needed • Errors in avionics (VDL-Mode 2 deactivated as far as possible) • Change of fleet during implementation • Large investment made but no benefits expected in the coming years • Technical problems (provider aborts are too frequent) • Fragmented implementation causing frequent logon-logoff, hence increased cockpit workload • No benefits • Slow rollout undermines investments

[42] Report of 52nd Single Sky Committee, 17/18 December 2013.
[43] Report of the Workshop on the Implementation of Regulation No (EC) 29/2009, 23 September 2013

Stakeholder Group	Issues faced
Supply industry	• Integration of data Link in ANSP operational environment has been difficult • Importance of receiving EASA Certification Specifications at least three years in advance of implementation date • The need for a flexible process for exemption provisions • AOC/ATC co-existence • Performance – unexpected disconnections • Need for an agreed end-to-end service monitoring • Need of a proper certification framework to address liabilities or a European certification framework • VDM multi-frequency (possible channel congestion in the future) • Tight schedule (Group B MS are knocking at SITA"s door for implementation

Implications for SESAR

4.42 We conclude that the implementation of Data Link was subject to a number of shortcomings leading to incomplete and ineffective deployment of the technology. Airspace users have been particularly frustrated by the lack of progress, notwithstanding their efforts to meet legally binding and exacting deadlines. ANSPs, while recognising that they have failed to make the required investment in ground-based equipment, have indicated that the timescales were unrealistic, the legislation was ambiguous in some respects, and the programme was anyway challenging due to a constraint on funding in the wake of the economic recession. Both parties have suggested that there was lack of effective project management and that monitoring of progress was inadequate. All agreed that there were important implications for SESAR, and we have sought to capture these in the table below.

Table 4.3: Implications of deployment of Data Link for SESAR

	Lesson learned
Future Regulation	• The need for a strong and robust CBA prior to adopting regulations and deadlines • The need for flexibility clauses in future regulations • The need for clear and understandable provisions and clauses • Provisions should not be based on speculative lifecycles • The need for a single and well-defined exemption policy • A single regulatory framework is preferable • Certification specifications are required prior to adopting regulations, EASA and NSAs need to be able to prepare and address all certification issues
Future implementation	• The need of a validation/investigation collaboration from the start of deployment • Deployment scenarios, including clear accountability, are required to accompany the validation process • The need for technical expert steering groups for implementation • Strong project management and monitoring is required • Optimisation of deployment of ground infrastructure (perhaps at FAB level)
Future incentives	• Benefits for early adopters must be higher • Incentive scheme for early adopters is required
Future stakeholder involvement	• Need for continuous consultation with all stakeholders

Communication services in Canada

4.43 NavCanada, the Canadian ANSP, charges different prices for international communication services for aircraft flying in oceanic airspace. The charge for voice communication is higher than that for Data Link communication as it is more cost efficient for NavCanada to provide services over Data Link than over voice channels. The impact of savings available to airspace users from the deployment of Data Link is limited, as oceanic charges are only a small component of overall charges. For example, for an international flight overflying Canadian-controlled airspace with no landing or take off in Canada, the total ANS charges would be CAN$1,800.00 for an unequipped aircraft and CAN$1,763.48 for aircraft equipped with Data Link, a 2% reduction. The largest part of the cost is accounted for by en-route charges which, unlike oceanic charges, are not modulated in this way.

4.44 NavCanada indicated that some 85% of the aircraft now flying on Atlantic routes are fitted with Data Link, compared to 60% in January 2010 and less than 20% when the modulation was introduced in 2001. However, it was doubtful that the modulation of communication charges had been the main driver in the increase in take-up of Data Link as the discount did not represent a significant saving relative to the overall communication and navigation charges incurred by airspace users. Rather, it considered that take-up was mainly driven by newer aircraft coming into service, although it noted that the Data Link mandate on the North Atlantic currently being phased was likely to increase the take-up rate as operators need to be equipped to get the best routings.

4.45 The rationale for introducing modulation of charges for international communications handled by NavCanda appears to have been largely driven by cost considerations. According to the ANSP, the number of voice communication contacts reduces on average from 6 per flight without Data Link to 1.5 per flight with the technology, and as the cost of a single voice communication contact is estimated to be CAN$8-9, the saving is significant. However, NavCanada also noted that productivity savings were difficult to calculate as the capacity of the communication systems had to be maintained for safety reasons.

4.46 When introduced in 2001, the modulation of charges was based on a discount/levy approach, with the original communication charge of CAN$39.5 being replaced with a charge of up to CAN$44 for communication through voice against CAN$21 for communication through Data Link. The rates were designed to generate the same total revenue per fiscal year as that which would have been generated without modulation of charges. Stakeholders were generally willing to accept the scheme given the significant savings available for equipped users.

4.47 This example provides some evidence that modulation of charging schemes providing some incentive to adopt new technology can be implemented, although the effects of this particular scheme are unclear. On the Atlantic routes no other oceanic ANSP has introduced similar schemes, and NavCanada noted that they have not yet considered incentivising Data Link through modulation of domestic en-route charges. As this is the only example of such a scheme being applied in the ANS industry that we were able to identify, we conclude that the policy is largely untested. This means that it is difficult to predict the results of using similar incentives to encourage the adoption of SESAR and further strengthens the case for effective industry consultation on scheme design and implementation.

Objectives of an incentive scheme

4.48 The overall objective of an incentive scheme based on the modulation of charges is to ensure the timely deployment of SESAR technology. In particular, it should provide an incentive for investment in on-board technology which, while it improves the efficiency of the industry as a whole, does not necessarily deliver significant immediate benefits for airspace users. In a well-functioning market, there should be a natural incentive for ANSPs and airspace users to invest jointly in new technologies and for sharing cost efficiency savings. However, the experience of Data Link suggests that, in practice, coordination failures may lead to a sub-optimal deployment of technology that could benefit the industry as a whole. In particular, based on our understanding of experience of the Data Link project and discussions with stakeholders, we note that airspace users are likely to be reluctant to invest where the benefits take the form of potential significant but uncertain reductions in ANS charges in the longer term, and/or where they are dependent on ANSPs undertaking complementary investment in ground-based equipment.

4.49 At the same time, any incentive mechanism should meet the general objectives for modulation of charges schemes set out in Chapter 1, not least the objective of economic efficiency. In principle, early on-board equipage could be achieved through means other than incentives, for example a requirement in legislation that all aircraft were equipped by a defined date regardless of the benefits for an individual airline (following the precedent set by Data Link). By contrast, an incentive scheme can result in a more economically efficient outcome, since there is discretion for individual airspace users to determine whether and how quickly to invest according to an assessment of the benefits (including any financial incentives) and the costs, leading to a more optimal profile of investment over time. It follows that an incentive scheme should only be adopted in preference to mandating the adoption of a technology if policy makers can be confident that it will provide a more economically efficient solution.

4.50 This means that the incentive scheme must be designed in order to encourage the deployment of a well-defined technology for which the benefits are well understood and quantified to an acceptable level of accuracy. In the absence of a thorough understanding of the benefits, it is not possible to calibrate incentive payments accurately, and the scheme may lead to under or over-investment. We have therefore designed a possible scheme with a view to incentivising deployment of technology developed through a specific SESAR common project, as discussed in the following section.

4.51 As in the case of other modulation of charges schemes, it is also important that an incentive scheme should meet other objectives, for example intelligibility and credibility. Again, the experience of Data Link demonstrates that all stakeholders must consider a scheme to be fair and workable if they are to reach agreement on it. Incentives that do not command the confidence of the industry are unlikely to work effectively no matter how powerful they may be in theory. An evaluation of the scheme developed here against the full range of objectives described in Chapter 1 is presented as part of our final conclusions and recommendations in paragraph 4.165 below.

SESAR Pilot Common Project

ATM Functionalities

As shown in paragraph 4.6, the PCP Regulation mandates the deployment of the six most mature AFs between 2014 and 2020. All AFs require coordinated deployment by different stakeholders, as shown in the figure below.

Figure 4.2: Stakeholder involvement per ATM Functionality

SHs \ AFs	AF 01	AF 02	AF 03	AF 04	AF 05	AF 06
ANSPs	✓	✓	✓	✓	✓	✓
Military			✓		✓	
Airspace Users			✓		✓	✓
Airports		✓		✓	✓	
Network Manager			✓	✓	✓	✓
MET Service Providers					✓	

Source: PCP proposal May 2013

4.52 It is clear from the figure that only AF3, AF5 and AF6 involve the participation of airspace users. In each case, the need for airline involvement is driven by a requirement for investment in airborne equipment, the introduction of which must be coordinated with parallel investment by ANSPs on the ground. The table below summarises some of the key characteristics of each of these AFs, including the results of the associated Cost Benefit Analysis (CBA).

Table 4.4: Characteristics of AFs involving equipping of aircraft

AF	Description	Cost Benefit Analysis
3: Flexible Airspace Management and Free Route	AF3 aims to deploy Free Route operations at the Regional Level to allow airspace users to plan a route freely between fixed published entry and exit points, with the possibility to route via intermediate (published or unpublished) way points, without reference to the published ATS route network, subject to airspace availability.	**NPV = €1.3 billion** **Benefits = €1.8 billion** 89% fuel cost savings 11% CO_2 savings **Costs = -€0.5 billion** 75% borne by ANSPs 25% borne by Military 2% borne by Network Manager 1% borne by Airspace Users
5: SWIM functionality	System Wide Information Management (SWIM) is concerned with the development of services to establish the information exchanges required to implement the SESAR concept in an agile and cost-effective in a way that is new to aviation. SWIM consists of standards, infrastructure and governance enabling the management of ATM information and its exchange between qualified parties via interoperable services.	**NPV = -€0.1 billion** **Benefits = €0.4 billion** 100% of benefits from ANS productivity gains **Costs = -€0.6 billion** 41% borne by ANSPs 29% borne by Network Manager 10% borne by Military 3% borne by Airport Operators 2% borne by Airspace Users

AF	Description	Cost Benefit Analysis
6: Initial Trajectory Information Sharing	This AF includes the first steps towards improved predictability at both Network and local level through the improved use of target times and trajectory information. The sharing and use of on-board 4D trajectory data by the ground ATC system will result in improved predictability.	**NPV = -€0.2 billion** **Benefits = €0.2 billion** 94% of benefits from ANS productivity gains 5% from fuel cost savings, 1% from CO_2 savings **Costs = -€0.4 billion** 66% borne by Airspace Users 33% borne by ANSPs 1% borne by Network Manager

Source: PCP proposal May 2013

4.53 We note that both AF5 and AF6 have negative Net Present Values (NPVs), which raises the question of whether they should be deployed. However, both are necessary foundations for future ATM infrastructure, a factor that is not fully reflected in the CBA results. Accordingly, the PCP proposal noted that "these two AFs should be considered for establishing incentive schemes, through both EU funding and charges modulation, to encourage on-time equipping of aircraft". We also note that the CBA results are anyway partly determined by the time horizon for the NPV calculation, a period of only 16 years, which arguably does not reflect the economic life of the associated investment[44].

Characteristics of Initial Trajectory Information Sharing (AF6)

4.54 In our view, AF6 is likely to be the most appropriate candidate for support through the introduction of an incentive scheme based on the modulation of ANS charges. In particular, it has a number of characteristics which, taken together, will tend to discourage airlines from making the necessary investment:

- In principle, improved predictability of aircraft trajectories will benefit both airspace users and ANSPs, implying fewer tactical interventions and more effective avoidance of conflicts. In time, these benefits could be reflected in greater ANSP productivity and reduced ANS charges. However, airspace users are unlikely to undertake significant investment in on-board technology if the benefits are uncertain and can only be realised after a number of years, as already noted.
- Some 66% of total costs must be borne by airspace users, as compared with only 2% in the case of AF5.

4.55 We have therefore selected AF6 as the basis for the development of an incentive scheme. The table below summarises some of the key characteristics of the AF that must be taken into account in the scheme design.

[44] We would expect the economic life of on-board equipment to be potentially equivalent to the life of the aircraft itself, which may be considerably longer than 16 years at the time the on-board investment is made (at least in the case of new aircraft).

Table 4.5: Characteristics of Initial Trajectory Information Sharing (AF6)

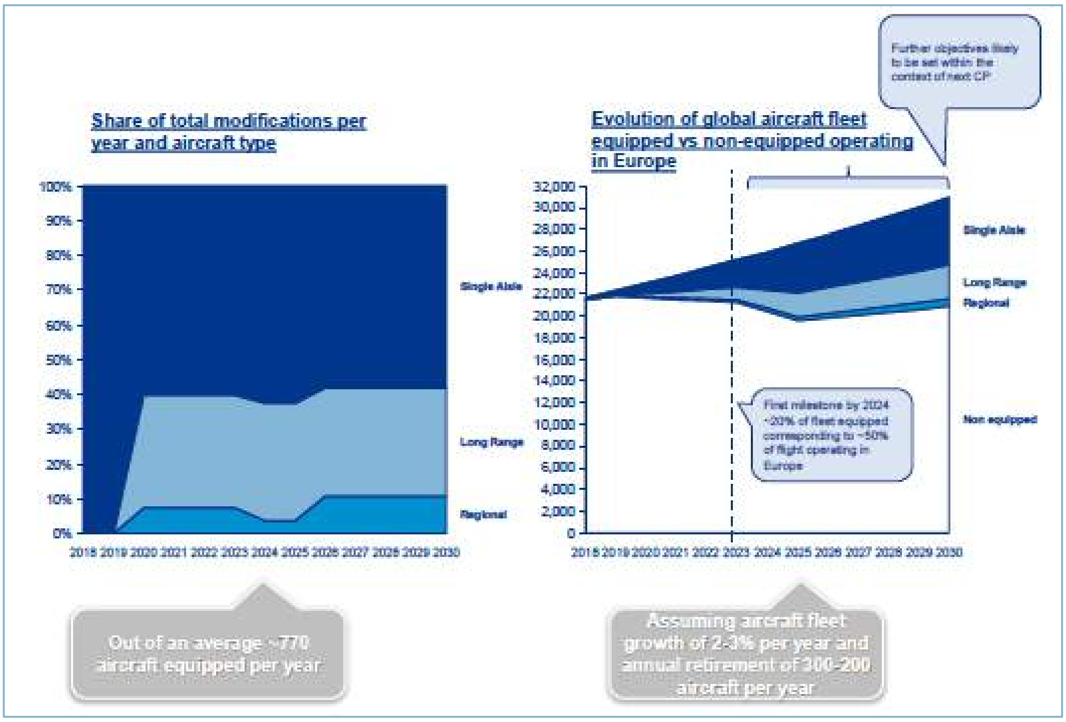
Characteristics	Summary	
Description	This AF includes the first steps towards improved predictability at both Network and local level through the improved use of target times and trajectory information. The sharing and use of on-board 4D trajectory data by the ground ATC system will result in improved predictability.	
Key programme dates	Ground equipment • Start of Investment:2016 • Start of Deployment:2018 • Start of Benefit:2018 • End of Investment:2022 • End of Deployment:2024 • Full Benefit:2024	Airborne equipment • Start of Investment:2018 • Start of Deployment:2018 • Start of Benefit:2018 • End of Investment:2025 • End of Deployment:2025 • Full Benefit:2030
Scope of deployment[45]	Ground equipment Installation at all 61 Air Traffic Control Centres of Eurocontrol Members	Airborne equipment 20% of aircraft (45% of flights) operating within European Airspace to equip on voluntary basis in order to achieve critical mass
Impact	Ground equipment Data Link communications systems shall support CPDLC and ADS-C as defined in the “ATN Baseline 2” standard, supporting sharing of information between ATC and Aircraft. Flight Data Processing (FDP) systems shall be adapted to make use of downlinked trajectories and Controller Working Position (CWP) shall implement monitoring of trajectory adherence to the flight plan.	Airborne equipment The “ATN Baseline 2” functionality, supporting CPDLC and ADS-C, including the provisions for i4D, will be required to support the downlink of trajectory information through the EPP.

Source: PCP proposal May 2013

4.56 AF6 depends critically on the implementation of Data Link communications systems, both on the ground and airborne, as it is intended to support CPDLC and ADS-C, as defined in the “ATN Baseline 2” standard, enabling a downlink of the aircraft trajectory using EPP. The SESAR Joint Undertaking’s PCP proposal had envisaged the voluntary forward fitting and retrofitting of mainline aircraft between 2020 and 2025, with voluntary forward fitting only of regional aircraft over the same period. It had also envisaged that operators of business aviation and military aircraft will not be required to equip their fleets. The expected time profile of equipped aircraft and flights illustrated is illustrated in the figure below.

[45] In principle, the deployment of AF6 and any associated incentive scheme could be extended to ECAC members. However, for the purposes of this analysis, we have used as the scope of deployment Eurocontrol Member States.

Figure 4.3: Aircraft modifications ramp-up to reach initial critical mass



Source: PCP proposal May 2013

Implications of AF6 for ATM

4.57 The principle of "First Come First Served" (FCFS) traditionally applies in the management of air traffic. However, the PCP proposal noted that in the context of AF6, this approach will not necessarily guarantee the most efficient use of ATM systems and procedures. The SESAR JU has therefore proposed a shift towards "Best Efficiency Best Served" (BEBS), leading to a progressively stronger focus on a "Serve by Schedule" philosophy for main airports and making it possible to fully meet the 4-D Business Trajectory objective. More specifically, the PCP consultation document for AF6 advocated a first BEBS supporting measure, whereby preferential service would be given to equipped aircraft. BEBS implementation would need to be enforced through neutral, transparent and non-discriminatory processes to ensure that all aircraft equipped with the relevant technology would be eligible for preferential treatment.

4.58 However, some airspace users have expressed the view that BEBS may not be feasible in practice. They fear that the reduced workload associated with the handling of AF6 fitted aircraft would free up ATCOs to allow controllers to focus on the more complex needs of the non-fitted aircraft – and therefore providing non-fitted aircraft with a better service rather than AF6 fitted ones.

4.59 It is not yet clear whether AF6 will result in implementation of BEBS rather than FCFS, but it is expected that the deployment of AF6 will result in a reduction in ATCO's workload at some point. In the short-term, the traffic handled by ATCOs would include both equipped and non-equipped aircraft, while it is expected that in the longer term the majority of traffic will be equipped with AF6 technology.

4.60 The PCP proposal of 2013 estimated that benefits to be expected from the implementation of the PCP included ANS productivity gains that could be derived through ATCO productivity increases of up to 12% and would allow an overall performance gain of 3.2%. It also noted that

AF6 would be expected to receive an overall performance gain of 1.3% on cost-effectiveness. However, there is no mention of the timeframe required for this cost saving.

4.61 As presented in paragraph 4.43, there exists a modulation of charges in Canada for the oceanic communication charge regarding the use of Data Link rather than voice channels. However we have not been able to obtain an estimate of ATCO's productivity savings from having the aircraft equipped with Data Link. Some US research into operational benefits from mixed voice and Data Link operations in a number of scenarios is inconclusive on workload savings[46]. Eurocontrol regulatory Impact Assessment supporting the development of regulation No 29/2009 quotes Honeywell as expecting that "the reduced workload in en-route communications to add 11% to effective capacity once 75% of aircraft using the airspace are equipped" with Data Link.

The design of an incentive scheme for Initial Trajectory Information Sharing (AF6)

Legislative frameworks

4.62 It is important that the design of the incentive scheme takes full account of the both the EU and wider international legislative and regulatory framework governing ANS charges. Therefore, before considering the implications of the specific characteristics of AF6 for the scheme, we have reviewed the relevant legislation with the aim of identifying any relevant guidance and regulatory constraints.

ICAO policy framework

4.63 ICAO's Policies on Charges for Airport and Air Navigation Services (Doc. 9082) and the Air Navigation Service Economics Manual (Doc 9161) provide a framework for the use of incentives, in particular differential and modulated charges within a cost recovery regime. The primary intent of ICAO's guidance in this area is to help States develop a cost recovery approach for services consistent with four key principles. It states that charges should be:

- Cost based;
- Non-discriminatory (for example between foreign and domestic users);
- Transparent; and
- Not cross-subsidising users.

4.64 Article 6 (v) of ICAO's Policies on Charges for Air Navigation Services states that States should assess, on a case-by-case basis and according to local or national circumstances, the positive and negative effects of differential air navigation services charges. It further clarifies that "without prejudice to modulated charging schemes, the costs associated with such differential charges should not be allocated to users not benefiting from them. Charges offered for the purpose of attracting or retaining new air services should only be offered on a temporary basis". It also states that, to avoid undue disruption to users, any increase in charges should be introduced on a gradual basis, but that in some circumstances a departure from this approach may be necessary.

CRCO publication

4.65 Article 3.4.2 of the Principles for establishing the cost-base for en route charges and the calculation of the unit rates, published by CRCO, notes the possibility of modulation of charges. Member States may, on a non-discriminatory and transparent basis, modulate en-

[46] Controller and pilot evaluation of a DataLink-enabled trajectory-based operations concept, Mueller, 2011

route charges incurred by airspace users to reflect their efforts made to reduce the overall costs of such services and to increase their efficiency. In particular, charges may be decreased or modulated according to the availability of airborne equipment that increases capacity or reduces the inconvenience of choosing less congested routings. It also clarifies that en-route charges may be modulated to accelerate the deployment of new technologies and that the modulation may provide incentives to equip aircraft with systems included in the common projects.

4.66 However, the article also makes clear that modulation of charges must not result in any overall change in revenue for the air navigation service provider, and clarifies that for Contracting States applying the determined cost method over- or under-recoveries shall be passed on to the following reference period. Following ICAO, it also states that the incentive scheme should be limited in time, scope and amount. The estimated savings generated by the operational efficiency improvements must at least offset the cost of the incentives within a reasonable timeframe, and the scheme should be subject to regular review involving airspace users' representatives.

The Implementing Regulation on common projects

4.67 Financial incentives are also permitted under Article 4.6 (b) and Section 3 of Chapter III of the draft Implementing Regulation on common projects, "in particular to mitigate negative impacts on a specific geographical area or category of operational stakeholders". Section 3 of Chapter III of the same Regulation provides more details on such incentives, which fall into two main categories:

- EU funding, focusing on the implementation projects (Level 3 of SESAR deployment governance). This funding may be allocated to ANSPs and/or airspace users on a non-discriminatory basis. EU funding allocated to ANSPs is also beneficial to airspace users in that it is considered as "other revenues[47]" in accordance with the Charging Regulation and deducted from the chargeable cost-base; and
- Incentives relating to the Performance and Charging Regulations, which contain two main sub categories:
  - Incentives on air navigation service providers (Article 15) consisting of bonuses/penalties for reaching/not reaching performance targets, in particular in the capacity/delay Key Performance Area. This category is not perceived as relevant for common projects; and
  - Incentives on airspace users in the form of modulation of ANS charges (Article 16) can be applied to optimise the use of ANS, reduce the environmental impact of flying and/or encourage the use of specific routes. In addition, charges modulation may aim to accelerate the deployment of SESAR ATM capabilities, which is particularly relevant in the PCP context.

Implications of legislation for scheme design

4.68 This legislative framework provides a clear legal foundation for the introduction of an incentive scheme designed to encourage early adoption of SESAR technology, including on-board equipage of aircraft with functionalities such as AF6. It also provides for considerable flexibility in the design of a scheme. At the same time, we note that any scheme must be

[47] "Other revenues" sourced from CEF funding could be considered in the calculation of the unit rate differentiated between airspace users according to equipment status. This way only equipped aircraft would benefit from the lower charges.

temporary, ensure that the costs of providing the incentives are recovered within a reasonable timeframe, and preserve ANS revenues.

Addressing key problem drivers

4.69 Taken together, the overall benefits of AF6 are expected to be substantial. They include the following:

- **Fuel savings:** these represent the savings that airspace users will make from flying shorter distances, through fewer manoeuvres to resolve conflicts, direct routes across sectors/centres/FABs, and better descent profiles;
- **CO2 Savings:** fuel savings translate also deliver benefits for airspace users in terms of reduced CO2 emissions. Such benefits are monetised in terms of EU Emission Allowances (EUAs) which are credits allocated to the companies covered by the EU Emission Trading Scheme (each credit represents the right to emit 1 tonne of carbon dioxide). However, the future of the ETC scheme for internal EU flights remains uncertain; and
- **ANS productivity gains:** these relate to benefits for ANSPs in terms of expected cost effectiveness through ATCO productivity increases of 12%.

4.70 However, delivery of these benefits depends on both the equipage of aircraft and the deployment of ground equipment by ANSPs. Delays on the part of either group of stakeholders would reduce the benefits for the industry as a whole. The figure below shows the overall CBA results for Initial Trajectory Information Sharing (AF6) and demonstrates that significant costs must be borne by stakeholders several years before the benefits can be realised.

Figure 4.4: Overall CBA for AF6

Source: PCP proposal May 2013

4.71 The figure also shows that costs and benefits vary significantly between stakeholders, as illustrated in more detail in Table 4.6. The direct benefits for airspace users, in the form of fuel and CO_2 savings, are particularly small, resulting in a substantially negative overall business case for this group of stakeholders. While in time the productivity gains for ANSPs might be expected to translate into lower ANS charges, resulting in additional airspace user benefits, the associated timescales and uncertainty surrounding the extent of any reduction in charges means that they are unlikely to incentivise the required on-board investment.

Table 4.6: Costs and benefits of AF6 by stakeholder category

Stakeholder	Benefits (NPV) € billion	Costs (NPV) € billion	Result (NPV) € billion
Airspace users	Fuel cost savings = 0.01 CO_2 credit savings = 0.01	- 0.2	-0.18
ANSPs	ANS productivity gains = 0.20	- 0.2	0
Network Manager		- 0.01	-0.01
Total	**0.2**	**- 0.4**	**-0.2**

Source: Steer Davies Gleave analysis of PCP proposal May 2013. Costs and benefits discounted over 2014 – 2030.

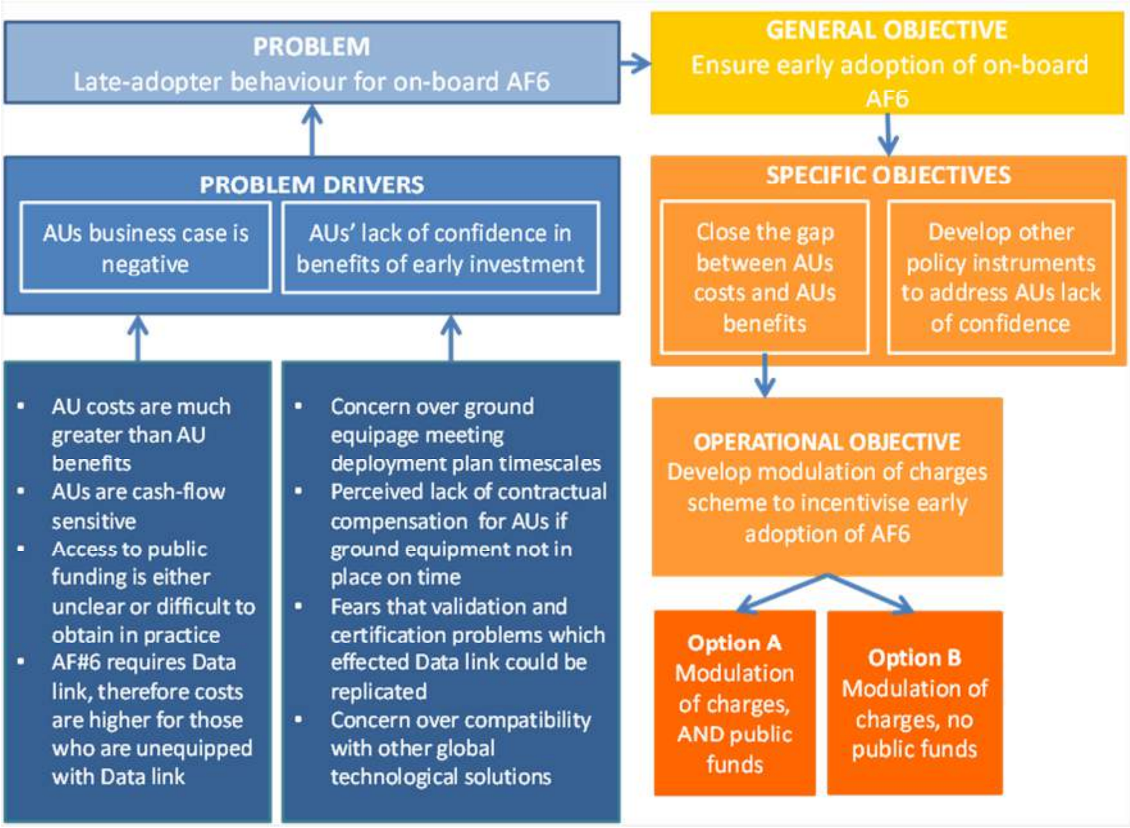
4.72 Moreover, from our discussions with airspace users it is clear that the lack of a clear commercial case for investment is likely to be compounded by a number of factors:

- Airspace users are cash-flow sensitive and are generally not willing to recoup investments over an extended period, especially when the financial benefits are heavily dependent on a complementary programme of ANSP investment;
- Related to the previous point, airspace users are unclear as to the compensation that might be provided in the event that they incurred substantial costs but were unable to realise any benefits due to delays in ground-based investment;
- Access to public funding that may help to close the gap between costs and benefits is unclear and, given the experience of Data Link, potentially difficult to obtain in practice even if coordinated centrally;
- Fitting of Data Link on-board is a prerequisite for AF6 and the overall cost of deploying AF6 could therefore be substantial for airspace users whose fleets are not already equipped with Data Link;
- There are concerns that AF6 could be subject to the same delays in the validation and certification as Data Link; and
- There are also concerns about the compatibility of comparable technological solutions currently being developed around the world - SESAR in EU and NextGen in US.

4.73 In order to illustrate the issues surrounding on-board equipage for AF6, we have drawn on European Commission guidance for the development and assessment of new policy measures to identify the relationship between the various problem drivers[48]. The resulting problem tree is illustrated in Figure 4.5.

[48] Economic Impact Assessment Guidelines issued by the European Commission.

Figure 4.5: Problem tree



Source: Steer Davies Gleave analysis

Principles of scheme design

4.74 Against this background, we have developed an incentive scheme according to a number of principles reflecting good practice in the design of incentives, the characteristics of AF6 and the concerns that stakeholders have expressed about the deployment of the technology. These principles are as follows:

- Airspace users should not receive any more in incentive payments than is necessary to ensure that they equip their aircraft with the required technology. In effect, the incentive scheme should "close the gap" in the airspace user's business case, turning a negative NPV into a zero or slightly positive one (after taking account of any direct benefits such as savings in fuel costs).
- The overall costs of the scheme (including both incentive payments and the costs of administration) should be lower than the expected benefits of AF6 (recognising that the long term benefits are difficult to quantify).
- The design of the scheme should be consistent with the deployment timescales set out in the PCP Regulation. In particular, we have assumed that critical mass will be achieved if 45% of flights operating in Europe are equipped by 1 January 2026 and 100% of air traffic centres are equipped for 1st January 2025.
- Eligible airspace users should be incentivised entirely through a discount in the level of ANS charges that they pay. They will not receive direct funding to cover some or all of the costs of equipping aircraft.
- The scheme should be supported with other measures to address the concerns expressed by stakeholders, ensuring that airspace users have greater confidence that the benefits of

AF6 will be realised. Regulation (EU) 716/2014 already mandates ground investment by 1st January 2025 and sanctions for ANSPs failing to meet the required deadlines exist in the form penalties to be imposed by Member States or, in case the EU funding was awarded to co-finance the ground investment, in the form of the reduction of an awarded grant. However, there is no compensation for airspace users investing in redundant airborne equipment (as a result of the failure of ANSPs to undertake investment on the ground). Time for effective testing and validation of AF6 technology, involving technology providers and manufacturers as well as EASA, to address and mitigate possible difficulties during the subsequent certification process also needs to be taken into account.

4.75 While we consider that these principles will help to ensure the success of the scheme, we envisage that they would be subject to further stakeholder consultation in the course of implementation.

Key assumptions

4.76 In designing the scheme, we have assumed that all the principles set out above are applied and that all stakeholders can be confident either that the benefits of AF6 will be realised or that they will receive adequate compensation in the event that it is delayed or abandoned. In view of stakeholder concerns reported above, we consider this to be a strong assumption, albeit necessary in order to progress the specification of incentive mechanisms and payments. More generally, we stress the importance of full stakeholder engagement in the further development of the scheme in order to ensure that they regard it as fair and workable.

4.77 We have also made a number of assumptions concerning the evolution of the aircraft fleet, the costs of deploying AF6, the expected level of financial returns and other factors in order to calibrate the required incentive payments and determine the cost of the scheme. These are set out in the following paragraphs. Note that, throughout, we assume that the scope of deployment and the operation of the incentive scheme is restricted to Eurocontrol Member States. This assumption was adopted to ensure a consistent and sufficiently detailed dataset for the purposes of analysis, although we recognise that in principle the scope could be extended to members of ECAC.

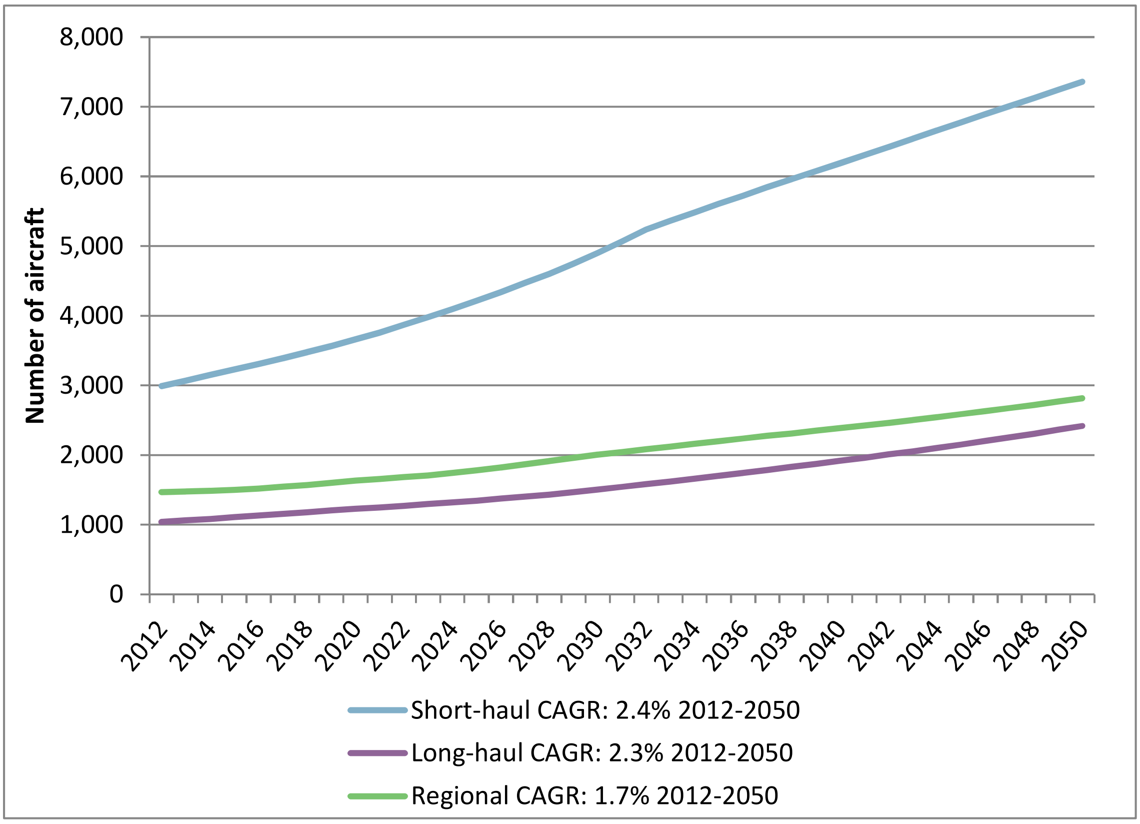
Fleet and flight forecast

4.78 The evolution of the fleet size and volume of flights in European airspace is a critical determinant of the costs of equipping aircraft and hence of the required level of incentive scheme payments. We have prepared separate forecasts for short-haul, long-haul and regional aircraft based on the following methodology:

- Quantification of the size of the existing fleet registered in the relevant States, along with its age profile (sourced from the Flightglobal fleet database for a base-year of 2012);
- Estimation of annual aircraft deliveries and retirements, based on long-term growth projections from Airbus (for short-haul and long-haul) and Bombardier (for regional), and on the age profile of the existing fleet. We assume that all aircraft delivered while the scheme is in place will be automatically fitted with AF6 by the manufacturer;
- Use of airframe utilisation inputs and average flight-time assumptions to relate the fleet size to the volume of flights flown (based on Eurocontrol airframe utilisation statistics); and
- Use of STATFOR flight forecasts for European airspace to develop a forecast of flights flown by the in-scope fleet. This step also relies on Airbus assumptions for the proportion of global fleets that fly through European airspace in order to estimate the in-scope flights flown by the in-scope fleet.

4.79 The figure below shows the fleet forecast for the each of the three aircraft types. The short-haul and long-haul fleets are both forecast to grow at an average rate of just under +2.5% per annum, with regional fleets growing at +1.7% per annum.

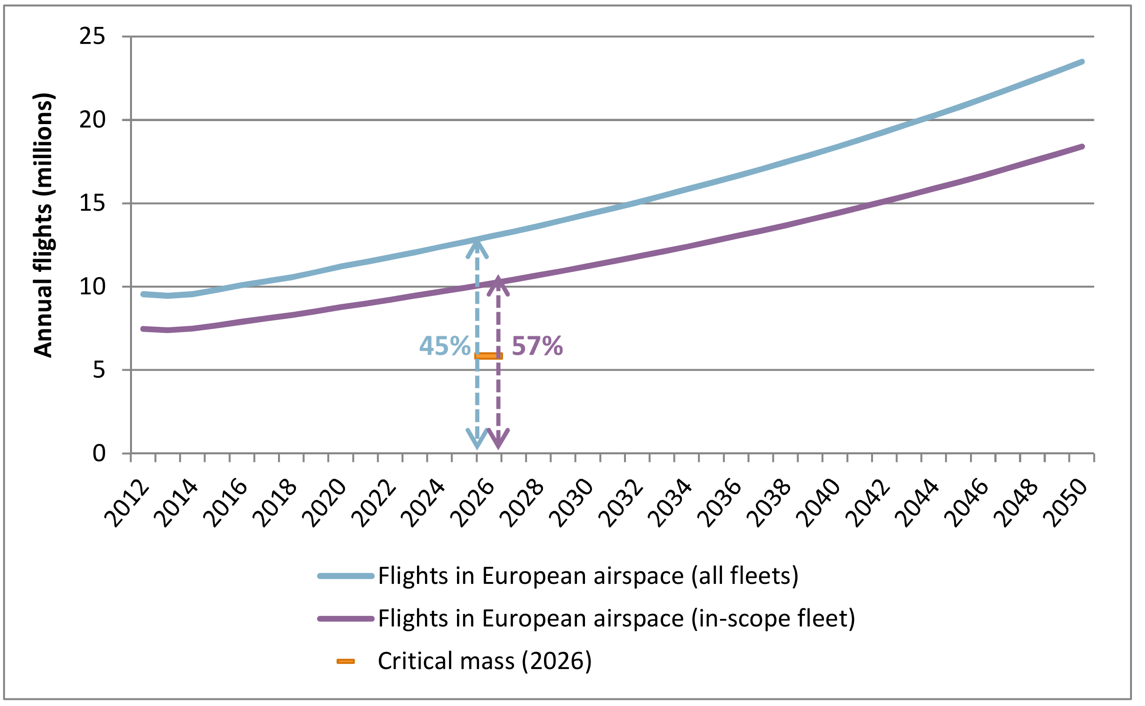
Figure 4.6: Fleet forecast 2012-2050



Source: Flightglobal fleet database (Eurocontrol region fleet), Airbus, Bombardier, Steer Davies Gleave analysis

4.80 The figure below shows the STATFOR flight forecasts for European airspace, as well as the flights made in this airspace by the in-scope fleet. Also shown is the volume of flights that is considered to represent critical mass for the purpose of adoption of AF6 technology (45% of all flights in European airspace according to the PCP, or in this example 57% of the in-scope Eurocontrol region fleet).

Figure 4.7: Flight forecast for European airspace 2012-2050



Source: STATFOR, Steer Davies Gleave analysis (Eurocontrol region fleet)

Business case parameters

4.81 As already noted, the NPV of AF6 of -€0.2 billion, as reported in the PCP proposal, has been calculated over only 16 years (assuming a calculation start date in 2014 and end date in 2030). In our view, an NPV derived for the purposes of a commercial business case should be based on the entire life of the assets deployed or modified as part of the project (that is the number of years where benefits can be received), which in this case depends on the life of the aircraft assets in question. Industry sources acknowledge that around 50% of aircraft can expect to be retired at 20 years, while the remaining 50% will continue in use and be gradually retired. We therefore consider that a longer time interval should be considered in the calculation of the NPV.

4.82 We also consider that a different discount rate from that assumed in the PCP proposal is required for the purposes of the business case analysis. As commercial entities, airspace users apply a weighted average cost of capital (WACC) in order to determine the case for investment. We have assumed a real 10% WACC and undertaken sensitivity tests using alternative values of 12% and 14%.

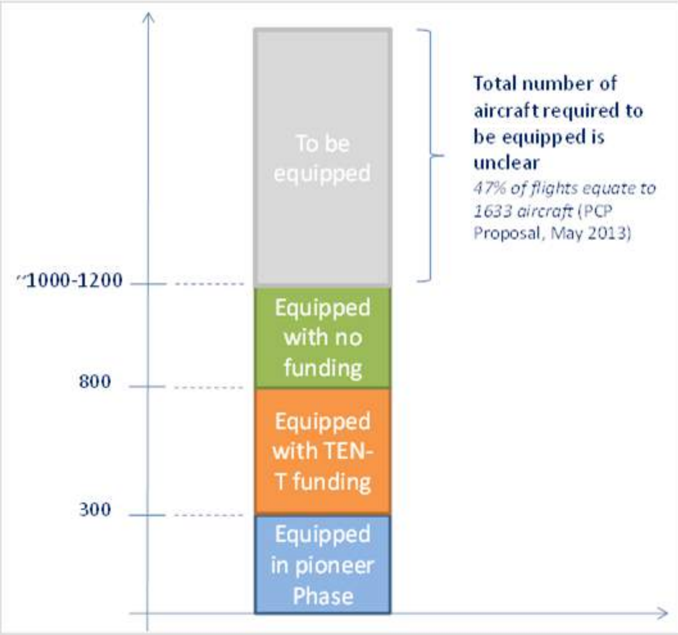
Cost of Initial Trajectory Information Sharing (AF6) technology

4.83 The PCP proposal provided cost estimates for aircraft to equip with AF6 technologies. The fitting costs are in the order of (excluding authorisation, certification or maintenance costs) €32,000 per aircraft for forward fitting of single aisle or long range aircraft and €50,000 per aircraft for retrofitting of single aisle or long range aircraft. We have not been able to confirm these costs with suppliers, manufacturers or airspace users, and would expect costs to vary by aircraft or airline type.

4.84 Moreover, it is not clear whether unit costs of installation will decline as more aircraft in a fleet are fitted with AF6. If this is the case then airspace users with large fleets flying in European airspace (such as low-cost carriers and large network airlines) would benefit more than those with smaller fleets (such as some smaller network airlines and charter operators). However, the size of the market for AF6 equipment is likely to be relatively small, suggesting that there is only limited scope for economies of scale or for strong competition on price from suppliers and manufacturers of the technology.

4.85 We have already noted that aircraft must be fitted with Data Link if they are to benefit from the deployment of AF6. The figure below shows the extent of Data Link installation across Europe and indicates that a substantial proportion of the European fleet is yet to be fitted.

Figure 4.8: Aircraft fitted with Data Link 2014



Source: Steer Davies Gleave analysis

4.86 According to the PCP cost-benefit analysis and airline stakeholders, costs would range between €150,000 and up to €500,000 for those aircraft that were not previously fitted with Data Link. This is mainly the case for older fleet, but also for airlines that have not made the investment or have been exempted (as in the case of airlines operating regional fleets). We have assumed that the incentive scheme would not cover the Data Link fitting costs of non-equipped airspace users. We have also assumed that it would be compulsory for regional airspace users to be fitted with Data Link by 2018.

Revenue neutrality principle

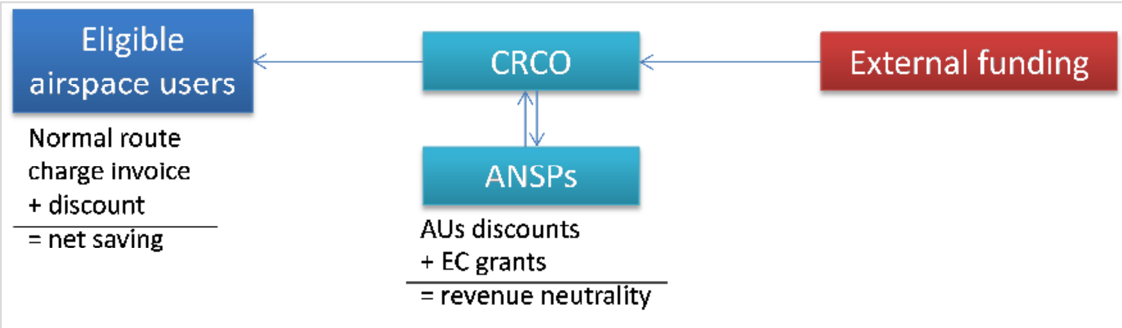
4.87 Article 16 of the Charging Regulation requires ANSP revenue neutrality by stating “the modulation of charges shall not result in any overall change in revenue for the air navigation service provider. Over- or under recoveries shall be passed on to the following period”. This means that any decrease or increase in ANSPs’ revenues arising due to a modulation of charges scheme must be compensated. Funding could come from different sources, including the EU (CEF and other sources) as well as national sources.

4.88 If external funding is not available then Article 16 requires that the modulation of charges scheme should be “self-sufficient”, meaning that if a discount is given to an airspace user, then other airspace users will need to pay higher charges in order to maintain the same level of overall revenue.

4.89 We discuss in more detail the funding sources available to SESAR in paragraph 4.134. For the purpose of analysis, we have considered two options, both complying with the requirements of Article 16.

4.90 Option A is therefore defined as a discount only scheme with direct funding to cover the associated operational shortfall, as shown in the figure below.

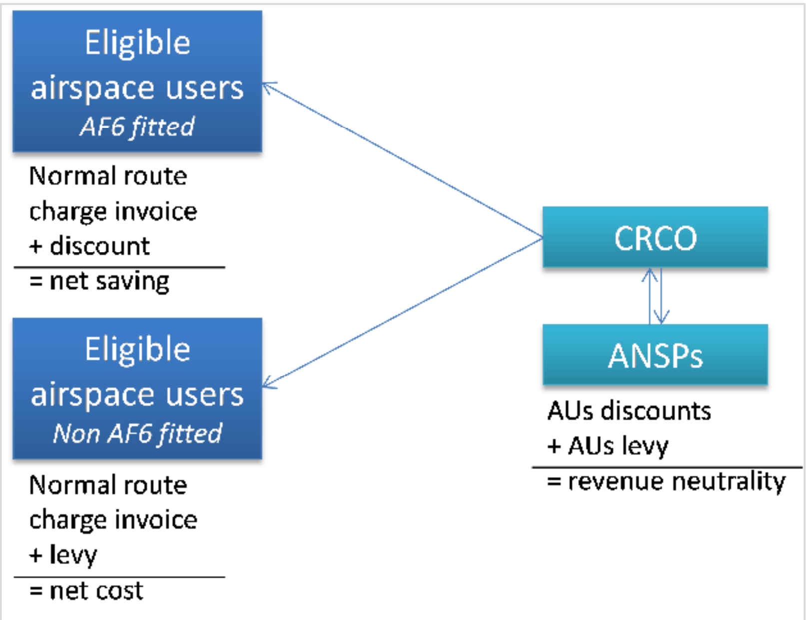
Figure 4.9: Illustration of option A



Source: Steer Davies Gleave

4.91 Option B is defined as a scheme in which reductions in charges would be balanced by a corresponding increase for flights by aircraft not equipped with AF6. We have sought, in particular, to determine the possible increase in charges for these flights given the reductions required elsewhere in order to deliver effective incentives. Option B is illustrated below.

Figure 4.10: Illustration of option B



Source: Steer Davies Gleave

Scheme operating period

4.92 The PCP proposal states that deployment of on-board equipment should reach critical mass by January 2026. However, it is not clear whether this date is based on an assumption that all aircraft will have been fitted with Data Link, as required by the Implementing Regulation, or according to an alternative timescale taking into account the difficulties of Data Link deployment reported above. In the scenario developed, we have examined the impact of on-board deployment reaching critical mass by 2026. Nevertheless, we suggest that there would be advantages in linking the start of a modulation of charges schemes with the start of a future Reference Period. We also consider that the lead time between airlines' (and lessors') aircraft orders and their delivery by manufacturers, as well as the time necessary for AF6 technology to be properly tested and certified, should be taken into account.

4.93 EU and ICAO legislation require that a modulation scheme should only be temporary. We have therefore assumed that it would be phased out after it had achieved its objectives. The period of scheme operation is determined by the time taken for enough aircraft to be fitted/retrofitted to reach critical mass and for early adopter airspace users to have achieved a positive or at least neutral NPV.

Eligibility of airspace users

4.94 The PCP proposal noted that in addition to EU Member States, airspace users registered in third-countries[49] within the ATM Master Plan Geographical Scope would be eligible for incentives. The PCP proposal target for equipage is defined in terms of a number of flights in European airspace, but the speed with which the target is met is partly determined by the identity of the airspace users operating eligible AF6 fitted flights. More specifically, as critical mass is defined in terms of flights, a wide geographic scope results in critical mass being achieved more quickly, since there are more flights in the European airspace. We have also tested the impact of variations in this assumption, as discussed further below.

4.95 In the case of airspace users not eligible for the scheme (regardless of whether they had fitted AF6 or not), there would be no impact on their European airspace charges, which would remain at the standard unit-rates set for RP2 and future periods. Eligible airspace users with fitted aircraft would receive discounted charges until their investment costs had been paid back, with charges returning to their previous levels subsequently. Eligible airspace users operating aircraft might or might not experience a change in the level of charges, depending on which of the options described above was adopted:

- Under Option A, their charges would remain at the standard unit-rates;
- Under Option B, their charges would need to be set at a higher rate than the standard unit-rate in order to compensate the discounts provided to equipped aircraft. After all fitted airspace users had been compensated, non-fitted airspace users' charges would return to the standard unit-rates.

4.96 Airspace users would need to benefit from discounted charges as soon as they made the required investment given the need to maintain cash-flows. Nevertheless, they would first be required to demonstrate that they had equipped their aircraft with AF6 on presentation of appropriate documentation.

4.97 In our view, the party eligible for a discount should be the operator of the aircraft rather than the owner, although it would be open to both parties to share the benefits if appropriate (for example where the owner incurred a proportion of the equipping costs).

Fitting of AF6 on-board aircraft

4.98 We understand that AF6 requires only a software upgrade, and that an aircraft can be equipped with the technology overnight during a standard maintenance operation. However,

[49] Azerbaijan, Albania, Armenia, Bosnia and Herzegovina, Georgia, Iceland, Macedonia, Moldova, Montenegro, Norway, San Marino, Serbia, Switzerland, Turkey, Ukraine.

if aircraft are not already fitted with Data Link, hardware must be installed and fitting may have to take place during a C check when the aircraft is grounded for several days.

4.99 We have assumed that it would take 3 years for the existing fleet at the start of the scheme to be retrofitted with AF6. The fact that AF6 only requires software updates should mean that it could happen more quickly, but we note that eligible airspace users would determine the appropriate time to retrofit their aircraft. In addition, we have assumed that the size of the fleet to be retrofitted is determined by the number of aircraft that would be 10 years old or less by the time the 3-year retrofit was completed (on the grounds that fitting older aircraft would not be considered commercially viable).

Key profiles

4.100 The Performance Plan includes objectives to improve the cost efficiency of ANSPs, which should lead to a reduction of airspace charges. We have assumed that cost reductions of 1.7% per annum would be achieved between 2011 and 2019.

4.101 Payments to airspace users in the form of discounts to ANS charges could be paid at different speeds, provided that adequate compensation for the costs of equipping aircraft was received before the end of the scheme operating period. The faster the payment of compensation of airspace users, the greater the modulation of charges would need to be. We have assumed that airspace users should be able to recover their investment over a one to two year period, which requires an overall discount on airspace charges of 6%.

Summary of assumptions

4.102 The assumptions underpinning the base case scenario are summarised in the table below. As already noted, we have tested the impact of variations in a number of these values and report the results later in this chapter. We also summarise the options for ensuring revenue neutrality in Table 4.8.

Table 4.7: Summary of base case assumptions

Item	Assumption
Retrofit costs of AF6	€50,020 (for short haul, long haul and regional aircraft)
Forward-fit costs of AF6	€32,600 (for short haul, long haul and regional aircraft)
Percentage of airspace users costs fitting compensated by the scheme	100%
Geographic coverage	Eurocontrol area[50]
Airspace Users WACC	10%
Scheme start date	2020, in order to have reached critical mass by 1st January 2026.
Scheme operating period	2020-2026
Average length of time during which aircraft can accrue benefits	20 years
Aircraft age after which AF6 retrofit would not be considered by the airspace users	10 years
Time taken to retrofit the existing eligible European fleet	3 years

[50] The PCP states that its scope is ECAC Member States. There is very little difference between the list of States members of ECAC, but not of Eurocontrol (Azerbaijan and Iceland). No States are members of Eurocontrol but not of ECAC.

Item	Assumption
Long-term ANS unit cost reduction	-1.7% CAGR (real terms). Based on average unit cost target reduction between 2011-2019
Profile of compensation (en-route charge discount)	6%
Average ANS charge per flight (2012)	€842/flight
Initial Trajectory Information Sharing (i4D) fuel efficiency per TI	0.02% (PCP proposal assumption)

Source: Steer Davies Gleave analysis

Table 4.8: Options for ensuring revenue neutrality

Option	Summary
A: discount only scheme	Eligible airspace users equipping their aircraft with AF6 receive a discount on ANS charges for flights operated with equipped aircraft. The associated reduction in ANSP revenues is compensated for with EU or national funding.
B: discount and levy scheme	Eligible airspace users equipping their aircraft with AF6 receive a discount on ANS charges for flights operated with equipped aircraft. The associated reduction in ANSP revenues is balanced by increased charges paid by airspace users operating non-equipped flights.

Source: Steer Davies Gleave analysis

Scheme payments

4.103 Under the assumptions set out above, we estimate that the value of the incentive payments made under the modulation of charges scheme would be as shown in the table below. Note that we have estimated the impact on this value if the deployment of AF6 were to be delayed.

Table 4.9: Summary of scheme payments

Assumption	NPV value in 2012 real terms (discounted to 2014)
ANSPs Deployment happens as required: Fuel and CO_2 benefits from 2026	72.9 million €
Delayed ANSP deployment plan for AF6: No fuel and CO_2 benefits until 2039	92.4 million €

Source: Steer Davies Gleave analysis

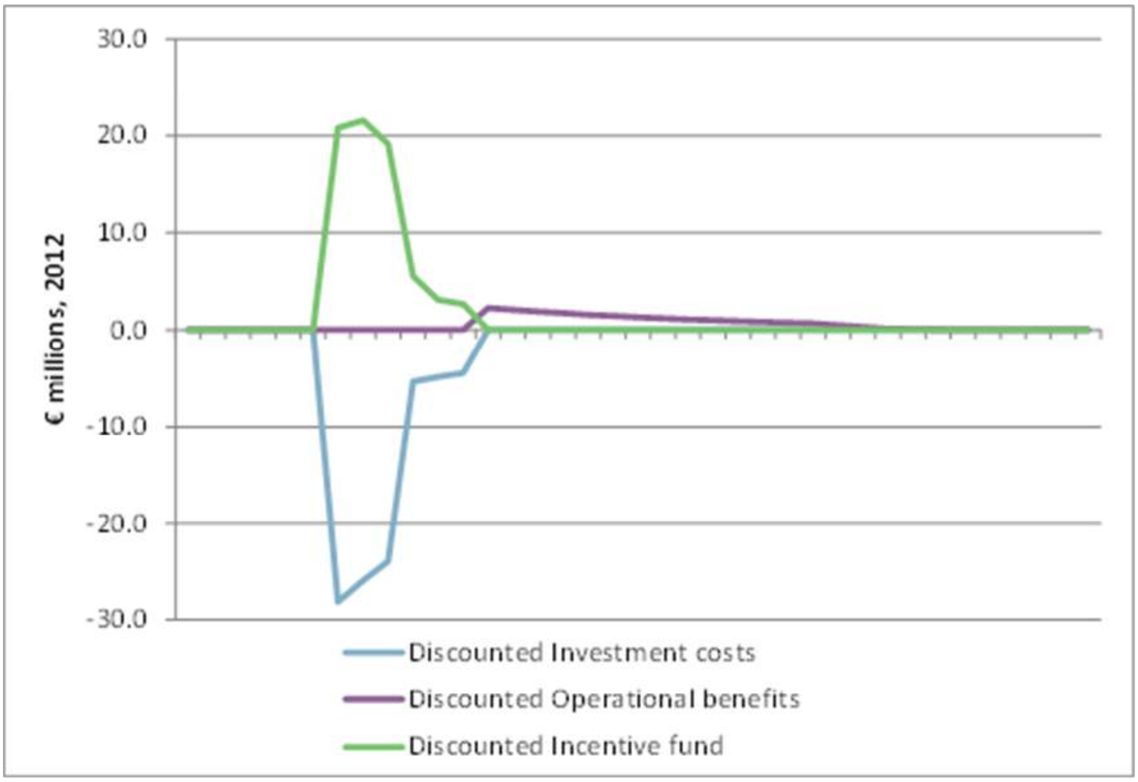
4.104 Figure 4.11 below shows the profile of the discounted total annual cash flows, from the airspace users' perspective, for the following:

- Costs of equipping aircraft (negative, blue line);
- Operational benefits (positive, purple line); and
- Incentive scheme (positive, green line).

4.105 The incentive scheme cash flows closely mirror the cost profile, as equipped aircraft become eligible for discounted ANS charges. The level of discount to the ANS charges is set at a level that allows equipped aircraft to 'recover' their investment costs over years 1 and 2, and there is therefore a slight lag between the cost and funding profiles. Once airspace users have recovered their equipping costs, they no longer receive an ANS charge discount.

4.106 The total area under the cost (blue) line is equal to the total area under the operational benefits (purple) line plus the area under the incentive fund (green) line. Over the first three years of the scheme, newly delivered aircraft being equipped and the existing fleet is being retrofitted, resulting in relatively high total annual costs. After the first three years only newly delivered aircraft need to be equipped and costs are consequently lower. Costs fall to zero once critical mass has been achieved and scheme ends.

Figure 4.11: Proposed modulation of charges scheme profile



Source: Steer Davies Gleave analysis

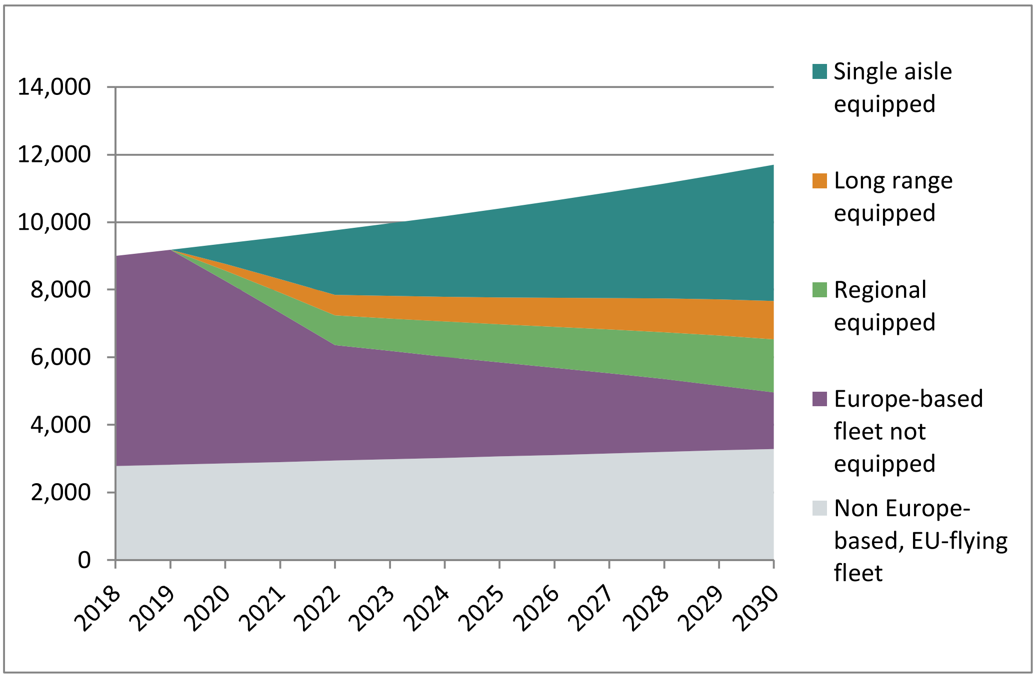
4.107 Operational benefits are only achieved from 2026 when Air Traffic Control Centres are fully equipped and the technology is operational. They continue to be realised throughout the appraisal period as the equipped aircraft continue flying. However, as the cash flows are discounted, the longer-term benefits tend towards zero the further into the future they are.

4.108 The largest aircraft category fitted with AF6 according to our model is short-haul aircraft. The average utilisation of these aircraft is some 8.5 hours per day[51], with the overwhelming majority of this time spent in European airspace. Long-haul aircraft are estimated to be utilised for nearly 14 hours in average each day and spend less time in European airspace, although they incur higher ANS charges (because charges are based on MTOW).

4.109 The figure below shows the profile of fitted and non-fitted fleets operating within European airspace.

[51] http://www.eurocontrol.int/sites/default/files/content/documents/official-documents/facts-and-figures/coda-reports/study-impact-global-economic-crisis-2011.pdf

Figure 4.12: Projected AF6 fitted fleet operating in Europe



Source: Steer Davies Gleave analysis

4.110 Under option A, the reduction in ANSP revenues is compensated for by external funding and there is therefore no impact on charges incurred by unequipped flights. Under Option B, the levy rate paid by airspace users operating non-fitted aircraft is shown in the table below. It reaches a maximum of 2.3% in 2023, three years after the start of the scheme.

Table 4.10: Option B: annual levy rate for airspace users not fitted with AF6

Year	2020	2021	2022	2023	2024	2025	2026
Levy	1.3%	1.8%	2.3%	0.8%	0.5%	0.6%	0%

Source: Steer Davies Gleave analysis

4.111 In early years, there is a large pool of airspace users operating non-fitted flights that can compensate the early adopters of AF6. After three years, the retrofitted fleet has been fitted, increasing the burden on non-fitted flights (particularly as the number of non-fitted users is reduced compared to 2020). However, by 2023 the first aircraft fitted have already been compensated, reducing the size of the required levy.

Impact of key assumptions

4.112 We have considered the impact of varying a number of key assumptions including those relating to regional scope, costs of equipping aircraft with AF6, the discount rate applied by airspace users and retrofitting assumptions. The level of discount applied to the en-route charges was kept fixed at -6% in all cases. This level was chosen in the base case as it allowed airspace users to be reimbursed within 1 to 2 years of equipping their aircraft. The levy applied to non-equipped airspace users is an output and varies across sensitivity scenarios depending on the total costs relative to the size of the non-equipped fleet in each year.

4.113 We have also assumed that CBA for AF6 is valid and accepted by all parties. It is important to note, however, that the correct measurement and forecast of AF6 operational benefits remains challenging.

Costs of equipping aircraft with AF6

4.114 It has been difficult to establish the costs of fitting AF6, and we have therefore tested the impact of varying the cost assumption. Holding all other assumptions constant, the only change relates to the overall value of the scheme, although the impact is substantial. We have tested two scenarios and obtained the results shown in the table below.

Table 4.11: AF6 cost sensitivity

Scenarios	AF 6 base case costs	AF6 Base case costs + €10,000	% difference with base case	AF6 Base case costs + €20,000	% difference with base case
ASNP deployment as per PCP proposal	€72.9 millions	€94.8 millions	+30%	€116.7 millions	+60%
Delayed ANSP deployment	€92.4 millions	€114.4 millions	+24%	€136.3 millions	+47%

Source: Steer Davies Gleave. NPV at 2012 euro value, discounted to 2014.

4.115 We conclude that obtaining an accurate estimate of AF6 costs will be key to an accurate assessment of the overall value of the scheme.

Airspace users WACC

4.116 We have estimated the impact of a WACC of 12% and 14%. Again, a variation of this assumption has a significant impact on the scheme value, as shown in the table below. We note that the sensitivity tests are based on relatively small changes in the WACC, highlighting the importance of establishing a robust estimate of airspace users' cost of capital.

Table 4.12: WACC sensitivity

Scenarios	WACC at 10% (Base case)	WACC at 12%	% difference with base case	WACC at 14%	% difference with base case
ASNP deployment as per PCP proposal	€72.9 millions	€66.6 millions	-12%	€60.4 millions	-23%
Delayed ANSP deployment	€92.4 millions	€80.9 millions	-8%	€71 millions	-17%

Source: Steer Davies Gleave analysis. NPV at 2012 euro value, discounted to 2014.

Time taken to retrofit the existing eligible fleet

4.117 We have assumed in our base case that it takes 3 years for the eligible fleet to be retrofitted with AF6. Under this assumption, an average of 759 aircraft a year are fitted during the scheme, including both forward fitting and retrofitting. If the assumed timescale for retrofitting the existing fleet is reduced, the number of aircraft that are fitted increases. We have assumed that only aircraft that are less than 10 years old would be retrofitted under the scheme. The longer it takes to retrofit the existing fleet, the fewer the existing aircraft that are under 10 years old; or conversely, the quicker the existing fleet is retrofitted, the more there is to equip. This means that, other things being equal, while it takes less time to reach critical mass the overall value of the scheme increases, as shown below.

Table 4.13: Time to retrofit sensitivity

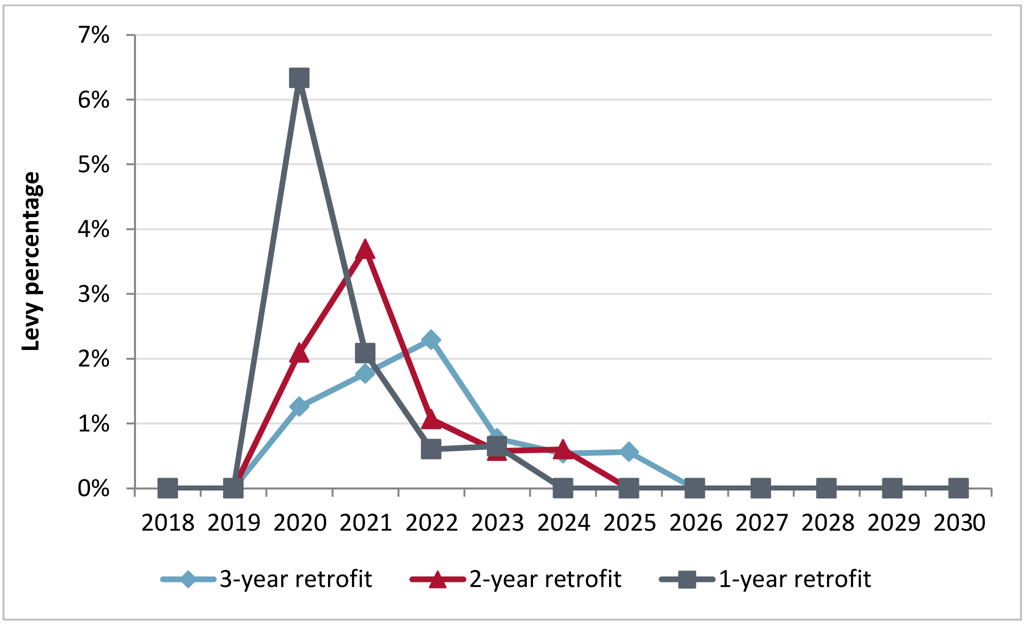
Scenarios	3 year retrofit (Base case)	2 years retrofit	% difference with base case	1 year retrofit	% difference with base case
Average number of aircraft equipped per year	759	892	+17%	1,095	+44%

Scenarios	3 year retrofit (Base case)	2 years retrofit	% difference with base case	1 year retrofit	% difference with base case
Length of the scheme required to reach critical mass	6 years	5 years	-	4 years	-
Period that the scheme would be running	Start of 2020 End of 2025	Start of 2020 End of 2025	-	Start of 2020 End of 2025	-
ASNP deployment as per PCP proposal	€72.9 millions	€80.0 millions	+10%	€87.8 millions	+20%
Delayed ANSP deployment	€92.4 millions	€98.9 millions	+7%	€106.0 millions	+15%

Source: Steer Davies Gleave analysis. NPV at 2012 euro value, discounted to 2014.

4.118 In addition, the greater the size of the fitted fleet receiving the discount at any one time (i.e. that has not yet recovered its costs), the smaller the size of the non-equipped fleet over which costs must be spread under option B. Further, we assume that equipped flights return to the standard tariff once costs have been recovered, so the greater the size of the fitted fleet concurrently receiving the discount at any one time, the greater the ANSP revenue 'gap' that a levy on non-equipped aircraft has to cover. Hence, the implied levy on non-equipped flights under option B increases sharply from 2.3% at its peak in the base case to 6.3% in the worst case scenario, as shown in the figure.

Figure 4.13: Impact of retrofit time sensitivity on option B levy



Source: Steer Davies Gleave analysis

Geographical scope

4.119 We have considered the impact that different geographical scope of eligibility may have on the scheme. Varying the list of Member States in which airlines are based affects mainly the time taken to reach critical mass. The fewer eligible aircraft there are, the more time it takes to reach 45% of all flights in European airspace.

4.120 Under the assumption that only EU and EFTA ((Iceland, Liechtenstein, Norway and Switzerland) based fleets are eligible for the scheme, reaching 45% of all flights in European airspace equates to 65% of the in-scope EU and EEA fleet. Rather than six years, it takes seven years to reach critical mass. It remains possible to achieve this by 1st January 2026, but only under the assumption that the scheme starts in 2019, one year earlier than in the base case. The impact on the overall value of the scheme does not diverge from the base case significantly however.

Table 4.14: Geographical scope sensitivity

Scenarios	Eurocontrol (Base case)	EU and EFTA	EU 28
Critical mass (45% of all flights in EU airspace)	57% of in-scope flights	65% of in-scope flights	70% of in-scope flights
Average number of aircraft equipped per year	759	611	427
Length of the scheme required to reach critical mass	6 years	7 years	12 years
Period that the scheme would be running	Start of 2020 End of 2025	Start of 2019 End of 2015	Start of 2018 End of 2029
ASNP deployment as per PCP proposal	€72.9 million	€73.9 million	€72.1 million
Delayed ANSP deployment	€92.4 million	€91.9 million	€92.7 million

Source: Steer Davies Gleave analysis

4.121 In the third scenario (EU28 only), it takes slightly longer to reach critical mass (70% of the in-scope fleet) and, with less aircraft available, the scheme must operate over 12 years. In this scenario, it is not possible to reach critical mass for the PCP assumption, even with a start of 2018.

A further refinement – capturing ANSP productivity gains

4.122 As shown in Table 4.6, the main scheme described above is based on the rationale that airspace users must be incentivised to invest in AF6 given the relatively low level of direct benefits that they might expect to receive (due to lower fuel and emissions costs). Moreover, as already noted, while in time they could be expected to benefit from lower air navigation charges as a result of ANSP productivity gains from the deployment of AF6, the benefit is uncertain and cannot be relied upon to provide the necessary incentives for investment. We have therefore considered whether it would be possible to capture ANSP productivity gains in the form of discounted air navigation charges, thereby passing on the associated benefits directly to airspace users. This is illustrated in the table below, which is based on the estimates of the costs and benefits of AF6 set out in the May 2013 PCP proposal.

Table 4.15: Costs and benefits of AF6 by stakeholder category in alternative scenario

Stakeholder	Benefits (NPV) € billion	Costs (NPV) € billion	Result (NPV) € billion
Airspace users	Fuel cost savings = 0.01 CO_2 credit savings = 0.01 ANS productivity gains = 0.20	- 0.2	0.02
ANSPs	0	- 0.2	-0.2
Network Manager	0	- 0.01	-0.01
Total	**0.2**	**- 0.4**	**-0.2**

Source: Steer Davies Gleave analysis of PCP proposal May 2013. Costs and benefits discounted over 2014 – 2030.

4.123 The main differences between this refinement and the scheme previously discussed are as follows:

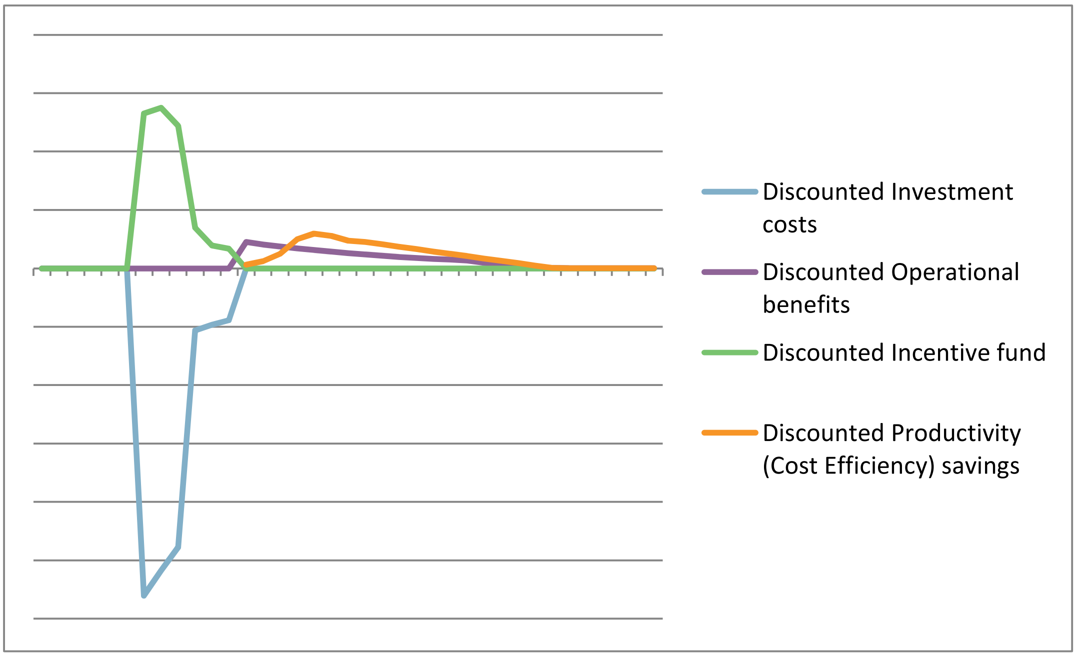
- Airspace users equipping aircraft with AF6 would receive discounts calibrated against the total value of productivity gains for ANSPs rather than against the costs of the on-board investment.
- ANSPs, unable to rely on cost savings for remuneration of investment on the ground, would require additional grant funding through CEF or some other mechanism (notwithstanding the requirement for ANSPs to deploy AF6 by the required deadlines in accordance with Regulation (EU) 716/2014.

4.124 In principle, depending on the level of productivity gains achievable and the associated reduction in air navigation charges, this approach could therefore provide a more powerful incentive for airspace users to invest. However, a number of issues would need to be addressed if this variation were to have the desired outcome.

4.125 In particular, the uncertainty over the level and timing of productivity gains would make it difficult to determine the level of discounts in advance of AF6 deployment. We have already noted that the benefits of the technology might be limited before the equipping of the fleet had reached critical mass. In addition, some stakeholders consider that ATCO workload might actually increase during the transition phase when significant numbers of both equipped and non-equipped aircraft are operating because of the need to employ different types of communication technology.

4.126 In addition, as shown in the figure below, there is a significant difference in the timing of the profile of investment costs and that for the delivery of productivity gains. This means that there would need to be a bridging mechanism whereby support for on-board investment could be secured against an expected 'revenue' stream in the form of future discounts on air navigation charges (possibly paid directly to a provider of loan finance). As already noted, in our view airspace users are unlikely to make the necessary investment unless they can be confident of full remuneration in the short term. We also question whether it would possible secure financing of the kind described, as discussed further below in the context of a wider consideration of SESAR funding.

Figure 4.14: Alternative modulation of charges scheme illustrative profile



Source: Steer Davies Gleave analysis. Note: for illustration purposes only

4.127 This approach would also place much greater reliance on grant funding for ANSPs, since the cost savings previously available to remunerate investment would all be passed on to airspace users. The CEF Regulation, discussed in paragraph 4.146, provides for co-funding rates of up to 50% for ANSPs and the remainder of the investment would therefore need to be funded through additional grant mechanisms or possibly through the regulated capital expenditure programme of the Performance Scheme.

Scheme administration

Administrative responsibility

4.128 Implementation of the main scheme would involve a number of one-off and ongoing administrative activities. These would include the following:

- **Modification of the billing system:** changes would be needed in order to enable discounts and possibly levies to be applied. At present, CRCO is responsible for invoicing and collecting en-route charges on behalf of Eurocontrol's Member States, and for transmitting revenues to the States after receiving payments from airspace users. Changes to the system would need to be specified, tested and implemented as well as subject to consultation at appropriate points in the implementation programme.
- **Collection of information on aircraft certification:** airspace users would need to demonstrate that individual aircraft had been equipped by providing the necessary certification documents. This information would then need to be incorporated into a database to enable the system to calculate adjustments to charges.
- **Reconciliation of revenues:** the impact of the scheme on ANSP revenues would need to be determined in order to ensure revenue neutrality. In the case of option B, any shortfall or over recovery following an initial calibration of discounts and levies would need to be addressed through a wash-up process. The process would be simpler under option A as the shortfall in revenue arising from the application of discounts would be matched by external funding, but these funding arrangements would nevertheless require some administration.

- **Stakeholder liaison and consultation:** throughout the development and implementation of the scheme, it would be necessary to consult with airspace users, ANSPs and Member States. There would also be a need for ongoing liaison and consultation throughout the period of scheme operation in order to ensure that it was meeting its objectives and that any issues raised by stakeholders were considered and addressed.

4.129 These activities would need to be undertaken as efficiently as possible and subject to appropriate levels of transparency in order to build confidence in the scheme. It would also need to be subject to internal monitoring and external scrutiny, with provision for independent audit of scheme operation and payments. We suggest that a single organisation be primarily responsible for the administration of the scheme, including management of the one-off activities enabling implementation. This will ensure greater accountability for the efficiency of the administrative process, in particular by preventing one organisation from blaming another for administrative failures. In principle, the following entities could undertake the administration role:

- Eurocontrol's CRCO;
- The European Commission (in the form of a dedicated department);
- The Deployment Manager; or
- An external contractor.

4.130 We have undertaken a qualitative assessment of these options against a number of criteria, and have concluded that the CRCO is best placed to undertake the administrative role for a number of reasons:

- **Technical capability:** CRCO has a thorough understanding of the current charging system and would therefore be well placed to manage any changes required in support of the modulation of charges scheme. In addition, CRCO already manages a database of aircraft (registered by tail number), which includes a detailed list of the various avionics and air navigation devices installed on-board. The other entities would need to assimilate this information and would anyway require CRCO's assistance given its primary role in the administration of the current charging system.
- **Implementation of control procedures:** we consider that the internal and external control procedures would be similar regardless of the identity of the administrator, although we note that there may be synergies with any existing arrangements for auditing current payments (with which CRCO would be familiar).
- **Transparency:** CRCO is highly experienced in operating the charging system and is well placed to ensure an appropriate level of transparency. We note, however, that transparency requirements should be determined independently, possibly by the Commission in consultation with stakeholders.
- **Cost efficiency:** by definition, a modulation of charges incentive scheme would build on the existing charging arrangements and the scheme administrator would require access to, or at least be able to interface with, the systems operated by CRCO. If it were to be administered by an entity other than CRCO, there would be a high risk of duplication of both operating activities and investment in software and other infrastructure. We note, however, that the administration could be subject to competitive tender if it were to be undertaken by an independent contractor (although Eurocontrol would be in a position to tender particular activities if this was considered likely to deliver cost savings).
- **Management across the relevant geographical area:** CRCO already manages a charging framework extending beyond the EU28 and has established relationships with ANSPs and

other stakeholders in a number of non-EU countries. It is possible that jurisdictional issues might arise if administration were undertaken by the European Commission.

Administrative procedures

4.131 We consider that Eurocontrol's current system is capable of accommodating the introduction of an additional dimension to the calculation of charges (based on whether aircraft are fitted or not fitted with AF6). The Central Flow Management Unit (CFMU) already provides CRCO with the route description filed by the aircraft operator for a given aircraft, based on the last filed flight plan, and charges are levied only for flights actually performed. In addition, flight plan data submitted to Eurocontrol include aircraft registration details (as detailed in Eurocontrol Specification for the Initial Flight Plan), and it would therefore be possible to match an aircraft in a flight plan with a corresponding set of registration details (including whether or not the aircraft had been fitted with AF6).

4.132 CRCO also processes flight messages automatically and checks them against the CRCO data bank to identify any discrepancies. Rejected messages are handled within the CRCO or, if necessary, returned to the originator for verification. Messages passing these checks are then ready to be used in the route charges calculation. We envisage that these processes would continue to operate as now, with automatic checking similarly supporting the calculation of discounts and levies. We also see no reason to modify billing, revenue collection and revenue disbursement arrangements, with invoices based on planned distance flown issued to airspace users on a monthly basis.

4.133 We note that following the deployment of AF6, it will be possible to obtain regular and precise records of when and where the technology has been used. Hence, in principle, this information could be used to provide an independent check of invoices. However, the costs of such an exercise are unclear, and it might not be appropriate to use the additional information other than for a periodic audit of payments, although this would need to be kept under review once the scheme was in operation.

Financing for SESAR

EU funding

Allocation of Connecting Europe Facility and other funding

4.134 The largest source of financing available for SESAR is the Connecting Europe Facility (CEF). The Regulation introducing CEF (Regulation (EU) 1316/2013) was adopted by the Council of the European Union and European Parliament in late 2013. It sets out the rules for awarding EU financial support to the transport, energy and telecommunications sectors during the 2014-2020 financing period. Under CEF, €33.2 billion of funds will be made available over this period, with €26.2 billion earmarked for transport projects of the Trans European Network as well as Horizontal Priorities including SESAR. Of the €26.2 billion, €14.9 billion will be made available to all EU Member States and €11.3 billion will be transferred from the Cohesion Fund to be allocated exclusively to projects in Member States eligible for this support.

4.135 Recital 55 of the Regulation earmarks €3 billion for SESAR but this allocation is not binding allocation, rather an estimate that may differ from the actual outturn funding level. In January 2014, the Commission published a Communication[52] on 'Building the Transport Core Network:

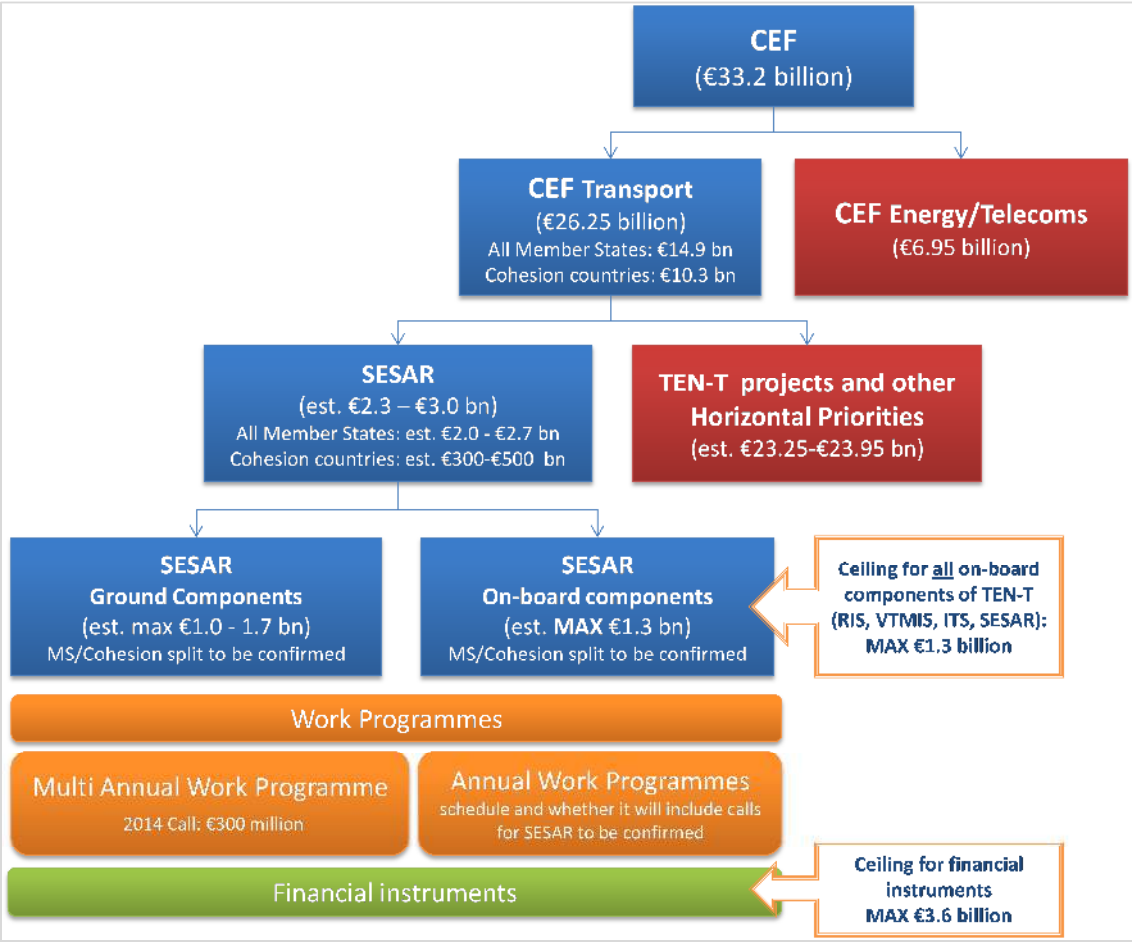
[52] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013DC0940&from=EN

Core Network Corridors and Connecting Europe Facility', which included an indicative figure of €2.3 - €3 billion for SESAR. It is also estimated that approximately €300-€500 million will be made available for SESAR from the Cohesion Fund.

4.136 Article 10 of the Regulation also states that there is a combined ceiling for on-board components of SESAR, River Intelligent Systems (RIS), VTMIS and ITS of up to 5% of the total CEF transport budget (€26.25 billion), which means that the total EU funding of the on-board components of these technologies cannot exceed €1.3 billion.

4.137 The figure below summarises the allocation of CEF funding for transport and shows the breakdown of funds allocated to SESAR.

Figure 4.15: SESAR funding under CEF



Source: Steer Davies Gleave analysis

4.138 States that are not members of the European Union but with whom the EU may cooperate to achieve the objectives of CEF are not permitted to apply for funding under the Regulation except "where it is indispensable to the achievement of the objectives of a given project of common interest" (Regulation (EU) 1316/2013, Article 8.3) .

Summary of funding mechanisms

4.139 CEF will be provided through three mechanisms as follows:

- Grants, which are paid to both the public and private sector, managed through a call for proposals for Work Programme projects and monitored closely by the European Commission;
- Procurement of studies, a minor element of the CEF remit in financial terms, covering the procurement of assistance from the PRB and other entities (we do not discuss this mechanism further here as it is not available to airspace users or ANSPs); and
- Financial instruments, which target the private sector and are designed to be flexible while minimising the associated administrative burden.

4.140 The funds available under CEF are all subject to a 'use it or lose it' principle. If no adequate proposals are received, then no funds are allocated during that call for proposals, and there may or may not be another call for proposals in subsequent years up to 2020. In addition, if the funds allocated to a project are not used according to the rules and requirements of the call for proposals, then the funds will not be provided to the project promoter.

4.141 We consider each type of funding mechanism in more detail in the following paragraphs.

Grants

4.142 CEF funding distributed in the form of grants is administered through two different work programmes:

- The **Multi-Annual Work Programme (MAP)** is the main component of CEF, receiving approximately 80%-85% of the €14.9 billion funding available, allocated on a multi-annual basis, over a period covering up to seven years, via a work programme and dedicated calls for proposals. The projects eligible are those identified in the Annex to the CEF Regulation. Providing co-financing for up to seven years (2014-2020) is intended to help ensure the financial security and stability of strategic infrastructure projects with a number of years to completion. Calls for the Multi-Annual Work Programme, which targets longer term projects, are expected to take place in 2014 and 2015.
- The **Annual Work Programme (AWP)** provides funding for projects of European common interest not included in the MAP. The remaining 15% to 20% of the €14.9 billion transport budget will be allocated via annual work programmes and on the basis of specific calls for projects. These will target projects with a more limited time-span that are not among those pre-identified in the Annex to the CEF regulation.

4.143 The same allocation of funds between multi-annual (80%-85%) and annual work programmes (15%-20%) applies also to the €11.3 billion allocated from the Cohesion Fund.

4.144 Following a public call process, proposals are selected and evaluated according to a number of pre-defined criteria such as project maturity, socioeconomic and environmental effects, soundness of the financial package and EU added value. The evaluation process takes place in two steps: an assessment by independent technical experts, who establish a shortlist of proposals recommended for funding, followed by the selection of proposals by DG MOVE from the technical experts' shortlist. These two steps are followed by consultation with the other Directorate Generals and the Financial Assistance Committee (FAC) of the European Commission, following which the European Parliament may invoke its right of scrutiny.

4.145 The Innovation and Networks Agency (INEA) is responsible for managing all EU-supported projects established under CEF. It issues the call publications and organises the external evaluation by independent experts. INEA is also responsible for monitoring and follow-up of the selected projects. In the case of MAP projects, pre-financing is initially provided as a type of seed funding, and the remaining payments are dependent on the adequate completion of project milestones against targets that were submitted at the time of the funding decision.

4.146 Article 10(2)(c) of the CEF Regulation sets out the co-funding rates which will apply for SESAR projects under CEF, and these are shown in the table below. It indicates that:

- For on-board components of SESAR, the co-funding rate is up to 20%. The only exception to this ceiling is for funds allocated from the Cohesion Fund where the rate of co-funding can be raised to 85%.
- For land components of SESAR, the co-funding rate for grants allocated under CEF is up to 50%. Again, the only exception to this ceiling is for funds allocated from the Cohesion Fund where the rate of co-funding can be raised to 85%.

Table 4.16: Co-funding rates

Type of project	Member States	Co-funding rate	Conditions
On-board components of SESAR	All	20%	There is a combined ceiling of €1.3 billion (5% of the total CEF transport budget) for on-board components of the SESAR system, of RIS, of VTMIS and of ITS for the road sector.[53]
	Member States eligible for Cohesion Fund	85%	There is a combined ceiling of €1.3 billion (5% of the total CEF transport budget) for on-board components of the SESAR system, of RIS, of VTMIS and of ITS for the road sector.[54] This funding rate will only be available if an amount for SESAR is placed in the Cohesion envelope.
Land components of SESAR	All	50%	
	Member States eligible for Cohesion Fund	85%	This funding rate will only be available if an amount for SESAR is placed in the Cohesion envelope.

Source: Steer Davies Gleave analysis

4.147 The stakeholders for land components include ANSPs, the Military, MET Service Providers and the Network Manager.

4.148 The programme for the calls for proposals and the amount of funds available during each Multi-Annual and Annual Work Programme call are determined by the CEF Unit of DG MOVE, in consultation with other relevant units within the Directorate. The first call for CEF was published in September 2014 and offers funding for SESAR via the Multi-Annual Work Programme only. The maximum available funding for SESAR in the MAP 2014 is €300 million. No funds from the Cohesion Fund have been earmarked for SESAR projects in this call.

4.149 It is unclear at the time of submission of this report what plans exist for any new call for proposals for SESAR under the Multi-annual Work Programme. We expect that if such a call

[53] Article 10(2)(c)(iv) of Regulation (EU) No 1316/2013 of the European Parliament and of the Council of 11 December 2013 establishing the Connecting Europe Facility.
[54] Article 10(2)(c)(iv) of Regulation (EU) No 1316/2013 of the European Parliament and of the Council of 11 December 2013 establishing the Connecting Europe Facility.

were to be made, it would be in 2015 or 2016 but not beyond, for the reasons stated in paragraph 4.142. This suggests that the remaining grants for SESAR would need to be obtained through the Annual Work Programme Call, which is more suitable for investments over a relatively short period of time.

4.150 In practice, it is uncertain whether airspace users will be able to take advantage of the available grant funding for several reasons:

- The co-funding rate for airspace users has been set at 20%, with users expected to bear the cost of the remaining 80% of the investment. This is low in comparison to the 50% co-funding rate for ANSPs, who are largely able to recover investments through user fees. We believe that the amount of funding on offer to airspace users may not be high enough to encourage them to make applications.
- Co-funding rates apply per project. While there can be a multi-beneficiary grant agreement covering a project equipping several fleets (and lasting several years), this would require significant coordination between the airlines coming together for the grant application. The 20% co-funding rate would be applied at the level of the whole project allowing in theory, inside the project, to modulate the financial intervention by aircraft. It is unclear however, if modulation between airlines (such as one airline receiving 30% of the funding and another 10% of the funding for instance) is allowed.
- Applying for CEF funding requires considerable administrative work, especially with regard to investments of the order of €50,000 per aircraft. There are strict deadlines and compliance procedures in place, making the process complex and expensive. A mid-term evaluation of the TEN-T Programme (2007-2013) in 2011 found that, at the time, proposals received during calls of a value under €1 million had not been selected because of the administrative costs borne by the TEN-T Executive Agency in managing them. A way around this issue would be for airline associations to act as the intermediary for the funding of their member airlines. This would result in higher grants awarded and could provide some economies of scale of administrative costs.
- Although some pre-financing is available to successful applicants, the majority of CEF funding is recovered upon receipt of the purchase of the equipment, which can take time, impacting the cash-flow of airspace users fitted with the technology.
- The rules of CEF are very strict. There is limited scope for flexibility in the number of aircraft that will be fitted. This is a difficult requirement for the commercial air transport industry since fleet sizes vary frequently, and may further discourage airspace users from applying.

4.151 As already noted, Eurocontrol was put in charge of administering the TEN-T funding for Data Link because it was recognised that the TEN-T requirements were too onerous for airspace users. One stakeholder nevertheless considered that Eurocontrol underestimated the level of resources required to enable liaison with TEN-T EA required as well as management of the project, and that this contributed to delays in implementation. We consider that many airspace users may be discouraged from making applications in the light of this experience.

Financial instruments

4.152 CEF provisions for financial instruments are based on the rationale that "in many cases sub-optimal investment situations and market imperfections may be more efficiently tackled by financial instruments than by grants[55]". The overall contribution to financial instruments is

[55] Recital 43 of the CEF Regulation

limited to €3.3 billion or 10% of the total CEF budget. Financial instruments from the Cohesion Fund will also be available but only from 2017.

4.153 CEF provides for two types of instrument:

- Debt instruments such as loans and guarantees facilitated by risk-sharing instruments, including credit enhancement mechanisms and project bonds; and
- Equity instruments.

4.154 Financial instruments are managed by the European Investment Bank (EIB) and are based on ex ante assessments of market imperfections or sub-optimal investment situations and investment needs, undertaken by DG MOVE. The selection of activities to be supported by financial instruments is based on consideration of the following factors:

- Representation of European added value;
- Response to the objectives of the Europe 2020 Strategy; and
- Presentation of a leverage effect with regard to EU support, aiming to mobilise a global investment exceeding the size of the EU contribution according to indicators defined in advance.

4.155 Financial Instruments may also be combined with other EU grants and financial assistance from Member States and other investors.

4.156 The CEF Unit of DG MOVE has commented that financial instruments appear to be particularly adapted to the funding requirements and investment periods of the on-board components of SESAR, through its Debt Instruments and in particular the “risk-sharing instrument for loans and guarantees”. However, following discussions with the EIB, we understand that the use of current financial instruments is subject to a number of constraints and that they are not necessarily well suited to investment in support of SESAR:

- Financial instruments are designed for projects with identifiable revenue streams or commercial benefits long-term repayment profiles. The size of the revenue stream and the timing must be specified when the financing instrument is secured. This would be particularly difficult for airspace users as the revenue (or saving) stream is very dependent on the deployment of the ground technology, although the introduction of an incentive scheme would help to provide greater confidence in expected financial benefits.
- Financial instruments are also geared towards projects requiring large capital investment. Investments of €10 million were considered by the EIB to be “very small by EIB standards”. Its Investment Loans cover one or more defined investment projects and are all subject to full appraisal before the loan is approved. The normal EIB lending threshold is €25 million.
- Small investment can nonetheless benefit from “accelerated procedures” or Global Loans that are not subject to the same administrative process, but they must still demonstrate an adequate rate of return.

4.157 Against these constraints, it has been suggested by the EIB that funding and financing for SESAR may need to be accessed through a Framework Loan via the Deployment Manager or FABs as financial instruments are not an appropriate source of funding for individual airspace users. Framework Loans are “a way of delivering EIB finance managed by an intermediary, usually a financial institution, with the checks prior to loan approval focusing on the capabilities of the intermediary. Framework Loans cover multiple sub-projects, often in multiple sectors. The capabilities of the EIB’s main counterpart, on whom it relies to manage the allocation of funds to suitable subprojects, are very important. The loan contract establishes a framework under which subsequent allocation of funds to specific sub-projects, followed by disbursement of those funds, can be made[56]".

4.158 Framework loans could be an attractive alternative in the context of AF6, if the Deployment Manager and/or FABs can establish or can become legal entities, able to meet the requirements of the EIB. We discuss in greater detail in Chapter 5 the key issues regarding sovereignty within FABs and, based on this assessment, we do not believe that FABs would be able to be the counterparty to the EIB. We are not clear whether Deployment Manager will be a legal entity, but note that its status may change over time, for example when a new common project is adopted. Article 9 of the Implementing Regulation (409/2013) requires the Deployment Manager to identify the most appropriate financing mechanisms combining public and private funding.

4.159 In discussions, the EIB stated it would be particularly willing to work with the Commission to develop a specific application of financial instruments tailored to the circumstances of SESAR.

4.160 CEF has clearly set aside EU funding to aid with the deployment of SESAR and the amount of funds available in principle for airspace users is a step in the right direction. However, we consider that the efforts that have been made to secure such funds will not translate into funding to support and incentivise early on-board equipage of AF6.

- The current financial instruments focus on either debt or equity. Whilst equity instruments are clearly not the right mechanism for airspace users in the context of AF6, debt instruments all require a definable revenue stream. Earlier analysis has demonstrated that AF6 delivers only limited savings to airspace users (and only when both the ground and on-board are both deployed). Financial instruments lower the cost of finance by enhancing the credit rating of senior debt and help broaden the choice of lenders, but users must still expect associated costs –albeit lower than in the absence of these instruments. We do not consider that airspace users would regard financial instruments and their associated costs as being suitable for supporting investment in AF6, particularly if they are anyway reluctant to invest in the technology.
- The current rules of CEF are too constraining for airspace users in the context of AF6. The rules have been drafted with very large international infrastructure projects, raising particularly complex environmental and economic issues, in mind. The costs of AF6 are small relative to the costs of making applications, and the strict rules are likely to act as a further disincentive to make applications. In addition, co-funding rates resulting in airspace users expected to pay for 80% of the investments against long-term and very limited savings means that CEF grants in their current form will not be seen as an appropriate source of finance.

4.161 However, we note that the EIB has expressed an interest in developing tailored financial instruments to meet the needs of SESAR, and this should be further pursued through meetings and discussions to be arranged between the Commission, the EIB and the Deployment Manager.

Other financing sources

4.162 There has been a recent announcement of the intention to make €315 billion in public and private investments in Europe over the next three years, targeting transport among other

[56] Ex post evaluation of the use of Framework Loans to finance EIB investments in the EU (2000-2011)

sectors. The details of the European Fund for Strategic Investment (EFSI) plan need to be confirmed, but we understand that the EFSI will seek to leverage small amounts of public money to attract large amounts of private capital. This could take the form of guarantees.

4.163 A press report[57] indicates that “EU budget funds would come from several sources, including CEF and Horizon 2020, the EU’s €80bn research and development programme. EU budget reserves would also fill out any remaining needs”. However, this stimulus plan is likely to impose funding conditions similar to those applied to financial instruments, and may therefore be a similarly unattractive source of funding for airspace users.

Stakeholders’ views

4.164 We consulted stakeholders in order to seek their views on the concept of modulation of charges as a means of incentivising deployment of SESAR technology and to obtain data and information. We have not consulted on our findings in relation to the modulation of charges scheme, although we have shared emerging issues with stakeholder representative bodies. In our discussions, a number of key themes emerged as follows:

- All those consulted agreed on the importance of learning from the experience of Data Link, in particular the need for coordination of investment in ground-based and on-board equipment. A scheme focused on-board equipping with AF6 technology would be unlikely to succeed if there were no guarantees that the necessary ground-based investment was made by defined deadlines.
- In the light of the Data Link experience, it might be necessary to ensure that the necessary ground-based investment was undertaken first. Otherwise airspace users might need to be compensated, for example if they invested in on-board equipment while ANSPs failed to deliver complementary ground-based equipment. However, it was also noted that investment requirements could not yet be determined, since they were partly dependent on the deployment of Data Link.
- While there was strong resistance to a discount and levy scheme in some quarters, it was recognised that a discount only scheme would involve funding ANSPs for any resulting shortfall in revenues. Some stakeholders stressed the importance of ensuring that such funding was only used in support of SESAR and not diverted to ensure that efficiency targets were met.
- There was a case for considering both direct funding and modulation of charges as a means of incentivising investment in on-board equipment. Modulation of charges might be more appropriate where there is a lag between investment being made and benefits accruing to airspace users. Grant funding might be prefereable where investment was necessary to deliver overall industry benefits and the benefits for airspace users themselves were expected to be limited. Any scheme should be designed as part of an overall strategy involving discounts on charges, funding and regulation.
- The CRCO would be best placed to manage a modultation of charges scheme. Such a scheme could simplify the administration of direct funding of on-board investment through CEF/INEA. Billing systems would, however, need to be modified to take account of equipping of aircraft with SESAR technology.
- There might be some increased workload for ANSPs during any transition involving a mix of equipped and unequipped flights, for example because of the need to communicate with aircraft using either new or established technology. The transition would also complicate

[57] http://www.ft.com/cms/s/0/aa5afbec-73cc-11e4-92bc-00144feabdc0.html#ixzz3KAR6vEb8

revenue management, since ANSPs would need to forecast the number of equipped and non-equipped flights.

Conclusions and recommendations

Evaluation of options

4.165 Given stakeholder concerns and the administrative implications, we consider that the choice between a discount only and a discount and levy scheme is particularly important, and we have therefore subjected these options to a qualitative evaluation against the objectives set out in Chapter 1. The results are summarised in the table below and reflected in our conclusions and recommendations.

Table 4.17: Evaluation of options for ensuring revenue neutrality

	Option	
	A	B
Summary of option	Eligible airspace users equipping their aircraft with AF6 receive a discount on ANS charges for flights operated with equipped aircraft. The associated reduction in ANSP revenues is compensated for with EU or national funding.	Eligible airspace users equipping their aircraft with AF6 receive a discount on ANS charges for flights operated with equipped aircraft. The associated reduction in ANSP revenues is balanced by increased charges paid by airspace users operating non-equipped flights.
Economic efficiency	Will be economically efficient if the costs of providing incentives do not exceed the overall (industry) benefits of AF6. The levy/discount should also reflect the additional savings/costs of ATCO interventions in the presence/absence of AF6 technology.	Will be economically efficient if the costs of providing incentives do not exceed the overall (industry) benefits of AF6. The levy paid by non-equipped flights should also reflect the additional costs of ATCO interventions in the absence of AF6 technology.
Intelligibility	Relatively simple to understand providing the basis of the discount is clear and calculations are made transparent.	Potentially complex given the need to calibrate discount and levy rates and introduce a wash up mechanism to ensure revenue neutrality.
Revenue/cost neutrality	Can be preserved providing there is access to appropriate funding.	Can be preserved in principle but leads to complex administration.
Minimal administration costs	Relatively simple to administer using information and systems already available to CRCO. An additional process for confirming certification of equipped aircraft would be required.	Potentially complex to administer in view of the need to apply discounts and levies and reconcile payments through a wash up process. Would be supported by information and systems already available to CRCO. An additional process for confirming certification of equipped aircraft would be required.
Credibility	Potentially credible providing measures were taken to ensure that ground equipment was installed by defined dates and compensation was made available to airspace users in the event of delay. Extensive stakeholder engagement would be required however.	Would not be regarded as credible by either airspace users or ANSPs in view of the complexities and the fact that discounts for equipped flights would be recovered through additional payments for non-equipped flights.

Source: Steer Davies Gleave analysis

Conclusions and recommendations

4.166 In the course of this workstream, we have developed a scheme for incentivising the adoption of AF6 technology based on modulation of ANS charges. In our view, such a scheme is workable in principle, but we note that there is considerable scepticism among stakeholders, particularly in the light of their experience of deployment of Data Link. It is important that the lessons of Data Link are acknowledged and that they are seen to inform the development of any incentive scheme.

Recommendation C1:

We recommend the preparation of a statement of principles to underpin the design of a modulation of charges scheme, explicitly drawing on the lessons of Data Link. The principles could be based on those identified in paragraph 4.74 above, but these should be subject to consultation as part of the programme for developing the scheme.

4.167 Based on our review of the PCP proposal, we suggest that AF6 is the most appropriate functionality for the purposes of incentivisation. While the NPV for the scheme reported in the PCP proposal is negative, this may reflect the time horizon chosen for the discounted cash flow analysis. In addition, we note that AF6 is regarded as an important precursor to the subsequent deployment of other SESAR technologies. Nevertheless, it is important that the benefits of AF6 are reviewed and confirmed prior to the development of any incentive scheme.

Recommendation C2:

We recommend that AF6 is subject to an independent review, commissioned as appropriate, in order to validate the associated costs and benefits.

4.168 In principle, deployment of AF6 could be made mandatory through the introduction of new legislation, as in the case of Data Link. However, given stakeholder concerns about the benefits of the technology, any policy requiring airspace users to incur costs without adequate compensation is likely to be strongly resisted. We also note that an incentive scheme, if properly calibrated, can deliver a more economically efficient outcome (with airspace users determining whether or not to invest on the basis of an assessment of costs and benefits). At the same time, we consider that to be effective in the current climate, an incentive scheme must enable airspace users to recover the full costs of investment through discounts on ANS charges, at least until the equipping of aircraft has reached critical mass.

Recommendation C3:

We recommend that through the incentive scheme airspace users should not receive any more in incentive payments than is necessary to ensure that they equip their aircraft with the required technology. In effect, the incentive scheme should "close the gap" in the airspace user's business case, turning a negative NPV into a zero or slightly positive one (after taking account of any direct benefits such as savings in fuel costs); For example, charges could be modulated until air space users start to receive benefits.. Regulation 761/2014 of June 2014 introduces a legally binding requirement for ANSPs and the Network Manager to enable Initial Trajectory Information Sharing within a defined timescale. In our view, legislative provisions only are unlikely to ensure sufficient confidence among airspace users that ground-based equipment will be installed. It would therefore be necessary to consider supplementary measures, in particular compensation for airspace users incurring equipping costs in the event that ground-based investment is delayed or not made at all.

We also recommend that appropriate compensation is considered to airspace users in the event that they are unable to derive material benefits from equipping of aircraft due a failure on the part of ANSPs to undertake sufficient investment on the ground.

4.169 We have noted that there airspace users would strongly resist the introduction of any scheme involving both discounts and levies, whereby the costs of the scheme are effectively covered by users operating non-equipped aircraft. We anyway consider such a scheme to be more administratively complex given the need to calibrate separate values for the discount and the levy and the difficulty of forecasting the number of equipped and unequipped flights. We therefore consider that a workable scheme would need to be a discount only scheme, financed through funding from other sources.

Recommendation C4

We recommend that any scheme for incentivising the adoption of SESAR technology should be a discount only scheme. As noted below, in our view this means that the Commission will need to investigate different sources of funding. However, discounts need not be constrained by the level of funding obtained to support investment in SESAR technology. Under Regulation (EU) 391/2013, any subsidies obtained by ANSPs must be passed on to airspace users in the form of reduced charges, and any reductions could be structured to provide an additional incentive to equip aircraft with SESAR technology.

4.170 As stated above, we consider that a workable scheme would need to ensure that airspace users recovered 100% of any investment made within a relatively short timescale. However, based on our review of the rules and procedures governing CEF, it appears unlikely that it represents a realistic source funding, not least because of the maximum funding rate of 20%. We therefore suggest that the Commission should investigate other funding sources. We also suggest that current financial instruments are not appropriate sources of finance for on-board investment in AF6.

Recommendation C5

We recommend the Commission investigates other funding sources. The willingness of the EIB to work with the Commission to develop financial instruments tailored to the needs of SESAR is welcome, and we suggest that this option is pursued in the first instance, as well as meetings with involving the Deployment Manager.

5 Common charging zones

Introduction

5.1 Under our Terms of Reference, we are required to investigate the implications of a move towards common charging zones. More specifically, we are asked to examine the key practical issues and plans for implementing common charging zones, taking into account the differences between existing zones within established Functional Airspace Blocks (FABs). Our examination must include the development of at least two scenarios for temporary revenue redistribution systems within a common charging zone, and an assessment of the feasibility of the system under the existing charging system as well as the impact of common charging zones on other performance areas, in particular flight efficiency.

5.2 This chapter includes the following:

- A summary of previous studies and stakeholders' opinions of the key issues to address;
- An examination of the issues associated with revenue redistribution mechanisms and the potential benefits of common charging zones in reducing flight route extensions;
- A summary of the key issues raised by the analysis and of proposals for addressing them; and
- Our conclusions and recommendations.

Background

Definition of a common charging zone

5.3 Article 2 of Regulation (EU) 391/2013 (the Charging Regulation) defines an en-route charging zone as "a volume of airspace for which a single cost base and a single unit rate are established". Article 5 of the Regulation further states that "an en-route charging zone shall extend from the ground up to, and including, upper airspace". The same article permits Member States to establish a specific zone for a complex terminal area, although any modification to a charging zone must be subject to consultation with airspace users' representatives.

5.4 Across the European Union (EU), currently, most States operate one charging zone for their en-route services territory (Spain and Portugal operate two). This leads to a range of unit rates associated with routings that cross European airspace. There is currently a large variation between charging zone unit rates, ranging from €28.4 in Ireland (€9.65 in Portugal's Santa Maria charging zone, which operates over oceanic airspace only) to €96.7 in Switzerland (September 2013 adjusted unit rates). These differences have sometimes provided an incentive for airlines to change route to optimise Air Navigation Service (ANS) costs (if the savings more than outweigh the additional fuel costs incurred), leading to an extension of flight distance and an adverse effect on measures of flight efficiency and the environment.

5.5 When the Single European Sky (SES) was created in 1999, the principles driving the establishment of common charging zones were operational rather than financial. Common charging zones were intended to encourage the removal of barriers that prevented the efficient reorganisation of airspace. The concept did not include features such as the reduction of route extension or incentivising cost-efficiency. Nevertheless, the 1999 Communication creating the SES[58] noted that the organisation of air traffic infrastructure in Europe "suffers from fragmentation caused by national frontiers".

Legislative underpinning

5.6 Preamble 15 and Article 15(2) of the Charging Regulation set out the approach to developing a common charging zone in a FAB. Preamble (15) states that:

"Member States should be able to set their unit rates collectively, in particular when charging zones extend across the airspace of more than one Member State or when they are parties to a joint route charges system."

5.7 Article 15 (2) further provides that:

"*Unit rates shall be set in national currency. Where Member States which form part of a functional airspace block decide to establish a common charging zone with a single unit rate, that unit rate shall be set in euros or in the national currency of one of the Member States concerned. The Member States concerned shall notify the Commission and Eurocontrol of the applicable currency.*"

Potential benefits of common charging zones

5.8 One of the potential benefits of greater co-operation and consolidation among European ANSPs is a movement to common charging zones, providing neutrality with respect to different routes across airspace. In principle, this may be built around the co-operation of a FAB, or potentially a wider co-operation agreement. In either case, movement towards common en-route charging zones could be expected to result in a number of benefits for different stakeholders. In the case of airspace users, these include:

- Increased potential for Free Route Airspace (currently flights may take a suboptimal route, driven by requirements to use particular entry and exit points on national boundaries);
- Potential avoidance of the incentive towards route extension (which may have arisen previously due to the application of airline flight efficiency software);
- A simpler system, with fewer charging zones in Europe; and
- Facilitation of greater modulation of charges (within a common charging zone), for example simplifying the introduction of congestion charging as discussed in Chapter 2.

[58] COM(1999) 614, The creation of the Single European Sky

5.9 ANSPs would also benefit in terms of:

- Efficiency improvements in relation to improved staff allocation at a multi-national rather than national level; and
- Improved coordination and planning of use of segregated areas (e.g. military zones).

5.10 FABs, while they are not an essential pre-condition for the formation of charging zones, nevertheless provide a framework for establishing them and securing these benefits.

Previous studies of common charging zones

5.11 There are lessons to be drawn from discussions that have already taken place at FAB level, particularly within FABEC, BlueMed and FAB CE, where the implications of common charging zones have been considered in some detail and a number of key issues identified. Previous studies for Eurocontrol and the European Commission (the Commission) have similarly considered common charging zones, particularly during the period 2004-2006 when the SES legislation was being drafted. While some of these findings are dated, they provide insight into the issues and challenges that will need to be addressed to move towards a practical implementation of common charging zones in European airspace. We have grouped the issues identified from review of the literature by major theme.

Revenue distribution effects

5.12 The creation of a single FAB charging zone can be expected to have a positive impact on operations as re-routing of major traffic flows will be easier to implement within a FAB, regardless of charging constraints[59]. The ultimate goal of having a single charging zone for each FAB is supported by the Eurocontrol enlarged Committee for Route Charges. However, the difficulties of reaching this goal have been acknowledged[60].

5.13 In their May 2005 report on the Commission's mandate to support the establishment of FABs[61], Eurocontrol noted that in cases where further design of airspace according to operational criteria results in a projected loss of traffic within one of the original charging zones, the economic consequences of introducing route network changes could be an inhibiting factor. More specifically, if a cost recovery scheme was not in place, this could result in a projected loss of revenue for the ANSP/State whilst the costs associated with providing the service remained the same.

5.14 A number of studies mentioned the importance of defining the principles for revenue sharing in a clear and equitable manner in FABs where several operators provide ANS. They generally conclude that the method of redistribution of revenue should be as neutral as possible with respect to operations, and should not be designed to safeguard revenue or market shares and as a result put pressure on the structure of service. Three revenue sharing option parameters are considered in the literature that we have reviewed[62]:

- Operational sharing parameters (number of controllers, etc.);
- Financial sharing parameters (percentage of the total cost-base attributable to a service provider applied to the generated revenue); and

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[59] Final Report on EC's mandate to support the establishment of FABs, Eurocontrol, 2005
[60] Development of Implementing Rules on a Common Charging Scheme for Air Navigation Services, Eurocontrol, 2004
[61] Final Report on EC's mandate to support the establishment of FABs, Eurocontrol, 2005
[62] Final Report on EC's mandate to support the establishment of FABs, Eurocontrol, 2005

- Activity sharing parameters (i.e. kilometres controlled or number of service units[63] generated in each subset of the FAB airspace).

5.15 The risks associated with revenue sharing are that the option considered might not create a sufficiently challenging environment for the service providers, such that improvements in the SES KPAs would not be encouraged, or that it might create financial uncertainties having adverse consequences for the service provider. FABEC considered that, under an ideal common charging zone scenario, there should be mutual oversight of costs under a single FAB unit rate, which would lead to joint management[64].

Impact on ANSPs

5.16 A scenario involving common unit rates considered, but later set aside, by FABEC required the pooling of costs to establish a single unit rate across a FAB, with protection of ANSP revenues noted as a key requirement. In 2008, FABEC recommended that it should constitute a single charging zone with a single unit rate. The cost bases of the six Member States within the FAB would be pooled to establish a single cost base for the charging zone. The unit rate for the zone would then be obtained by dividing the total cost base by the total service units calculated for it. FABEC considered that this would ensure that the revenue earned by each ANSP was independent of the traffic that it attracted to its airspace. It was seen as essential that there was no competition for traffic between ANSPs, and that traffic should be encouraged to route itself in ways that minimised total costs to FAB stakeholders[65].

5.17 In January 2010, FABEC noted their preferred model for a single unit rate[66]:

- One charging zone across the FAB with a single unit rate;
- Harmonization on incentive schemes and exemptions (principles);
- Decisions at FABEC level and national implementation as needed;
- Revenue sharing (allocation) between States/ANSPs (and common cost management); and
- The application of revenue sharing based on costs, avoiding the need for money streams between the States.

5.18 At the time, FABEC listed three central requirements for successful cooperation between Member States:

- Shared responsibility between States and ANSPs for a common cost base;
- Common measures for cost-efficiency; and
- Common cost management across ANSPs (preferably via a common business plan).

5.19 However, as noted in the following section reporting the results of stakeholder interviews, the FABEC view has changed, as sovereign countries found it difficult to accept the proposals to uncouple the costs and collection of charges and introduce the concept of income pooling and redistribution.

5.20 Significant differences in unit rates between members are a key issue for Blue Med FAB, as highlighted in discussions with them in the course of this study. Blue Med FAB's analysis

[63] A service unit represent the product of the distance factor and the weight factor of the aircraft concerned
[64] Creating the FABEC Feasibility Study Report, FABEC, version 2, 2008
[65] Creating the FABEC Feasibility Study Report, FABEC, version 2, 2008
[66] 2nd Financial Round Table. FABEC and Charging – The States View, FABEC, 2010

shows that users, as well as ANSPs, might be affected by, respectively, higher en-route charges and less "attractive" areas of operation if a single unit rate were established[67].

5.21 In 2005, Eurocontrol considered that Belgium and Luxembourg could be representative of a simple form of FAB operation (involving a single cost base and unit rate, and other conditions such as exemptions and revenue sharing). MUAC was also highlighted as having its own cost base but with no separate direct charging scheme - MUAC costs are distributed between the four participating States using an operational sharing parameter (number of controllers manning sectors). These redistributed costs are added to each national cost-base and recovered through route charges that are levied for each national charging area[68].

Impact on airspace users

5.22 The literature suggests that airspace users are likely to be affected in the event that common charging zones are established across FABs. FABEC expect the introduction of a single unit rate, as an average of national rates, to have some redistributive effect on users[69], and that some users will benefit through lower charges while others will lose out as a result of higher charges.

5.23 The potential for airspace users to adjust routes in order to avoid areas with high unit rates is also noted in the academic literature. In a 2008 study on ANS charges in Europe, Castelli notes that there is evidence that the high variability of en-route unit rates among different countries has resulted in airlines possibly preferring to fly longer routes (thus spending more in terms of fuel, maintenance and crew costs) that are cheaper in terms of en-route charges to minimize their predictable route costs[70]. The author adds that limited variations in en-route charges often have a disproportionate impact on low-cost carriers because these organisations have a highly optimized level of operating costs.

5.24 Some analysis on the impact of a single unit rate on airlines has been considered, with the main analysis undertaken focusing on a scenario where a cross-border upper airspace charging zone is established. Castelli's study of 2005 investigated the impact on airlines of such a development, and noted that a single unit rate for upper airspace would result in the regional carriers losing and extra-European airlines gaining. A single unit rate for all airspace resulted in extra- European airlines being worse off and regional carriers being better off.

Other issues

5.25 The creation of an aggregate charging zone would probably result in a change to the total number of service units across the FAB. The service units calculated for the aggregate charging zone would not be equal to the sum of the units for the individual national charging zones; the aggregate calculation would result in a lower figure, as the service units calculated are based on the great circle distance between entry and exit points to and from the charging zone. FABEC's analysis shows that that the service units with a single FAB charging zone would be around 1.5% lower than the sum of those for the national charging zones (using CRCO data), and that the unit rate for aggregated charging zone would need to be around 1.5% higher than the arithmetical average of the individual national unit rates, although the net

[67] Blue MED Feasibility Study Final Report, Blue Med, 2008
[68] Final Report on EC's mandate to support the establishment of FABs, Eurocontrol, 2005
[69] 2nd Financial Round Table. FABEC and Charging – The States View, FABEC, 2010
[70] ANS Charges in Europe, Lorenzo Castelli, Andrea Ranieri, 2008

position for all users would remain the same[71]. Castelli's 2005 study also noted this issue, stating that the difference tends to be lower than 3% on average [72].

5.26 One study noted the importance of timing, as the introduction of a single charging zone should not result in significant complications in other, operational areas. FABEC stated that a single charging zone should be introduced before operational improvements in "hot spots" (involving cross border sectorisation) were implemented. Failure to do this would necessitate complex revenue-sharing arrangements to ensure ANSPs had no incentive to compete for traffic.

5.27 Taxation, in particular value added tax (VAT), and exemption rule differences must also be considered. Different national tax regimes apply VAT using different rules. While most flights in most jurisdictions are zero-rated for VAT purposes, there are certain exceptions. For example, non-commercial flights by German operators are liable for VAT on their en-route charges for the portion of their flight that is subject to German VAT regulations. The same is true for Switzerland. FABEC note that convergence on VAT policy is unlikely to arise based on air navigation service industry considerations[73].

5.28 To mitigate against this potential issue, CRCO advised that they could provide information on the proportion of service units, and hence of charges, in the aggregate FAB charging zone that arose from a flight through a particular country's airspace. Furthermore, they would be able to collect VAT, as necessary, for any separate billing zones for which a separate VAT rate was chargeable. States are required to fund all exemptions, and exempted flights are occasionally at the discretion of States. CRCO also expressed their willingness to take into account particular national exemptions within an aggregate charging zone.

5.29 To address these potential issues, FABEC proposed the following guidelines[74]:

- For charging purposes, FABs should remain relatively stable for a reasonable period of time (e.g. for at least one year), although they may constitute non-static operational entities by nature, with a life-cycle of their own; and
- Uniform (charges) conditions of application should prevail within a FAB, in particular concerning exemptions and the VAT regime.

5.30 The legal/institutional aspects of cross border issues faced by all FABs also need to be addressed.

Stakeholder issues

5.31 During the course of the study, we have consulted with two main stakeholder groups on their direct experience of considering the issues raised by the creation of common charging zones:

- FABs, represented by FAB European Central (FABEC), Blue Med and FAB Central Europe (FABCE), and their constituent ANSPs: these organisations have investigated the possibility of common charging zones within the relevant FAB and identified key issues and challenges which could not be easily resolved. DFS provided particular insights based on experience of working within FABEC. CANSO also provided some more general comments on behalf of ANSPs.

[71] Creating the FABEC Feasibility Study Report, FABEC, version 2, 2008
[72] Route-charging policies for a central European cross-border upper airspace, Lorenzo Castelli, Philippe Debels, Walter Ukovich, 2005
[73] Creating the FABEC Feasibility Study Report, FABEC, version 2, 2008
[74] Final Report on EC's mandate to support the establishment of FABs, Eurocontrol, 2005

- The Commission and Eurocontrol: both have commissioned or undertaken previous studies into the practical implementation of common charging zones.

5.32 We also contacted the Danube and Denmark-Sweden FABs but they did not provide any comments.

FABEC

5.33 The Performance and Finance Committee of FABEC has considered the case for developing a common charging zone, with the objective of facilitating and enabling airspace redesign and providing more efficient flight plans to unblock "hot spots". The airspace redesign analysis showed that all scenarios resulted in a shift of traffic across charging zones. As a consequence, simulation showed that some Member States (Belgium in this case) would be likely to lose a significant proportion of their traffic (estimated at up to 15%). In FABEC's opinion, from a national perspective the prospect of reduced demand for services was not acceptable as there were concerns that it would make it difficult for the ANSP to meet SES performance targets and, in the extreme, put the financial viability of the organisation at risk.

5.34 Short term solutions have been developed (i.e. redistribution of revenues) but FABEC stated that the real requirement is for a long term financial framework. In discussion, sovereign countries found it difficult to accept the proposals for uncoupling of costs and collection of charges and introducing income redistribution. FABEC stated that the revenue redistribution would not be a simple task, as participating private companies could not simply pass revenue earned to another due to tax and accounting legislation. In addition, national laws in countries such as Germany prevent revenue earned by charging for a service provided in the Member State from being passed to other organisations. Hence, when an approach to introduce a common charging zone for FABEC was proposed to the Performance and Finance Committee the FAB was unwilling to proceed as there were concerns about States losing control of charge collection powers as well as legal impediments to introducing the changes.

5.35 In relation to the service unit redistribution impacts of airspace change, potential transitional arrangements were discussed as it was recognised that it takes time to redesign and reduce sectors and reduce operating costs. Transitional arrangements would fund the gap initially, but gradually the funding would be reduced in order to incentivise the ANSPs to make the operational and staffing changes necessary for meeting the reduced service units accommodated and charges collected. The proposal included a requirement for an independent auditor to oversee the efforts to reduce capacity in line with the demand reduction following any traffic shift.

5.36 The impact on airspace users was also considered, with a movement to a common charging zone implying higher payments for Air France, but relatively lower payments for Lufthansa (as the FABEC common unit rate would be lower than Germany's and higher than France's). FABEC argued that the operational benefits of shorter routes resulting from a common charging zone would be a multiple of the changes in charges paid by airlines. However, airlines do not appear to have accepted this argument, emphasising the certainty of cost increments but uncertainty over the operational benefits of airspace redesign.

5.37 In any event, FABEC was itself sceptical about the benefits of a common charging zone in terms of flight efficiency. The FAB's RP1 report indicated that only 1.8% of flights were longer than they needed to be and only a proportion of these were inefficient as a result of the impact of differential charging on airline flight planning decisions. It had no clear quantitative evidence of this impact, and stated that it would welcome any quantitative assessment that a study might provide.

5.38 FABEC did consider that a common charging zone might encourage greater co-operation across the FAB in terms of cost management and investment. However, it was generally recognised that these benefits derived from the integration needed to enable common charging rather than from common charging itself. FABEC continues to work on a solution that will be acceptable to Member States and ANSPs and benefit airspace users through airspace redesign. The long term aim is to move to full integration through a four stage process:

- Open book (sharing of data, investigating differences and addressing issues of comparability);
- Common goals (e.g. in relation to operational efficiency and management change);
- Limited accountability; and finally
- Full accountability (effectively a merger of the participating organisations).

5.39 FABEC believes that the fourth stage could not be achieved in less than seven to eight years, even if it were simply a question of focusing on commercial, operational and management integration (i.e. setting aside the political issues).

DFS

5.40 DFS described its experience of working within FABEC to create a workable common charging zone. It identified 11 key issues that it considered would need to be addressed to provide a practical solution:

- **Institutional framework:** different organisational structures around public-sector or corporate bodies can have an impact on the cost base and hence on the movement towards a common cost base. Member States are not prepared to cede any sovereignty.
- **Tax issues:** as already noted, there is often a different treatment of VAT and corporate taxes within different national organisations.
- **Service units:** a change in the entry and exits points leads to roughly 1.5% fewer service units for the same traffic compared with national charging zones.
- **Complexity of airspace:** airspace complexity influences the costs required to support a particular service unit, with units in upper airspace and over the high seas relatively easier to support than those in lower airspace, particularly in busy areas.
- **Exempted flights:** different Member States have different approaches to exempted flights; a common approach would need to be agreed.
- **En-route vs terminal:** common charging can only apply to en-route services as the conditions in which airports operate vary too much to enable a common approach to terminal ANS charges.
- **Redistribution effects on airspace users:** a common charge will lead to winners and losers and will be strongly resisted by airspace users.
- **Airspace bottlenecks:** elimination of airspace bottlenecks may lead to higher costs while neighbouring Member States receive benefits.
- **Incentives (bonuses and penalties):** the approach to managing these incentives needs to be clarified within the FAB.
- **Use of IFRS:** different approaches to IFRS are taken in different Member States and there could therefore be a conflict between a FAB and State-based cost calculation.
- **Inflation rates:** each country has a different inflation rates and the merits of applying a uniform versus a country inflation rate need to be considered.

DSNA

5.41 DSNA provided a written submission drawing attention to the following issues:

- **Revenue distribution:** Member States would have to agree on a method to distribute revenues, which could be done based on actual traffic or actual costs as follows:
  - Under a traffic-based approach, the issue of calculating service units by Member State becomes an issue if only overall FAB service units are measured; and
  - Under a cost-based approach, the differences between Member States should be accounted for when determining the cost base.
- **Institutional differences:** member ANSPs have different institutional frameworks and legal statuses, with the following affecting both the cost base and target setting:
  - accounting rules (e.g. individual cost accounting methods and flexibilities in approach to IFRS implementation);
  - pension schemes;
  - inflation rates;
  - currencies; and
  - tax treatment (VAT and corporate tax).
- **Traffic:** as noted by DFS, country borders would no longer be used as entry/exit points as the latter would be located on the borders of the FAB. This might affect the means by which service units were determined for each Member State and would lead to a reduction in overall service units and a redistribution of traffic across the charging zone.
- **Exempt flights:** Member States do not share a common definition of flights that are exempted from air navigation charges. In France the costs incurred by DSNA for exempted flights are covered by a civil aviation tax. This may differ from the way it is dealt with in other countries.
- **Impact on national airspace users:** the political impact on a national level must be taken into account when setting a common unit rate for FABEC (as it would result in winners and losers among all airspace users, including national airspace users).
- **Incentives:** how the new system of bonuses and penalties that has been set up for RP2 would be dealt with in a common charging zone, and responsibilities assigned, should be considered.
- **National Supervisory Authority role:** the role of the National Supervisory Authority (NSA) regarding performance targets at FAB level would need to be clearly defined, as would the division of effort across ANSPs.
- **Other factors:** the unit cost of provision of ANS depends significantly on the airspace design and its complexity, as well as on the productivity of the Air Traffic Controllers (ATCOs). In addition, the principle of a common unit rate for FABEC should be limited to route charges. A comparison between aerodromes of different countries would be difficult, as even within a country there can be significant differences.

FAB CE

5.42 The Performance and Charging Group of FAB CE has also been considering the case for introducing a single unit rate, under a common charging zone. The main issues that have arisen during the discussions have been:

- How changes in unit rate affect traffic flows and interact with optimising route networks in the context of Free Route Airspace; and

- How changes interact with the traffic risk sharing arrangements of the SES Performance Scheme.

5.43 As there is a wide range of current charging zone unit rates within FAB CE (ranging between circa €40 to circa €70 per service unit), moving to a common charging zone would lead to winners and losers for airspace users. FAB CE has analysed the potential impact on flag carriers and found that it would, in principle, be relatively small (noting that Hungary has no flag carrier following Malev's bankruptcy).

5.44 However, in the group's opinion a far greater risk is the potential for traffic across the consolidated single charging zone to remain within the +/-2% dead band of 100% ANSP traffic risk sharing in the Performance Scheme (due to the portfolio effect across a wider range of airspace). For example, if the traffic of two ANSPs were 4% lower than expected, but two experienced traffic 2% higher, then overall under the single charging zone they would be financially worse off than if they applied the traffic risk sharing arrangements at a national charging zone level. However, it should be noted that as the Performance Scheme is symmetric this effect runs both ways.

5.45 The traffic risk sharing arrangements of Article 13 of the Charging Regulation require that additional or lost revenue of the ANSPs (in respect of determined costs) due to the difference in traffic between the actual and forecast service units are shared between ANSPs and airspace users. This mechanism has the following features:

- Service unit difference less than 2%: ANSPs bear all of the risk and receive all of the rewards. This 2% neutral zone means small variations in traffic or forecasting errors do not result in changes in the unit rate.
- Service unit difference less than 10% but higher than 2%: ANSPs bear 30% of the revenue difference, airspace users bearing 70% for RP1.
- Service unit difference greater than 10%: airspace users bear 100% of the revenue difference.

5.46 FAB CE has made the case to the Commission to abolish the dead band to avoid the strong disincentive to move towards a common charging zone. We understand that the Commission is not currently minded to make this change.

5.47 One of the main operational benefits of a common charging zone would be to encourage route optimisation in the context of moving towards use of the Free Route Airspace. In simulations conducted by the Network Manager, this led to material changes in the current service unit patterns by Member State with, for example, Slovenia projected to lose service units while other States benefitted from an increase. FAB CE considers transitional arrangements would be needed for ANSPs to balance charges received and costs incurred, while also retaining incentives to encourage the efficient provision of ANS. They have investigated whether some form of traffic risk sharing arrangements, internal to FAB CE, could be designed to address these issues.

5.48 The options are still under consideration, but at this stage the issues arising from interaction of common charging with the traffic risk sharing mechanism and route optimisation leading to a redistribution of traffic flows have not been addressed. Moreover, following initial discussions, FAB CE understands that IATA do not support the introduction of common charging zones as they consider that there is a risk that ANSPs would move to a higher cost base, and do not regard the potential benefits as material.

Blue Med FAB

5.49 Blue Med FAB has considered the case for introducing a common charging zone and recognises the potential benefits of avoiding flight extensions from diversions from parts of Italian airspace due to differences in service unit levels. However, given the significant differences in the unit cost bases, and therefore unit rates, as well as the traffic volumes, of the member countries (Italy, Malta, Greece and Cyprus), the implementation would be challenging, and there is no plan to develop a common charging zone for Blue Med at present.

5.50 Where there are significant differences in unit costs, and where the highest unit cost is incurred by the largest country in the FAB (Italy in the case of Blue Med), there is a risk that the smaller traffic volume countries are put under pressure to increase costs (for example as a result of ATCOs in the smaller traffic volume countries seeking the same terms as ATCOs in the larger traffic volume country). Although there might also be some pressure for the highest cost country to improve cost efficiency, this would be likely to be limited. As the approach to the delivery of cost efficiency under the Performance Scheme envisages contributions from all ANSPs, these pressures could undermine the achievement of efficiency targets. There is a strong view that this risk outweighs any benefits in terms of the more efficient routing of flights. Airspace users also consider that users of the smaller volume, lower unit cost ANSPs would in practice cross-subsidise the high volume, higher unit cost ANSPs and therefore do not support the move to a common charging zone.

5.51 Blue Med does, however, recognise that Member States with a similar unit cost base could form a common charging zone, and have noted that the differences between Greece, Cyprus and Malta may be small enough to overcome the practical implementation issues. At the same time, it is recognised that this would not enable the full exploitation of benefits of cooperation on airspace design and Free Route Airspace.

Other stakeholders

5.52 We also consulted with CANSO and a number of airspace users' organisation on the principle and practical implementation of common charging zones. Our discussions highlighted the uncertainty surrounding the possible benefits in terms of greater flight efficiency, and the significant challenges, already noted above, that would need to be overcome to establish a common charging framework at the FAB level.

Objectives of a common charging zone

5.53 We have evaluated the impact of implementing common charging zones in terms of the objectives described in Chapter 1. As discussed below, following discussion with stakeholders and a review of published information, we consider the objective of credibility as one of the greatest challenges to implementation. Across the stakeholder community, airspace users, ANSPs and Member States have major concerns about how easy it would be to implement a common charging scheme resulting in manageable changes. We also note that the loss of economic efficiency resulting from the current, national charging framework has not been demonstrated, and that the administrative challenges are significant.

5.54 As in the case of the other modulation of charges schemes considered in this report, we present a summary evaluation of common charging zones against the objectives before setting out our conclusions and recommendations. This evaluation draws on both stakeholder views and the results of further analysis of the various impacts and implementation issues described in the following paragraphs.

Revenue distribution impacts

5.55 Any practical implementation of common charging zones must provide for a redistribution of revenue. Commentators have suggested the following metrics that could be used to apportion revenues following the introduction of a common charging zone:

- Operational sharing parameters (e.g. number of controllers);
- Financial sharing parameters (% of the total cost-base attributable to a service provider applied to the generated revenue); and
- Activity sharing parameters (i.e. kilometres controlled or number of service units generated in each subset of the FAB airspace).

5.56 We have considered the implications, for both ANSPs and airspace users, of applying a revenue distribution system on the basis of:

- Percentage of the total cost-base attributable to a service provider applied to the generated revenue; and
- The number of service units generated in each subset of the FAB airspace.

Cost-based distribution of revenue

5.57 In principle, following collection of revenues from a common charging zone at a FAB level, revenues could be attributed proportionally according to the costs incurred by each ANSP. Revenue neutrality at a FAB level would be maintained. However, although this would in principle limit the impacts on ANSPs, the impact on airspace users could be expected to be significant. Moreover, there would still be challenges to address within the revenue redistribution system as:

- The introduction of a FAB common charge might lead to rerouting and a change to the level of activity in each of the operational areas covered by each ANSP. This, in turn, might result in sectors and staff being underutilised, and the need for extra staff or splitting of sectors in other areas. In these circumstances it would be difficult to predict the ex-ante and ex-post costs of each ANSP as the operational impacts may be difficult to determine. Moreover, as highlighted by the stakeholder comments outlined above, where a large reduction in activity for an ANSP is predicted (as in the case of Belgium under the FABEC simulations), that State/ ANSP is unlikely to support the change unless it has a means of restructuring its organisation and staff to meet the reduced level of activity.
- Different approaches to VAT and other taxes would need to be agreed across the FAB Member States to enable the allocation of revenues to costs on a similar basis. Stakeholders have also pointed out that if different States/ ANSPs have a different approach to IFRS and in particular pensions, this may also cause significant difficulties when agreeing the cost base of each ANSP.
- The interaction with the Performance Scheme and cost targets for each FAB and ANSP would need to be considered carefully. If cost efficiency targets were set at a FAB level then some of these issues would be resolved, but if ANSP level cost efficiency targets were maintained then introducing these changes would be complicated, as the operational reactions ex-post might differ from those predicted.

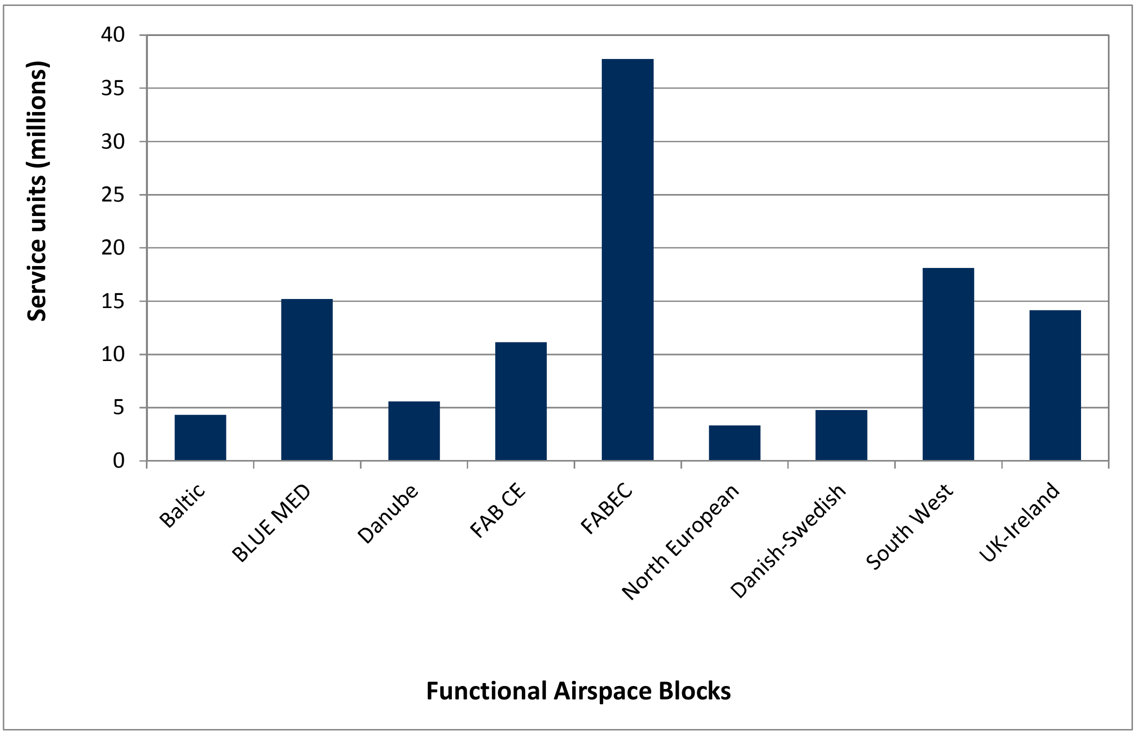
Revenue distribution on the basis of service units

5.58 If a FAB level common charging zone, applying the principle of total revenue neutrality, was adopted, the application of a single unit rate (determined by pooling total costs across all FAB Member States and dividing by total service units) would result in some States' unit rates increasing and others decreasing. In these circumstances, the revenues collected at State level would not necessarily match the level of activity and associated cost base.

5.59 We have undertaken a high level review of all FABs including, in each case, the number of charging zones, the currencies used, service unit rate differentials and determined unit cost (DUC) differentials. The analysis was undertaken using publically available Central Route Charges Office (CRCO) data[75]. The CRCO's Report on the Operation of the Route Charges System 2012 provides a breakdown of costs chargeable to users, service units and unit rates by ANSP charging zone. Costs from various currencies were converted to euros using average September 2011 exchange rates. The results, summarised below, demonstrate the range of characteristics of the current declared FABs.

5.60 The number and size of Member States participating in individual FABs results in significant variations in total service unit volumes at FAB level, with the North European FAB having the lowest level, at 3.3 million, and FABEC the highest with 37.8 million (see Figure 5.1). In each FAB, the traffic split between charging zones varies. For example, the traffic in Lithuania accounts for only 10% of all traffic in the Baltic FAB, with Poland accounting for the remainder.

Figure 5.1: Service units by FAB in 2012



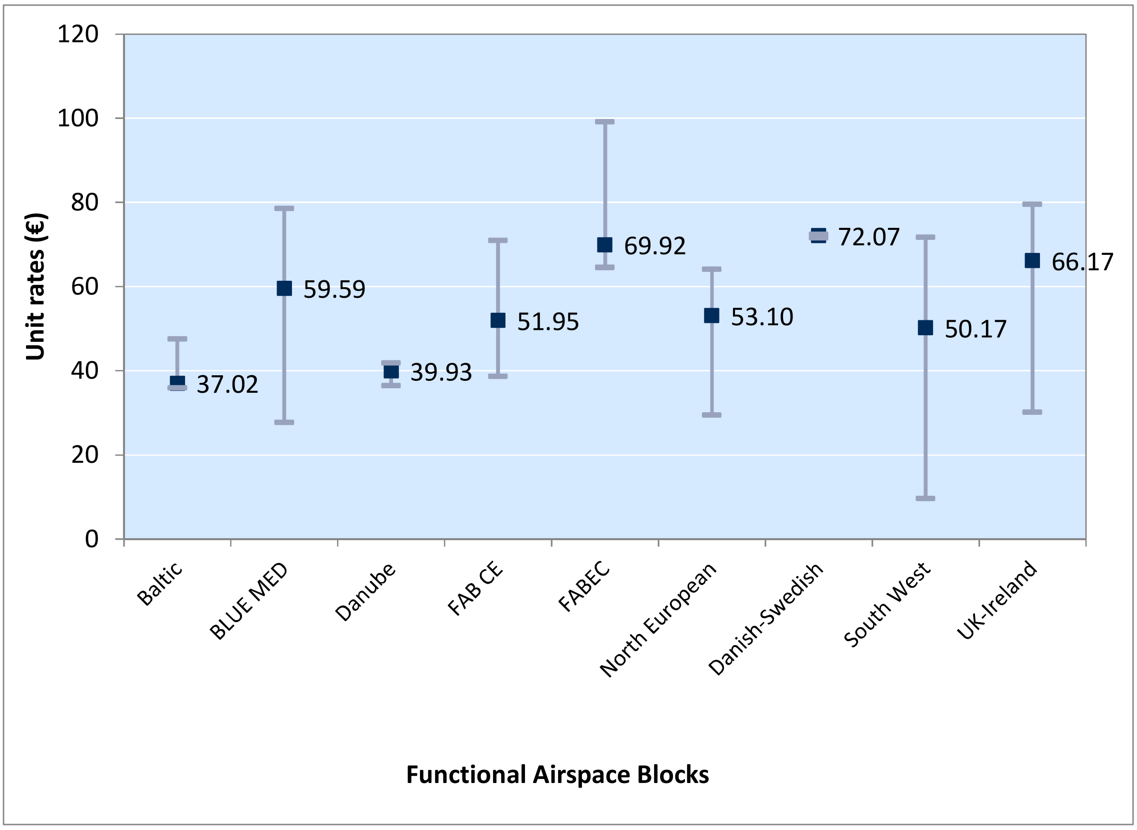
Source: Steer Davies Gleave analysis of CRCO Report on the Operation of the Route Charges System in 2012 (March 2013)

5.61 National unit rates for en-route charging zones are calculated by dividing the costs chargeable to users by service units for each charging zone, and range from €9.65 in Portugal Santa Maria

[75] Report on the Operation of the Route Charges System 2012, CRCO, March 2013 (Table 2)

to €99.13 in Switzerland. The FAB level unit rate is calculated by dividing the sum of all members' total costs chargeable to the users by the total service units across the FAB. Figure 5.2 shows the calculated FAB level unit rates along with the range of national rates within each FAB. For the Danish-Swedish FAB and the Danube FAB (each with only two members), the range of unit rates is small – less than one euro difference between Denmark and Sweden, and less than six euros difference between Bulgaria and Romania. The range for South West FAB is €62 due to the very low unit rate of €9.65 for Portugal Santa Maria and a much higher rate of €71.70 for continental Spain.

Figure 5.2: FAB level unit rates and range of existing unit rates (2012)



Source: Steer Davies Gleave analysis of CRCO data

Summary of options

5.62 The two options for distributing revenue between the member ANSPs within a FAB are summarised in the table below. We have undertaken more detailed analysis of option CZ2, as described in the following paragraphs, as it would have major financial implications for individual ANSPs, at least in the short to medium term. Both options have been subjected to evaluation against the objectives described in Chapter 1, as set out in paragraph 1.6.

Table 5.1: Options for distribution of revenues under a common charging zone

Option	Summary
CZ1: Cost-based distribution	Revenues collected according to common unit rate and number of service units within the FAB, preserving revenue neutrality. Revenues distributed in proportion to the underlying cost base of each member ANSP.

Option	Summary
CZ2: Service unit-based distribution	Revenues collected according to common unit rate and number of service units within the FAB, preserving revenue neutrality. Revenues distributed according to the number of service units within each FAB.

Source: Steer Davies Gleave analysis

Illustration of service unit-based revenue distribution

5.63 We have selected two specific cases to illustrate the issues likely to arise in moving towards a common charging zone using service units as the revenue allocation mechanism:

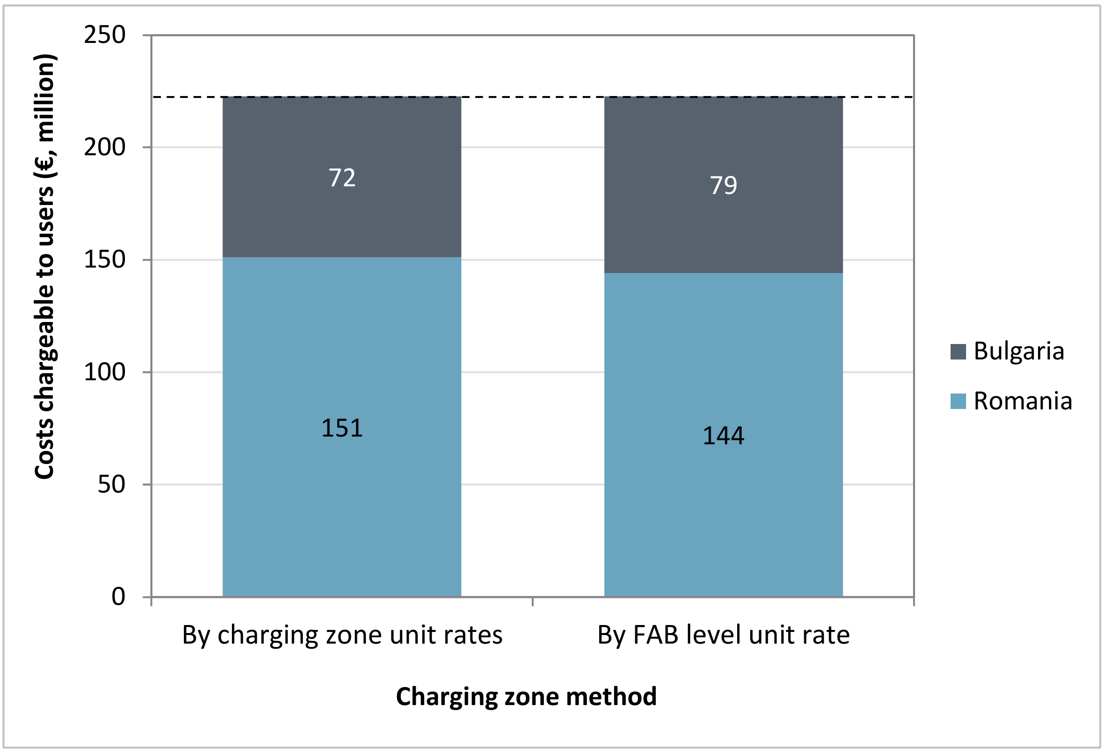
- Danube FAB: chosen because the establishment of a single charging zone for the FAB is not expected to pose significant issues, as all members are similar in terms of size of cost base, current unit rates and traffic levels.
- FABEC: chosen because there are significant issues and risks relating to the implementation of a single FAB charging zone for FABEC, due in part to participating members using a number of different currencies, and having materially different unit cost bases. As noted above, FABEC has made significant efforts towards the establishment of a FAB charging zone, and through this concluded that the difficulties and risks inherent are too significant at this stage to enable immediate implementation.

Danube FAB

5.64 The adoption of a FAB level unit rate for Danube FAB results in a change in the distribution of charges recovered across the Member States (Bulgaria and Romania). The black dotted line in Figure 5.3 shows the total charges recovered by the Danube FAB in both scenarios (since the introduction of a common charging zone would be revenue neutral), some €223 million.

5.65 Under the adoption of a FAB level unit rate, Romania's unit rate reduces from €41.84 to €39.93. If the level of traffic over Romania remains at 3.6 million service units, Romania experiences a revenue reduction of €7 million, or 5%. As Bulgaria has a lower national unit rate of €36.42, it experiences a net increase in revenue of 10% (Figure 5.3 and Table 5.2).

Figure 5.3: Difference in Danube FAB charges recovered (2012)



Source: Steer Davies Gleave analysis of CRCO data

Table 5.2: Danube FAB unit rates and charges recovered (2012)

	Romania	Bulgaria	FAB level
Charges recovered in 2012 (€ millions)	€151m	€72m	€223m
Service units (millions)	3.6	2.0	5.6
Proportion of service units	65%	35%	100%
Unit rates (€)	€41.84	€36.42	€39.93
Charges recovered using FAB unit rate (€ millions)	€144m	€79m	€223m
Difference in charges recovered (€ millions)	(€7m)	€7m	-
Percentage difference in charges recovered	(5%)	10%	-

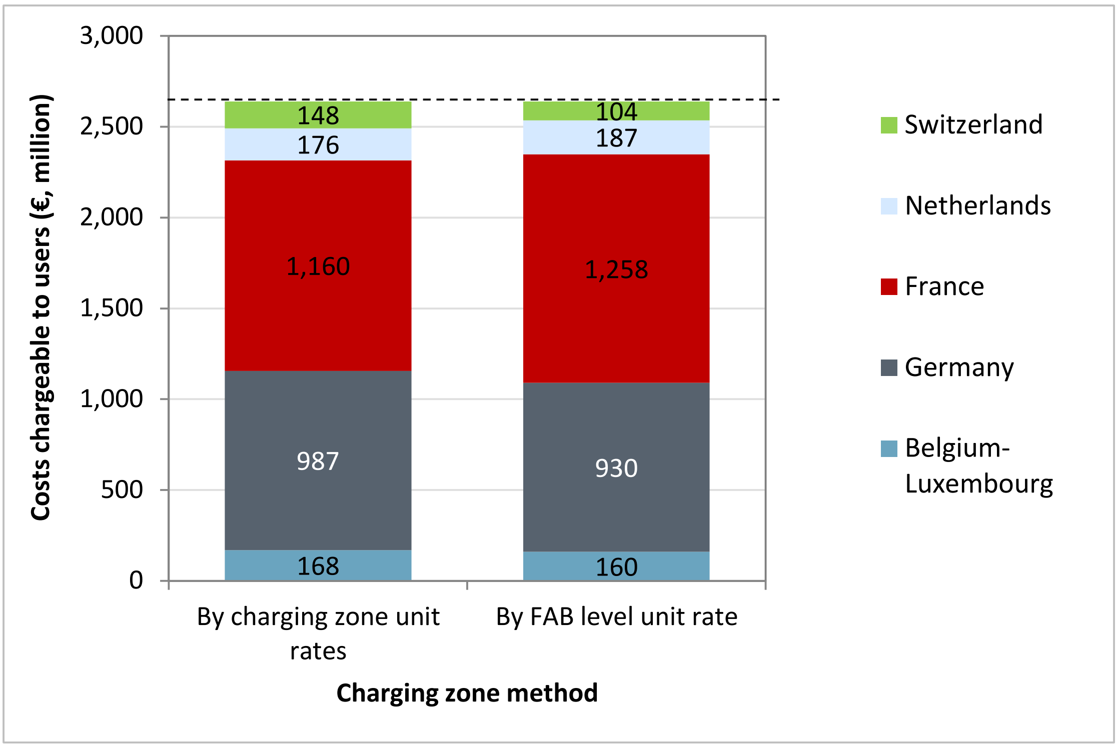
Source: Steer Davies Gleave analysis of CRCO data

FABEC

5.66 The FAB level unit rate for FABEC is similarly determined by taking the total charges recovered (€2,639 million in 2012) and dividing by the total service units across all Member States in the FAB (38 million). This results in a FAB level unit rate of €69.92.

5.67 Figure 5.4 demonstrates the impact of applying this new single unit rate to the revenues collected by each FABEC Member State. The black dotted line shows that the total charges recovered by the FAB remain at €2,639 million, but at State level Belgium-Luxembourg, Germany and Switzerland recover less, while France and the Netherlands gain revenue.

Figure 5.4: Difference in FABEC charges recovered (2012)



Source: Steer Davies Gleave analysis of CRCO data

5.68 Table 5.3 shows that following the introduction of a FAB level unit rate, Switzerland lowers its unit rate from €99.13 to €69.92. If the level of traffic over Switzerland remains at 1.5 million service units, it experiences a reduction of €44 million in revenue, 29% lower than that recovered under their national unit rate. Belgium-Luxembourg and Germany experience lower levels of reduction (5-6%), as their original national unit rates are not significantly different from the new FABEC common unit rate. As France and Netherlands have national unit rates of €64.49 and €65.58 respectively, both of which are lower than the common FABEC unit rate, these States gain additional revenue if the FAB level unit rate is applied (again assuming traffic levels remain the same).

Table 5.3: FABEC unit rates and charges recovered (2012)

	Belgium-Luxembourg	Germany	France	Netherlands	Switzerland	Total
Charges recovered in 2012 (€ millions)	€168m	€987m	€1,160m	€176m	€148m	€2,639m
Service units (millions)	2.3	13.3	18.0	2.7	1.5	38
Proportion of service units	6%	35%	48%	7%	4%	100%
Unit rates (€)	€73.77	€74.19	€64.49	€65.58	€99.13	€69.92
Charges recovered using FAB unit rate (€ millions)	€160m	€930m	€1,258m	€187m	€104m	€2,639m
Difference in charges recovered (€ millions)	(€9m)	(€57m)	€98m	€12m	(€44m)	-

	Belgium-Luxembourg	Germany	France	Netherlands	Switzerland	Total
Percentage difference in charges recovered	(5%)	(6%)	8%	7%	(29%)	-

Source: Steer Davies Gleave analysis of CRCO data

The impact of traffic shift

5.69 The previous analysis assumes that traffic levels in each charging zone do not change when the common unit rates are implemented. However, it is likely that there will be some traffic shift as a result of airlines' route optimisation activities. States experiencing a reduction in unit rates when the FAB level unit rate is adopted may see an increase in traffic, as there is no longer any benefit for an airline in avoiding flying through their airspace. The level of traffic shift is difficult to predict, although simulation can give some indication of the likely changes. We have chosen Danube FAB to illustrate the effect of changing traffic levels in the following section, as it is a relatively simple, two-state FAB.

5.70 Table 5.4 compares the charges recovered in Danube FAB under three scenarios:

- Scenario 1: national unit rates (i.e. current situation);
- Scenario 2: a common FAB level unit rate is used, assuming no change in service units; and
- Scenario 3: a common FAB level unit rate is used, assuming a 10% increase in service units in Romania.

5.71 In scenario 2, with the level of traffic over Romania held constant at 3.6 million service units, the Member State experiences a 5% reduction in revenue by adopting the FAB level unit rate. However, if there is a traffic shift towards Romania from Bulgaria, as in Scenario 3, Romania may recover additional revenue at the expense of Bulgaria.

Table 5.4: Impact on change in traffic in Danube FAB (2012)

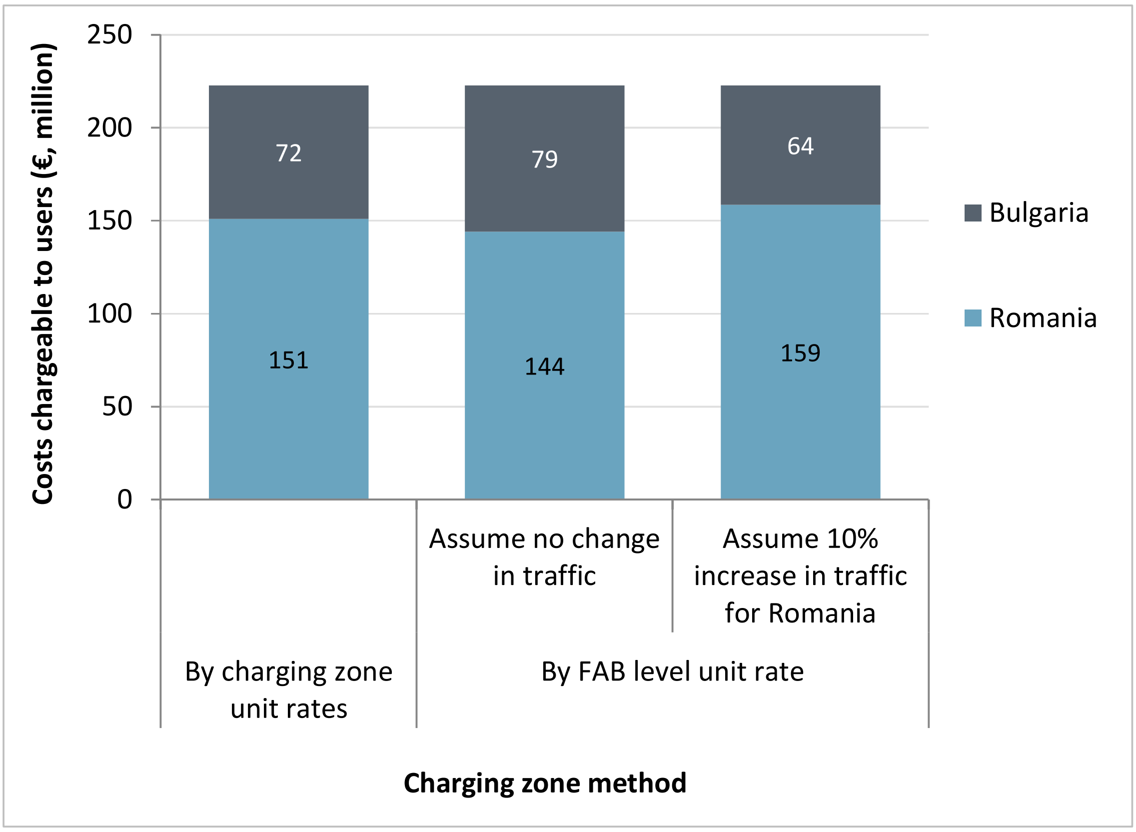
		Romania	Bulgaria	FAB level
	Unit rate (€)	€41.84	€36.42	€39.93
	Service units (millions)	3.6	2.0	5.6
Scenario 1: National charging zone rates:				
	Charges recovered (€ millions)	€151m	€72m	€223m
Scenario 2: FAB level unit rate, assuming no change in traffic:				
	Charges recovered (€ millions)	€144m	€79m	€223m
	% change from using charging zone rates	(5%)	10%	-
Scenario 3: FAB level unit rate, assuming 10% increase in traffic for Romania:				
	New service units (millions)	4.0	1.6	5.6
	Charges recovered (€ millions)	€159m	€64m	€223m
	% change from using charging zone rates	5%	(11%)	-

Source: Steer Davies Gleave analysis of CRCO data

5.72 The example in Table 5.4 assumes a 10% increase in service units in Romania. Our analysis assumes that the total volume of units in the FAB remains constant at 5.6 million, and the increase in Romanian traffic therefore results in a decrease in service units in Bulgaria. Multiplying the new service units in each State by the FAB level unit rate, it is clear that

Romania experiences a 5% increase in charges recovered rather than a reduction. Bulgaria's charges recovered reduce by 11%.

Figure 5.5: Difference in Danube FAB charges recovered (2012)



Source: Steer Davies Gleave analysis of CRCO data

5.73 In this scenario, the Romanian ANSP, ROMATSA, would need to adjust its operation to provide for the increased demand and the Bulgarian ANSP, Bulatsa, would need to adjust its operation to reflect reduced demand. In practice, these adjustments would take time to make, and in the interim the financial performance of Bulatsa would suffer. In addition, the State might also fail to meet its SES Performance Scheme cost efficiency (and possibly other) targets.

Impact on airlines

5.74 Airspace users are also likely to either gain or lose under a common unit rate, depending on their level of activity in different States' airspace. We have investigated the possible impacts using service unit and route charge data for 2010 to 2014, split by ANSP zones and airline, provided in confidence by Eurocontrol. Data for the year 2012 was used to align with the ANSP analysis summarised above. The results of the analysis presented below have been anonymised for reasons of confidentiality.

5.75 The focus for the analysis is on two FABS, with data anonymised for the States and airlines involved, extending to an adjustment to the national unit rates charged to preserve anonymity. We identified the top five airlines by volume of service units for each State in the FAB and calculated the impact of a change to a single unit rate to determine whether any airlines could be expected to win or lose from the implementation of a common charging zone.

FAB A

5.76 The top five airlines by service units for each State in FAB A, as shown in Table 5.5, were selected for this analysis. Airline A has the highest number of service units in both charging zones and airline B the second highest level. Airline F is the fifth highest in State 2 so has been included in the analysis for both States, despite being seventh highest in State 1. For State 1, the top airlines are A, B, C, D, and E; for State 2, they are A, B, C, E, F. Airlines A to F have been included in the analysis.

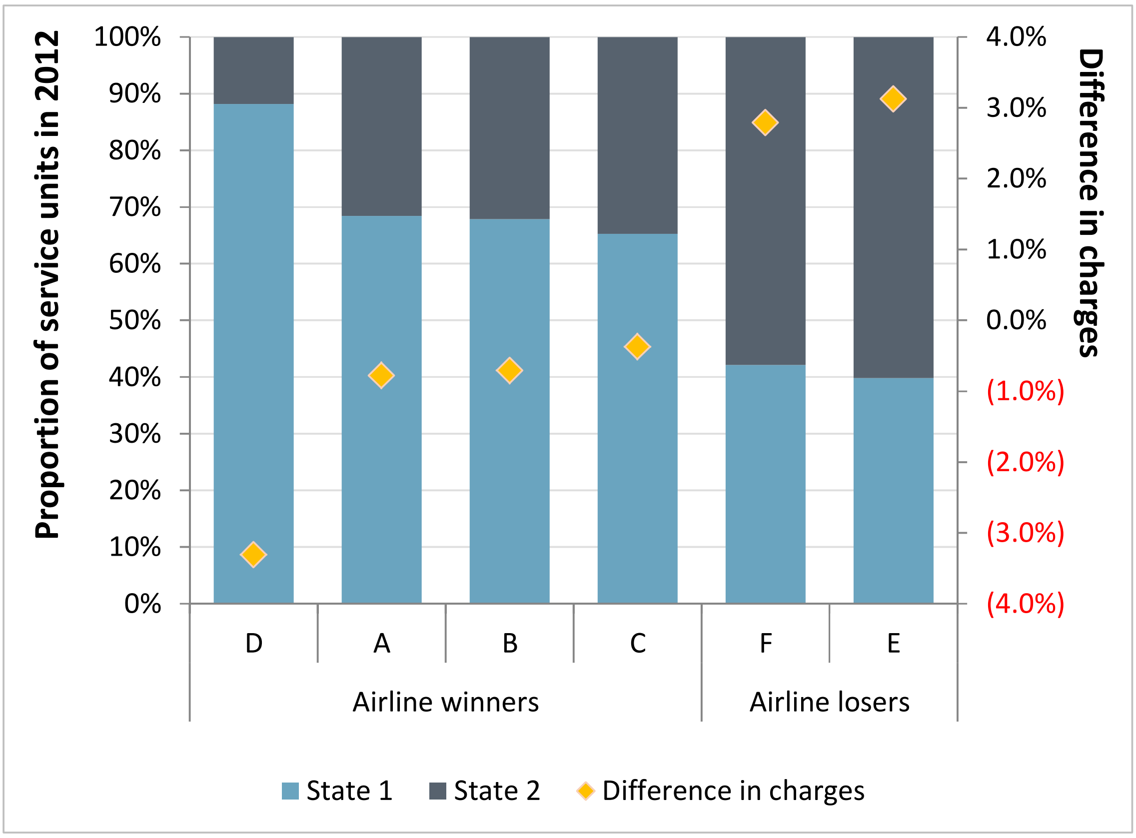
Table 5.5: Top airlines by % of service units for FAB A in 2012

Rank	State 1		State 2	
	Airline	% Service units in State	Airline	% Service units in State
1	A	19.1%	A	15.6%
2	B	9.2%	B	7.6%
3	C	6.8%	E	7.3%
4	D	3.3%	C	6.3%
5	E	2.7%	F	6.0%
... 7	F	2.5%	-	-
... 25	-	-	D	0.8%

Source: Steer Davies Gleave analysis of Eurocontrol data

5.77 Out of these six airlines (A to F), four are ‘winners’ under a common charging zone scenario (i.e. they have lower en-route charges overall) and two are ‘losers’ (higher en-route charges overall). Figure 5.6 shows that airlines A, B, C and D will pay less in charges (difference in charges is negative), whilst airlines E and F pay more (difference in charges is positive).

Figure 5.6: Impact on top airlines compared to proportion of traffic in FAB A



Source: Steer Davies Gleave analysis

5.78 Airline D is a clear 'winner' as it would pay 3.3% less in charges under a single FAB level unit rate than it currently pays in each of State 1 and State 2 with national unit rates (€4.28m compared to €4.43m, see Table 5.6). This is due to the fact that a significant proportion, some 88%, of its traffic across FAB A is in State 1, where the unit rate falls from €63.00 to €60.00. Only 12% of airline D's total traffic across this FAB is in State 2, and the impact of the decrease in the unit rate in State 1 on its charges is therefore greater than the increase of the unit rate in State 2.

Table 5.6: Breakdown for Airline D: FAB A

Airline D	State 1	State 2	FAB Total
% of service units across FAB	88%	12%	100%
National unit rate (€)	€63.00	€55.00	-
FAB level unit rate (€)	-	-	€60.00
Charges for ANSP level (€ 000s)	€3,965	€465	€4,430
Charges for FAB level (€ 000s)	€3,776	€507	€4,283
Difference (€ 000s)	(€189)	€42	(€147)
% change in total charges			(3.3%)

Source: Steer Davies Gleave analysis

5.79 Airlines A, B and C are marginal 'winners' as they see a minor (0.4% to 0.8%) reduction in charges overall. These airlines all have similar traffic profiles, with approximately 65% of their traffic in the airspace of State 1 and the remainder across State 2.

5.80 Airlines E and F are clear 'losers' under a common charging zone scenario, as they would be liable for 2.8% - 3.1% more in charges. The majority of traffic for these airlines is in State 2 (approximately 60%), and the increase in charges for State 2 (approximately €0.32-0.39 million) is larger than the savings made in State 1 (€0.14-0.16 million).

FAB B

5.81 As for FAB A, we have analysed current and prospective charges for the top five airlines by service units for each of the five charging zones in FAB B. As can be seen in Table 5.7, the top five airlines vary across the charging zones. Airlines G and H are consistently in the top five for all charging zones, but for example, Airline Q is in the top five only for State 5 and is much lower in the ranking for the other charging zones. Our analysis examines the impact on all airlines that appear in the top five for each charging zone, giving a total of 11 airlines in all (Airlines G to Q).

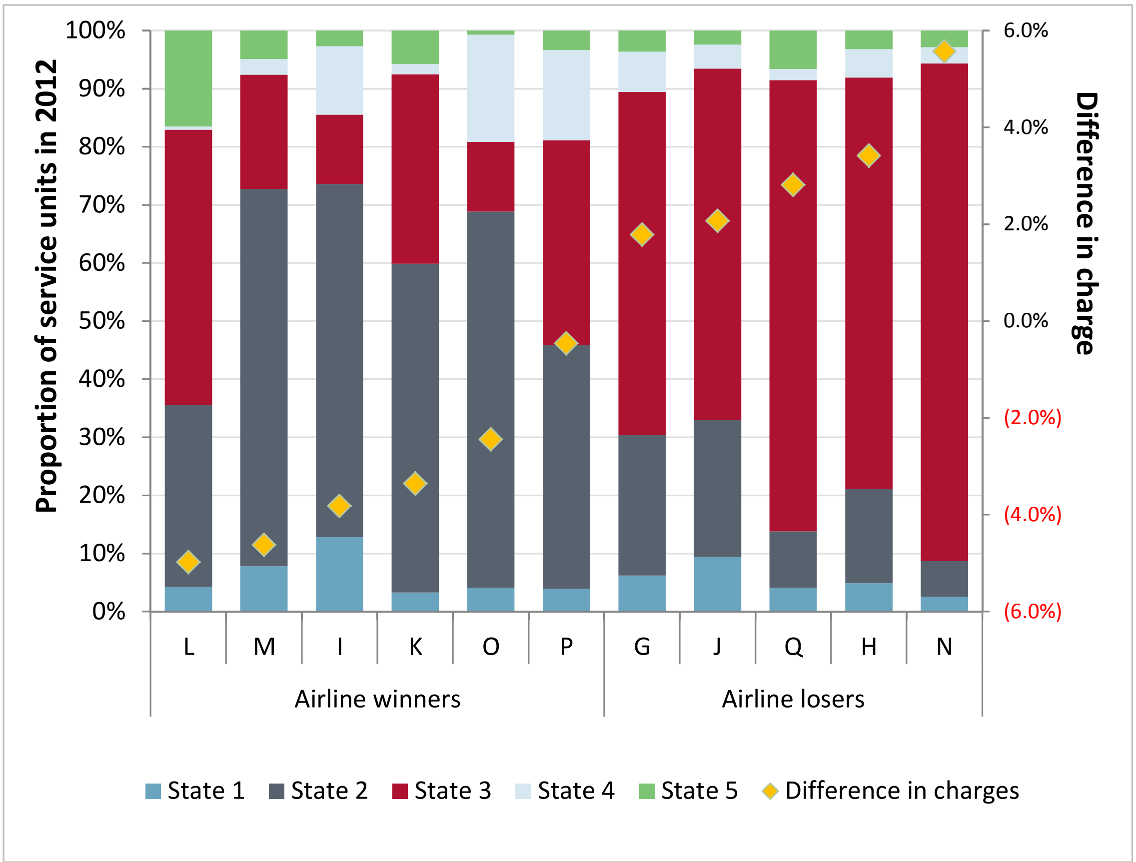
Table 5.7: Top airlines by % service units in each State for FAB B in 2012

	State 1		State 2		State 3		State 4		State 5	
Rank	Airline	% SU	Airline	% SU	Airline	% SU	Airline	% SU	Airline	% SU
1	G	17.4%	K	14.1%	G	19.4%	G	20.0%	L	19.9%0
2	H	10.8%	G	11.9%	H	18.4%	H	11.0%	G	13,7%
3	I	5.5%	H	6.3%	K	5.5%	O	7.1%	K	11.2%
4	J	5.0%	L	4.9%	L	4.9%	P	6.9%	H	9.6%
5	K	4.7%	M	4.6%	N	4.2%	I	5.2%	Q	3.4%
6	L	3.7%	I	4.6%	J	3.8%	K	2.5%	M	2.7%
7			O	4.3%	Q	3.5%				
8	M	3.2%	P	3.2%			J	2.2%	P	1.9%
9					P	1.8%			J	1.8%
10			J	2.2%					N	1.6%
11									I	1.6%
…14	P	1.7%								
…15	Q	1.6%								
…16	O	1.5%					N	1.2%		
…18					M	0.9%	M	1.1%		
…21	N	1.1%								
…22			Q	0.7%	I	0.6%				
…25							Q	0.8%		
…27					O	0.5%				
…34			N	0.4%			L	0.5%		
…35									O	0.4%

Source: Steer Davies Gleave analysis of Eurocontrol data. Note SU = Service Units

5.82 Of these 11 airlines, six are 'winners' and five are 'losers' (Figure 5.7 - airlines L, M, I, K, O and P pay less in charges under a single unit rate scenario (difference in charges is negative), whilst airlines G, J, Q, H and N see an increase in charges (difference in charges is positive).

Figure 5.7: Impact on top airlines compared to proportion of traffic in FAB B (2012)



Source: Steer Davies Gleave analysis

5.83 Airlines L, M, I, K, O and P pay lower charges because they have a high proportion of their total traffic in countries that currently have high national unit rates, which are reduced under a common charging zone (States 1, 2 and 5). The impact is primarily due to activity in State 2, as the proportion of traffic for these airlines is not as significant in States 1 and 5. Airlines G, J, Q, H and N are liable for higher charges under a common charge scenario because they have a high proportion of their total traffic in State 3, where the FAB level unit rate (€126.00) is higher than the national unit rate (€116.00).

5.84 Airline L is a clear 'winner' as it experiences a 5.0% reduction in charges with the FAB level unit rate as compared to national unit rates (€108.5m compared to €114.2m, see Table 5.8). This is because it has a high proportion of traffic in States 1, 2, and 5 (total of 52%), all States experiencing a unit rate reduction under a common unit rate. Whilst airline L is also liable for higher charges in States 3 and 4, the increase in charges for these two countries is outweighed by the reduction for the other three countries.

Table 5.8: Breakdown for Airline L: FAB B

Airline L	State 1	State 2	State 3	State 4	State 5	FAB Total
% of service units across FAB	4%	31%	47%	1%	17%	100%
National unit rate (€)	€133.00	€134.00	€116.00	€118.00	€178.00	-
FAB level unit rate (€)	-	-	-	-	-	€126.00

Airline L	State 1	State 2	State 3	State 4	State 5	FAB Total
Charges for ANSP level (€ 000s)	€4,851	€36,110	€47,337	€577	€25,299	€114,175
Charges for FAB level (€ 000s)	€4,596	€33,955	€51,418	€616	€17,908	€108,493
Difference (€ 000s)	(€255)	(€2,156)	€4,081	€39	(€7,391)	(€5,682)
% change in total charges						(5.0%)

Source: Steer Davies Gleave analysis

5.85 Airline N is a clear 'loser' if the common charging zone is adopted, as it pays 5.6% more in charges (see Table 5.9). The reduction in charges paid to States 1, 2 ,and 5 is not sufficient to cover the increase in charges to States 3 and 4. This is because 86% of this airline's traffic is over State 3, which has the lowest national unit rate.

Table 5.9: Breakdown for Airline N: FAB B

Airline N	State 1	State 2	State 3	State 4	State 5	FAB Total
% of service units across FAB	3%	6%	86%	3%	3%	100%
National unit rate (€)	€133.00	€134.00	€116.00	€118.00	€178.00	-
FAB level unit rate (€)	-	-	-	-	-	€126.00
Charges for ANSP level (€ 000s)	€1,384	€3,328	€40,449	€1,350	€2,063	€48,574
Charges for FAB level (€ 000s)	€1,311	€3,129	€43,936	€1,442	€1,460	€51,278
Difference (€ 000s)	(€73)	(€199)	€3,487	€92	(€603)	€2,704
% change in total charges						5.6%

Source: Steer Davies Gleave analysis

Transitional measures

5.86 The analysis of the application of service units as a means of revenue distribution for ANSPs shows that it has the potential to lead to differences between revenues received and costs incurred. In the short term, this is likely to lead to transitional problems. This approach to revenue distribution could also have a significant impact on the charges paid by airlines according to the location and volume of flights within the FAB concerned. These effects could be mitigated in the short to medium term through transition measures, in particular:

- To reduce the impact on airspace users, introducing the impact of the change over a period of, say, 5 years. Using a similar principle to the Terminal navigation charge harmonisation to $N^{0.7}$, this approach would require calculation of the charges under the existing system as well as common charging.
- To reduce the impact on individual ANSPs, cost efficiency targets could be set at the FAB level, enabling transition from management of national cost bases to a cost base managed at the FAB level. This might be allied with transitional incentives (potentially some relaxation of the cost-efficiency target for the period of transition from ANSP to FAB

common charging, although this would undermine the benefits of common charging and would be difficult to reconcile with wider industry objectives).

Implications for industry systems

5.87 We have discussed both the cost-based and service unit-based revenue distribution options with representatives of the CRCO and they consider that both could be implemented with relatively little change to the current charging systems. Charges to airlines would be simplified, while a record of ANSP revenues would be provided on the basis of the allocation principle agreed.

5.88 There would, however, need to be a "wash-up" mechanism under either approach as the allocation under either cost or service unit-based distribution might be different ex-ante and ex-post. In addition, if transitional arrangements were introduced requiring calculation of charges to airspace users using the new and old basis of charging, this would result in additional administrative costs.

The benefits of reduced flight extensions

5.89 A move towards a common charging zone may result in economic benefits related to increased flight efficiency, through fuel savings and a reduction to the environmental impact of aviation from shorter routes. There is some evidence that airlines choose to fly further where there are economic benefits in doing so due to the differential in ANS charges between two en-route charging zones. For example, Thomas Cook state that "*When you have a very cheap country that sits next to a very expensive country you will fly a lot longer to save a lot of money. That's not efficient. If something was done about that at a European level we would see a big change in the way we operate.*"[76]

5.90 At the same time, our analysis and data collection across Workstreams A and D indicate that it is relatively difficult to assess the flight efficiency benefits resulting from common charging zones. While it is generally agreed that the benefits might be significant, estimates of their size and incidence are based primarily anecdotal information, and have there have been relatively few detailed simulations (undertaken by some FABs and the Network Manager) aimed at a more systematic quantification.

5.91 Furthermore, the uncertainty of the operational benefits has resulted in considerable scepticism among airspace users regarding the merits of common charging zones. This scepticism is reinforced by the fact that the benefits of Free Route Airpace, while difficult to distinguish from those potentially derives from common charging zones, could nevertheless be delivered in the absence of common charging. We understand that the Eurocontrol's Performance Review Unit (PRU) is currently investigating this issue, but the results of the work are not yet available.

5.92 Nevertheless, there is some data and analysis available from the Performance Review Commission's (PRC's) 2010 Performance Review Report[77] enabling an estimation of the additional kilometres flown by airlines to avoid charging zones with higher charges. This is the most recent assessment of the extent to which routes are extended to mitigate route charges and we have applied the analysis to up-to-date traffic forecasts and flight efficiency data in order to quantify the range of savings that might be available under a common charging zone

[76] Skyway 61 Summer 2014, EUROCONTROL

[77] PRR 2010 Performance Review Report, Performance Review Commission, 2011

at SES level. We have also investigated the range of improvements that might be possible at FAB level.

Benefits at the level of the SES

5.93 Section 7.4 of the PRR report states that in 2010 43% of flights did not file the shortest route on a given city pair. Of this group of flights, only 7% flew a longer route that had lower route charges. The average additional distance flown compared to the shortest route was 50km. If a movement towards common charging zones were to reduce the incidence of airlines choosing longer but cheaper (in terms of ANS charges) routes, the maximum impact would be on approximately 3% of traffic, with a reduction of 50km in route length on average. On a per flight basis, this equates to a 1.5km reduction, compared to the level of horizontal en-route flight inefficiency in 2010 of 33.9 km (see Figure 7-13 in PRR 2010[78]).

5.94 We have quantified the impact of this potential improvement in flight efficiency (0.17% per flight) on fuel costs and CO_2 emissions, taking 2010 and 2013 data as the baseline. A 0.17% improvement in flight efficiency across SES airspace would result in the following savings:

- 1,498 minutes of en-route flight time (PRR 2010);
- 71,000 tonnes of fuel (PRR 2010); and
- 225,000 tonnes of CO_2 (PRR 2013).

5.95 As noted above, a 0.17% improvement in flight efficiency is the maximum improvement that could be seen as a result of the introduction of common charging zones using evidence from data collected in 2010. However, there is uncertainty around this estimate (we chose the average flight extension, for example), and behaviours since 2010 have changed. Evidence suggests that the incidence of airlines choosing to fly longer routes to avoid higher ANS charges is increasing:

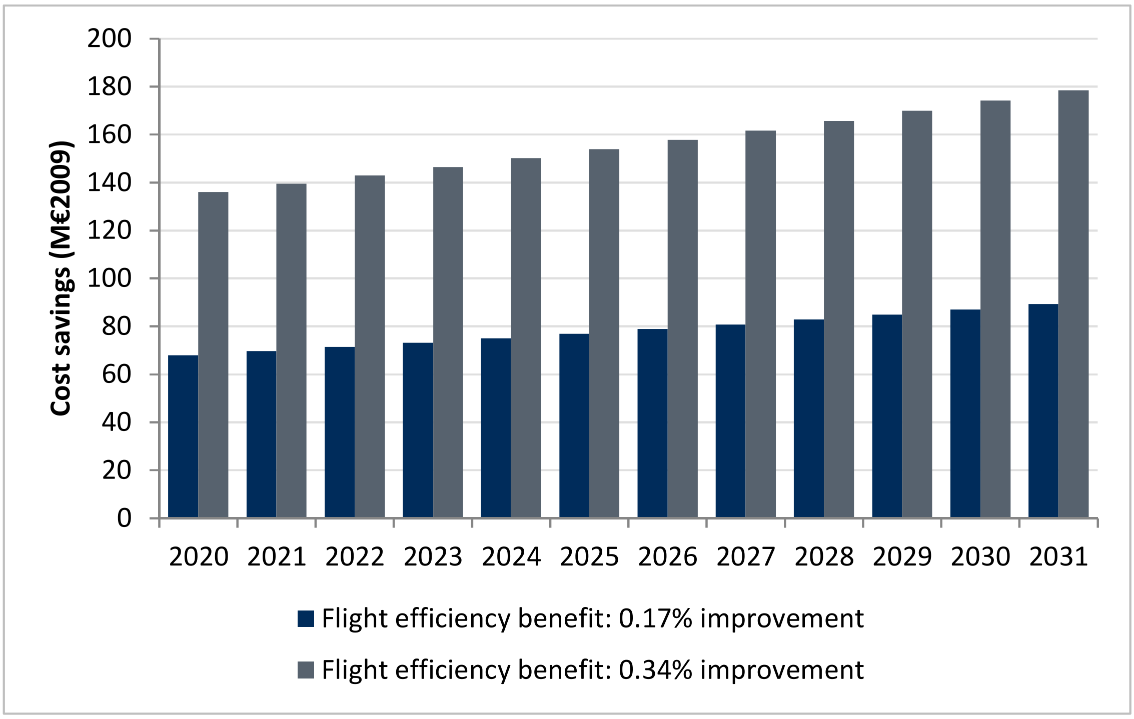
- As noted above, Thomas Cook, has stated that it does this currently;
- We understand from detailed PRU analysis that this occurs on specific routes in Italy, with flights choosing to cross Croatian airspace to avoid higher charges in Italy; and
- In their RP2 Performance Plan, the SW FAB stated that airlines flying Atlantic routes are choosing to fly a longer route over Portuguese airspace to avoid the more expensive Spain Canarias zones.

5.96 To reflect the uncertainty around the data and perceived changes in airline behaviour since 2010, we have assumed an upper bound of 0.34%, double the previous estimate, for the purposes of a sensitivity test.

5.97 Using the STATFOR February 2014 medium-term traffic forecast and STATFOR 2013 long term forecasts, and assuming that common charging zones would not be in place until 2020 at the earliest (after RP2), expected cost savings at SES level would range between approximately €68 million and €136 million per annum (in real 2009 Euros) in 2020, rising in line with traffic increases in the years following. These savings represent approximately 1.0% - 2.0% of the actual total 2013 SES costs, increasing to 1.5%-2.9% by 2030. Given the flexibility that airlines have in filing flight plans, we anticipate that any cost savings would be immediately available.

[78] Stet.

Figure 5.8: Maximum cost savings from reduced route lengths under a common charging zone, 2020-2031



Source: Steer Davies Gleave analysis of PRR and STATFOR data

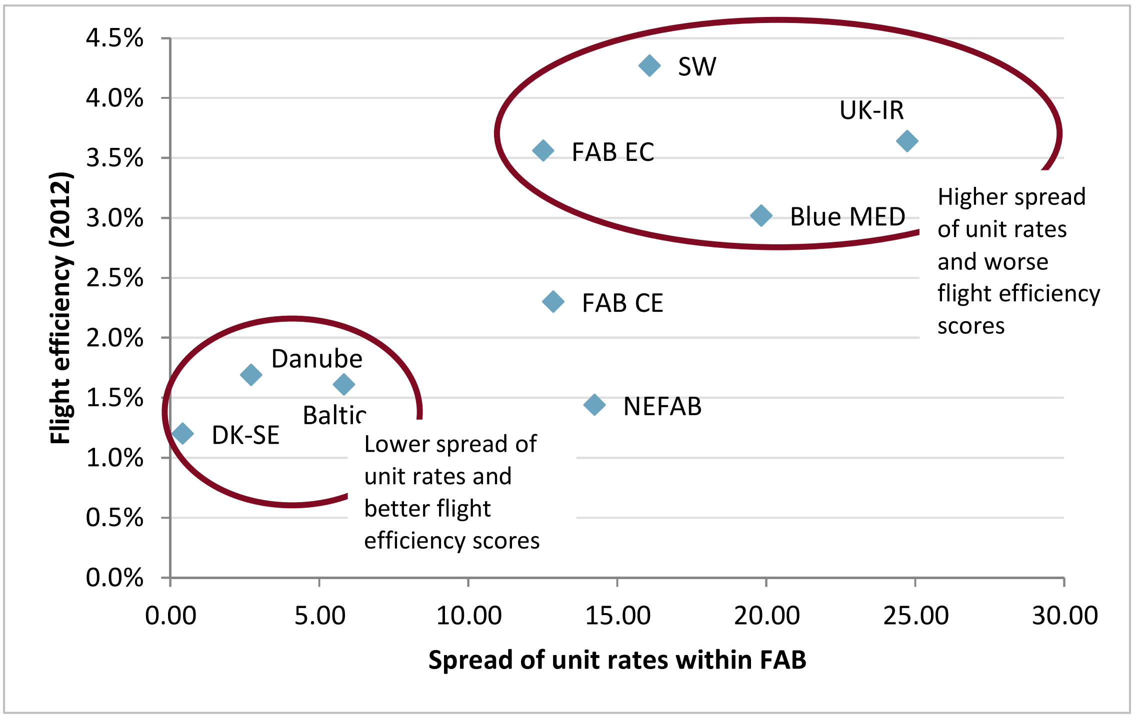
5.98 Assuming carbon dioxide emissions at a rate of 3.15kg per kilogram of fuel consumed (PRR 2012), improvements in flight efficiency that resulted from a movement towards a common charging zone would reduce CO_2 emissions by an amount in the range of 225,000 – 450,000 tonnes in 2020.

Benefits at the level of the FAB

5.99 The range of flight efficiency benefits at SES level that could arise under a common charging zone would not be distributed evenly across each of the FABs. The difference in operational and economic environments within FABs would mean that some would have greater potential for improvement than others.

5.100 Figure 5.9 shows flight efficiency scores plotted against the spread of unit rates for each FAB. FABs with a lower spread of unit rates tend to achieve better flight efficiency scores (Danube, Baltic and Denmark-Sweden FABs), while FABs with a larger spread of unit rates have a worse flight efficiency score (UK-IE, South West, Blue Med and FAB EC). While flight efficiency scores are determined by a number of factors, the comparison nevertheless suggests that the potential improvements from a movement towards common charging zones are greater in those FABs with a larger spread of unit rates across the member states. As we have seen from the literature review and stakeholder interviews, it is also these FABs that face the most significant challenges in implementing a common charging zone.

Figure 5.9: Flight efficiency vs spread of unit rates 2012



Source: Steer Davies Gleave analysis of PRU data

5.101 The table below shows, for each FAB, the size of the internal difference in unit rates, the flight efficiency score, and the percentage of total SES traffic in the FAB in 2012. SW FAB has the worst efficiency score and the third highest difference in unit rates between members, while DK-SE FAB has almost no difference in unit rates between its two members and the best flight efficiency score.

Table 5.10: FAB flight efficiency ranked by size of internal unit rate difference 2012

ANSP	Weighted average unit rate (€, 2012)	Average internal difference (€)	2012 flight efficiency	Percentage of total SES traffic
DK-SE	72.07	0.41	1.2%	4.3%
Danube	39.93	2.71	1.7%	5.1%
Baltic	37.02	5.82	1.6%	4.0%
FAB EC	69.92	12.51	3.6%	34.5%
FAB CE	52.87	12.85	2.3%	9.5%
NEFAB	53.10	14.24	1.4%	3.0%
SW Portugal-Spain	61.94	16.09	4.3%	12.8%
Blue MED	59.59	19.83	3.0%	13.9%
UK-IR	66.17	24.73	3.6%	12.9%
Total				100.0%

Source: Steer Davies Gleave analysis of PRU and CRCO data

5.102 If all FABs were to move towards a common unit rate, the maximum level of improvement seen would be in the range 0.17% - 0.34%. In reality, improvements in flight efficiency scores would be lower, as a move towards a FAB common unit rate would not eliminate the effect of different unit rates between FABs.

Moving towards common charging zones

Summary of issues

5.103 Our analysis of CRCO data shows that even in cases where FAB members have similar national unit rates, the introduction of a common charging zone at FAB level would have an immediate impact on airspace users. State ANS revenue would also be affected by a change in the unit rate and possibly an associated traffic shift, requiring necessary temporary redistribution systems be in place to enable adjustment. These issues were particularly highlighted by stakeholders in our discussions, with some providing further insight into specific issues, notably the need for workable governance and sovereignty arrangements. A summary of these issues, grouped by major theme, is presented in Table 5.11.

Table 5.11: Common charging zone: issues summary

States/ANSPs	
Gap between revenue received and costs incurred Due to charge levels Due to traffic shift	The potential economic consequences of a common charging zone at FAB level are a significant inhibiting factor for ANSPs. Primarily the issue is centred on the potential gap between revenue received and costs incurred i.e. if changes result in a loss of revenue for ANSPs but with no corresponding change in cost base. This could result from both changes in charge levels and traffic shift resulting from changes to airspace users' route choices. Implication of a loss of revenue for ANSP and resultant gap to cost base: • financial insecurity for the ANSP • lost revenue stream for State (political issue). Stakeholders reported that the prospect of traffic shift poses serious issues for single charging zone implementation – some States may lose up to 15% of traffic. However this is an indication that national boundaries and the route network as it stands may not meet the needs of customers.
Upwards cost pressure where there are differences in unit rates between ANSPs	Significant differences in unit rates between ANSPs in a FAB mean that there is a potential for unit costs under a common cost base to increase to the level of the higher-cost ANSP, rather than reduce to the lower-cost ANSP level (e.g. ATCOs in smaller States may ask for same terms as those in the larger States). These increases would outweigh any cost-efficiency pressures.
FAB Governance Issues	Stakeholders noted there are governance issues around managing a cost base at FAB level – particularly regarding where the control lies, how the revenue will be distributed, and how any required adjustments to cost bases will be monitored. FABEC noted that whilst a common charging zone would encourage greater co-operation in terms of cost management and investment, it was important to recognise that these benefits derived from the integration required to enable common charging zone implementation rather than from common charging itself.
Political issues	Stakeholders report that sovereign States do not accept proposals that uncouple costs and collection of charges by pooling and redistributing revenue. They also reported serious objections to loss of State control in setting and collecting charges.

Airspace Users	
Charge adjustment winners and losers	The redistributive effect of a change in unit cost would affect airspace users – there would be winners and losers, depending on the movement in unit rates in the areas they fly through.
Lack of conviction of operational benefits	There might be operational benefits (shorter routes) for airspace users but stakeholders report they are not convinced by this argument, citing certainty of cost increments but uncertainty of other benefits (both in likelihood and materiality).
Perception of cross-subsidising	There is a perception that users of smaller volume, lower unit cost ANSPs would be cross-subsidising the high volume, high unit cost ANSPs.

Airspace Users	
Greater impact on LCCs	Variations in charges could have a greater effect on low cost carriers as they operate at a more optimized level of controllable operating costs.

Performance Scheme	
Revenue sharing environment eases challenge on ANSP re: SES KPIs	The literature noted the risk that any revenue sharing schemes would not provide a sufficiently challenging environment for the ANSPs, meaning the SES KPIs would not be supported. Incentives would need to be maintained to encourage efficient ATM provision.
Traffic risk sharing portfolio effect means ANSPs potentially worse off in single charging zone	Stakeholders noted that under a single charging zone, ANSPs would be worse off under the current traffic risk sharing arrangements in the Performance Scheme (i.e. the portfolio effect over a larger airspace results in an increased likelihood of traffic falling within the ±2% deadband). In one FAB, this is a major obstacle to progress towards a common charging zone. However, it should be noted that the mechanism is symmetric so the impact could go both ways.
Route optimisation encouraged	Stakeholder analysis indicates that route optimisation would be further encouraged, and would be likely to improve, under a single charging zone.

Administrative	
Different incentives, exceptions and tax applications between States	States have different billing and charging methodologies: Incentives, Exceptions and Tax regimes (particularly VAT) all differ between States. The methodology for applying these differences under a single charging zone would need to be agreed prior to implementation and implemented by CRCO.
CRCO framework and operation to continue	Stakeholders and the literature highlighted the importance of CRCO collection and redistribution of revenues continuing. States do not want to have revenue distributed between them.
Changing total SUs across FAB results in increase to unit cost	The introduction of a FAB charging zone would change the total number of Service Units across the FAB (as the calculation methodology is based on great circle distance between entry and exit points to the charging zone). This would probably result in a decrease in SUs of between 1.5-3%, which would mean a corresponding increase in unit costs.
Single charging zone should not hinder other operational improvements	Timing is important – introduction of single charging zone should be implemented to aid operational improvements and not hinder them (by resulting in ANSPs competing for traffic).
Currency variations & exchange rate risk	Some FABs contain Member States with cost bases in different currencies. Revenue collection in one currency and costs in a different currency could leave the process open to exchange rate risks. We note, however, that these issues exist in the current system so they are no longer considered a major impediment under a common charging zone.

Source: Steer Davies Gleave analysis

Potential implementation measures

5.104 Any proposals for implementing common charging zones must aim to meet the objectives set out in Chapter 1, recognising that there is inevitably some tension between them. One of the biggest challenges will be to obtain universal stakeholder support; following current discussions at FAB level there is widespread opposition to the introduction of common charging from both airspace users and some state/ ANSP stakeholders. If it is to address this issue, any proposal will need to be:

- Revenue neutral at the FAB common charging level (i.e. airspace users should not pay more than they would have done under the existing arrangements);

- Practical and capable of being implemented using current billing and collection systems (albeit with some modification, for example to support changes to invoices);
- Capable of addressing the redistribution issues faced by both airlines and ANSPs, as discussed above; and
- Capable of providing incentives for performance improvement, in line with the SES Performance Scheme.

5.105 There is unlikely to be a single solution that will address every issue facing the various stakeholders. Rather, we suggest that a menu of solutions that could then be tailored to suit the particular circumstances of each FAB would need to be developed, notwithstanding the need for a pan-EU approach to addressing differential impacts on airspace users. At the same time, we note that any proposed solution for redistribution of revenues is unlikely to resolve political issues, for example the lack of willingness among Member States to 'lose control' of nationally determined unit rates and revenues.

5.106 Table 5.12 summarises our proposals for addressing each issue. More specifically:

- In the column "Decision level", we present our view of the level at which the decision should be taken - FAB or EU-wide level. We expect that this would vary according to the issue and the proposal for resolving it.
- In the column "Inclusion", we set out our view as to whether the proposal should be mandatory or optional. For example, we believe that it should be mandatory that all solutions should be implemented within the current CRCO charging arrangements, whereas FABs could be free to consider a range of incentives to their members to reduce cost bases within a revenue redistribution scheme.

Table 5.12: Common charging zone: potential solutions

States			
Problem	Proposal	Decision level	Inclusion
FAB Governance Issues	Potential for FABs to assign independent auditor/observer to monitor cost base changes. Other governance issues to be agreed by FABs	FAB-level decision and implementation	Optional
Political issues	Proposed revenue redistribution solutions cannot resolve political issues.	n/a	n/a

ANSPs			
Problem	Proposal	Decision level	Inclusion
Gap between revenue received and costs incurred Due to charge levels Due to traffic shift	Revenue redistribution system to be fair, equitable, stabilising (i.e. must mitigate against the uncertainty about ANSP's financial situation).	FAB-level decision and implementation	Mandatory
	Parameters for revenue redistribution: operational, financial, or activity-based Cost base adjustments could: Encourage gradual movement towards similar national cost bases; Allow for gradual movement to a cost base that aligns with any traffic shift that results from a movement to a common charging zone	FAB-level decision and implementation	Optional

ANSPs			
	Use of intra-FAB traffic risk sharing mechanisms to redistribute revenue.	FAB-level decision and implementation	Optional
Upwards cost pressure where there are differences in unit rates between ANSPs	Merge a sub-set of national charging zones within FAB to single charging zone, only for States with similar unit rates.	FAB-level decision and implementation	Optional
FAB Governance Issues	Potential for FABs to assign independent auditor/observer to monitor cost base changes. Other governance issues to be agreed by FABs	FAB-level decision and implementation	Optional

Airspace Users			
Problem	Proposal	Decision level	Inclusion
Charge adjustment winners and losers	Transitional arrangements will need to be considered, possibly similar to the transition changes to the Terminal Navigation Service Unit exponent factor (which led to a redistribution of user charges) providing for a nine year transition period	Union-wide: any transitional arrangements must be set and agreed at SES level.	Mandatory
Lack of conviction of operational benefits	Transitional arrangements might include scope to reflect potential operational benefits	FAB-level decision and implementation	Optional
Perception of cross-subsidising	Link to performance scheme target improvements to ensure outcomes meet expectations. Operational benefits need to be demonstrated and more certain than hitherto.	FAB-level decision and implementation	Mandatory
Greater impact on LCCs	Any solution proposed should be universally and equally applicable to all airspace users, regardless of carrier type or operational model.	n/a	n/a

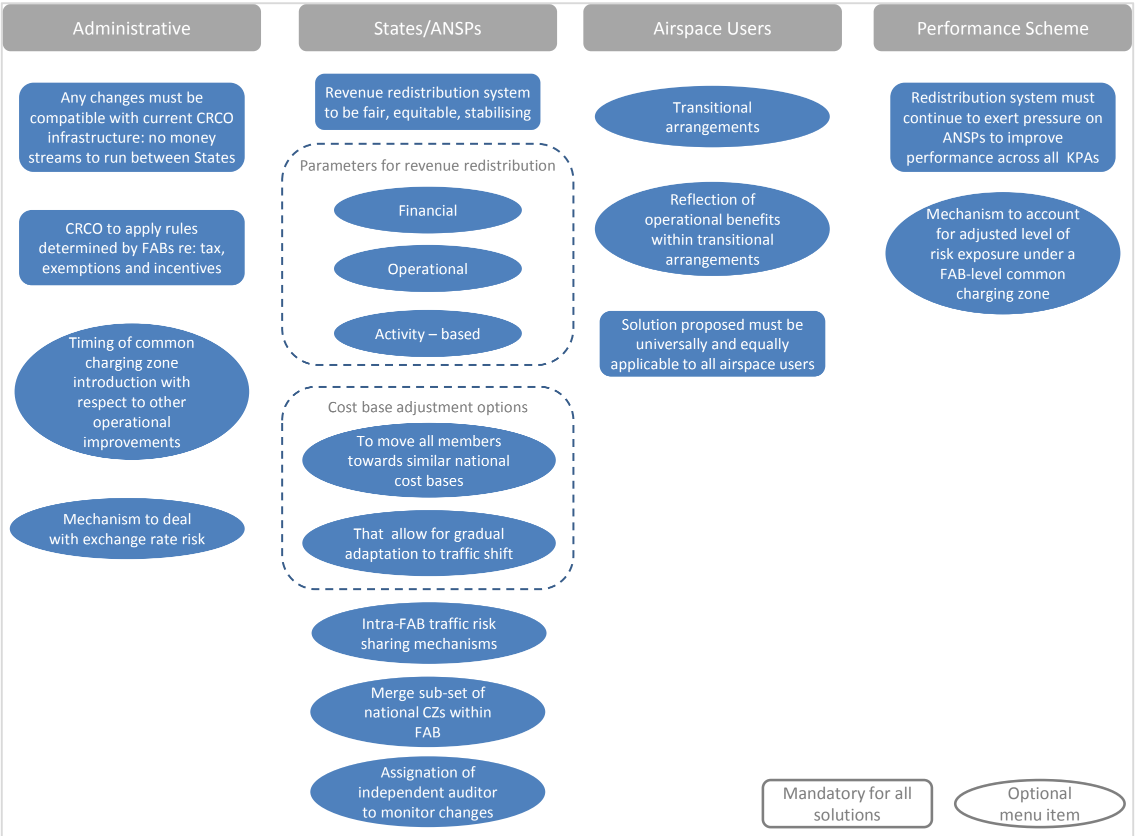
Performance Scheme			
Problem	Proposal	Decision level	Inclusion
Revenue sharing environment eases challenge on ANSP re: SES KPIs	Any redistribution system must continue to exert pressure on ANSPs to improve performance across all Performance Scheme KPAs, particularly cost-efficiency	Union-wide	Mandatory
Traffic risk sharing portfolio effect means ANSPs worse off in single charging zone	Mechanism to account for the adjusted level of risk exposure under a common charging zone at FAB level	FAB-level decision and implementation	Optional
Route optimisation encouraged	Common charging zones should encourage this.	n/a	n/a

Administrative			
Problem	Proposal	Decision level	Inclusion
Different incentives, exceptions and tax applications between States	Any change in the approach will need to be agreed and compatible with the current infrastructure available for collecting route charges. Tax schemes, liabilities and treatment to be agreed prior to implementation, CRCO to apply rules CRCO have provided provisional indication that they are capable of dealing with VAT and exemptions into account under an aggregate charging zone	Union-wide: CRCO issue Incentives & exemptions must be agreed at FAB level	Mandatory
CRCO framework and operation to continue	CRCO have provided provisional indication that they are capable of dealing with many of the issues posed under an aggregate charging zone (see above) Any redistribution rules to be applied at CRCO level and no money streams to run between States	Union-wide: CRCO issue	Mandatory
Changing total SUs across FAB results in increase to unit cost	Acknowledgement of the potential for total FAB traffic to decrease due to the SU formula calculation and the impact of this resulting in an increase in unit rate. This should NOT have a significant effect on net airspace user charges as the impact is likely to net off but may have redistributive effects.	Union-wide but no action required	No action
Single charging zone should not hinder other operational improvements	Timing is important – introduction of single charging zone should be implemented to aid operational improvements and not hinder them (by resulting in ANSPs competing for traffic)	FAB-level decision and implementation	Optional
Currency variations & exchange rate risk	Use of hedging instruments might be considered at FAB level.	FAB-level decision and implementation	Optional

Source: Steer Davies Gleave analysis

5.107 Figure 5.10 summarises our proposals and shows whether, in our view, they should be a mandatory (if represented by a rectangle) or optional (if represented by an oval) part of the overall implementation.

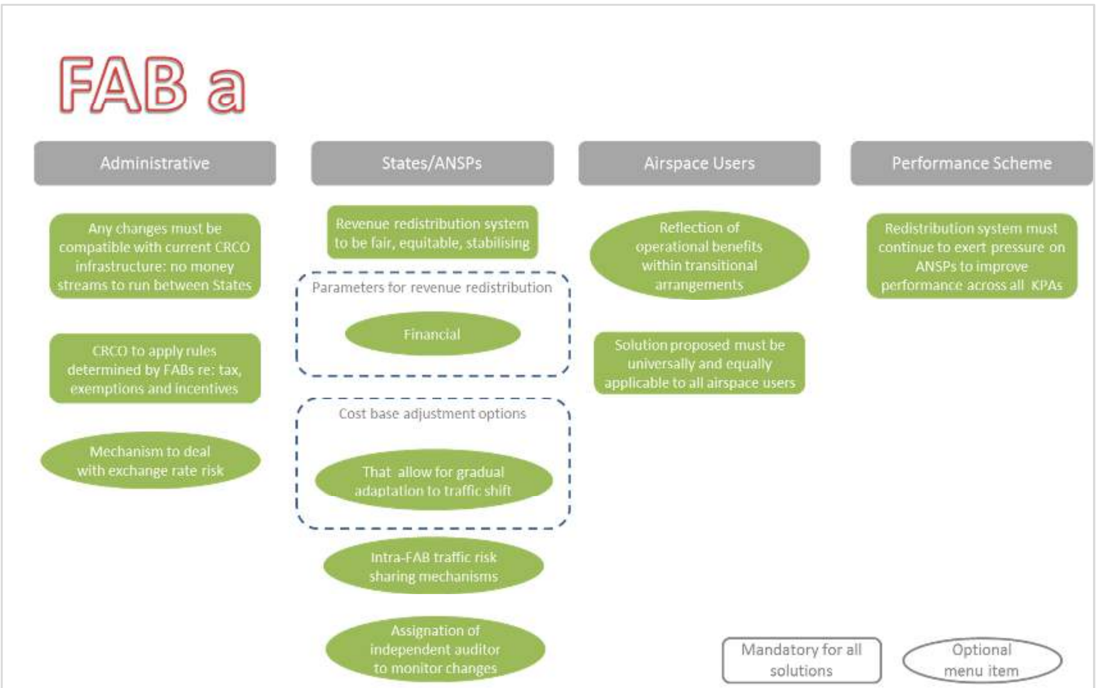
Figure 5.10: Summary of potential solutions that each FAB may consider



Source: Steer Davies Gleave

5.108 Given that different FABs may take different decisions for those proposals over which they have some flexibility, solutions may differ between FABs, as illustrated in Figure 5.11):

Figure 5.11: Illustration of a possible solution at FAB level



Source: Steer Davies Gleave

5.109 In our conclusions and recommendations, we highlight areas where further investigation or policy development may help unblock barriers to the introduction of common charging zones. However, we emphasise that in order to meet the objectives set out in Chapter 1, in particular the objective of credibility, for work will be needed to demonstrate both the benefits and potential for practical implementation.

Relationship with other aspects of ANS policy

5.110 As noted above, a move towards common charging zones would probably result in some improvement to the flight efficiency Key Performance Area (KPA), but the potential size of this benefit is uncertain. Using data and analysis included in the Performance Review Reports for 2010, 2012 and 2013, we have estimated that the maximum improvement in the flight efficiency KPA is 0.17%-0.34%. Assuming this was achieved in 2020 at the earliest (following the end of RP2), and that airspace users were able to modify their flight paths to reflect the fact that the shortest distance for the flight was also the most cost effective (from their perspective), we estimate annual savings in the region of €70-140 million (2009 prices). These would comprise a reduction in fuel consumption and a reduction in CO_2 emissions of 225,000-450,000 tonnes per annum. Given the limitations of the available data, it is not possible to disaggregated these savings by FAB in a robust way.

5.111 In principle, there might be benefits in terms of reduced delay through facilitation of Free Route Airspace, although common charging zones are not a necessary precondition for the introduction of Free Route Airspace. There are also a number of relationships between common charging zones and some of the other charging initiatives covered by this report, notably congestion charging. In particular, we consider the introduction of common charging zones would facilitate the introduction of congestion charging, since it would enable charges to be calibrated across a wider geographical area and address potential charging anomalies on the borders between ANSPs (although not on the borders between FABs).

Conclusions and recommendations

Evaluation of options

5.112 The results our evaluation of the two options for distribution of revenue under common charging zones are summarised in the table below. We conclude that the implementation of either option would be challenging, particularly given the stakeholder concerns expressed in the course of this and other studies. Moreover, we note that the introduction of common charging zones must be considered in the context of the wider challenges relating to the establishment of workable governance, management and financial arrangements for FABS.

Table 5.13: Evaluation of options for revenue distribution under common charging zones

	Option	
	CZ1	CZ2
Summary of option	Revenues collected according to common unit rate and number of service units within the FAB, preserving revenue neutrality. Revenues distributed in proportion to the underlying cost base of each member ANSP.	Revenues collected according to common unit rate and number of service units within the FAB, preserving revenue neutrality. Revenues distributed according to the number of service units within each FAB.

	Option	
Economic efficiency	Introduction of common unit rates at the FAB level would improve flight efficiency by removing distortions. However, any differences in the underlying level of efficient costs between ANSPs would no longer be reflected in charges, although there would be some pressure to adjust cost bases in line with revised traffic levels. In addition, there could be pressure for ANSP cost bases to converge on the highest level (e.g. due to comparability of staff terms and conditions and consequent changes to contracts within individual ANSPs).	Introduction of common unit rates at the FAB level would improve flight efficiency by removing distortions. However, any differences in the underlying level of efficient costs between ANSPs would no longer be reflected in charges, although individual ANSPs would face pressure to bring their cost bases into line with revised traffic levels (as measured by service units). In addition, there could be pressure for ANSP cost bases to converge on the highest level (e.g. due to comparability of staff terms and conditions and consequent changes to contracts within individual ANSPs).
Intelligibility	Would simplify charging arrangements for airlines, although a common unit rate would also result in winners and losers. The introduction of transition arrangements would complicate the charging regime while providing temporary relief from adverse changes in ANS charges. In principle, changes from the perspective of ANSPs would be limited, although issues such as the need for common approaches to taxation could introduce complexity.	Would simplify charging arrangements for airlines, although a common unit rate would also result in winners and losers. The introduction of transition arrangements would complicate the charging regime while providing temporary relief from adverse changes in ANS charges. The impacts on ANSPs could be difficult to forecast, and the need for transitional arrangements for those losing significant traffic would add to the complexity of the arrangements.
Revenue/cost neutrality	In principle, would preserve revenue/cost neutrality at the FAB and ANSP level, although individual ANSP cost bases could move out of line with traffic levels.	In principle, would preserve revenue/cost neutrality at the FAB level, but ANSP revenues would be likely to change significantly as a result of the introduction of a common unit rate and a shift in traffic levels. The immediate impact could be mitigated through transitional arrangements.
Minimal administration costs	Could be implemented using existing CRCO systems but there would be implications for ANSP and airspace user systems.	Could be implemented using existing CRCO systems but there would be implications for ANSP and airspace user systems. The need for transitional arrangements would result in additional CRCO administration and monitoring activity.
Credibility	Unlikely to be seen as credible by airspace users given the substantial impact on ANS charges paid by individual users, notwithstanding the potential to introduce transitional arrangements. ANSPs would also consider implementation in advance of resolving broader issues surrounding the governance and operational and financial management of FABs as inadvisable.	Unlikely to be seen as credible by airspace users given the substantial impact on ANS charges paid by individual users, notwithstanding the potential to introduce transitional arrangements. ANSPs would also consider implementation in advance of resolving broader issues surrounding the governance and operational and financial management of FABs as inadvisable. The potential impact on individual ANSPs could be expected to result in further opposition, although this might be addressed through transitional arrangements.

Source: Steer Davies Gleave analysis

Conclusions and recommendations

5.113 Our review of the literature, consideration of stakeholders' views and analysis have demonstrated that there are significant challenges in introducing common charging zones across the SES. While the terms of reference focus on revenue redistribution and the potential benefits from reducing route extension, there are also a number of other issues to be addressed to ensure a practical approach to implementation. These include the governance and political issues associated with the change, as well as the administrative practicalities and the interaction with other aspects of EU ANS policy.

5.114 Our analysis shows that the reduction in route extension benefits is likely to be greatest in complex FABs (containing members with larger differences in their national unit rates). Hence, although implementation might be easier in Danube, SK-DE and Baltic FABs, the operational benefits would be lower. Conversely, although the potential operational benefits would be higher, the complexity in terms of the number of States and currencies and size of the differences in cost base means establishing common charges for FABEC, BlueMed and UK-IRL would be more challenging.

5.115 Although the maximum potential benefits from introducing common charging at a FAB level could be significant for the SES as a whole (€70-140 million per annum), it is not possible to reliably disaggregate these by FAB (although we understand the PRB is currently investigating benefits at the FAB level). Moreover, where FABs have suggested potential operational benefits to airspace users, the latter have regarded these as less certain than the change in costs (generally expected to be adverse). Additional work is therefore needed to quantify the benefits with greater confidence.

Recommendation D1:

Support should be provided for the independent estimate of the likely benefits to airspace users of a movement to common charging at a FAB level. The analysis would need to be seen to be independent and unbiased to be acceptable to airspace users.

5.116 In enabling the introduction of common charging schemes, transitional arrangements might be considered for both airspace users and ANSPs. For airspace users, a transition from the current charges to a common charge might take place over five years (a Reference Period), with the winners and losers and the impacts only fully established at the end of the period.

5.117 For ANSPs, the biggest challenge would be the impact on their businesses from changes in airspace user behaviour. This is difficult to predict ex-ante, but ex-post would lead to some ANSPs accommodating more Flight-Hours and others less. This could be addressed if resourcing and sector configuration were organised at a FAB rather than national level but this would take time to implement. Some form of allowance or incentive should therefore be considered to allow for the reorganisation associated with restructuring of airspace.

Recommendation D2:

To encourage the introduction of common charging schemes, transitional arrangements for airspace users and ANSPs may be considered.

5.118 We understand from discussions with the CRCO that its billing and revenue distribution systems would be able to accommodate the options considered in this study. However, this claim needs further investigation.

Recommendation D3:

We suggest that the system implications of common charging zones should be investigated further through a shadow running process. In particular, the ability to calculate two sets of

charges, one based at a State level and one at a FAB level, and to phase such an impact over a five year period should be the subject of a real time test.

6 Overall conclusions

Relationship between modulation of charges schemes

6.1 Our Terms of Reference require us to report on the inter-relationship between the different modulation and realignment of charges schemes covered by the study. We have therefore considered their compatibility as well as the potential for one scheme to facilitate another and for synergies in implementation. Notwithstanding the major issues raised in each case, as described in the previous chapters, we have concluded that the schemes are consistent with one another and that they could operate in parallel. More specifically, in principle it is possible to envisage an overall EU framework for ANS charges that provided for, inter alia:

- Charging for en-route ANS on the basis of common unit rates established at the FAB level;
- A realignment of charges with respect to the underlying distribution of en-route and terminal costs;
- The payment of congestion charge supplements in order to encourage a more efficient use of available airspace; and
- Temporary incentivisation of airspace users to equip their aircraft with SESAR technology such as AF6.

6.2 However, while the development of such a comprehensive framework for economically efficient ANS charges might be a reasonable long term objective, we consider that it would be inappropriate to seek to implement all these modulation of charges schemes in parallel within the timeframe of, say, a single Reference Period. This is partly because the implementation in each case would be subject to major challenges of the kind already identified, but also for a number of reasons related to the interaction of both the schemes themselves and their associated implementation programmes.

6.3 First, as we have sought to make clear in our recommendations, a substantial volume of work is needed to further investigate the merits of each modulation scheme, the scope for its practical implementation and the resource, systems and other costs associated with its operation. In all, we have made 18 recommendations, including a number involving simulation, systems development or other work requiring active stakeholder participation. These recommendations should only be taken forward as part of a set of integrated work programmes that fully reflect the demands of other industry workstreams and associated stakeholder resource constraints, not least the Performance Plan targets for ANSPs and the competitive environment of airspace users.

6.4 Second, the issues and challenges to be addressed in the case of each modulation scheme, some of which are interrelated, imply substantially different timescales for implementation with opportunities to review, modify or even abandon proposals at different stages. In particular, we note that:

- A number of SESAR technologies are already in development and, if they are to deliver significant benefits within the timescales currently envisaged, should be deployed (and their adoption therefore incentivised) within the current Reference Period. This would mean the introduction of an incentive scheme, coupled with supporting funding arrangements.
- There is no support among stakeholders for a major realignment of en-route and terminal charges, and any move to such a change would need to be preceded by a more thorough policy analysis than has been possible in the course of this study. This would need to take account of the long term implications, and hence the desirability, of rebalancing charges in a way that favoured airlines flying over the EU relative to those operating within it. At the same time, modifications to ANSP reporting requirements to support a better understanding of the relative costs of en-route and terminal ANS (for example, the introduction of a requirement to report disaggregated ATCO hours) could be implemented relatively quickly.
- The introduction of common charging zones could only be achieved following the establishment of governance as well as operational and financial management arrangements for FABs, the realistic timescale for which at least one FAB considers to be seven to eight years (even in the absence of political concerns). Again however, further work to demonstrate the benefits of common charging could usefully be undertaken within a much shorter timescale, possibly building on current PRU work to isolate the benefits of Free Route Airspace.
- Any implementation of congestion charging should be timed to take advantage of the synergies with introduction of common charging zones, for example a single exercise to recalibrate en-route ANS charges for the FAB while introducing congestion supplements at the sector level, and a comprehensive programme to undertake all required monitoring and billing system investment and modification. We also suggest that the design of a congestion charging scheme should take account of patterns of congestion arising after the implementation of Free Route Airspace, although further investigation of sector capacity and demand should be undertaken in advance.

6.5 Third, we consider that the introduction of a number of modulation schemes within a relatively short timescale, even if it were practical given resource constraints, would be inadvisable as the resulting price signals would be difficult for stakeholders to interpret. Parallel implementation could, for example, lead to the following changes either simultaneously or in quick succession, potentially giving rise to confusion and economically inefficient decisions:

- Common charging zones would result in the cost of flying on some routes rising while the cost of flying on others fell;

- The introduction of congestion charging could have the effect of exaggerating differentials, albeit in respect only of flights through congested sectors versus flights through uncongested airspace;
- A rebalancing of charges between en-route and terminal airspace would further complicate pricing signals; and
- Any temporary incentives introduced in order to encourage early adoption of SESAR technology could be difficult for airspace users to assess against a background of other changes.

6.6 We emphasise that this does not mean that the schemes could not operate in parallel if they were well established, only that different and potentially conflicting price signals would be difficult to read if introduced at the same time.

Prioritisation of recommendations

6.7 In the light of these considerations, we have sought to prioritise our recommendations, taking account of the timescales for further investigating, consulting on and possibly implementing the various modulation of charges schemes, the expected benefits of implementation and the likely level of support among stakeholders. The table below summarises the factors considered in determining our proposed prioritisation.

Table 6.1: Factors considered in prioritising modulation of charges schemes

Modulation of charges scheme	Estimated benefits	Timescales for implementation	Stakeholder support
Congestion pricing	€0.9 billion per annum from elimination of en-route delays if 2012 levels of delay persist. Benefits may fall to €0.27 billion per annum if RP2 targets are achieved.	Up to 10 years if implemented in conjunction with common charging zones.	Strong resistance from both airspace users and ANSPs.
Realignment of en-route and terminal charges	Difficult to estimate. Realignment could significantly disadvantage European airspace users.	Theoretically possible to implement within 5 years, although improved transparency could be achieved in a shorter timescale.	Strong scepticism among ANSPs and concerns among airspace users about impact on terminal charges. General support for greater transparency however.
Incentivisation of SESAR	AF6 not expected to deliver positive benefits in short to medium term, but could unlock substantial benefits for the wider SESAR programme.	Could be introduced within two years providing appropriate financing mechanisms can be put in place.	Scepticism among stakeholders about the likely benefits, particularly in the light of experience with Data Link.
Common charging zones	€68 – 136 million per annum in 2020, depending on the level of improvement in flight efficiency.	Up to 10 years given the need to address related issues surrounding the governance and management of FABs.	Strong resistance from airspace users, particularly given scepticism about the impacts in terms of flight efficiency and concerns about the potential for inflation of ANSP cost bases.

6.8 The tables below set our suggested prioritisation of recommendations based on consideration of these factors, distinguishing between the short term (within the next two years), the medium term (in three to five years) and the long term (in six to ten years). Priorities might need to change, not least in response to the consultation exercises that are themselves included in our recommendations.

Table 6.2: Short term priority recommendations – within the next two years

Recommendation		Rationale for prioritisation
A3	We recommend that the current Regulations 390/2013 and 391/2013, relating to incentive schemes for ANSPs is reviewed with the aim of determining whether an increase in the value of incentives, above the value of one per cent of revenue permitted under current legislation, could provide an effective impetus to enhance capacity.	We suggest that any modifications to the guidance in order to strengthen incentives are developed in advance of RP3.
A4	We recommend that consideration be given to the introduction of an operational performance regime, based on the payment of rebates determined according to the level of delay incurred.	This would help to incentivise improvements in ANSP efficiency in advance of the development of a congestion charging scheme, and should ideally be implemented in RP3.
B1	Transparency of cost allocation principles and metrics used, as required by the Charging Regulation, should be better enforced. Principles should also be developed to ensure more consistent enforcement by NSAs.	This would reaffirm stakeholder confidence in the Charging Regulation objectives.
B2	Consideration should be given to clarifying the definitions of terminal, approach and en-route services for the purposes of legislation and supporting policy guidance.	This would help to inform the development of cost allocation methodologies and should ideally be undertaken prior to RP3.
B3	We recommend that the option of bottom-up cost allocation is not pursued.	An early statement that the Commission does not intend to pursue an onerous, bottom-up exercise would reassure the industry.
B4	We recommend that information on ATCO hours, disaggregated by en-route and terminal activity, should be reported by ANSPs as part of their Reporting Tables.	This information would help to inform the development of cost allocation methodologies and a requirement to report it should be in place by the start of RP3.
B5	We recommend that consideration should be given to mandating the organisational and financial separation of ANS and airport businesses where these are currently undertaken by a single corporate entity.	While a requirement to separate these businesses could be established within a short timescale, policy should allow a reasonable timescale (a further two to three years) for implementing the separation itself.
C1	We recommend the preparation of a statement of principles to underpin the design of a modulation of charges scheme, explicitly drawing on the lessons of Data Link.	Would reassure stakeholders in advance of the further development of an incentive scheme. Stakeholder support is essential if the scheme is to be progressed rapidly.
C2	We recommend that AF6 is subject to an independent review, commissioned as appropriate, in order to validate the associated costs and benefits.	This would establish the case for an incentive scheme prior to any substantial development work.

Recommendation		Rationale for prioritisation
C3	We recommend that through the incentive scheme airspace users should not receive any more in incentive payments than is necessary to ensure that they equip their aircraft with the required technology. We also recommend that appropriate compensation is considered to airspace users in the event that they are unable to derive material benefits from equipping of aircraft due a failure on the part of ANSPs to undertake sufficient investment on the ground.	Early confirmation of this would help to establish the credibility of the scheme.
C4	We recommend that any scheme for incentivising the adoption of SESAR technology should be a discount only scheme.	Early confirmation of this would help to establish the credibility of the scheme.
C5	We recommend that the Commission investigates other funding sources.	Suitable funding sources need to be established as a matter of urgency.
D1	Support should be provided for the independent estimate of the likely benefits to airspace users of a movement to common charging at a FAB level. The analysis would need to be seen to be independent and unbiased to be acceptable to airspace users.	Early progress on this issue would determine whether there was a case for progressing further work on common charging zones.

Table 6.3: Medium term priority recommendations – in three to five years

Recommendation		Rationale for prioritisation
A1	We recommend that the focus of further development work should be on en-route rather than terminal congestion charging.	Not an immediate priority, but the focus of the initiative on en-route should be confirmed at an early stage to provide direction to further development.
D3	We suggest that the system implications of common charging zones should be investigated further through a shadow running process. In particular, the ability to calculate two sets of charges, one based at a State level and one at a FAB level, and to phase such an impact over a five year period should be the subject of a real time test.	The systems implications of common charging zones should be thoroughly investigated prior to the start of any implementation programme. However, there would be a need to make some system changes to enable shadow running, and time should be allowed to enable this.

Table 6.4: Recommendations for the longer term – in five to ten years

Recommendation		Rationale for prioritisation
A2	We recommend that any further work on the appropriate level of congestion charges should focus on the option of introducing a fixed supplement into the existing charging formula.	Should be undertaken as part of an implementation programme. Would need to take account of flight economics at the time, as determined by aircraft technology, fuel and carbon prices and other factors.
D2	To encourage the introduction of common charging schemes, transitional arrangements for airspace users and ANSPs may be considered.	May be considered as part of an implementation programme. Would need to take account of ANSP and FAB economics, including relative levels of efficiency and differences in unit rates, at the time.

A Appendix A - Stakeholder consultation

Workstream A

A.1 For Workstream A, we did not undertake a formal and comprehensive consultation with all stakeholders as we considered that it would be appropriate to develop proposals, which could be subject to such a consultation, first. We did, however, engage with a range of parties in order to improve our understanding of the practical issues surrounding congestion charging and test various propositions relating to its implementation. This engagement included discussions with stakeholder representative bodies, in particular CANSO and airspace users representatives (IATA, AEA, IACA, ELFAA, ERAA), as well as with individual organisations with direct experience of planning and charging for the use of European airspace.

A.2 The table below sets out the organisations contacted in the course of Workstream A.

Appendix Table A.1: Workstream A: Stakeholders contacted

Stakeholder Group	Specific organisation(s)	Response
SES congestion charging expert	University of Belgrade	Telephone interview
Airspace Users	British Airways	Meeting held
	IATA, AEA, IACA, ELFAA, ERAA	Meeting held
ANSP	NATS	Meeting held
	CANSO	Meeting held
NSA	FABEC	Meeting held
Data and capacity experts	Eurocontrol	Telephone interview

Workstream B

A.3 As part of this workstream, we examined the regulatory framework applying to en-route and terminal cost allocation, as well as the treatment of approach sector costs, and analysed Eurocontrol's ATM Cost-Effectiveness ACE data to identify the apparent range of cost allocation methods in use across the EU. This analysis enabled us to determine a sample of ANSPs for further consideration, which we agreed with the Commission. We subsequently prepared a questionnaire on the allocation of costs to activities, and the apportionment of approach costs to en route and terminal, which was sent to the sample of ANSPs as well as to a number of National Supervisory Agencies (NSAs).

A.4 Following review of our Intermediate Report, we requested further information from ANSPs and NSAs on the principles of, and rationale for, cost allocation between en-route and terminal activities. In the event, only a limited number of ANSPs responded to our request for further information and we arranged a telephone interview with appropriate ANSP representatives in each case . The findings from a review of this additional information informed the identification of possible metrics and the approach to the analysis of possible options for harmonisation. The table below shows the level of engagement with each of the ANSPs in our sample in the course of Workstream B.

Appendix Table A.2: Workstream B: ANSPs stakeholders

ANSP	State	Contacted	Questionnaire	Clarifications	Interview
Aena	Spain	✓	✓	✓	
BelgoControl	Belgium	✓	✓	✓	
DFS	Germany	✓	✓	✓	✓
DSNA	France	✓	✓	✓	
Finavia	Finland	✓	✓	✓	
Hungaro-Control	Hungary	✓	✓	✓	✓
LVNL	Netherlands	✓	✓	✓	
NATS	UK	✓	✓	✓	✓
Skyguide	Switzerland	✓	✓	✓	
LPS	Slovakia	✓			
LFV	Sweden	✓	Referred to NSA		✓
ANA	Luxembourg	✓	Declined		
ANS CR	Czech Republic	✓	Declined		
CANSO	European-wide	✓		✓	

A.5 We also contacted a number of NSAs and obtained some responses from them, as summarised in the table below.

Appendix Table A.3: Workstream B: NSA stakeholders

NSA	State	Contacted	Questionnaire	Clarifications
UK CAA	UK	✓	✓	✓
DTA	France	✓	✓	
IVW	Netherlands	✓	✓	
Transportstyrelsen	Sweden	✓	✓	
DG Transport aérien	Belgium	✓	Joint with ANSP	
FOCA	Switzerland	✓	Joint with ANSP	
CAA (Czech Republic)	Czech Republic	✓	Declined	
CAA (Finland)	Finland	✓	Declined	
BAF	Germany	✓	Referred to ANSP	
CAA Luxembourg	Luxembourg	✓	Referred elsewhere	
AESA	Spain	✓	Declined	
CAA (Slovakia)	Slovakia	✓	Declined	
NTA, AA	Hungary	✓	Declined	

Workstream C

A.6 In Workstream C, we held face-to-face and telephone meetings with stakeholders from the aviation industry in order to discuss SESAR technology, experience from previous attempts to encourage the deployment of new technology and potential funding options. We also met with a number of rail industry stakeholders in view of the potential learning from incentivisation of equipping of trains with technology in support of the European Rail Traffic Management System (ERTMS). The stakeholders contacted are shown in the tables below.

Appendix Table A.4: Workstream C: Aviation stakeholders

Stakeholder Group	Specific organisation(s)	Response
European stakeholders	SESAR JU	Telephone interview
	Eurocontrol	Telephone interview
	Unit E2 (SES), DG MOVE	Telephone interview
	INEA	Telephone interview
Airspace users	IATA	Telephone interview and meeting held
	AEA	Telephone interview and meeting held
	IACA	Face-to-face meetings held
	ELFAA	Written responses received and meeting held
	ERAA	Face-to-face meeting held
	EBAA	Declined to participate

Stakeholder Group	Specific organisation(s)	Response
ANSPs	CANSO	Meeting held
Technology providers	ASD Europe	Face-to-face meeting held
Aircraft manufacturers	Airbus	Face-to-face meeting held
	Boeing	Telephone meeting held

Appendix Table A.5: Workstream C: Financing stakeholders

Stakeholder Group	Specific organisation(s)	Response
European institutions	European Commission Unit B4 (CEF), DG MOVE	Face-to-face meeting held
	European Investment Bank	Telephone conference held

Appendix Table A.6: Workstream C: Rail stakeholders

Stakeholder Group	Specific organisation(s)	Response
European	DG MOVE – TEN-T unit	Face-to-face meeting held
	European ERTMS Coordinator	Face-to-face meeting held
Belgium	Federal Ministry of Transport	Face-to-face meeting to discuss modulation of charges for ERTMS
	Infrabel	Face-to-face meeting held

Workstream D

A.7 For Workstream D, we contacted stakeholders with relevant experience of establishing FABs, in particular FABEC (which includes a number of ANSPs with significantly different charges and cost structures) and FAB Danube (with only two ANSPs, each charging broadly similar prices). The table below shows the stakeholders contacted.

Appendix Table A.7: Workstream D: Stakeholders contacted

Stakeholder Group	Specific organisation(s)	Response
Expert	Independent	Telephone meeting held
ANSP	HungaroControl	Telephone meeting held
ANSP	DFS	Telephone meeting held
ANSP	DSNA	Written submission received
ANSP	Bulatsa	Declined to participate
NSA	ENAC (Italy)	Telephone meeting held
NSA	Naviair	Declined to participate
NSA	FABEC	Face-to-face meeting held

B Appendix B - Cost harmonisation

Allocation of costs to activities

AENA (Spain)

B.1 AENA described its approach as being activity-based costing (ABC), with rules for the allocation of each cost category. It noted that ATCO staff costs, and other staff costs, are allocated to en-route, approach and terminal according to the "sectors/positions" operated in each operational cost centre. It is unclear as to whether this response is for the whole of Aena ANS or for its Continental activities only.

B.2 AENA considered that its methodology, designed by PwC and subject to several audits, was compliant with the current legislation, reflected the direct costs of providing services, and had no disadvantages.

ANS CR (Czech Republic)

B.3 ANS CR have not responded to the questionnaire, but the Performance Plan for RP2 states that costs are allocated to cost centres and identified to activities in the accounting and budgeting systems. Allocation of "indirect-joint" costs, such as training and administration, between the two main cost bases is based on "Composite Flight Hours".

BelgoControl (Belgium and Luxembourg)

B.4 BelgoControl described its approach as being activity-based costing (ABC), taking into account the organisational structure, ATCO staff numbers and territory controlled, with rules for the allocation of each cost category. BelgoControl's Performance Plan for RP2 provides further details of methodology, such as the disaggregation by service and the structure of cost centres.

B.5 BelgoControl stated that ATCO staff costs are directly allocated to the activity they work on. We have not been able to clarify whether this means all ATCOs are direct (dedicated to an activity) or that they fill in timesheets or that that the sectors/positions operated by activity are counted.

B.6 BelgoControl considered that its system of over 500 cost centres, with every staff member and cost item linked to a cost centre, allocated costs as directly as possible to activities and was transparent and very flexible.

DFS (Germany)

B.7 DFS described its approach as being partly activity-based costing (ABC), taking into account operational, financial and organisational responsibilities, working positions and territory controlled, with rules for the allocation of each cost category. DFS also noted that interest in liabilities was allocated on the basis of total costs, but the cost of capital was an individual calculation for each asset. The same approach was used to allocate approach ANS between en route and terminal charges.

B.8 DFS referred to Chapter II of Regulation (EU) No 391/2013 and stated that all data were taken from its accounting system, with total cost charged to en route or terminal according to actual demand and considering the objectives set by the NSA. The resulting system was compliant and transparent. DFS conceded that the system was complex compared to the use of “simple keys”, but was a better reflection of cost drivers.

DSNA (France)

B.9 DSNA provided as supplementary information an extract from its Performance Plan for RP1 stating that the cost analysis was based on a pyramid organisation of the management plan: 55 “cost-accounting units”, in turn divided into around 400 “cost centres”, more specialised bodies to which staff and technical installations are allocated. Its approach did not explicitly subdivide time spend by individual staff, but did take account of ATCO staff numbers, the share of human resources necessary for each service, the organisational structure and the flight kilometres controlled, with rules for the allocation of each cost category.

B.10 DSNA’s Performance Plan for RP2 provided further details of methodology and stated that the ratio takes into account “the share of human resources” necessary for each service, such as the disaggregation by service and the structure of cost centres.

B.11 DSNA provided an extract from an earlier document which explained that the allocation of approach costs takes into account factors such as the following:

B.12 Air traffic Control Centres (ACC) are allocated 100% to en route, and small aerodrome centres (TWR) are allocated 100% to terminal, but aerodromes with approach control are apportioned between en route and terminal;

B.13 VOR remote from aerodromes are allocated 100% to en route, VOR near controlled aerodromes are apportioned partially to terminal, and ILS are allocated 100% to terminal.

B.14 Staff and general operating costs for large TMAs are apportioned to en route and terminal taking into account the proportion of transit traffic and the dimension of the controlled airspace relative to the “20 kilometre rule”.

B.15 The extract also stated that costs relating to administrative support activities were only apportioned at the end of the process and are prorated across en route and terminal (as an uplift on costs already allocated and apportioned).

B.16 DNSA stated that its method for allocating costs between en route and terminal aimed to get close to “the real world”, but conceded that there was a certain complexity due, inter alia, to the number of operational and other units.

Finavia (Finland)

B.17 Finavia did not responded to the questionnaire, but the Performance Plan for RP2 stated that the cost base of en route services includes:

B.18 The costs of the Air traffic Control Centre (ACC);

B.19 Approximately 40% of ANS costs of five airports which have a separate approach unit, at which the “20 kilometre rule has been applied”;

B.20 Part of the centralised services (such as Technical, Air Navigation Services (ANS) and Aeronautical Information Services (AIS); and

B.21 Part of the overhead costs of Finavia headquarters.

B.22 There is no description of the allocation and apportionment rules applied.

HungaroControl (Hungary)

B.23 HungaroControl described its approach as being partly activity-based costing (ABC), with any apportionment of approach costs between en route and terminal being on the basis of average distance flown. On this basis, 85.94% of approach costs are allocated to en route charges.

B.24 HungaroControl stated that all costs clearly identifiable as either en route or terminal were registered to their own cost category, and that approach direct costs are allocated on the basis of average distance flown, allocated half each to en route and terminal. All costs that cannot be identified to one of Air traffic Control Centre (ACC), Approach control (APP) or Aerodrome control (TWR) are shared in proportion to the average distance flown between en route and terminal. A claimed advantage of the system is that a very large part of costs is limited to actual users, with limited scope for cross-subsidies, and a single allocation system brings simplicity and hence value for money. The ANSP did, however, acknowledge that simplicity can result in generalisation of some cost categories.

LFV (Sweden)

B.25 LFV describes its approach as being based on flight kilometres controlled, with every cost item being allocated 75% to en route, 18.5% to approach and 6.5% to terminal.

B.26 LFV’s Performance Plan for RP2 stated that LFV uses an accounting model with costs separated into cost centres or operational sites, and the net result of a cost centre is allocated to en route costs using predetermined allocation figures.

B.27 LFV has a standardised approach for all costs, with each airport allocated to one of four categories with a specified percentage distribution, based on the distance from the runway to the Final Approach Point (FAP), between en route and terminal. The stated advantage is that it was convenient and manageable to use a standardised cost allocation method, but a disadvantage was that it can be somewhat misleading for some airports.

LPS

B.28 LPS did not responded to the questionnaire, but the Performance Plan for RP2 stated that facilities and services which serve both en route and terminal activities are allocated through application of an “allocation key”, reviewed annually, which is based on the share of terminal and en route IFR movements. Approach costs are the allocated to satisfy the “20 kilometre” rule, with different allocation rates including:

B.29 Terminal units or tons controlled, for allocation to aerodromes;

B.30 ATCO hours controlled, for allocation between approach (APP) and aerodrome (TWR) control; and

B.31 Distance controlled, for allocation of approach between en route and terminal.

LVNL (Netherlands)

B.32 LVNL stated that its approach is not activity-based costing (ABC), but it does take into account allocation on the basis of factors including number of flights, frequencies and staff numbers. 21% of approach costs are allocated to en route charges, but there was no statement of how this is done.

B.33 LVNL's Performance Plan for RP2 states that the costs of providing ANS above FL 30 or more than 18 kilometres from LVNL-controlled airports is allocated to the en route charging zone, the costs of ATCOs are directly allocated to the relevant charging zone, and there are "sharing keys" to allocate other costs to charging zones. The stated advantage of this system is its compliance with operational requirements.

NATS (United Kingdom)

B.34 NATS describes its approach as being activity-based costing (ABC), taking into account the organisational structure, with SAP used to allocate costs, including timesheets, to activities and drivers used to allocate costs to services. NATS's Performance Plan for RP2 provided no additional information but notes that under NATS's licence arrangement, revenue from other services is offset against the en-route cost to reduce the overall en-route charges.

B.35 NATS stated that the majority of costs did not need allocation as they are incurred by separate companies, and that many other costs are subject to inter-company agreement for specific services. Allocation, within NERL, to en-route and London approach is carried out mainly on the basis of controller workstations with other cost allocations based on an appropriate mix of drivers. The stated advantages are that the approach allows appropriate and verifiable allocations to internal projects, external income and contract reporting, is consistent and compliant with ICAO Document 9161, and stakeholders can be confident that NERL's licence requirements are being met using best practice cost allocation approaches.

B.36 The UK NSA, the Civil Aviation Authority, provided a separate response to the questionnaire which duplicated NATS' responses.

Skyguide (Switzerland)

B.37 Skyguide did not state what methods are used to allocate costs but indicated that they include the organisational structure, ATCO staff numbers and territory controlled, with allocation rules such as direct cost, use of frequencies, controlling working positions and other drivers. Approach costs are allocated between en route and terminal charges according to operational shifts.

B.38 Skyguide's Performance Plan for RP2 stated that these costs include training of future ATCOs, some flight data management costs, some aircraft communication costs, and some associated administrative services.

B.39 Skyguide considered that its approach was as cost-related as possible, with the advantage of transparent models and allocation procedures, moderate complexity and fairness, but conceded that, as in all allocation models, including ABC, company overheads are spread according to subjective rules.

A different approach: stand-alone en-route costs

Introduction

B.40 The European Commission is concerned that the current demarcation between terminal and en-route services leads to a disproportionate amount of costs being allocated to en-route services, and hence to a potential misallocation of resources. The main part of our analysis has focused on the implications in terms of cost allocation. However, the European Commission has also asked the study team to estimate the stand-alone costs of an en-route only operation, assuming all other costs - preparing for landing, approach and reaching cruising height - are allocated to Terminal ANS. This section reviews the current legislation and definitions of en-route and terminal services and estimates the impact of moving to charging en-route services on the basis of their stand-alone costs, with all other costs charged to terminal ANS.

Existing definitions – ICAO and Single European Sky

B.41 In this section we outline the existing definitions of en-route and terminal in relation to the provision of services and for the purpose of charging.

B.42 The ICAO Manual on Air Navigation Services Economics 9161 provides the following definition of different services and the en-route phase of flights:

> ***"Aerodrome control service.*** Air traffic control service for aerodrome traffic.
>
> ***Approach control service.*** Air traffic control service for arriving or departing controlled flights.
>
> ***En-route phase.*** That part of flight from the end of the take-off and initial climb phase to the commencement of the approach and landing phase."

B.43 The Manual goes on to provide guidance on the categories of charges that might levied for different air navigation services:

> **Charges**
>
> Separate air navigation services charges may be levied to cover the different types of services provided.
>
> Principal types of services and their related charges are described below. It should be noted that an alternative categorization of services for cost allocation purposes is discussed in paragraphs 5.102 to 5.113.

a) ***Approach and aerodrome control service.*** The associated charge may be levied either as a combined charge or levied separately.

b) ***Centralized approach control service.*** This service usually refers to a situation where approach control is provided to a number of airports from a centralized unit — normally an area control centre. A combined charge or separate charges may apply.

c) ***Centralized approach/terminal area control service.*** This refers to the situation where approach control and en-route services are provided by a terminal area control unit as described in 5.205. A combined charge or separate charges may apply.

d) ***Area control service.*** This refers to all en-route (area control) services provided in the domestic FIR(s) of the State concerned. It is more common to have a single charge covering all those air navigation services properly attributable to en-route services. It may be considered appropriate, however, to have separate charges for individual FIRs.

e) ***Oceanic control service.*** This refers to the situation where a State has accepted the responsibility of providing air navigation services over the high seas under specific delegation by ICAO. Separate route air navigation services charges for these services normally apply.

B.44 In addition ICAO provides international rules on charges for air navigation services79. It states that

"the costs of air navigation services provided during the en-route, approach and aerodrome phases of aircraft operations should be identified separately where possible."

B.45 The document also states that:

"charges should be levied in such a way that no facility or service is charged for twice with respect to the same utilization. In cases where certain facilities or services have a dual role (for example, approach and aerodrome control as well as en-route air traffic control), their cost should be equitably allocated for charging purposes."

[79] Document 9082 Section III

B.46 The allocation method itself is inevitably left to the ANSP to decide on.

B.47 Under the Single European Sky, en-route services and terminal services are not defined terms. However under the Charging Regulation 391/2013, charging zones are defined as:

> ‘en route charging zone’ means a volume of airspace for which a single cost base and a single unit rate are established;
>
> ‘terminal charging zone’ means an airport or a group of airports for which a single cost base and a single unit rate are established;

B.48 Under the Single European Sky Service Provision regulation 550/2004 as amended talks about the prohibition of cross-subsidy between services:

> cross-subsidy shall not be allowed between en-route services and terminal services.
>
> Costs that pertain to both terminal services and en-route services shall be allocated in a proportional way between en-route services and terminal services on the basis of a transparent methodology. Cross-subsidy shall be allowed between different air navigation services in either one of those two categories only when justified for objective reasons, subject to clear identification;

B.49 In addition, allocation of approach control costs between en-route and terminal is carried out using different methods across the States, due to practical reasons, depending on how each ANSP operates.

B.50 The ICAO and SES definitions show that there is considerable freedom for interpretation by ANSPs as to the allocation of activities, and hence costs, between en-route and terminal for the purposes of determining charges.

Suggested definition to be tested

B.51 To estimate the size of the potential misallocation, we have been asked by the European Commission to assess the stand-alone costs of an en-route only operation, assuming all other costs for preparing for landing, approach and reaching cruising height are allocated to Terminal ANS. The premise behind the approach is that all incremental costs (over and above standalone en-route costs) related to ANS provision are caused by requirements to move between flight levels and prepare for approach and landing and therefore should be charged as a Terminal ANS cost.

Estimating the stand alone costs of en-route provision

B.52 The best proxies that can be used for the stand-alone cost of en-route service provision are:

- MUAC, which provides cross-border air navigation services in the upper airspace (above 24,500 feet) of Belgium, the Netherlands, Luxembourg and north-west Germany; and

- IAA, which controls mostly en-route activity in its airspace. From the June 2014 Reporting Tables, there were 3.8 million en-route SUs, compared to only 0.13 million for terminal.

B.53 In Appendix Table B.1 below, we have used the en-route unit rates as proxies for costs of IAA and for MUAC. For MUAC we have used the equivalent unit rate which recognises that: "*This indicator takes into account the specific MUAC costs and production. 'Equivalent' indicates that the calculation does not take the full cost of MUAC service provision into account; EUROCONTROL support costs and the cost of using CNS infrastructure, which is made available free of charge by the Four States, are not included*."

Appendix Table B.1: MUAC and IAA en-route unit rates

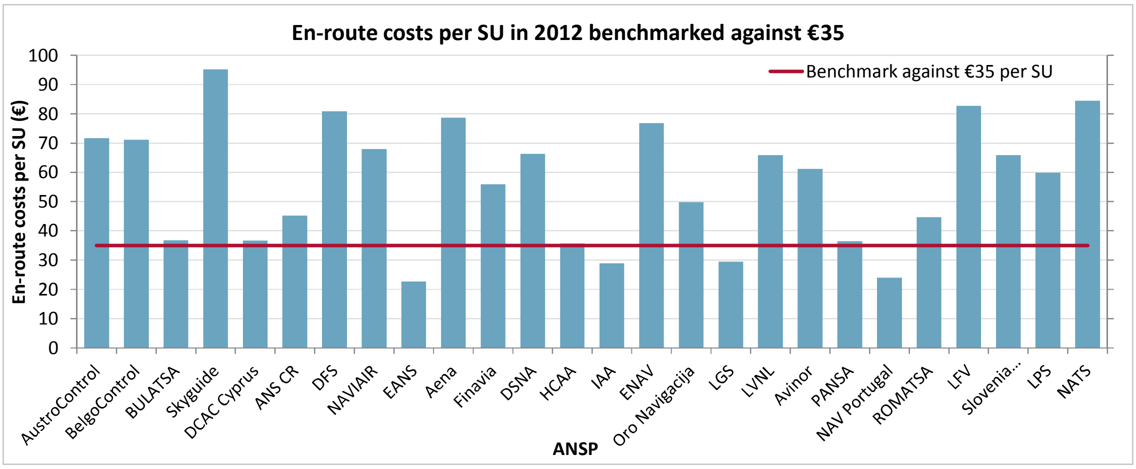
ANSP	En-route unit rates
MUAC	21.70
IAA	30.77

Source: IAA Eurocontrol October 2014 monthly rates, MUAC 2013 annual report.

B.54 We recognise that both these values represent a proxy for providing a stand-alone en-route service, as there are likely to be some overheads and services which are not included in this cost base. Due to the associated uncertainty, we have used €35 per SU as the estimated benchmark for providing stand-alone en-route services and to illustrate the impact of redistributing costs to terminal ANS. This represents a 33% uplift on the average of MUAC and IAA unit rates, which we consider a reasonable reflection of these additional costs.

B.55 Note that the analysis below excludes CroatiaControl, HungaroControl and Malta due to lack of available data on their respective terminal services.

Appendix Figure B.1: En-route costs per SU benchmarked against €35 per SU standalone cost



Source: Steer Davies Gleave analysis of June 2014 Reporting Tables

B.56 Appendix Figure B.1 shows that most en-route unit costs are higher than the €35 stand-alone benchmark. Many ANSPs would have to lower costs allocated to en-route by moving costs to terminal, which would increase both the overall and average terminal unit cost.

B.57 At an EU wide level using our sample of ANSPs, 81% of costs were allocated to en-route and 19% to terminal in 2012. The EU wide average unit costs were calculated by dividing the EU aggregate costs by the aggregate SUs, resulting in an average en-route unit cost of €63 and a terminal unit cost of €204.

B.58 If the en-route unit cost was set at the €35 benchmark, total en-route costs would reduce by almost half (unit cost multiplied by en-route Service Units) and terminal unit costs would more than double from €204 to €582 (terminal costs divided by terminal Service Units). This analysis is summarised in the table below.

Appendix Table B.2: Impact on EU wide en-route and terminal unit costs

		Actual 2012		Benchmark en-route €35 per SU	
En-route	Costs	€6,516m	81%	€3,610m	45%
	Service Units	103m		103m	
	Average EU wide unit cost	**€63**		**€35**	
Terminal	Costs	€1,572m	19%	€4,479m	55%
	Service Units	8m		8m	
	Average EU wide unit cost	**€204**		**€582**	
Total	Costs	€8,089m	100%	€8,089m	100%
	Service Units	111m		111m	

Source: Steer Davies Gleave analysis

B.59 Using the €35 benchmark would result in a significant change in cost allocation between en-route and terminal from a ratio of 81:19 to 45:55.

B.60 A 45% decrease in the average en-route unit cost (from €63 to €35) results in a much larger increase (185%) in the terminal unit cost, as there is a much lower number of terminal SUs to divide the terminal costs between.

Winners and losers

B.61 Following a redistribution of costs on this scale, there would be both winners and losers in the airspace user industry.

B.62 The winners paying lower total ANS (en-route and terminal ANS) charges would be:

- EU based long-haul carriers flying over EU airspace and using mainly en-route services; and
- Non-EU carriers only flying long-haul and using predominantly en-route services.

B.63 The losers paying greater total ANS (en-route and terminal) charges would be:

- Low cost EU based carriers flying short-haul routes and using a mix of terminal and en-route services;
- Full service carriers based in the EU flying short-haul routes and using a mix of terminal and en-route services; and
- General aviation services flying short routes and using predominantly terminal ANS services.

Weaknesses in the approach

B.64 Using this different approach to charging would result in clear winners and losers amongst the airspace users, as it would redistribute total ANS charges from foreign carriers outside Europe towards EU-based carriers operating substantially inside Europe (particularly the Association of European Airlines (AEA) and European Low Fares Airline Association (ELFAA) members).

However, there would be very strong political opposition to implementing the change in the light of the potential damage to the European airline industry. Furthermore, the results of the analysis, while informative and supportive of further investigation, do not demonstrate unequivocally the scale and impact of the possible misallocation of resources. In principle further investigation of the concept could take place through bottom up analysis of 2 or 3 cases where there is the largest diversion to the en-route stand-alone benchmark. However, as discussed above, due to the scale of the impact and the likely objection from airspace users and other stakeholders, we do not consider that it could be applied as a basis for determining en-route and terminal air navigation charges.

Airport and ANS cost allocation

How many States?

B.65 A small number of organisations provide both air navigation services and also manage and operate airports:

- Hellenic CAA in Greece (however, changes are underway with the planned concession of two groups of regional airports in Greece due to conclude in 2014);
- Finavia in Finland;
- Avinor in Norway; and
- Aena in Spain (in June 2014 the government announced its intention to sell a 49% stake in Aena, with 28% sold through an Initial Public Offering (IPO) and 21% available to long term investors).

Review of relevant organisations

Greece, Hellenic CAA

B.66 In Greece, currently, Athens airport is operated by a company (Athens International Airport) with a 30-year concession. By contrast, all 37 regional airports are state-owned, without any corporate structure, and supervised by the Hellenic Civil Aviation Authority (HCAA). HCAA also provides all air navigation services. However, Greece has plans to allocate 21 regional airports between two groups to be let by concession to private investors for a period of 30-35 years.

B.67 Hellenic CAA financial accounts are not published and therefore there is no transparency of cost allocation between the two businesses.

Finland – Finavia

B.68 Finavia Corporation is a company responsible for managing a network of 25 airports in Finland and also manages the air navigation system covering the entire country. It is fully owned by the Finnish State.

B.69 As part of the government's transport policy review, a working group at the Ministry of Transport and Communications began examining the profitability of the airport network in January 2013 and is due to complete this by the end of 2014[80]. According to an official press release, "*In Finland, airports are maintained according to the so-called network principle. This means that the profits and losses of different airports are cross-subsidised*".

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[80] Official press release of the Ministry: www.lvm.fi/web/en/pressreleases/-/view/4137766

B.70 The press release also stated that in 2011, "regional airports made a network deficit of some €22 million. Airport operations are profitable only at Helsinki-Vantaa airport and at three airfields used for military aviation". A survey carried out in 2011 for the Ministry of Transport and Communications indicated that maintenance and air navigation services of regional airports were funded by profits generated by commercial services, "which means that a cross-subsidisation system is in place between Helsinki-Vantaa and the other airports". The survey also established that income statements do not sufficiently take into account investments necessary for the functioning of the airport network. According to the same source, full cost-relatedness would mean that the unit rates in the low-volume parts of the network (i.e. the regional airports) would grow two to four fold.

B.71 Finavia reports consolidated financial accounts. Revenues are disaggregated by business area, but costs are only presented at a consolidated level. Accounts are available from 2010-2013.

Norway – Avinor

B.72 Avinor is responsible for the provision of airport services at 46 airports across the country as well as the provision of ANS for civilian and military aviation (en-route and terminal ANS).

B.73 The financial accounts disaggregate operating income and expenses between the airport, air navigation services and other services provided by Avinor. A considerable amount of inter-group expenses are recharged between the business units, and these do not appear at the consolidated level. Notes to the accounts provide a more detailed breakdown by business. Accounts are available between 2010 and 2013.

Spain, Aena

B.74 Airspace users have, in particular, drawn attention to the large increase in airport charges for use of Aena's Spanish airports in 2012. Below, we outline the changes that took place, extracted from a study by Steer Davies Gleave[81] for the European Commission examining the airport charges Directive (EC 2009/12).

B.75 Law 1/2011 (amending Law 21/2003 of 7 July 2003 on aviation security) transposed the Directive into national legislation in March 2011 and, according to airport users, incorporated all the main aspects of the Directive. The law established a regulatory regime for airport charges based on a price cap (CPI +5%) for the 2013-2016 period, with a cost recovery formula applicable throughout the whole Aena network and a move from single till to dual till (introduced gradually over 5 years from 2014, 20% each year, according to Aena).

B.76 However, there were significant changes in airport charges in 2012, the year prior to the implementation of the Law. Two airlines reported that the 2012 increases in airport charges were the highest in the history of Aena, with an overall increase of 28% compared to 2011 levels. The largest increases were at Madrid and Barcelona airports, where charges rose by 50% and 54% respectively. The DGAC noted, however, that the transparency and consultation procedure could not be applied in 2011 (for 2012 airport charges) because it was not possible to undertake its application within the time limit for transposition of the Directive (which in Spain took place on 4 March 2011).

B.77 Royal Decree 20/2012 reduced the period of the price cap to 3 years (ending in 2015) and introduced the dual-till principle. Since 2013, stakeholders confirmed that the process for

[81] http://ec.europa.eu/transport/modes/air/studies/doc/airports/2013-09-evaluation-of-directive-2009-12-ec-on-airport-charges.pdf

setting airport charges has followed the provisions of the Directive, as transposed by Law 1/2011.

B.78 Aena Aeropuertos only reports consolidated revenues and costs for the entire airports network ahead of user consultation. According to stakeholders, it is therefore impossible to establish whether charges are cost-related at each Spanish airport. It is possible that there is discrimination with, for example, users of more profitable airports (like Madrid or Barcelona) financing users of less profitable ones.

B.79 The Spanish DGAC stated that national law requires that all the information referred to in Article 7 is made public, for the whole airport network, when conducting the transparency and consultation procedure. Also, the Independent Supervisory Authority has recommended in a resolution of 2012 that such transparency also applies to airports with more than five million annual passengers, although the Directive is not completely clear on this matter. However, only Parliament can modify the common charging system.

B.80 Aena applies an ABC (Activity Based Costing) system to calculate costs and revenues of regulated services. In 2011, Aena provided a consolidated set of financial accounts covering the whole business (Air Traffic Control Services, Airport Services and other services). They also provided a high level breakdown between the services. In 2012, a separate Aena Aeropuertos set of financial accounts was provided and a consolidated version available in Spanish only. The breakdown of costs and revenues between the 2010 and 2011 accounts appears to be reported on a different basis to 2012, making a time series comparison problematic.

Summary

B.81 The provision of airport services (runways, passenger terminal and apron services) is in principle distinct from the operation of the tower and en-route air navigation services. However, there are likely to be a number of joint corporate services such as finance, marketing and human resource functions, as well as potentially some engineering and maintenance functions which can service all business units. Assets may also be shared.

B.82 As a consequence, the majority of costs used for the airport services are likely to be direct costs. However, there will be a proportion of common and joint costs which are allocated between business units. In addition, many of the consolidated airport/ air navigation service providers are managing a large number of airports. Some of these are capital-city or large municipal-city airports which may make an operating profit. However, many are small regional airports whose revenues are unlikely to fully recover costs. Therefore, within the companies there is an accepted level of cross-subsidisation across the operator’s airports portfolio.

Trends over 2010-2013

B.83 To allow for meaningful analysis of financial accounts it is necessary to first consider the operational context and performance of all three operating groups discussed above. All have experienced a significant compound annual growth in passenger numbers, although Finavia has witnessed a decrease in Air Transport Movements (ATM) at its airports over the period. There has also been a small growth in employees (measured in terms of full time equivalents or FTEs) at Avinor over the four year period, whilst there has been a small decrease in employees at Finavia.

Appendix Table B.3: Passenger, Movements and full-time equivalents (FTE)

Passengers (millions)						Change			
	2010	2011	2012	2013		2011	2012	2013	CAGR
Avinor	40.1	44.3	46.4	48.0		10.5%	4.7%	3.4%	6.2%
Finavia	16.5	19.1	19.2	19.0		15.8%	0.5%	-1.0%	4.8%
AENA	192	204	N/A	N/A		6.3%	N/A	N/A	6.3%
ATM						**Change**			
	2010	2011	2012	2013		2011	2012	2013	CAGR
Avinor (departures only)	619,000	648,000	669,000	713,000		4.7%	3.2%	6.6%	4.8%
Finavia	523,706	539,345	433,735	413,057		3.0%	-19.6%	-4.8%	-7.6%
AENA	2,120,000	2,100,000	N/A	N/A		-0.9%	N/A	N/A	-0.9%
Full-time equivalents (FTE)						**Change**			
	2010	2011	2012	2013		2011	2012	2013	CAGR
Avinor	3,074	3,149	3,218	3,249		2.4%	2.2%	1.0%	1.9%
Finavia	2,938	3,001	2,840	2,814		2.1%	-5.4%	-0.9%	-1.4%
AENA	13,285	13,373	N/A	N/A		0.7%	N/A	N/A	0.7%

Source: Steer Davies Gleave analysis of annual reports

B.84 From information provided in Aena's financial accounts, it appears that support staff and senior executives account for just over 6% of the group's total FTEs, a reflection of the levels of support required to operate an airport and air navigation service. The finance and legal resources required by airport and air navigation services are limited. HR functions may be relatively complex at an airport given the typically high turnover of security staff, but the number of HR staff required by an air navigation service is generally low. Moreover, operations will require bespoke IT systems, with staff working within the group tending to specialise in either airport or air navigation systems, and their costs can be easily allocated to each service. Similarly, facilities costs and depreciation on equipment are relatively easy to identify, allowing depreciation on assets to be allocated to individual business units.

Appendix Table B.4: Operating costs (total and split by activity)

Total operating costs						Change			
	2010	2011	2012	2013		2011	2012	2013	CAGR
Avinor (MNOK)	6,162	7,101	7,570	8,358		15.2%	6.6%	10.4%	10.7%
Finavia (€ 000's)	299,778	343,474	339,861	322,400		14.6%	-1.1%	-5.1%	2.5%
AENA (€ 000's)	2,950,607	2,920,456	3,080,509	N/A		-1.0%	5.5%	N/A	2.2%
ANS operating costs						**Change**			
	2010	2011	2012	2013		2011	2012	2013	CAGR

Total operating costs						Change			
Avinor (MNOK)	1,718	1,698	1,810	1,967		-1.2%	6.6%	8.6%	4.6%
Finavia (€ 000's)	63,000	65,000	N/A	N/A		3.5%	N/A	N/A	3.5%
AENA (€ 000's)	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A

Airport operating costs						Change			
	2010	2011	2012	2013		2011	2012	2013	CAGR
Avinor (MNOK)	4,208	4,617	5,046	5,535		9.7%	9.3%	9.7%	9.6%
Finavia (€ 000's)	162,000	191,000	N/A	N/A		17.9%	N/A	N/A	17.9%
AENA (€ 000's)	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A

Source: Steer Davies Gleave analysis of annual reports

B.85 We understand that AENA's 2013 accounts have not yet been published and our review of costs and revenues was therefore based on the 2012 accounts. Aena provided financial statements by segment in 2010 and 2011, which included a split of costs between procurement, staff, depreciation and amortisation and also reported operating profit by segment. However, the data does not appear to contain all cost lines or reconcile. In addition, in 2012 AENA reported a different breakdown of costs between the two businesses for 2012 and 2011 which does not reconcile with previous reports. This change in reporting is unlikely to have increased the confidence of airspace and airport users in the cost reflectiveness of charges for each service.

B.86 The Avinor annual reports include notes covering segmental income and operating expenses for the four year period that enabled us to analyse costs by business unit. The Finavia annual reports only provide a segmental analysis in 2010 and 2011.

B.87 Operating costs at Avinor have risen across both business units and have risen in total at Aena and Finavia. However, as there is limited segmental information and a lack of transparency in how central function costs are allocated between segments, it is not possible to draw any meaningful conclusions as to whether there has been a change in the methodology of allocating these costs to business units. Further, it is not clear whether the recent increase in AENA's airport charges is due to a change in cost allocation methodology or some other reason.

B.88 At the same time, we note that it is unlikely that a change in the allocation of central function costs could have resulted in a steep rise in airport charges. First, the methodology for apportioning these costs in most companies tends to be based on a well-established accounting system and there is generally little reason to change it. In addition, as discussed above, we believe the shared function costs are small in comparison to the direct business unit costs and therefore not sufficient to cause the significant increase in charges reported.

Control Sheet

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