EUROCONTROL Trends in Air Traffic | Volume 2

A Matter of Time: Air Traffic Delay in Europe

EUROCONTROL

Acknowledgements

The idea for this study came from Tim Guest, Manager of the EUROCONTROL Central Office for Delay Analysis, who expressed concerns that outside of a few specialists in Air Traffic Management, there was a relatively poor understanding of air traffic delay. With the cooperation of the EDAG, the supervising group for CODA, and particularly with the help of the Association of European Airlines (AEA) and the International Air Carrier Association (IACA), this document has been developed to help explain delay and to eliminate misunderstandings and misconceptions. Tim Guest was the principal author of this study and the force behind its production; it was his encyclopedic knowledge of the subject that we have sought to capture in this volume.

Bo Redeborn, EUROCONTROL Director of ATM Strategies approved the further development of this series of studies into air traffic market sectors with the objective of increasing the depth of knowledge. I am grateful to him for his support and encouragement.

Thanks go to the CODA team, Tony Leggat, Catherine Yven and Yves De Wandeler for their considerable contributions and support. We are grateful also to EUROCONTROL's External and Public Relations Unit for their help in the design and publication of the document.

Thanks go also to a number of people who reviewed the document, suggested changes and helped in the proof reading. Notable among these were Terry Symmans of the EUROCONTROL Experimental Centre and Sue Lockey from AEA. Any remaining errors are our own.

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Printing: EUROCONTROL

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Foreword

Delay in a transport system is a symptom of either inefficiency or shortfall in capacity. As the traffic load on the European air traffic network grows year upon year, one of the main challenges facing the industry is to develop capacity to meet that demand. To provide excess capacity is to squander investment, while not providing capacity where it is needed leads to delays. Delay therefore, becomes an essential measurement of performance for the network. Indeed, it was the unacceptable growth in delays experienced by air traffic passengers in Europe in the late 1980's that led to the increased investments in Air Traffic Control, not only at national, but at European network level. Overall capacity performance has since been monitored by continuously measuring delay. It is one of the most mature performance indicators that we have, the others including safety and traffic volumes.

It is essential, in encountering delay, to know if it is just a consequence of another earlier event, or if it is the root cause. Knowing this is essential if delay causes are to be identified and addressed. So in-depth analysis and understanding are needed, and this driver has led to the creation and establishment of the EUROCONTROL Central Office of Delay Analysis (CODA). This document seeks to explain the meaning of delay, to explain how delay behaves, to understand causes and categories. In brief, the document seeks to educate the reader in the nature of delay.

Under the series title Trends in Air Traffic, EUROCONTROL systematically publishes its various studies into aspects of aviation that affect air traffic forecasts. This study, into the nature of delay is the second in that series, the first being "Getting to the Point: Business Aviation In Europe". The object of these studies is to inform and educate stakeholders across the industry thereby ensuring common understanding of the issue we face. We believe this report will be a useful contribution to the understanding of this important characteristic of the Air Traffic Management network.

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1. Introduction and scope

Delay – the time lapse which occurs when a planned event does not happen at the planned time - is an experience shared by anyone who has ever travelled. It is arguably an inevitable feature of any system in the real and often unpredictable world that has an economic level of resourcing. There are many strategies for managing and minimising delay in different areas of activity. Manufacturing and production processes have developed means to ensure uninterrupted activity, and the transport industries have similarly developed strategies to cope with disruption to their plans. The extent to which these strategies are successful in managing potential disruption is of prime importance to the traveller and to the management and shareholders of the transport business. Similarly, the nature and frequency of disruptive events, and the extent to which they can be anticipated and controlled, are crucial to the success of any transport enterprise.

This report considers all aspects of delay to Air Transport: its definition and categorisation; its causes; its measurement; and its mitigation. It is not intended that this work should be a technical discourse on any specific delay management activity, but it will inevitably include some aspects of the management process, and a little of the history of the industry to illuminate the path to its current position.

With these considerations in mind, the report begins with a closer examination of the nature of delay. Following this, there will be an inspection of the way in which delay is categorised, and then measured.

The report will then look at the impact which delay has on those involved in air travel, both the users and the providers of air services. Having considered this, it will examine more closely the cost implications of delay, and the way in which those costs might be calculated.

A further chapter is devoted to a review of EUROCONTROL's CODA, the Central Office for Delay Analysis, as an example of a delay monitoring system in action. This will cover how CODA began and why; how it developed, and how it functions today. The data collection necessary to meet reporting requirements will be described together with the management of those data and the process of analysis and report production.

While it is unlikely that any strictly accurate predictions of future delays can be made, it is nonetheless worth considering the current forecast ranges for air traffic growth, and the issues which will influence the way in which the availability of resources needed to provide the capacity for future traffic may affect delay. The final chapter of this report (**Chapter eight**) is devoted to examining some scenarios.

2. What is Delay?

As indicated in the introduction, delay is the time lapse which occurs when a planned event does not happen at the planned time. The fundamental question which arises in the context of delay for air travel is which events are of concern and may contribute?

For most travellers, the event which first grabs their attention is the departure. Air travel, any travel, can be a stressful experience, from the initial stages of preparation through to the process of checking-in. Against this background, and a largely inevitable desire to have the process under way, there is little that is more frustrating than to find this experience prolonged. The impact of a departure delay on a passenger will, of course, vary enormously, depending as it does on factors as diverse as the length of the delay, the amount of information received during the delay, and the conditions under which the waiting must take place: stress levels in a crowded and noisy departure area will inevitably be greater than in the hushed comfort of a First Class lounge.

There is a continuing debate about the significance of delay during different parts of the journey. For the holiday-maker, for whom push-back signals the beginning of the holiday experience, departure delay is likely to be paramount. For the business traveller, attention will be focused on the likely delay on arrival, as the reason for travel will almost certainly imply a time constraint at the destination. The likely greater experience of this traveller will tell him or her that time can be made up – hence a delay on departure does not inevitably mean a delayed arrival.

For the industry itself, there are a range of time points at which delay may usefully be measured. Each segment of a flight has its own characteristics, and may command a different group of resources. Measurement of time-keeping performance at other points can allow the identification and measurement of problems which need to be addressed in order to maintain a punctual, efficient and effective operation.

Foremost among the key event times are the Out/Off/On/In, or 'OOOI' times. These correspond to pushback from stand (Out), take-off (Off), landing (On), and on stand (In). These four times are well-defined, and easy to record. Armed with these, delays before departure, during taxi out, en-route and during taxi in can be measured, by comparison with scheduled or standard and computed times. The choice of time datum is important. There may be a number of times which could be described as the schedule for a departure. This may be the time which was published when the passenger made the original booking, or possibly the time modified and re-published prior to the day of the flight. Alternatively, it may be an operational target used by the airline on the day, following tactical changes to their operating plan. It is generally accepted for most operational purposes that departure delay is measured against the latest schedule that the airline was using on the day. However, there may be occasions where, for customer service reasons, the original schedule is the benchmark.

Other event times, such as start of approach (knowledge of which would enable a range of performance measures to be calculated) are much harder to define and record, and work continues in these areas.

Delays arise for a large number of reasons, and their categorisation is covered in the next part of this report. Some delay is simply the result of lack of a resource, mechanical issues, or other such problems. Other delays can be the result of a planned process. An Air Traffic Flow Management (ATFM) delay imposed on a departing aircraft by a flow management unit is the result of calculation of the potential flight profile, and the identification of conflicts or restrictions at some point during the flight. It is always cheaper to take delay on the ground than to allow the aircraft to become airborne, and then impose a delay by speed control, by holding, or by re-clearing the aircraft to non-optimum flight levels. It is always safer to delay an aircraft on the ground than risk an airborne flight conflict.

Not all airborne delay is necessarily bad. At some airports (London's Heathrow (LHR) is a notable example) short periods of holding are anticipated. Because of the very high demand at LHR, runway use must be optimised as far as possible. An even and regular 'supply' of landing aircraft is necessary, if wasteful periods with no landings are to be avoided. An uneven rate of arrivals into the terminal area can be smoothed out into constant approaches if inbound aircraft are placed in a holding pattern, and then released at precise intervals to start their final approach.

Some entities would argue that, for them, ground delay is beneficial. In particular, airport retail outlets at airports will see delayed travellers as potentially 'captive' customers who while away delay by shopping. The impact of delay is the focus of a later chapter in this report.

3. How is Delay categorised?

As indicated earlier, delay requires an initial definition based on the phase of the flight to which it refers. The most easily identified and categorised delay is that associated with departure. It is here that the many requirements for flight initiation are focused in order to allow the departure to be on time. Identified delay can, at this stage, be recorded with a good degree of accuracy. Recording of delay causes at other phases of the flight is more complex, as key events are not so easily identified, nor is the recording infrastructure *in situ*.

At this point, it helps to use the concepts of Primary and Secondary delay (also known as Reactionary or Rotation delay). A primary delay cause may be defined as delay that affects the initiation of the flight. This delay is unaffected by any earlier or accumulated delay. However, a reactionary delay is accumulated. This is a delay imposed as a consequence of the unavailability of aircraft, crew or load due inbound by the scheduled departure time because of a disruption earlier in the day. The cause of this earlier disruption will be itself either a primary delay at the start of the previous flight, or a reactionary delay arising from an even earlier incident. It has proved to be complex and difficult for airlines to record successfully the precise origins of reactionary delay, and these difficulties have outweighed the benefits. For this reason, and the logical extension, which states that there will have been (in 99% of cases) a primary cause, the recording and collection of primary delay and its causes has been a feasible and effective way to monitor operational performance.

In order to provide some means of comparison, and to enable airlines and those providing services to them to communicate issues associated with delayed departures, a standard set of delay definitions was introduced under the auspices of the International Air Transport Association (IATA) Airport Services Committee. The full list is published in the IATA Airport Handling Manual, (AHM 011). This set of definitions has been developed and modified over the years, and reflects both the broad range of delay causes, and the detail within. These categories can be broadly grouped by accountability for the purpose of delay analysis, and a brief description of this follows. The detailed reference to IATA delay codes can be found in Annex A of this report, together with an outline of high-level delay groupings. These high-level groupings are defined below.

Airline-related delays

These are the delays that are directly under the influence of the airline. They are:

- passengers and baggage;
- cargo and mail;
- aircraft and ramp handling;
- technical and aircraft equipment;
- aircraft damage and operations computer failure;
- flight operations; and
- other causes.

This definition might seem contentious, as many functions within this area are carried out by companies and agents that supply goods and services to the operator. However, the view is taken that any such supply contract is assumed to have associated with it a Service Level Agreement, with a supporting mechanism for enforcing performance standards. Should this not be the case, then the operator is still deemed to be responsible for not having ensured that the appropriate controls were in place.

Airport-related delays

Congestion at airports can take a number of forms. Some congestion, such as the inability of more than one aircraft to move out of some parking cul-de-sacs, will affect start-up, and hence departure. Subsequent taxiway congestion may result in late take-off, with consequential arrival delay. Other airport congestion issues, such as lack of parking spaces, excessive arrival demand, or taxiway problems may result in arrival delay, or possible delay to aircraft which have not yet departed from the previous airport. Other congestion may not be airside at all, but be in the terminal. Broken baggage belts or long security delays fall into this category.

En-route delays

This type of delay may be due to lack of en-route airspace capacity. This can result from an excessive peak of demand, say, or perhaps from a lack of Air Traffic Control staff due to sickness. The delay is not actually encountered en-route, but is reflected in the imposition of departure restrictions on aircraft scheduled to fly through the affected airspace.

3. How is Delay categorised?

Weather delays

Weather delays may be encountered at either departure or destination airport and, occasionally, en-route. As with airport delay, some weather delays affect the ability of aircraft to move around the airport of departure, while some may be due, for instance, to a requirement to de-ice departing aircraft for safety reasons. Other weather events may affect the destination. These include reduced landing rates due to high winds, or the need for additional separation due to low visibility procedures. This, as mentioned earlier, can impose delay on aircraft yet to depart for the affected airport.

Miscellaneous

There is always a small amount of delay which does not fit neatly into the above categories. Its recording is nonetheless important, hence the need for this group. Examination of the full code list in Annex A will provide an indication of the range of possibilities. Identification of area of accountability is important, as it is only by this process that lessons can be learned when delay occurs, and the available resources directed to the right areas to solve the problems giving rise to delay. As the industry evolves, the importance of particular delay categories changes, and this results in a changing focus. The IATA delay code system is periodically modified to enable better identification of particular issues. For example, there is currently a move to identify more clearly delays which are the result of environmental measures, which will in turn enable more accurate costing of any restrictions that may be put in place, and evaluation of future plans.

4. Where and when does Delay occur?

The previous chapter gives an overview of how delay is categorised. It is worth considering at this stage whether there are any particular issues associated with the identification of the location of delay, before looking at the measurement of delay in the next chapter.

The causes of many departure delays can be located at the airport of departure. Issues which are identified as airline-related will, in the main, be found here. Some airline problems, such as those related to technical or engineering faults, may have originated while the aircraft was elsewhere, but require rectification at the airline's base. Similarly, damage may have been sustained en-route, the repair of which is held over until full engineering facilities are available. Similarly, weather conditions affecting departure or issues related to the design or operation of the departure station can be easily identified.

However, some delays are generated by conditions elsewhere. The most obvious instance is that of reactionary, or rotation delay. This is delay resulting from the late arrival of a resource (aircraft, crew) or load from a previously delayed flight. This is discussed further in the chapter 'The Impact of Delay'. Other causes may be due to primary effects, but 'non-local' such as weather problems at the destination airport. These may require the uploading of additional fuel, or *in extremis* replanning to an alternative destination airport. Such adverse conditions may give rise to delay imposed by the flow management process. Certain conditions, such as low visibility, or high winds, can cause the arrival and landing rate at the destination airport to be restricted. This in turn means that the arrival demand must be reduced from that planned to a level which matches the reduced capacity. This is achieved by making a backwards calculation from a revised time at which arrival can be scheduled for a particular flight, and restricting the flight to a departure time which will meet this new arrival time.

This principle of tactically matching demand with capacity by imposing delay on the ground is the essence of flow control. It is cheaper, both in fuel and environmental cost terms, and less complicated, to delay a departure than to allow its commencement and then look for an opportunity to effectively 'park' the aircraft in a holding pattern until the arrival can begin. This is also applied to cope with restrictions which may arise en-route, where there is an upper limit to the number of aircraft which can safely be controlled in the sky at any one time. If the capacity of the airspace through which a flight is planned is reduced, or the number of flights planned through that airspace in a given time period exceeds the standard capacity (expressed in flights per time period) of that portion of airspace, it is then necessary to delay aircraft on departure to 'smooth out' the demand.

This flow control is applied in Europe by the Central Flow Management Unit (CFMU) at EUROCONTROL in Brussels. Here, detailed information on air traffic is gathered, and used to ensure that the required level of safety and aircraft separation can be achieved throughout Europe. This complex and difficult task is often unrecognised. Indeed, delay is often blamed on 'Brussels', when in fact the only involvement of the

CFMU is to manage the levels of capacity which the Air Traffic Control units in each country have made available. This is a classic example of 'non-local' delay.

Identifying the areas where delay originates, and hence working to improve capacity, can seem simple in the first instance as records of the flow restrictions applied can be consulted. However, this only tells part of the story. Reduced capacity in one area may be offset by the re-routing of traffic around the restricted area. This in turn may cause the neighbouring airspace to become overloaded, with corresponding flow measures being applied and leading to a so-called network effect. In addition, departures may be delayed by reference to the most penalising restriction without considering other areas en-route where traffic is also restricted but to a less penalising level than the primary area. It is only if the primary problem is resolved that the effect of the secondary restrictions can be clearly seen, making assessment of potential effects correspondingly more difficult.

The timing of delay can vary greatly. Where capacity and demand are involved, the likelihood of delay will increase at times of higher demand. This can vary by time of day, day of the week, or month of the year. *Figures [I] and [II]* illustrate some examples of these variations.

Figure I: Variation of average recorded delay with time of day

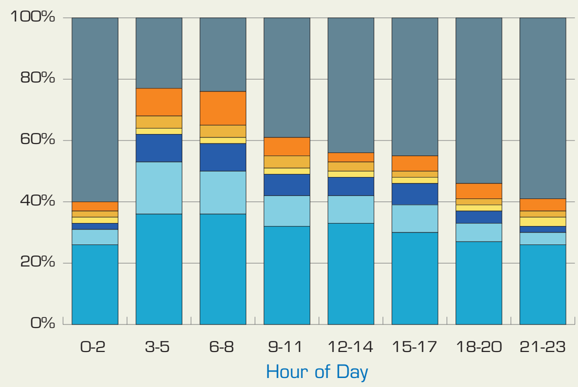
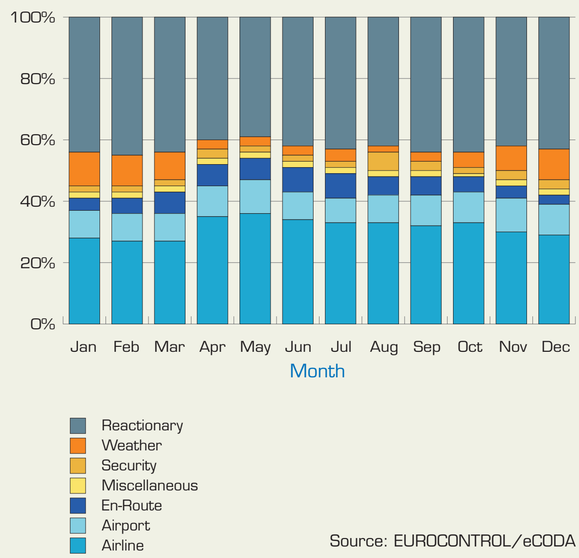


Figure II: Variation of average recorded delay with month for Europe



Source: EUROCONTROL/eCODA

Other types of delay cause may be random, and related statistically only to the volume of flights. Weather delays are statistically most likely during periods of bad weather, and can be anticipated. Some, however, may be totally unpredictable, such as delays due to increased security measures after a significant security event.

5. How is Delay measured?

In essence for an airline, delay measurement and cause assignment take place on the ramp.

It may be helpful therefore to consider the processes which take place during the aircraft turn-round, and where problems may arise.

An aircraft arriving late will, unless it has been brought from an engineering facility, have acquired delay either from a late departure from the previous airport or en-route. It is possible also that a tow from the hangar may have been held up, or the aircraft may not have been prepared in time. If the landing was on time, inbound taxi congestion may have imposed an arrival delay. The time 'on blocks' will be recorded, possibly automatically, by the registration of the park brake application in the ACARS (Aircraft Communication Addressing and Reporting) system, but no delay code will be assigned. It may, however, have a bearing on the allocation of a Reactionary delay to the following departure, if the turnaround cannot be accomplished in time to meet the departure schedule. There may be further delay in disembarkation after the arrival time is recorded, due to the unavailability of an air bridge or steps.

Baggage offload and fuelling (if required) will then start, followed by cleaning and catering. As these are being completed, passengers will be moving to the gate lounge, and the crew, if changed, will be arriving, having been to a briefing for the flight. The check-in, security and gate staff will also be present. Baggage and cargo will be loaded for the next sector and, once the crew have ensured that the cabin is available, the loading of passengers will begin.

Flight crew checklists will be in progress and once the hold doors are shut, the last passengers embarked, and the load sheet has been presented to the flight crew, doors will be closed and the aircraft will be able, provided no restrictions prevent this, to be cleared to start up and push back.

It is at this stage that the ground staff and crew will, in the event that there has been any delay so far, agree on, allocate and record delay causes. After this point, it will be the flight crew who are most aware of potential problems in the en-route phase, and they will have a greater input into the delay allocation process. At this stage, there may be questions relating to the issue of the ATFM departure slot, or there may be a delay to start-up and pushback resulting from congestion in the immediate vicinity of the stand, especially if this is in a cul-de-sac. There may be a requirement to push-back, start up and taxi to a holding point, where the engines would be shut down to await a take-off slot. In cold weather conditions, there may be delay caused by the need to de-ice and once completed, further delay may require that this be repeated. There may also be taxiway congestion on the way to the runway holding point, where further delay may be encountered due to the runway utilisation in force. Finally, there may be a delay in the take-off clearance once lined up. The degree to which delay at this stage affects the operation is heavily dependent on the layout of the departure airport. Some of these problems may affect the recorded departure time, such as the push-back from the stand, and therefore appear in the coded delay statistics. On the other hand they may additionally cause delay after pushback, in which case they will tend to show up in delay to arrival at destination.

For each departure, it is hoped that the delay 'jigsaw' pieces fit together as required, in order that the aircraft may leave on time.

Ramp location can increase the likelihood of delay

6. What is the impact of Delay?

Delays to air traffic have many implications and, both intuitively and with closer inspection, these are overwhelmingly detrimental. The proper functioning of any system which is time-dependent and in which the performance of one operation depends on the timely completion of a previous operation, will be compromised if events on the critical path are completed late. As with any complex system or project in which a number of events necessary for successful completion take place in parallel, any delay on a non-critical path also has the potential to become critical.

At its simplest, a flight delay may be intensely irritating to the customer, on whose continued patronage the business depends. At its most complex, delay effects can 'snowball', ultimately destroying any planned operation. We will look at a number of impacts in turn.

Customer perception

This is important to any business. Aviation is a highly technical business and one in which, as a result, confidence is important in the purchasing decision. Apart from the natural desire to avoid habitually delayed travel, lack of punctuality has the potential to cause prospective customers to question an airline's abilities and standards in other areas which might ultimately affect flight safety. The imposition of a delay may, in fact, be necessary to ensure flight safety, for example, in the case of the rectification of an engineering fault, but this is not necessarily going to be the perception gained by the passenger. In fact it may raise the question: "How come they have so many engineering problems?"

The extent of passenger frustration resulting from delay should not be underestimated.

Cost

Delay costs money. How this can be measured or estimated is a complex subject and in the next chapter, we will look at some of the work that has been done in this area. Suffice to say that additional cost should be borne in mind as a side-effect of any primary effect of delay.

Efficiency

Under this heading, the use of resources should be considered, ranging from fuel use, with its environmental and cost implications, to the facilities required to operate successfully. For a departure delay, the simple presence of an aircraft on an airport stand for longer than is scheduled starts to reduce efficiency. Airport stand occupancy is tightly planned and delay may result in a subsequent aircraft being unable to prepare for departure on time. In addition, stand time is rented and airline costs will rise. Lateness may cause peaks of activity at the airport which cause other capacity limits, such as those of taxiway and runway, to be exceeded causing further delay.

There is a clear thread running through this discussion which highlights the knock-on potential in delay situations and it is worth a digression. This consequential delay is normally referred to as reactionary or rotation delay when a particular flight is delayed due to the non-availability of aircraft, load or crew which were due to be available from a previous flight, which has itself been delayed. These secondary delays are a major factor in the performance of the system, often accounting for more than 40% of delay. However, where remedial action is called for, this statistic is of little help, as it tells us almost nothing which can be used to rectify the situation. While critically important due to its contribution to the cost of delay, it is the primary cause (the delay which started it all) which must be identified if effective action is to be taken. It is for this reason that delay statistics are focused on primary delay causes. By correctly identifying the root problems, the resources necessary for rectification can be properly distributed. Action may also be taken to mitigate the effect of reactionary delay, by the 'padding' of schedule times, or by increasing airport turn-around times, in order to absorb such delay. A useful analogy is the building of fire-breaks. However, these measures are in themselves costly. One major carrier has identified the fact that they have to purchase three aircraft simply to provide this slack in their operating pattern. The need for additional resources can be found in many areas where operational flexibility has to be built in to mitigate the effects of delay.

Environmental aspects of Delay

The previous chapter referred to the impact of unnecessary resource use on the environment. Environmentally-driven constraints and non-optimal operations can provide an inherent stimulus for delay by reducing the Air Traffic Management (ATM) system's flexibility. At a European level, the cumulative delay and inefficiency caused by the many local environmental constraints (usually at airports) is not yet fully understood. The Central Flow Management Unit (CFMU) has established a code to allow the reporting of 'environmental delay' but this accounts for only around 3% of total Air Traffic Flow Management (ATFM) delay and only a handful of flow management positions at air traffic control centres report environmental delay. Delay reported through IATA does not yet provide a specific environmental code and so this is not identified. In fact the effect of environmental constraints on punctuality remains largely hidden because it is strategic in nature and environmental constraints are built into flight planning and schedules. It is evident, however, that environmental requirements may trigger delay, including for example:

- when changing between complex environmental runway or airspace configurations;
- the strict application of flight curfews may compound the delay of an aircraft operating already slightly off schedule; and,
- major disruption can be caused by the response to environmental limitations being exceeded.

Conversely, delay which results in aircraft holding or queuing with **engines on** can result in significant excess environmental emissions (potentially adding to climate change) and air quality or noise impact. Delay at aerodromes with limited stands can result in unnecessary congestion, ground movements and activation of auxiliary power units. However, where such delay-related holding can be done with **engines off**

6. What is the impact of Delay?

then the adverse effects for sustainability are limited to wasted passenger time and its associated socio-economic impact.

Some airborne delay may occur, where, for instance, short periods of holding are used as a means to smooth out irregular terminal area arrival intervals, thus ensuring a steady supply of aircraft to the landing runway. However, while incurring an initial inefficiency, and an environmental penalty, the improved utilisation of a runway and other associated improvements mean that this procedure can boost efficiency elsewhere. The inter-related nature and complexity of procedures in aviation are illustrated by this example and in the space available here, only the general issues can be considered.

Another perception

This chapter began with the statement that delays are 'overwhelmingly detrimental'. This allows for perhaps a small benefit. It would be wrong to discuss the impact of delay without mentioning the fact that there are some businesses which find flight delays to their advantage. There is no suggestion here that such businesses may be able to influence delay and hence their bottom line, but their role is opportunist. Delays offer increased potential business to the retail outlets which are now so common in airport terminals. While they provide a useful distraction during normal periods of activity and can earn revenue, their positioning is ideal in the case of delay when they are provided with captive potential customers and are in a good position to maximise their revenue accordingly.

6.1 Cost of Delay

The cost of delay has, unsurprisingly, been the subject of much research. Identification of these costs can allow the prioritising of resources available for the reduction of delay and can assist decision-making for both strategic and tactical optimising of operations. It also provides a means whereby expenditure may be justified, at company, national and international level in order to minimise the effects of delay.

The problem is complex. However, a number of hypothetical examples can demonstrate this complexity. It is assumed for the sake of argument that a delay of 45 minutes occurs to two flights departing from the same airport.

The first aircraft is on a short-haul flight: for example an Airbus A320. It is the last flight that aircraft will perform that day. Both it, and its crew, will night-stop at the destination prior to returning first thing the following day. The duration of the night-stop is greater than the crew minimum rest period by an hour. The aircraft is full, but is delayed on departure by 45 minutes and is 45 minutes late on arrival. Apart from 45 minutes extra stand occupancy on departure, the direct cost of the delay is virtually zero and the indirect cost will be any dissatisfaction felt by the passengers.

The second aircraft, by way of example, is a Boeing 747. This aircraft is also full and is on a long-haul flight to the Far East with a critical need to arrive on schedule, as its destination begins a night jet ban 30 minutes after arrival. The passengers are checked in and the aircraft is then delayed, with an estimate of 45 minutes in total. This gives an estimated arrival after the destination has effectively closed. The chosen solution is to delay the departure to arrive after the jet ban. The result is that the aircraft will not be available for its onward flights, the passengers will most likely need to be accommodated in a hotel overnight and a new crew will be rostered, with knock-on effects.

Clearly, the costs per minute of the 45-minute delay are orders of magnitude greater for the 747 flight than the A320 flight. Clearly, no one number can be used reliably for any given flight. Only by working with very large samples and a range of circumstances can useable numbers be obtained and these will be limited in their application.

The latest detailed work on this subject was undertaken by EUROCONTROL's Performance Review Commission (PRC) with the University of Westminster in 2002. The full report is available at: http://www.eurocontrol.int/prc/gallery/content/public/Docs/cost_of_delay.pdf.

Two edited extracts of the conclusions, which were prepared with specific reference to air traffic flow management delays but can be extrapolated to other causes, are set out below. The first makes reference to buffers, or schedule 'padding', mentioned in the previous chapter, and describes how they may be used to minimise cost and the second refers to specific cost figures.

6. What is the impact of Delay?

6.1 Cost of Delay

Extract 1: Results of strategic delay cost calculations

1. *"The number of buffer minutes added to the schedule is a matter of compromise. In theory, strategic buffer minutes should be added to the airline schedule up to the point at which the cost of doing this equals the expected cost of the tactical delays they are designed to absorb, possibly with some extra margin for uncertainty. Buffers will generate costs for the [Aircraft Operator], whether or not they are fully used tactically."*

2. *"The allocation of strategic buffers by [Aircraft Operators] may be based on the statistical expectation of delay (based on previous experience), together with an assessment of the associated uncertainty, or unpredictability, of such delays. Some [Aircraft Operators] may take more buffering risks than others, for example by applying relatively small buffers, especially if they do not pay crew overtime and/or suffer costs due to passenger delay (although passenger compensation rules may soon change)."*

3. *"Adding buffer to the schedule impacts on all flights, whilst the saving made on tactical delays will depend on the percentage of flights delayed. Based on a simplified example for a B737-300, adding a number of buffer minutes to the schedule equal to the average tactical delay should be cost-effective if more than 22% of flights are expected to be delayed by more than 15 minutes."*

4. *"A reduction in the number of rotations possible in the day may become a limiting factor to the amount of buffer added, sooner than the apparent cost of the buffer minutes themselves suggests."*

5. *"It is cheaper to allocate buffer at-gate than to the airborne phase, although it may be advisable to strategically allocate some buffer specifically to the airborne phase.[…]"*

6. *"Predictability, or rather lack predictability, is an underpinning cause of the financial losses suffered as a consequence of delay. If all delays could be predicted with confidence to be exactly 10 minutes, then schedules could be re-adjusted accordingly."*

7. *"Predictability of delay (especially at the city-pair level) is an important complementary metric to average delay."*

Extract 2: Results of higher-level delay cost calculations

1. *[...]*

2. *"Based on these […] delays, a network average value of 72 euros per minute may be calculated for 'long' delays (of over 15 minutes) weighted by aircraft types and the known distribution of […] delay minutes. As with the network total range quoted above, this average value includes reactionary delay costs, but does not consider strategic costs associated with buffer minutes added to schedules. […]."*

3. *"Since 'long' delays (above 15 minutes) contribute the vast majority of the total cost, it would be instructive to examine the distribution of these delay minutes by causal factors […]."*

A further explanation of delay indicators is provided in the chapter entitled 'Data Analysis and Delay Reporting'

7. Delay analysis - CODA

One of the most important elements in tackling air traffic delays is to understand exactly what causes them. The EUROCONTROL Central Office for Delay Analysis (CODA) plays an increasingly important role in providing detailed and comprehensive data on the causes of delays so that remedies to the system can be effectively made.

History

The late 1980s was a time when delays to air traffic made headline news. Although weather and mechanical problems had always been a source of disruption, the extent of delays due to congestion during this period gave rise to political concerns. It was apparent that, although the symptoms of delay, such as large tents erected at airports to house the numbers of passengers whose flights had been delayed, were clear, there was surprisingly little detailed information about the causes of delay which might be used to identify ways of reducing or eliminating the problem. In the days before the establishment of the EUROCONTROL Central Flow Management Unit (CFMU), flow management was handled by a number of regional agencies and the best that could be achieved was that data were collected from each of these agencies and synthesised to produce an overall picture.

Delay data were collected and used by airlines for management control purposes, but in a fragmented way. The political momentum generated by the disruption in this period led to a decision by the Transport Ministers of the European Civil Aviation Conference (ECAC) States that there should be a programme to collect and report on air transport delays in Europe, covering all causes. This gave rise to CODA, the Central Office for Delay Analysis, established under the auspices of the EUROCONTROL Agency. Development work started in the early 1990s.

The airline industry was identified at an early stage as the primary source of delay cause data and the airline associations were willing partners in this activity. Both the Association of European Airlines (AEA) and the International Air Transport Association (IATA) began to use the data made available by their airline members to provide information to the newly formed CODA. Additionally airports, Airports Council International (ACI) and air navigation service providers played a major part in the development work and supplied data and support. The preparation of this external data was a significant task and without it there would have been severe limitations on the way in which CODA could have performed.

It was significant that as CODA began its work, the CFMU became fully operational and took on the functions of the original separate flow units. This in itself was an important contribution to the solution to the delay problem. However, a secondary effect was that a single source of data on specific effects of ATM capacity restrictions became available for the first time. This formed a crucial component of the work of CODA, whose brief was to report on all causes of delay. Currently, en-route ATFM restrictions, which have particular importance for EUROCONTROL, contribute to only around 15% of primary delay.

There were, however, difficulties associated with the reporting process. The important airline data was passed by the airlines to their associations, who then had to process it into a form which could be used by CODA. This process took time and it was often up to six weeks after the end of each reporting period that the relevant full report could be made available.

This was not really consistent with CODA's original mandate which was to "provide policy makers and managers of the ECAC air transport system with timely, consistent and comprehensive information on the air traffic delay situation in Europe", as it was hardly timely, even if it did meet most of the requirements.

Enhanced CODA developed

Although the delay reports were well received, there was a growing demand for more comprehensive performance reporting for ATM. It soon became evident that further improvement would be necessary if the reports, and the delay data behind them, were to be relevant to the sort of activities being considered by the newly-formed Performance Review Commission (PRC).

Comprehensive data for each flight was available in the context of ATFM delay, but this was not going to be enough. Airline delay data could not be directly mapped to ATFM data, as it was not available for each flight. The PRC, in its first report in June 1999, provided the necessary impetus to enable CODA to extend its activities by calling for industry cooperation in the provision of improved data. Accordingly, proposals were

7. Delay analysis - CODA

developed for a programme of improvements centred on better data that was available more quickly. This was approved by the EUROCONTROL governing bodies, and enhanced CODA (eCODA) was born.

The planned improvements also called for new analysis delivery methods, with a combination of a punctual supply of data, and the Internet as a means of distribution. These improvements would finally allow CODA to meet the 'timely' requirement of its mandate. It was no accident that the 'e' of eCODA hinted at its electronic future.

A voluntary effort

The improvement in the data supply was a challenge. Given that, as with the data supplied through the Associations, the improved data supply would be wholly voluntary, there was a significant amount of work involved in obtaining it. There was no legal requirement for the data to be made available and what was required, in terms of times and delay causes for each individual flight, would involve additional work for the potential data providers.

As before, it was the airlines whose data would be most informative, as they were the primary recorders of delay causes, and this was a time when airline budgets were being severely squeezed. Backed by a specific request from the EUROCONTROL Director General, airlines were contacted directly and some progress was made. Initially, it was important to ensure that a 'critical mass' of data was received, both to provide a sample big enough for useful reporting and also to allow demonstrations to be made to other potential data suppliers.

Currently, there are around 50 airlines supplying data to eCODA including major national carriers, charter and low-cost operators, taking the potential coverage to over 45% of IFR/ GAT (Instrument Flight Rules / General Air Traffic) flights. A significant effort is still needed, both to obtain new sources and to ensure that the existing supplies are maintained, given the financial climate in which airlines are operating. In order to facilitate this, recent agreements have been concluded under the terms of which the suppliers of operational control systems to airlines have modified their software such that those airlines who are their customers can assemble and transmit the data required by eCODA with no requirement for extra effort on their part.

7.1 Data Collection

Handling of data

All data for use in the delay analysis are stored in the PRISME (Pan-European Repository of Information Supporting the Management of EATM) database. EATM is the European Air Traffic Management Programme. Conventional reporting makes use of some very effective client software, which remains one of the principal tools for extracting information from these data. However, in order to ensure that results are delivered as soon as possible, the primary method of publication is via the Internet.

The EUROCONTROL Agency website has links to a page which contains graphs and tables (**see Figure III for examples**) which are generated automatically once the incoming data has been checked for consistency and loaded. These can be customised by users who create an account for themselves. For those in the industry who require it, there is an on-line version of the analysis tool used to prepare CODA reports, which can be used to prepare specific analyses using the available data.

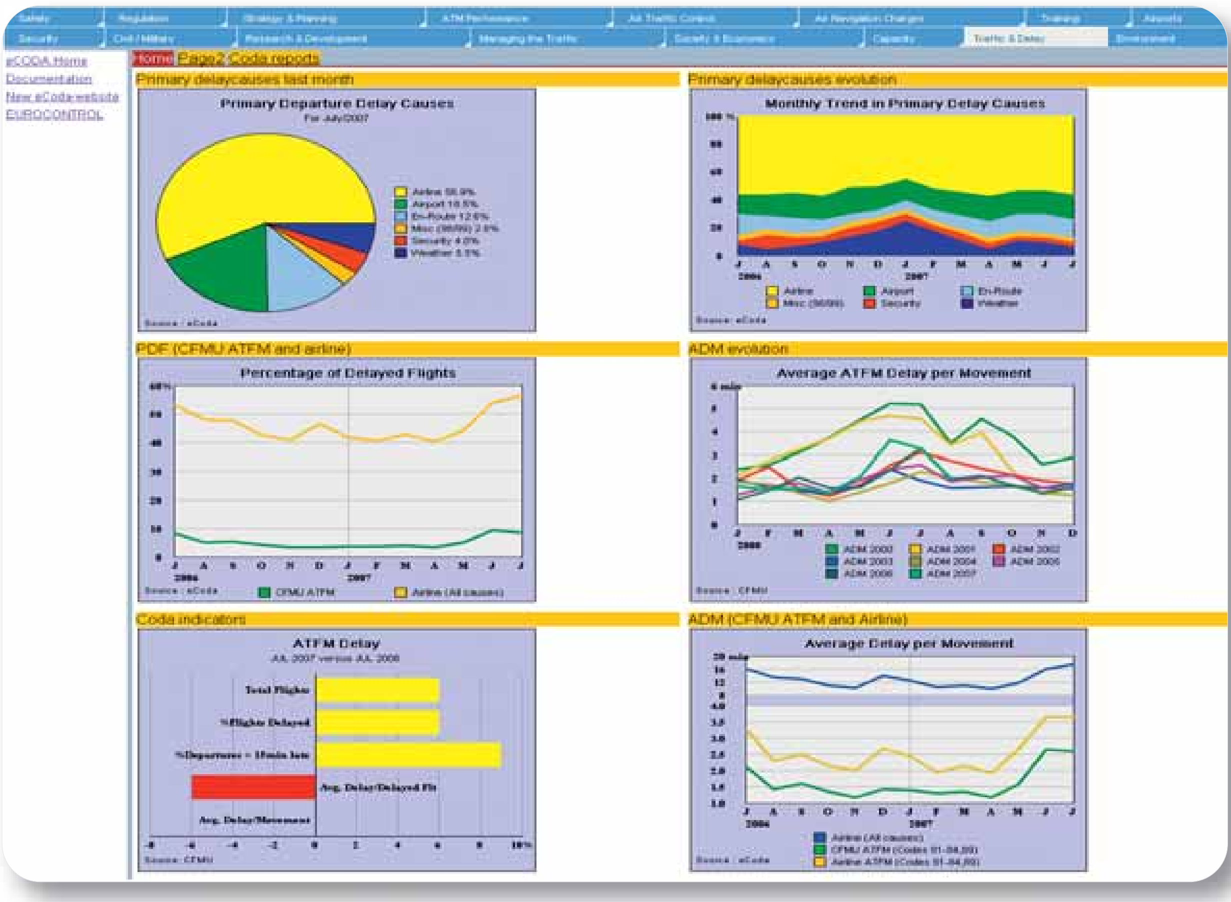


Figure III: Example of delay data from the Eurocontrol website

7. Delay analysis - CODA

7.1 Data Collection

Airline-supplied data is held under strict confidentiality, and no attempt is made or permitted to identify the performance of any individual airline. However, those supplying flight and delay data to CODA can have access to a further level of analysis, which permits them to benchmark their own performance against the network as a whole. This facility provides airlines with a potential cost saving. The reporting target requires that a given month's data and the results on the website should be available after the first week of the following month, thus moving from a production delay of up to seven weeks to one of seven days.

Although the move to on-line access has been made, there is still a demand for a form of conventional report which can be read off-line. This is prepared and made available either in separate parts, or as an electronic document through the web pages, or slightly later as a printed document and a summary flyer.

Of the information produced from the new flight-by-flight data, the proportion of differing delay causes has been one of the most significant. Airlines record delay by allocating delay time to one (or more) of the standard codes developed under the auspices of IATA and in use worldwide. By combining these very detailed codes into larger groupings, an interesting picture emerges. As might be expected with the reduction of en-route ATFM delay over the past two years the proportion of delay time allocated to this has been shown to be modest, which has, in turn, highlighted other causes of delay. For example, the proportion of delay attributable to airport issues has become noticeably larger.

Of all the delay causes, the largest single general category of primary cause is that attributable to technical problems with aircraft, which falls into the overall airline category. It is worth noting the use of the term 'primary delay cause' here. In many previous studies, the largest delay cause was shown to be 'reactionary' or 'rotation' delay: the delay caused by the late arrival of aircraft, crew or load caused by a delay in the previous sector. It is believed that this gave a false impression, as this delay is strictly an effect, not a cause. In order to solve departure problems, it is essential that the primary causes be known and understood, and for that reason reactionary delay is not included in these results.

Clearly, in order to understand the cost of disruption, such delay must be taken into account as it can seriously affect an airline's operation. In order to ensure that the way in which delay data is used and delay reports are prepared is impartial and fair, CODA has, since its inception, had a team member provided by an airline association. At present, this team member is supplied by IACA (the International Air Carrier Association) whose members comprise an industry segment from which data collection is very important.

The mechanics of data collection

In order to ensure that the collection of flight and delay data is manageable, there must be an order to the process. At the time of publication, data for some 60% of all IFR GAT flights in Europe are available for collection from airlines. Details of the current data suppliers are given in Annex C. Against a background of some 9 million flights a year, this results in over 5 million data lines per year. The process of acquiring this data has taken time, given the resource and cost limitations faced by airlines over recent years. **Figure IV** indicates the progress made in data collection since 2003.

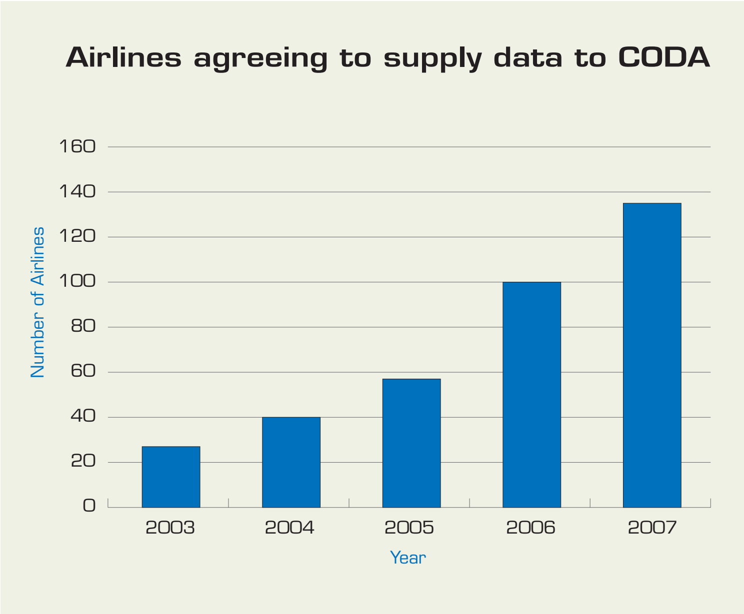


Figure IV: Data supplied by the airlines has increased rapidly

Crucially, the data from the EUROCONTROL Central Flow Management Unit (CFMU), comprising a complete record of IFR flights which have operated in Europe is available. This contains, among other attributes, flight times and identifiers and any air traffic flow management restrictions which may have been imposed because of congestion due to operational causes such as weather, airspace or airport capacity. As well as providing specific delay information reported directly by the CFMU on a regular basis, CFMU ATFM and flight plan data plays a vital role in the quality checking of other data sources, providing as it does the benchmark list of all flights which have operated.

In the collection of airline data, the first task in order to ensure that the desired content is included and can be read is to specify a data format (see Annex D). This

7. Delay analysis - CODA
7.1 Data Collection

takes the simple form of a list of data fields, their content and order. In practice, however, it is acknowledged that an excessively rigid definition may give some data suppliers a problem. To avoid this, the data receiving process is able to handle any non-standard input from a regular data supplier with the system simply adapted to expect their files in a specific format.

Naturally, with such a large amount of data, and large number of different voluntary suppliers with different capabilities, manual involvement is kept to a minimum as it is simply not possible to impose requirements. E-mail has been found to be the simplest and most reliable form of data file transmission. As with most of CODA, the decision was taken at an early stage that it was infinitely preferable to have a simple system which would produce useable results of demonstrable quality in a reasonable time, rather than an academically elegant system built to the most demanding engineering standards, for which excuses for non-implementation would still be being made ten years hence. The 80/20 principle was the leitmotif, and automation the only way forward.

Some level of manual intervention is, however, unavoidable. Receipt of expected files must be monitored, and reminders sent in the event of non-receipt. An automated process inspects the data, using an algorithm to attempt matches if any fields are outside expected values. Any data which fails this process is rejected. It is, however, testament to the quality of the data received that acceptance rates routinely exceed 99%. The matches and discrepancies can be automatically notified to the data provider if requested, so improving the data quality. A further quality check, the most time-consuming aspect of data receipt, is also performed to ensure the required level of consistency. A method by which data quality is further monitored by the comparison of computed indices as part of the analysis process is described later.

Given the voluntary nature of the data collection, it is important that, as mentioned earlier, the effort required from airlines is kept to a minimum. As also indicated earlier, collaboration has taken place between CODA and suppliers of operation control software. Many of the largest airlines run their own operational systems developed to their own designs. It is possible for the reporting parts of these systems to be adapted to provide the required data with minimal subsequent intervention. However, many airlines find it more effective to buy in third-party solutions, which are locally adapted. It is with the suppliers of these systems that agreements have been reached to modify the software in such a way that, with the airline's consent, data is automatically collated and transmitted, with no routine overhead for the airline.

Voluntary data collection does, however, rely on continuous communication, and personal contact. In an increasingly cost-conscious environment, there may be only a limited number of people available in an airline to manage the data process and it important to ensure that, in the event of personnel changes, an appropriate level of support is provided by CODA. The ultimate aim is, quite simply, to ensure that for airline contributors, data provision is as close to being cost-neutral as possible.

7.2 Delay Data Accuracy

Where airline-gathered statistics are used to measure and categorise delay, there has often been a suggestion that the accuracy of such statistics is compromised by the need to assign blame and by attempts to hide the influence of one or more of the direct contributors. It is probably true to say that 15-20 years ago there was an element of truth in this. Delay statistics are collected by aircraft operators primarily so that they can direct improvement efforts where they are most needed. Clearly in this regard, poorly performing areas within an airline will be subject to scrutiny and it is only human nature that those responsible would seek to minimise criticism by moving some of the blame to an external agency or cause should the opportunity arise. Thus, there was a tendency for ATC (Air Traffic Control), airport facilities, congestion and weather to appear as disproportionate causes. This also tended to serve the needs of those who wanted, quite rightly in many cases, to focus attention on infrastructure deficiencies.

However, times changed. Airlines were becoming more business driven and it became apparent that problems could only be solved if they were accurately identified. The needs of the overall business became more important than the defending of 'turf' and a greater emphasis was put on the accuracy of delay reporting. At the same time, the relationships between airspace users and airspace and airport service providers became more co-operative, as it became clear that many problems required a co-operative approach in order to find an appropriate solution.

In addition to data collection processes, most aircraft operators have a system whereby, either daily or over another time period, delay statistics are examined and any anomalies investigated and corrected. Data thus treated and 'cleaned' is then archived for future analysis, resulting in a more reliable source for use in improvement activities. Indeed, a routine check, such as is performed and published by EUROCONTROL in its regular eCODA statistics where like-for-like delays as recorded by the CFMU are compared with those recorded by operators, shows that although absolute values vary slightly due to the comparison of sample data with full data the trends nonetheless match exactly (**see Figure V**).

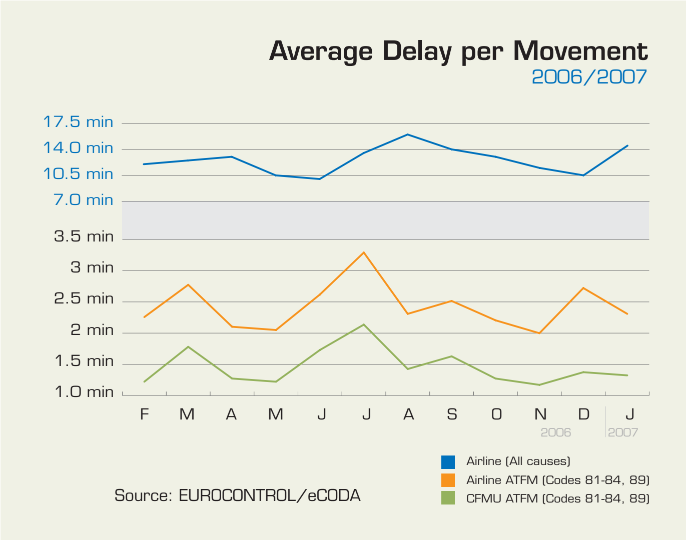


Figure V: Comparison of CFMU and Airline delays

The accuracy displayed here is taken as a good indicator that the accuracy of other delay causes is similar. Any suggestion that the delay data is in any way 'fixed' to favour a particular result quickly appears absurd, as the cost and effort required to manipulate and maintain a set of 'special' data for external use would be enormous. The data collected by airlines is reliable and is a rich resource supporting industry-wide efforts to improve the services provided.

7.3 Data Management

The general issues surrounding data collection were covered in the previous chapter. Here, we will discuss the issues in a little more depth, and look at some considerations regarding the stewardship of such data.

Having established a data transmission method (e-mail of files has proved to be the simplest and most effective to date), an initial data file from a provider is checked to ensure that it has a format which can be automatically read. Once a regular supply is established, a sequence of error checks takes place, benchmarking it against the list of all flights contained in the Air Traffic Flow Management (ATFM) data held by the Central Flow Management Unit (CFMU) in order to ensure that the content is acceptable, and the data is loaded into the main PRISME database where it is available for use in analysis. An outline of the data checking process is described in Annex B by using flow diagrams.

The security of the data held in this way and the way in which access can be obtained, is of critical importance. The data derived from third parties (in this case, airlines) are highly confidential. Inadvertent release might allow commercial advantage to be gained, notwithstanding any issues of intellectual property rights. Data are provided voluntarily in this case, on the basis of trust, backed up by a data agreement which is signed by both EUROCONTROL and the data supplier (see Annex D). The agreement is a simple statement to the effect that the purposes of the use of the data will be limited and that confidentiality will be maintained. Proper discharge of this trust is important as the misuse of the data entitles the supplier to cease provision.

The PRISME database is the warehouse that has become the central repository for archived operational data and flight data. Here, these data can be analysed without the necessary restrictions which are put in place in active operational databases to prevent corruption of the operational systems. PRISME supplies data services to a wide range of internal (EUROCONTROL) and external users in the industry, and access is being simplified with the development of a unified data portal whereby authorised users can extract and perform analysis on a wide range of data.

Internal users of data are required to subscribe to a service level agreement, which details the data to which they may have access, the uses to which they will put the data they receive, and the measures they will employ to ensure data security. This serves to further protect the data provided by external suppliers and to reinforce the guarantee of confidentiality.

7.4 Data Analysis and Delay Reporting

Delay data analysis has evolved over time, as users have decided which delay indicators suit their purposes best. Although a number of complex indicators have been developed, those which have become key are, in fact, the simplest. These are:

- Total flights
- Average delay per movement
- Percentage of delayed flights
- Average delay per delayed flight.

Others indicators do exist. 'Total delay minutes', by way of an example, is useful, but only if the sample is complete. However, none has been seen to be as useful as the four indicators listed above. In developing some of these, for example percentage of delayed flights a decision has to be taken regarding the delay threshold. There are a number of such thresholds in use.

Most delay is actually measured to the nearest minute. However, in some instances five minutes has been used where there is a level of 'noise' in the statistics. The 15 minute threshold has stood the test of time and is used for a number of industry data sets where percentage of delays is measured. In the airline world, the three minute threshold has been widely used operationally, and is the likely basis of delay statistics to be used within the European Single Sky Programme (SESAR).

Average Delay per Movement, when applied to departure, is a useful indicator of the performance of the system, but it tends to differ from the subjective experience of most passengers. The Average delay per

7.4 Data Analysis and Delay Reporting

Delayed Flight indicator goes some way to addressing this. Whilst being less useful for assessing trends in the system, this indicator shows, if a flight is delayed, the average delay which may be experienced. An example of the distribution of delays by length of delay is shown in **Figure VI**.

The average delay per movement corresponding to this distribution is 1.9 minutes, and the average delay per delayed flight is 20.3 minutes, illustrating the difference between these values.

These indicators, and their rate of change, can be represented in a number of presentations and graphical formats. Additionally, descriptive texts drawing attention to particular values and trends may be used. Indicators can refer to the totality of traffic or, where close analysis is required, to airports, countries, traffic flows, city pairs, or any other parameter whose performance is under review. Such delay reports were initially presented in printed form, but increasingly presentation on-line has been the preferred medium.

On-line access has the advantage that pre-prepared and edited documents can be made available quickly via the Internet and also that certain standard statistics can be presented automatically, as soon as the necessary data is available. By virtue of such automation, and the rapid response of data providers, some CODA monthly statistics can be made available within a few days of the end of the reference month. This availability has not removed totally the need for hard-copy documents however as there are occasions when users prefer to have something which can be studied off line. Such documents can also be transmitted in soft-copy for local printing and can be archived in both electronic and hard-copy forms. The archiving is useful, as on-line presentation tends to be ephemeral, notwithstanding the ability to re-calculate data for any period from the database.

As a further development users can be provided with access to analysis facilities via a portal, through which they can perform customised analyses to suit their own requirements. This method is cost-effective, as it reduces the need for standard analyses for general dissemination and it is also cost-effective in terms of analysis time allowing analysis staff to concentrate on other issues, as well as providing a greater degree of service over a wider area.

By way of illustration, sample pages from the printed CODA annual report for 2006 are included as Annex E, and pages from the online eCODA application are similarly presented. Also included in Annex F is a screenshot of the access page provided to authorised users.

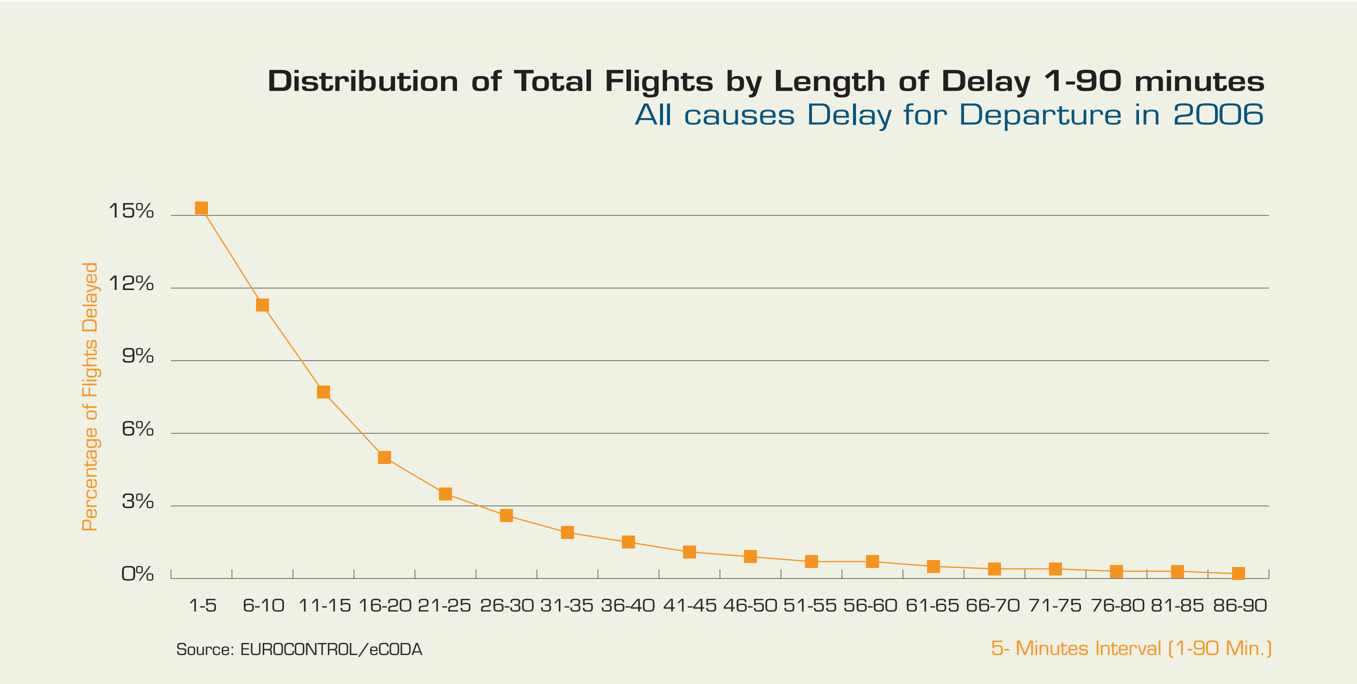


Figure VI: Distribution of Total Flights by Length of Delay during 2006

8. The Future

What can we expect?

EUROCONTROL's Statistics and Forecast Service (STATFOR) produces regular traffic forecasts based on a range of assumptions, such as levels of economic activity within Europe. These are translated into low, medium and high growth scenarios.

On the assumption that business will continue 'as usual', the projected air traffic growth rates are as indicated below in **figure VII**.

EUROCONTROL Long-Term Forecast 2005-2025,
Scenario B: Business as Usual

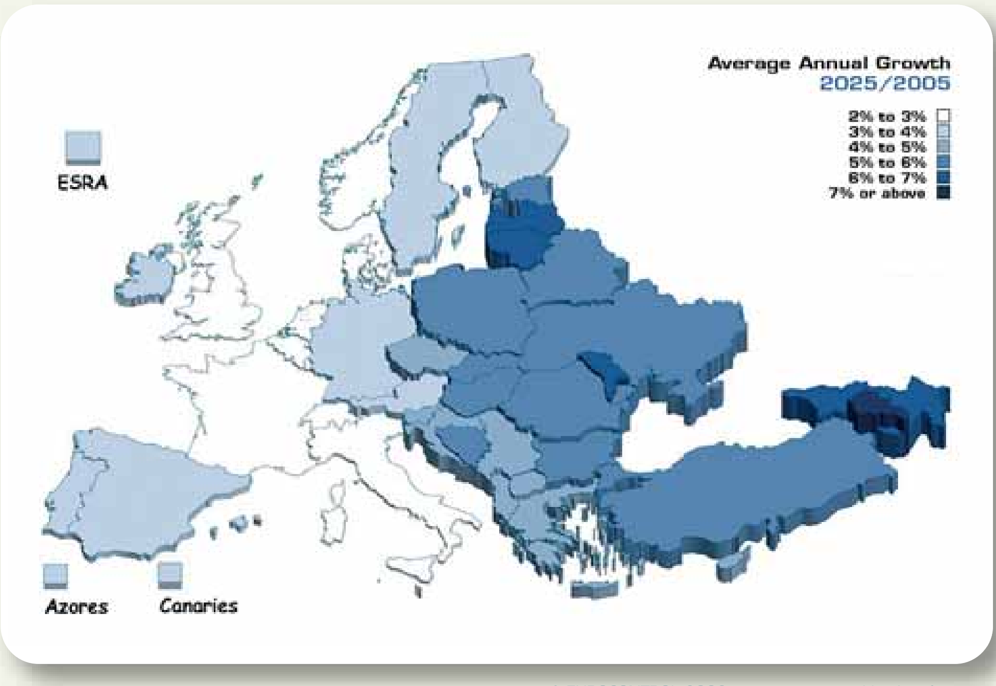


Figure VII: Projected Air Traffic growth rates in Europe

This can also be represented as the number of flights added to the network, where low growth in the busiest areas is seen to add large numbers of flights. See **Figure VIII.**

A dramatic representation showing the projected increasing density of flights over a 20-year period in the so-called core traffic areas of Europe can be seen by comparing **Figures IX and X**.

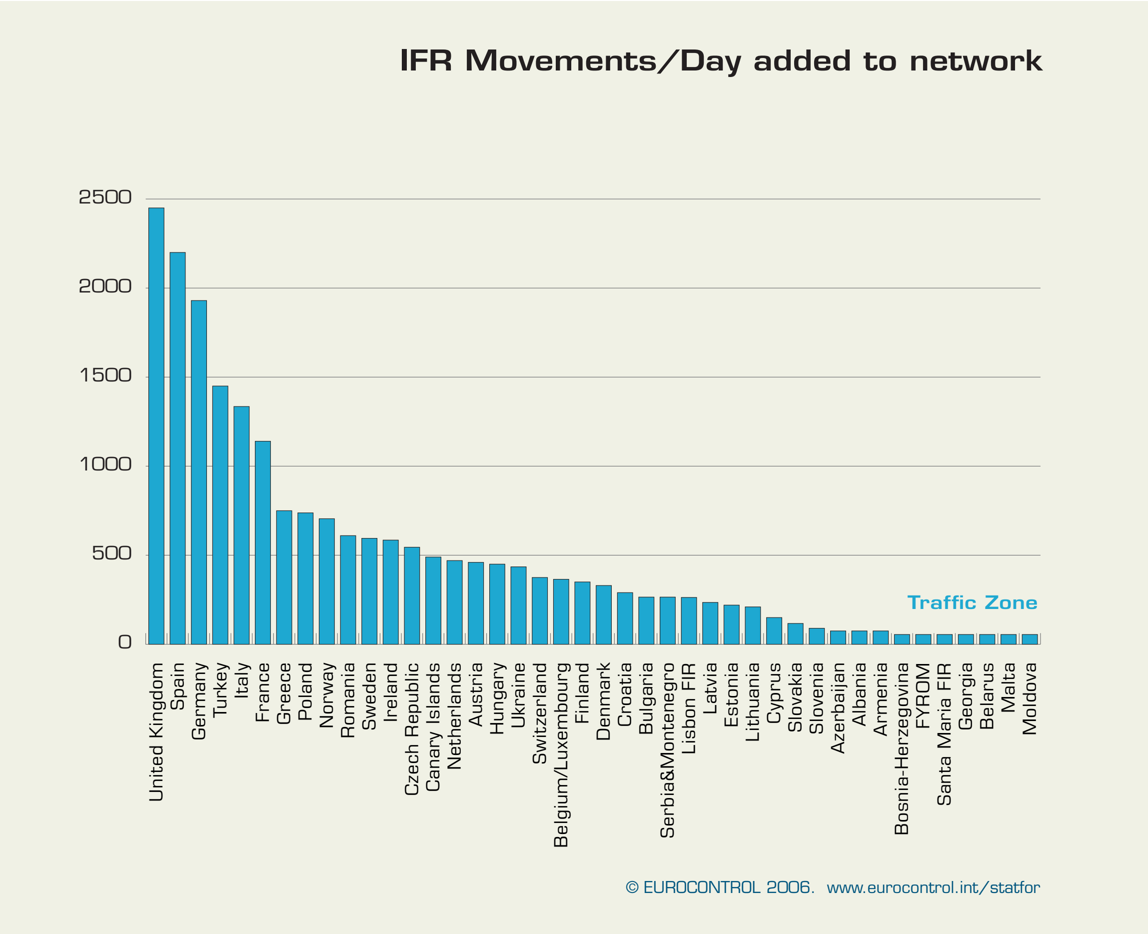


Figure VIII: Growth represented as additional flights per day

EUROCONTROL Long-Term Forecast 2006-2025,
Scenario A: Globalisation and Rapid Growth

Figure IX: Flight density in 2006 (high density = red)

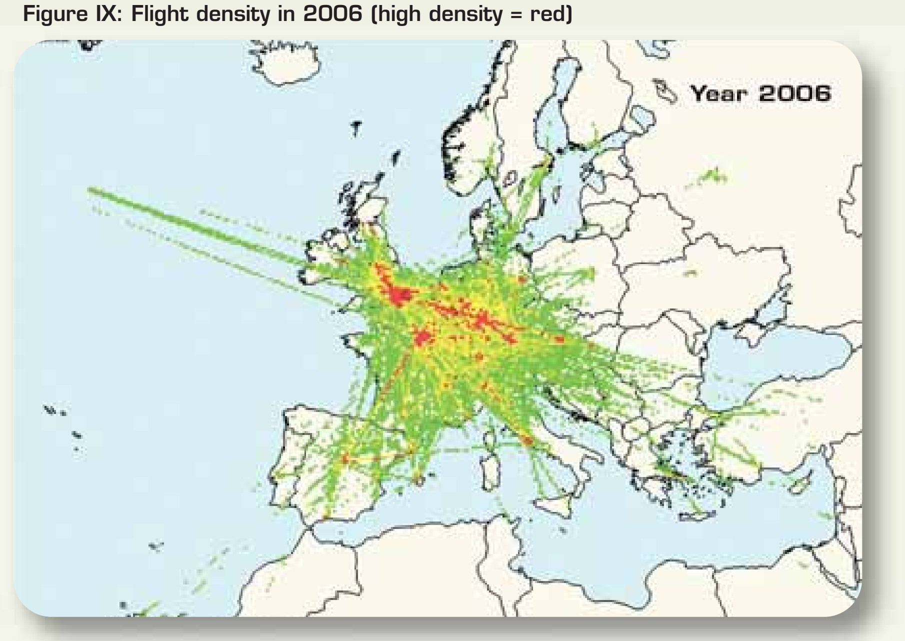
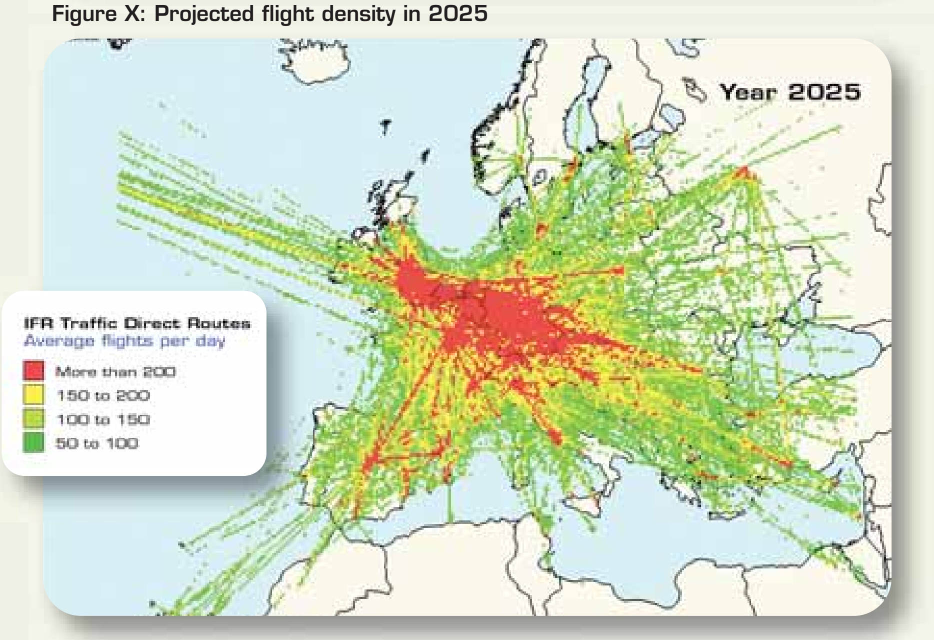


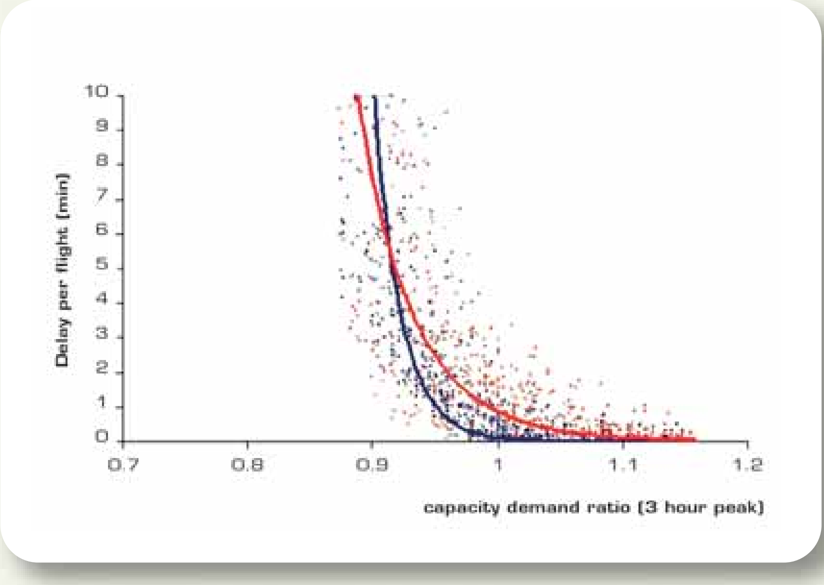
Figure X: Projected flight density in 2025



As air traffic increases, it is axiomatic that, if delay is not to increase, then the resources and capacity required to support that traffic must match the expected levels. If this does not happen, delay may increase very rapidly. **Figure XI** illustrates this rapid rise in delay once demand begins to exceed capacity.

Delay Sensitivities:
"Network" - "No Network"

Figure XI: Effect of demand capacity on flight delay



In view of the forecast traffic growth, there is a risk that delays, including those related to air traffic management (ATM), may rise again. At network level, air traffic is expected to grow by 21.7% between 2005 and 2011 (medium growth scenario). In order to cope with this traffic growth and to achieve and maintain the en-route delay target, the summer season European ATM network capacity will require an increase of 27% (ref: Capacity Plan).

The delay forecast for 2007 and 2008 indicates that the en-route average delay target will be met for the medium traffic growth scenario but not for the high traffic growth, see **Figures XII and XIII**.

2008 En-route Delay Forecast
Baseline traffic growth

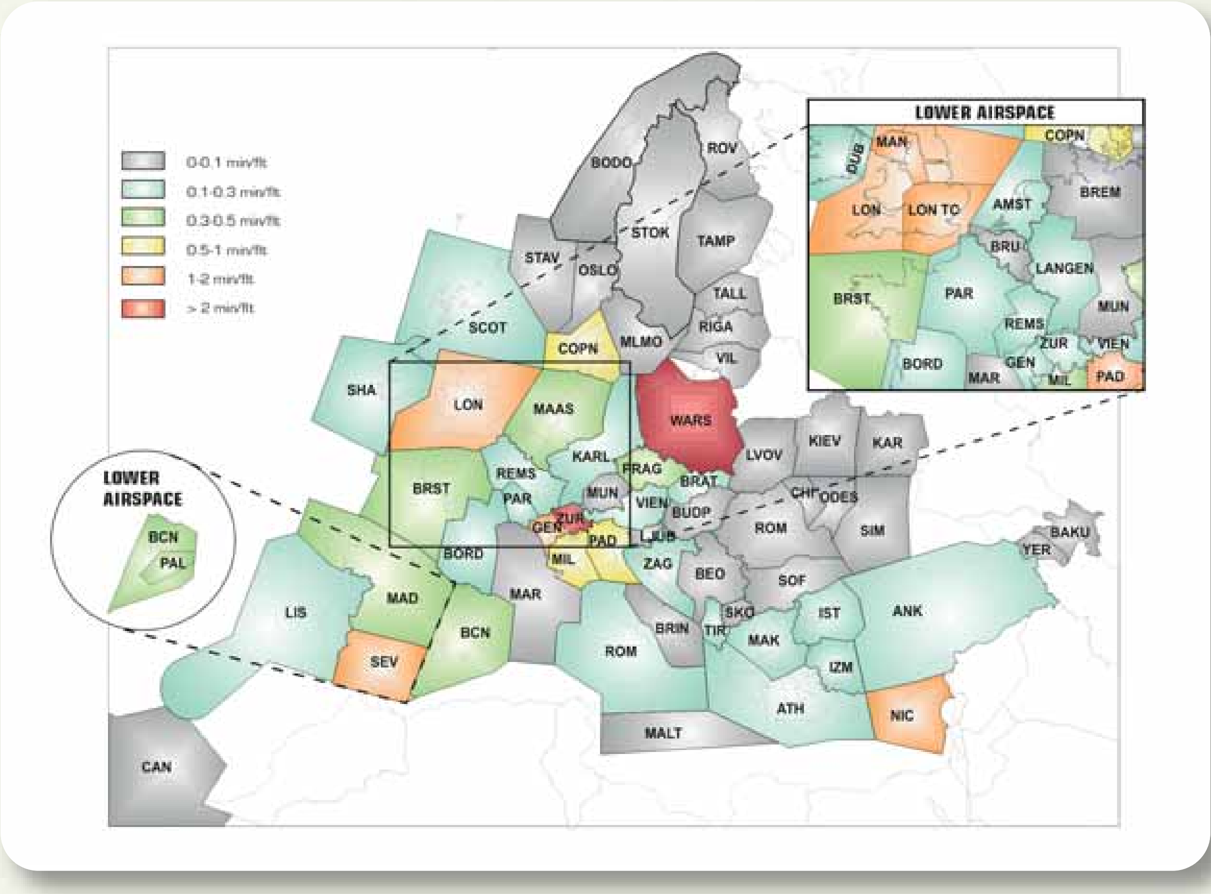


Figure XII: Projected en-route delay for medium growth

2008 En-route Delay Forecast
High traffic growth

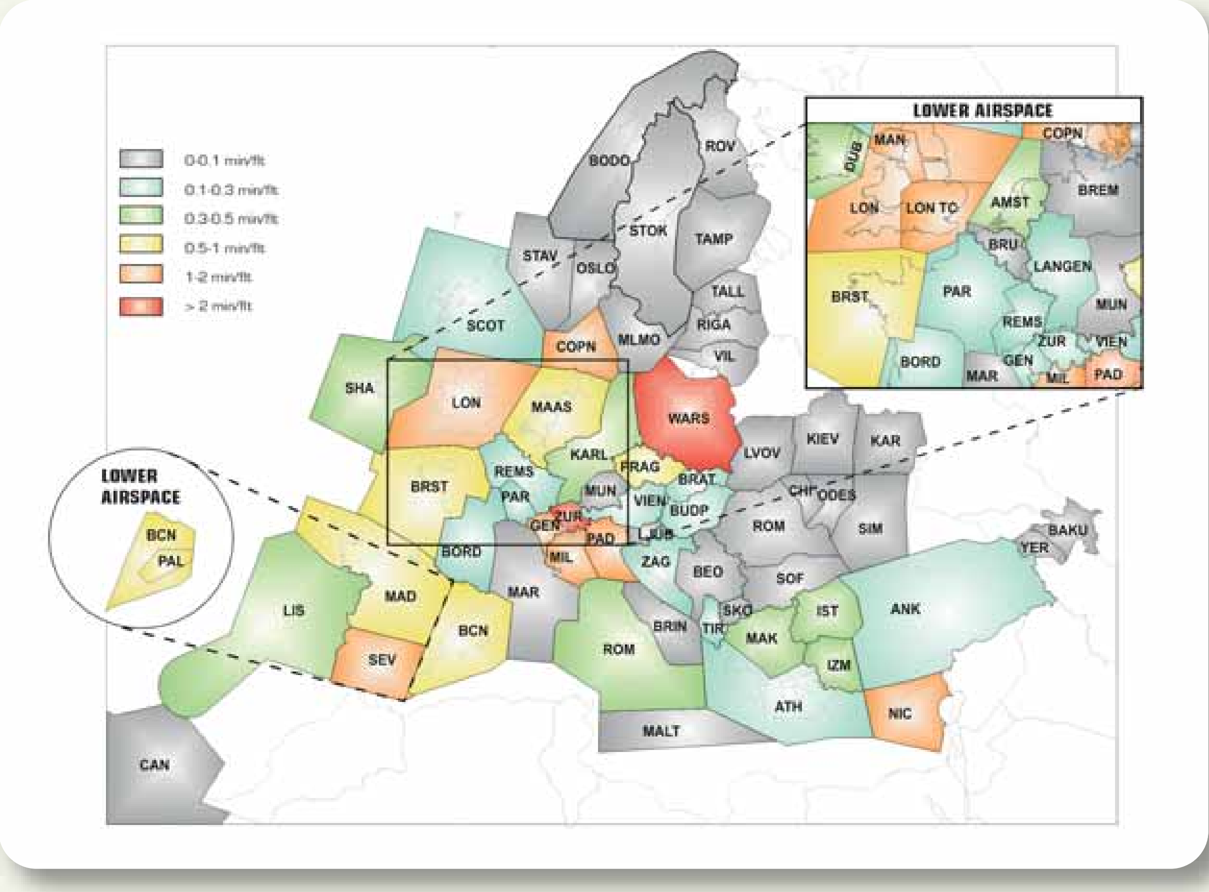


Figure XIII: Projected en-route delay for high growth

And finally.....

If there are any questions about this paper and its efforts to explain aspects of air transport delay, further information may be found on the Internet, and the following links may be useful.

For traffic data and forecasts: STATFOR, www.eurocontrol.int/statfor
For delay data and analysis: CODA, www.eurocontrol.int/ecoda
CFMU, www.eurocontrol.int/cfmu
For the airline perspective: AEA, www.aea.be

Annexes

Annex A

Standard IATA Delay Codes

Others

00-05 AIRLINE INTERNAL CODES
06 (OA) NO GATE/STAND AVAILABILITY DUE TO OWN AIRLINE ACTIVITY
09 (SG) SCHEDULED GROUND TIME LESS THAN DECLARED MINIMUM GROUND TIME

Passenger and Baggage

11 (PD) LATE CHECK-IN, acceptance after deadline
12 (PL) LATE CHECK-IN, congestions in check-in area
13 (PE) CHECK-IN ERROR, passenger and baggage
14 (PO) OVERSALES, booking errors
15 (PH) BOARDING, discrepancies and paging, missing checked-in passenger
16 (PS) COMMERCIAL PUBLICITY/PASSENGER CONVENIENCE, VIP, press, ground meals and missing personal items
17 (PC) CATERING ORDER, late or incorrect order given to supplier
18 (PB) BAGGAGE PROCESSING, sorting etc.

Cargo and Mail

21 (CD) DOCUMENTATION, errors etc.
22 (CP) LATE POSITIONING
23 (CC) LATE ACCEPTANCE
24 (CI) INADEQUATE PACKING
25 (CO) OVERSALES, booking errors
26 (CU) LATE PREPARATION IN WAREHOUSE
27 (CE) DOCUMENTATION, PACKING etc (Mail Only)
28 (CL) LATE POSITIONING (Mail Only)
29 (CA) LATE ACCEPTANCE (Mail Only)

Aircraft and Ramp Handling

31 (GD) AIRCRAFT DOCUMENTATION LATE/ INACCURATE, weight and balance, general declaration, pax manifest, etc.
32 (GL) LOADING/UNLOADING, bulky, special load, cabin load, lack of loading staff
33 (GE) LOADING EQUIPMENT, lack of or breakdown, e.g. container pallet loader, lack of staff
34 (GS) SERVICING EQUIPMENT, lack of or breakdown, lack of staff, e.g. steps
35 (GC) AIRCRAFT CLEANING
36 (GF) FUELLING/DEFUELLING, fuel supplier
37 (GB) CATERING, late delivery or loading
38 (GU) ULD, lack of or serviceability
39 (GT) TECHNICAL EQUIPMENT, lack of or breakdown, lack of staff, e.g. pushback

Technical and Aircraft Equipment

41 (TD) AIRCRAFT DEFECTS.
42 (TM) SCHEDULED MAINTENANCE, late release.
43 (TN) NON-SCHEDULED MAINTENANCE, special checks and/or additional works beyond normal maintenance schedule.
44 (TS) SPARES AND MAINTENANCE EQUIPMENT, lack of or breakdown.
45 (TA) AOG SPARES, to be carried to another station.
46 (TC) AIRCRAFT CHANGE, for technical reasons.
47 (TL) STAND-BY AIRCRAFT, lack of planned stand-by aircraft for technical reasons.
48 (TV) SCHEDULED CABIN CONFIGURATION/VERSION ADJUSTMENTS.

Damage to Aircraft & EDP/Automated Equipment Failure

51 (DF) DAMAGE DURING FLIGHT OPERATIONS, bird or lightning strike, turbulence, heavy or overweight landing, collision during taxiing
52 (DG) DAMAGE DURING GROUND OPERATIONS, collisions (other than during taxiing), loading/off-loading damage, contamination, towing, extreme weather conditions
55 (ED) DEPARTURE CONTROL
56 (EC) CARGO PREPARATION/ DOCUMENTATION
57 (EF) FLIGHT PLANS

Flight Operations and Crewing

61 (FP) FLIGHT PLAN, late completion or change of, flight documentation
62 (FF) OPERATIONAL REQUIREMENTS, fuel, load alteration
63 (FT) LATE CREW BOARDING OR DEPARTURE PROCEDURES, other than connection and standby (flight deck or entire crew)
64 (FS) FLIGHT DECK CREW SHORTAGE, sickness, awaiting standby, flight time limitations, crew meals, valid visa, health documents, etc.

65 (FR) FLIGHT DECK CREW SPECIAL REQUEST, not within operational requirements
66 (FL) LATE CABIN CREW BOARDING OR DEPARTURE PROCEDURES, other than connection and standby
67 (FC) CABIN CREW SHORTAGE, sickness, awaiting standby, flight time limitations, crew meals, valid visa, health documents, etc.
68 (FA) CABIN CREW ERROR OR SPECIAL REQUEST, not within operational requirements
69 (FB) CAPTAIN REQUEST FOR SECURITY CHECK, extraordinary

Weather

71 (WO) DEPARTURE STATION
72 (WT) DESTINATION STATION
73 (WR) EN ROUTE OR ALTERNATE
75 (WI) DE-ICING OF AIRCRAFT, removal of ice and/or snow, frost prevention excluding unserviceability of equipment
76 (WS) REMOVAL OF SNOW, ICE, WATER AND SAND FROM AIRPORT
77 (WG) GROUND HANDLING IMPAIRED BY ADVERSE WEATHER CONDITIONS

ATFM + AIRPORT + GOVERNMENTAL AUTHORITIES
AIR TRAFFIC FLOW MANAGEMENT RESTRICTIONS

81 (AT) ATFM due to ATC EN-ROUTE DEMAND/CAPACITY, standard demand/capacity problems
82 (AX) ATFM due to ATC STAFF/EQUIPMENT EN-ROUTE, reduced capacity caused by industrial action or staff shortage, equipment failure, military exercise or extraordinary demand due to capacity reduction in neighbouring area
83 (AE) ATFM due to RESTRICTION AT DESTINATION AIRPORT, airport and/or runway closed due to obstruction, industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights
84 (AW) ATFM due to WEATHER AT DESTINATION

AIRPORT AND GOVERNMENTAL AUTHORITIES

85 (AS) MANDATORY SECURITY
86 (AG) IMMIGRATION, CUSTOMS, HEALTH
87 (AF) AIRPORT FACILITIES, parking stands, ramp congestion, lighting, buildings, gate limitations, etc.
88 (AD) RESTRICTIONS AT AIRPORT OF DESTINATION, airport and/or runway closed due to obstruction, industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights
89 (AM) RESTRICTIONS AT AIRPORT OF DEPARTURE WITH OR WITHOUT ATFM RESTRICTIONS, including Air Traffic Services, start-up and pushback, airport and/or runway closed due to obstruction or weather[1] , industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights

Reactionary

91 (RL) LOAD CONNECTION, awaiting load from another flight
92 (RT) THROUGH CHECK-IN ERROR, passenger and baggage
93 (RA) AIRCRAFT ROTATION, late arrival of aircraft from another flight or previous sector
94 (RS) CABIN CREW ROTATION, awaiting cabin crew from another flight
95 (RC) CREW ROTATION, awaiting crew from another flight (flight deck or entire crew)
96 (RO) OPERATIONS CONTROL, re-routing, diversion, consolidation, aircraft change for reasons other than technical

Miscellaneous

97 (MI) INDUSTRIAL ACTION WITH OWN AIRLINE
98 (MO) INDUSTRIAL ACTION OUTSIDE OWN AIRLINE, excluding ATS
99 (MX) OTHER REASON, not matching any code above

SOURCE: Provisional list composed by IATA

[1] Restriction due to weather in case of ATFM regulation only, else refer to code 71 (WO)

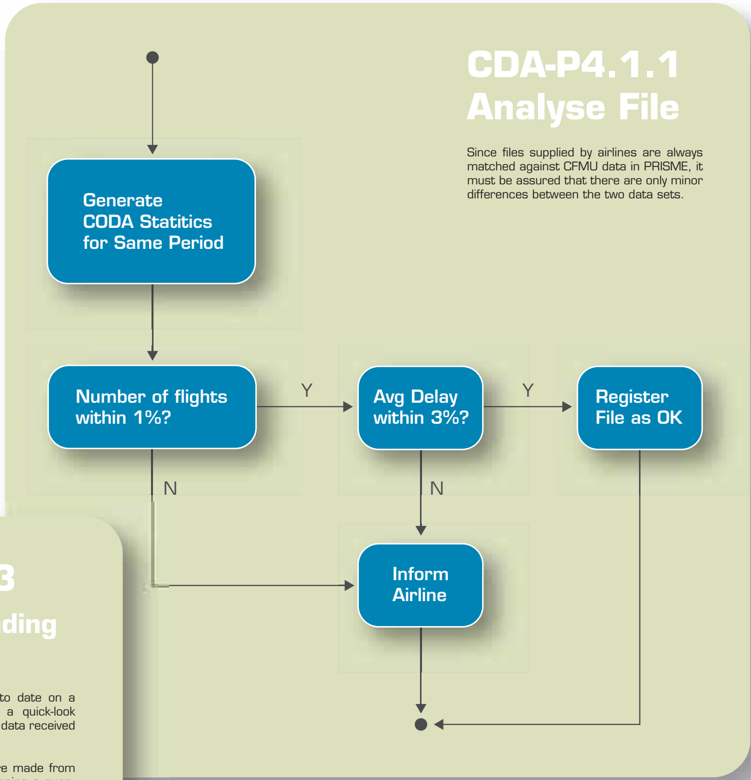
eCODA Cause	Description	IATA Code
Airline	Passengers + Baggage Cargo + Mail Aircraft + Ramp Handling Technical + Aircraft Equipment Aircraft Damage and Ops Computer failure. Flight Operations Other airline-related causes	11-19 21-29 31-39 41-49 51-59 61-69 Others
Airport	ATFM due to Restriction at Destination Airport Immigration, Customs, Health Airport Facilities Restriction at Destination Airport Restriction at Airport of Departure, with or without ATFM	83 86 87 88 89
En-Route	ATFM due to ATC En-Rte Demand Capacity ATFM due to ATC Staff / Equipment En-Route	81 82
Misc	Miscellaneous	98-99
Security	Mandatory Security	85
Weather	Weather ATFM due to Weather at Destination	71-79 84

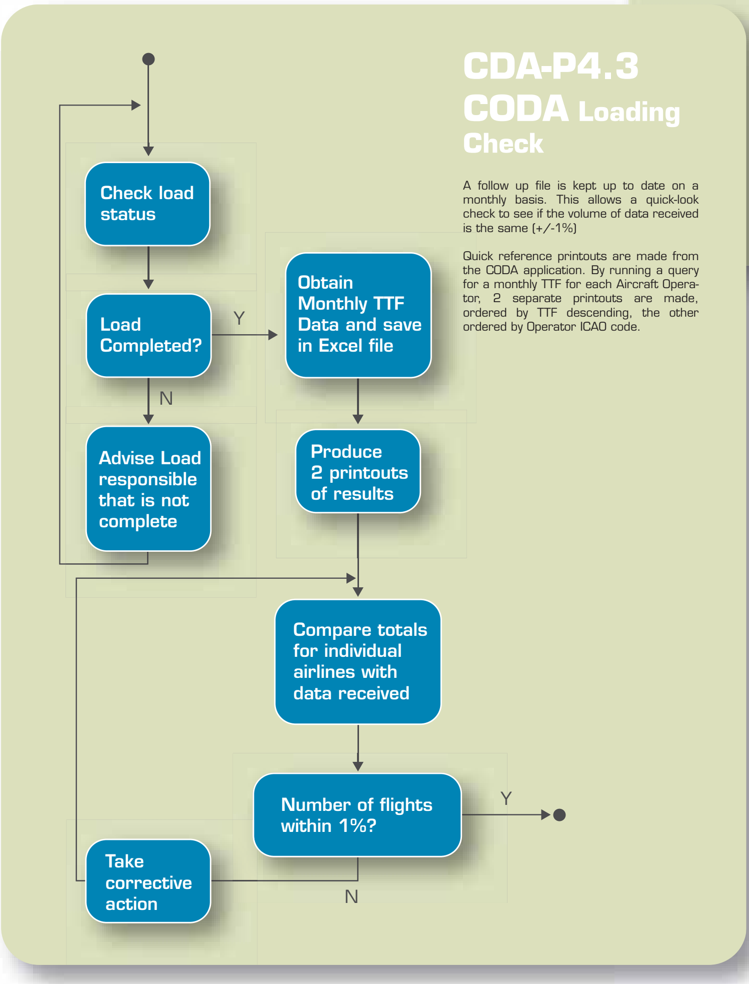
(Security delay is, at this time, shown separately from Airport delay, due to its high-profile nature.)

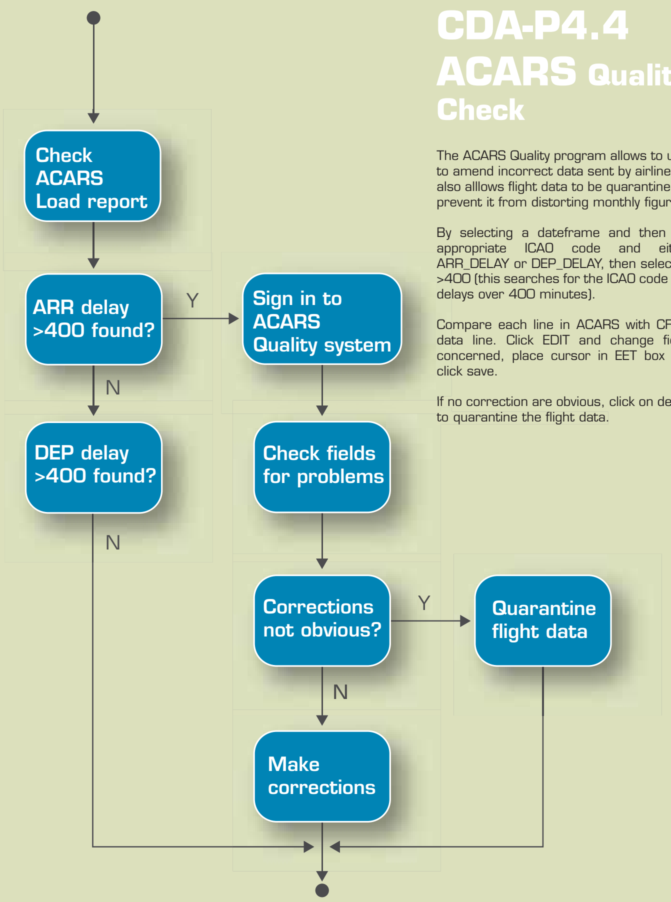

ETIHA
www.etihadairways.com

Annex B

Data quality-checking Diagrams







CDA-P4.4 ACARS Quality Check

The ACARS Quality program allows to user to amend incorrect data sent by airlines. It also alllows flight data to be quarantined to prevent it from distorting monthly figures.

By selecting a dateframe and then the appropriate ICAO code and either ARR_DELAY or DEP_DELAY, then selecting >400 (this searches for the ICAO code and delays over 400 minutes).

Compare each line in ACARS with CFMU data line. Click EDIT and change fields concerned, place cursor in EET box and click save.

If no correction are obvious, click on delete to quarantine the flight data.

Annex C

List of Airline Data Partners

American Airlines
Air One
Air Europa
Aegean Airlines
Air France
Austrian Airlines Group
Alitalia
Fly DBA
British Airways
Flybe
Air Berlin
Blue 1
TUIFly Nordic
British Midland
BMI Baby
Atlas Blue
Cityflyer Express
Air Baltic
Brit Air
Centralwings
SAS Braathens
CSA Czech Airlines
Coast Air
Cyprus Airlines
Brussels Airlines
Lufthansa
Denim Air
Danish Air Transport
Eurocypria
Edelweiss
Sky Europe
Etihad
Jet2
EasyJet Switzerland
EasyJet
First Choice
Air Finland
Finnair
Europe AirPost
Futura
German Cargo
Germania
Atlas Air
TUIFly
Sky Europe Hungary
Binter Canarias
Iberia
Iberworld
Jetair Fly
Spanair
AtlasJet International
KLM
Nouvelair
LOT Polish Airlines
Malev
Monarch
Martinair
Egyptair
Norweigian Airlines
NetJets Europe
Niki
Norsk Helicopter
Novair
Onur Air
Polar Air Cargo
Portugalia
Pegasus Airlines
Regional
Royal Air Maroc
Tarom
SATA International
SAS
SATA
South African Airways
Malmo Aviation
British Airways Shuttle
Sky Express
Skyways
Alitalia Express
Swiss International
Tunis Air
Thomas Cook Belgium
Thomas Cook UK
Arke Fly
Turkish Airlines
ThomsonFly
Transavia
Air Transat
Travel Servis Hungary
Travel Service
Emirates
UPS
My Travel A/S
Vueling
VLM
Wideroe
Wizz Air

AEA
Avient
AVINOR
IACA
AIMS
Sabre Airline Solutions
AIR NOSTRUM
AIR FRANCE
AIR-BERLIN
air transat
AirDolomiti
atlasjet
AEGEAN AIRLINES
airBaltic
AIR SENEGAL
AirEuropa
AIRPOST
AERO AIRLINES
Alitalia
Arkefly
Atlas-blue.com
cityjet
TUIfly.com
BinterCanarias
Blue 1
CCM Airlines
bmi
dba
Air One
ATLAS AIR
Brit air
brussels airlines
American Airlines
DANISH AIR TRANSPORT
BRITISH AIRWAYS
centralwings
Eastern airways
novair
First Choice
Austrian
CYPRUS AIRWAYS
FUTURA
flybe.com
Germania
EGYPTAIR
CSA CZECH AIRLINES
FINNAIR
KLM
Martinair your wings
Jetairfly
FREEBIRD
Jet2
edelweiss air
Lufthansa
SOUTH AFRICAN AIRWAYS
LOT
ETIHAD AIRWAYS
IBERIA
PEGASUS
DenimAir
Meridiana
PGA PORTUGALIA AIRLINES
MALMÖ AVIATION
Nouvelair
NIKI
Emirates
MALEV Hungarian Airlines
AIR FINLAND
TURKISH AIRLINES
ONUR AIR
royal air maroc
POLAR AIR CARGO
EUROCYPRIA AIRLINES
TAP PORTUGAL
REGIONAL airlines
SAS Braathens
norwegian.no
TRAVEL
smartWings
Spanair
SAS Scandinavian Airlines
TUIfly Nordic
QATAR AIRWAYS
TAROM
IBERWORLD
UPS
Thomsonfly
SunExpress
Grupo SATA
MY TRAVEL
SKYWAYS
transavia.com
easyJet
Thomas Cook
TUNISAIR
fly VLM
widerøe
WIZZ
swiss
SKY EUROPE

Annex D

eCODA Data Agreement

Supply of data by to EUROCONTROL

We are very grateful that you are able to consider supplying enhanced CODA data to EUROCONTROL. Following the arrangements discussed, we propose that hereunder are the terms under which your data are supplied to EUROCONTROL, and the conditions which will govern the use and protection of such data by EUROCONTROL.

1. agrees to provide flight data to EUROCONTROL. The content, format and timing of this data supply as arranged by the two parties is contained in Annex to this letter and can be modified when necessary further to the approval in writing of both parties.

2. EUROCONTROL agrees to keep the raw data confidential, and to use it only for the purpose of flight analysis. Outputs resulting from analysis of the data will not identify .

3. may cancel this agreement at any time via written notification to EUROCONTROL. Upon such cancellation, EUROCONTROL will maintain its obligation regarding data confidentiality.

EUROCONTROL undertakes to abide by these conditions, and we would ask that you confirm to us your acceptance thereof by adding your signature and details below, and returning this letter to :

Central Office for Delay Analysis (CODA)
EUROCONTROL
Rue de la Fuseé, 96
B-1130 Brussels
Belgium

(Salutation)

For .

Signature:

Name and title:

Date:

Air Transport Data

Data Item	Data Format	Note
Date	yyyymmdd	
Company	aaa	
Flight Number	nnnn	
Callsign	aaannnn	ATS plan
A/C Registration	aaaaa	
Departure Apt	(ICAO)	
Destination Apt	(ICAO)	
Scheduled Time of Departure	yyyyymmdd hhmm	
Scheduled Time of Arrival	yyyyymmdd hhmm	
Estimated Enroute Time	hhmm	Fuel flight plan
Out	yyyyymmdd hhmm	Gate
Off	yyyyymmdd hhmm	Take-off
On	yyyyymmdd hhmm	Landing
In	yyyyymmdd hhmm	Gate
Delay Code 1	nn	
Time 1	mm	
Delay Code 2	nn	
Time 2	mm	
Delay Code #	nn	
Time #	mm	
Reactionary from Flight	aaannn	
Std Out Taxi Time	mm	
Std In Taxi Time	mm	
ACARS	y/n	

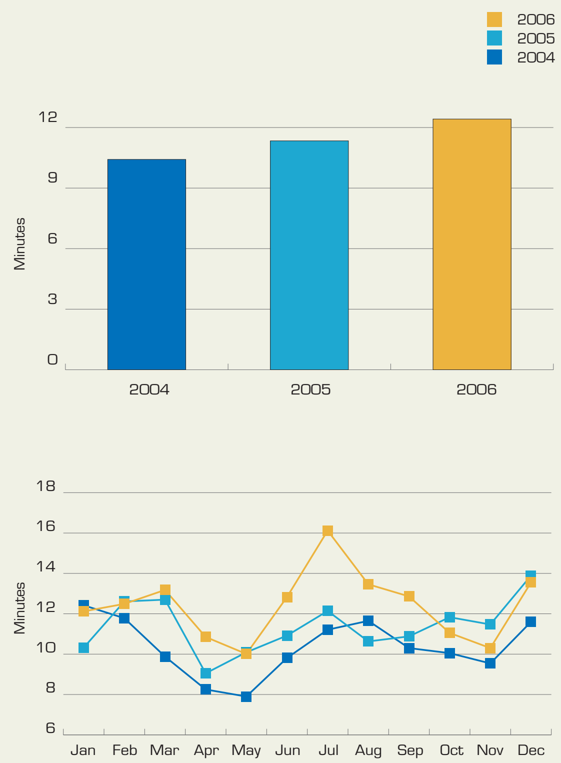
Annex E

ALL CAUSES DELAY SITUATION FOR 2006[2] (eCODA)

The average delay per movement for departures and for all causes of delay was 12.4 minutes; an increase of 9.5% on last year. 45.4% of flights had a departure delay (>= 5 minutes), with 21.9% being delayed by more than 15 minutes. On the other hand, 13.3% of flights departed before their scheduled time.

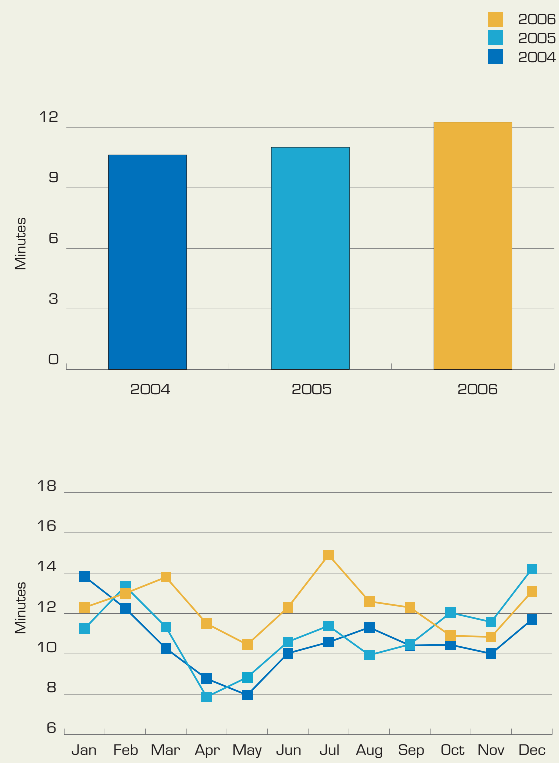
The average delay per movement for arrivals and for all causes of delay was 12.3 minutes; an increase of 11.4% on 2005. 42.4% of flights had an arrival delay (>= 5 minutes), with 21.4% being delayed by more than 15 minutes. However, 30.5% of flights landed before their scheduled time.

Average Delay per Movement (All Causes of Delay)
Departure Traffic



Source: EUROCONTROL/eCODA

Average Delay per Movement (All Causes of Delay)
Arrival Traffic

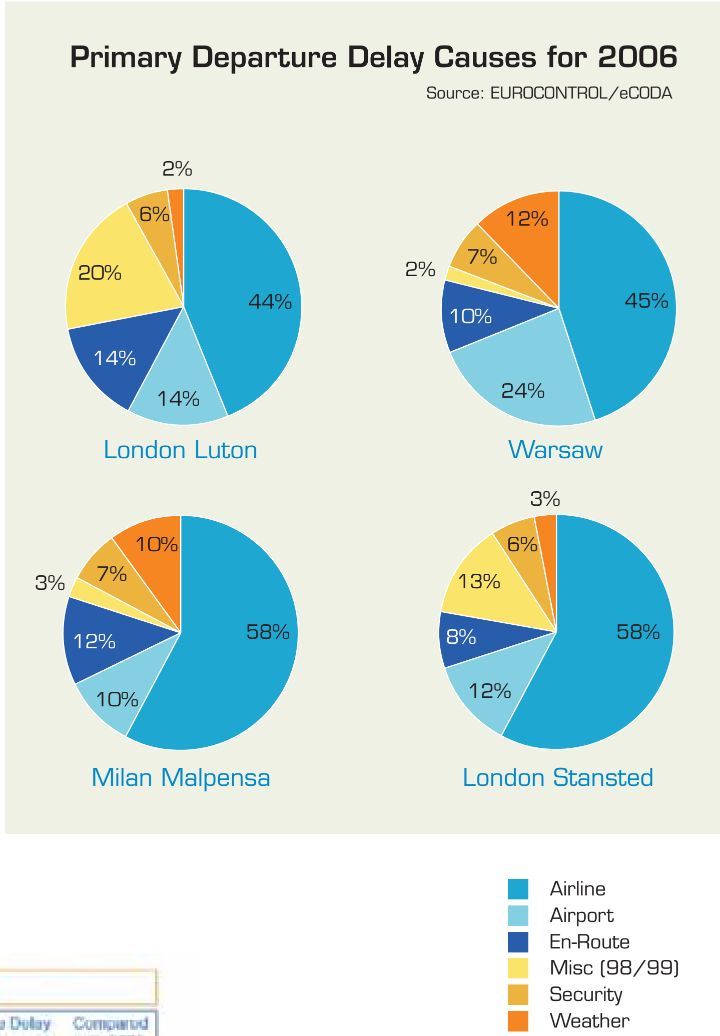


Source: EUROCONTROL/eCODA

[2] The analysis was based on airline data from eCODA, which for **2006** contains details on **56%** of IFR GAT flights in Europe.

All Causes Delay Situation for Departure Airports

70% of the busier departure airports (those with at least 15,000 flights per year) had an average delay per movement of more than 10 minutes, with London/Luton, Warsaw, Milan/Malpensa and London/Stansted having the largest average delay. Compared with 2005, 53% of the busier airports had an increase in average delay of more than 1 minute, with the largest rises at Lisbon, Copenhagen, London/Stansted, London/Luton (all 4 airports up 4 minutes), London/Gatwick, Warsaw and Glasgow (all 3 airports up 3 minutes). At the other end of the scale, there were falls at Milan/Linate (down 5 minutes), Istanbul (down 4 minutes), Turin and Venice (both airports down 3 minutes). All the airports had a proportion of their traffic departing before their scheduled time, ranging from 3% at Copenhagen to 25% at Belfast.



Top 50 Most Affected Departure Airports in 2006

Rank	Departure Airport	Average Delay per Movement	Compared with 2005	Rank	Departure Airport	Average Delay per Movement	Compared with 2005
1	London/Luton	17.8	20%	26	Las Palmas	13.1	4%
2	Warsaw/Okecie	16.8	22%	27	Frankfurt	12.6	22%
3	Milan/Malpensa	16.6	10%	28	Edinburgh	12.4	1%
4	London/Stansted	16.6	30%	29	Glasgow	12.3	31%
5	London/Gatwick	16.4	26%	30	Venice/Tessera	12.1	-19%
6	Dublin	16.3	15%	31	Prague/Ruzyne	12.0	-13%
7	Madrid/Barajas	16.1	14%	32	Birmingham	11.8	5%
8	London/Heathrow	16.1	19%	33	Bologna	11.8	9%
9	Paris/CDG	15.8	12%	34	Valencia	11.6	14%
10	Istanbul/Ataturk	14.9	-22%	35	Geneva	11.5	-2%
11	Bristol/Lulsgate	14.9	19%	36	Paris/Orly	11.3	11%
12	Rome/Fiumicino	14.8	-10%	37	Oslo/Gardermoen	11.2	22%
13	Naples	14.4	-7%	38	Marseille/Provence	11.1	34%
14	Alicante	14.2	11%	39	Torino/Caselle	11.0	-22%
15	Lisbon	14.1	43%	40	Budapest/Ferihegy	10.9	-14%
16	Malaga	14.1	11%	41	Zurich	10.8	-3%
17	Amsterdam	14.1	0%	42	Brussels	10.5	5%
18	Barcelona	14.0	5%	43	Munich	10.3	0%
19	Belfast/Aldergrove	13.4	-1%	44	Toulouse/Blagnac	10.2	33%
20	Palma De Mallorca	13.4	13%	45	Helsinki-Vantaa	10.1	31%
21	Manchester	13.3	7%	46	Milan/Linate	10.1	-34%
22	Newcastle	13.2	0%	47	Goteborg/Landvetter	9.8	10%
23	Copenhagen/Kastrup	13.2	45%	48	Vienna	9.7	18%
24	Nice	13.2	12%	49	Athens	9.6	15%
25	London/City	13.1	2%	50	Basle/Mulhouse	9.5	43%

Based on a sample representing 56% of IFR flights in Europe

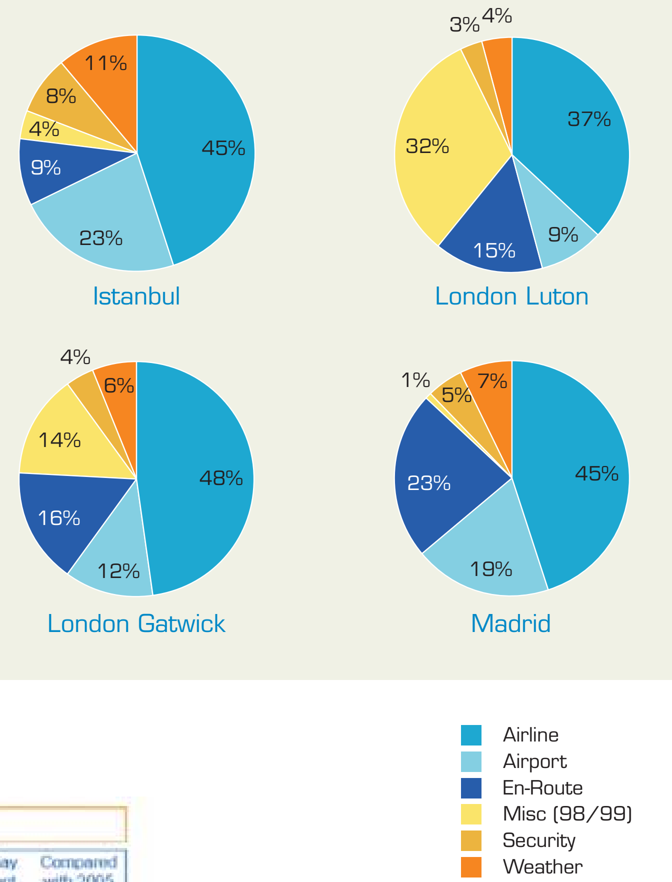
Source: EUROCONTROL/eCODA

All Causes Delay Situation for Destination Airports

Turning to the busier airports as destination (those with at least 15,000 flights per year) shows that traffic arriving at Istanbul, London/Luton, London/Gatwick, Madrid and Turin had the largest average delay per movement. Compared with last year, 59% of the busier airports had an increase in average delay of more than 1 minute, with the largest rises at Turin (up 6 minutes), London/Luton (up 5 minutes) and Dublin (up 4 minutes). To offset these increases, there were falls at Oslo and Stavanger (both airports down 7 minutes), Trondheim (down 6 minutes), Bergen, Istanbul and Bodo (all 3 airports down 5 minutes). All the airports had a proportion of their traffic arriving before their scheduled time, with Amsterdam having the largest with 45% and Bodo the lowest with 7%.

Primary Destination Delay Causes for 2006

Source: EUROCONTROL/eCODA



Top 50 Most Affected Destination Airports in 2006

Rank	Destination Airport	Average Delay per Movement	Compared with 2005	Rank	Destination Airport	Average Delay per Movement	Compared with 2005
1	Istanbul/Ataturk	19.0	-21%	26	Frankfurt	12.1	20%
2	London/Luton	18.0	34%	27	Amsterdam	12.0	-1%
3	London/Gatwick	17.3	12%	28	Paris/CDG	11.9	8%
4	Madrid/Barajas	16.6	21%	29	Palma De Mallorca	11.7	26%
5	Torino/Caselle	16.5	53%	30	Geneva	11.7	0%
6	Dublin	16.2	33%	31	Edinburgh	11.7	7%
7	London/Heathrow	16.1	10%	32	Nice	11.7	14%
8	Las Palmas	15.4	14%	33	Prague/Ruzyne	11.7	-12%
9	Manchester	15.1	18%	34	Milan/Linate	11.5	19%
10	Warsaw/Okecie	15.1	16%	35	Bilbao	11.4	22%
11	Bologna	14.7	29%	36	Marseille/Provence	11.4	44%
12	Lisbon	14.4	26%	37	Venice/Tessera	11.2	7%
13	Newcastle	14.2	9%	38	Gotenborg/Landvetter	11.1	26%
14	Alicante	13.8	22%	39	Birmingham	10.9	-1%
15	London/Stansted	13.8	22%	40	Brussels	10.8	5%
16	Rome/Fiumicino	13.6	25%	41	Basle/Mulhouse	10.8	35%
17	Milan/Malpensa	13.5	10%	42	Athens	10.1	17%
18	Malaga	13.4	25%	43	Stockholm/Arlanda	9.9	29%
19	Belfast/Aldergrove	13.1	20%	44	Paris/Orly	9.7	30%
20	Barcelona	12.8	-2%	45	Hanover	9.7	6%
21	Glasgow	12.4	24%	46	Toulouse/Blagnac	9.7	23%
22	Bristol/Lulsgate	12.4	12%	47	London/City	9.5	20%
23	Napoli Capodichino	12.3	17%	48	Helsinki-Vantaa	9.3	20%
24	Copenhagen/Kastrup	12.3	23%	49	Budapest/Ferihegy	9.3	-10%
25	Valencia	12.2	9%	50	Berlin-Tegel	9.3	13%

Based on a sample representing 56% of IFR flights in Europe

Source: EUROCONTROL/eCODA

All Causes Delay Situation for City Pairs

In 2006, the most affected city pairs (those with at least 2,500 flights per year) were London/ Heathrow – Madrid, Chicago – London/Heathrow, Madrid – London/Heathrow, Barcelona – London/Heathrow, Madrid – Milan/Malpensa London/Heathrow – Barcelona and Milan/Malpensa - Madrid. Compared with 2005, 67% of the busier city pairs had an increase in their average delay per movement, with 45% having a rise of more than 1 minute. The largest increases were between Chicago – London/Heathrow (up 12 minutes), Larnaca – Athens and London/ Heathrow – Chicago (both pairs up 6 minutes), Madrid – Brussels, London/Heathrow – New York, Madrid – Santiago, Copenhagen – Goteborg, Copenhagen – Oslo, London/Heathrow – Madrid (all 6 city pairs up 5 minutes). At the other end of the scale, 17% of the city pairs had a decrease in their average delay per movement, with the largest falls between Ankara – Istanbul, Izmir – Istanbul (both pairs down 28 minutes), Antalya – Istanbul (down 14 minutes), Adana – Istanbul and Izmir – Istanbul (both pairs down 13 minutes).

Top 50 Most Affected City Pairs in 2006

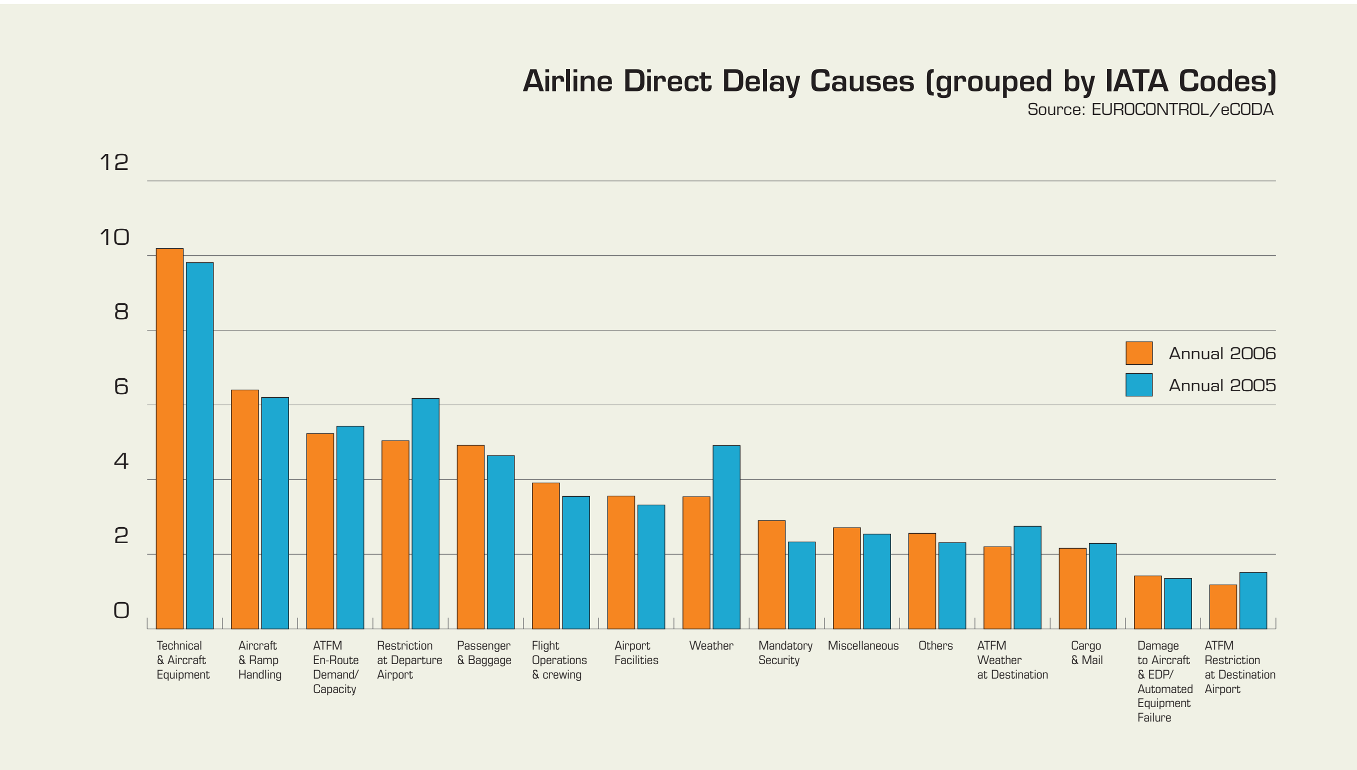
Rank	Departure	Destination	Average Delay per Movement	Compared with 2005
1	London/Heathrow	Madrid	24.2	23.1%
2	Chicago	London/Heathrow	23.4	113.4%
3	Madrid	London/Heathrow	22.7	12.6%
4	Barcelona	London/Heathrow	20.9	6.2%
5	Madrid	Milan/Malpensa	20.0	16.2%
6	London/Heathrow	Barcelona	19.7	16.2%
7	Milan/Malpensa	Madrid	19.5	24.8%
8	Edinburgh	London/Gatwick	19.1	-4.7%
9	New York	London/Heathrow	18.9	-0.5%
10	Madrid	Brussels	18.9	38.5%
11	Rome/Fiumicino	Catania	18.8	-9.4%
12	Paris/CDG	Milan/Malpensa	18.6	27.9%
13	London/Heathrow	Rome/Fiumicino	18.4	5.4%
14	Rome/Fiumicino	London/Heathrow	18.2	-3.5%
15	Rome/Fiumicino	Madrid	18.0	2.0%
16	Paris/CDG	Rome/Fiumicino	17.9	-2.1%
17	London/Heathrow	Copenhagen	17.8	25.3%
18	Madrid	Las Palmas	17.7	14.3%
19	London/Heathrow	Stockholm	17.4	20.1%
20	Madrid	Alicante	17.4	25.6%
21	Madrid	Malaga	17.3	22.8%
22	London/Heathrow	Frankfurt	17.3	33.7%
23	Paris/CDG	London/Heathrow	17.0	8.1%
24	London/Heathrow	Vienna	17.0	0.5%
25	Madrid	Vigo	16.9	35.8%
26	Milan/Malpensa	Rome/Fiumicino	16.8	10.4%
27	Paris/CDG	Copenhagen	16.8	26.9%
28	Madrid	Rome/Fiumicino	16.8	8.0%
29	London/Gatwick	Geneva	16.8	18.8%
30	Rome/Fiumicino	Bari Palese	16.7	0.7%
31	Amsterdam	Madrid	16.6	-11.6%
32	Milan/Malpensa	Paris/CDG	16.6	14.4%
33	Madrid	Frankfurt	16.3	22.6%
34	Barcelona	Rome/Fiumicino	16.3	1.7%
35	Madrid	Santiago	16.3	40.8%
36	Frankfurt	Madrid	16.2	15.9%
37	London/Heathrow	Oslo	16.2	13.5%
38	Rome/Fiumicino	Palermo	16.1	-12.9%
39	London/Gatwick	Edinburgh	16.0	11.5%
40	Rome/Fiumicino	Genova Sestri	16.0	-17.8%
41	Barcelona	Frankfurt	16.0	19.7%
42	Copenhagen	London/Heathrow	15.9	14.5%
43	Manchester	London/Gatwick	15.9	10.5%
44	Madrid	Bilbao	15.8	28.6%
45	Copenhagen	Paris/CDG	15.7	34.9%
46	Madrid	Asturias	15.6	28.4%
47	Barcelona	Paris/CDG	15.5	14.5%
48	Paris/CDG	Prague/Ruzyne	15.4	-12.6%
49	Madrid	Amsterdam	15.4	-3.8%
50	London/Heathrow	Paris/CDG	15.4	16.1%

Based on a sample representing 56% of IFR flights in Europe

Source: EUROCONTROL/eCODA

Industry Direct Delay Causes

An analysis of the delay causes and categories, grouped by IATA codes, shows the largest increases in the Mandatory Security, Technical & Aircraft Equipment, Flight Operations & Crewing, Passenger & Baggage, Others, Airport Facilities, Aircraft & Ramp Handling and Miscellaneous categories. To offset these increases, there were falls in the Weather, Restriction at Departure Airport, ATFM Weather at Destination, ATFM Restriction at Destination Airport, ATFM En-Route Demand/Capacity and Cargo & Mail categories (only those categories with more than 1% of the delay were taken into account). Technical & Aircraft Equipment was the most penalising direct delay category in 2006, with 10.2% and was followed by Aircraft & Ramp Handling with 6.4%, ATFM En-Route Demand/Capacity with 5.2%, Restriction at Departure Airport with 5%, Passenger & Baggage with 4.9%, Flight Operations & Crewing with 3.9%, Airport Facilities with 3.6% and Weather with 3.5% of the delay.

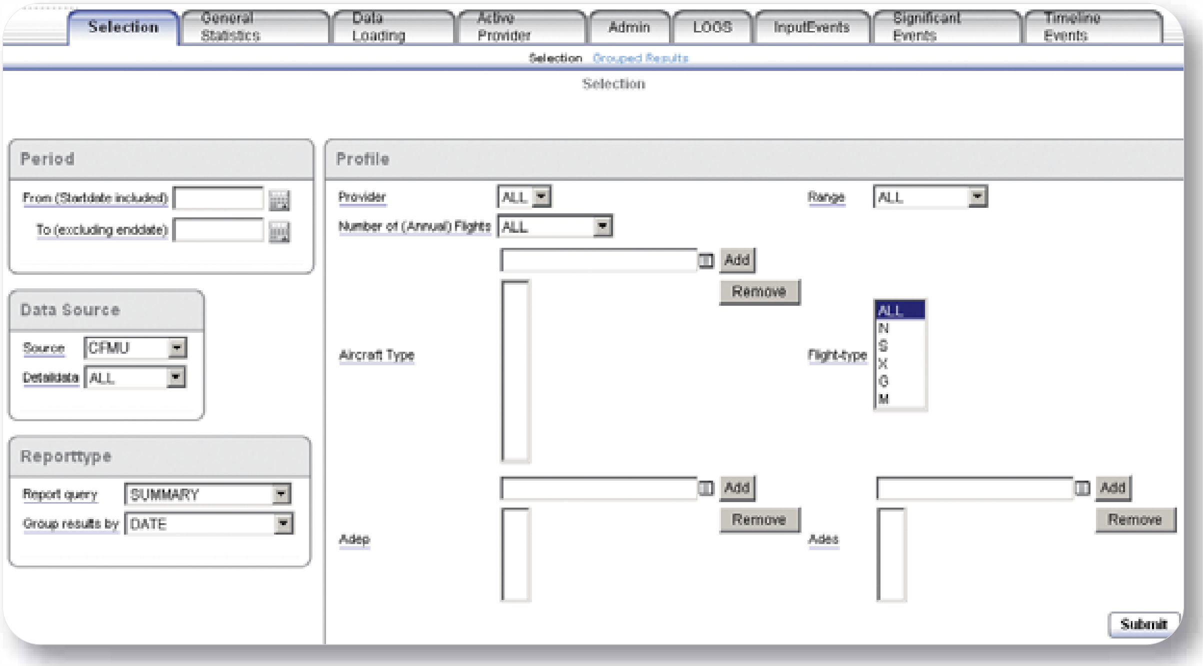


Annex F: Screenshots of access page to ecoda for Authorised users

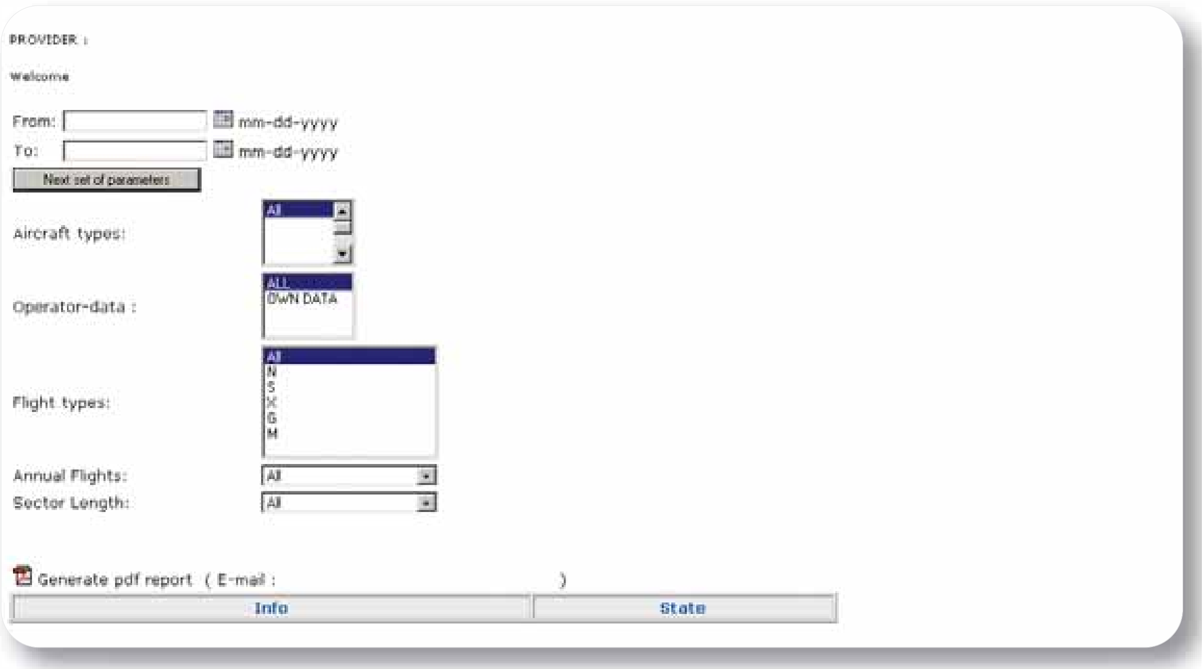
Main page with access to Airline Application

Airline Application: - Analysis Tool
- CORE - CODA Report (pdf generator)

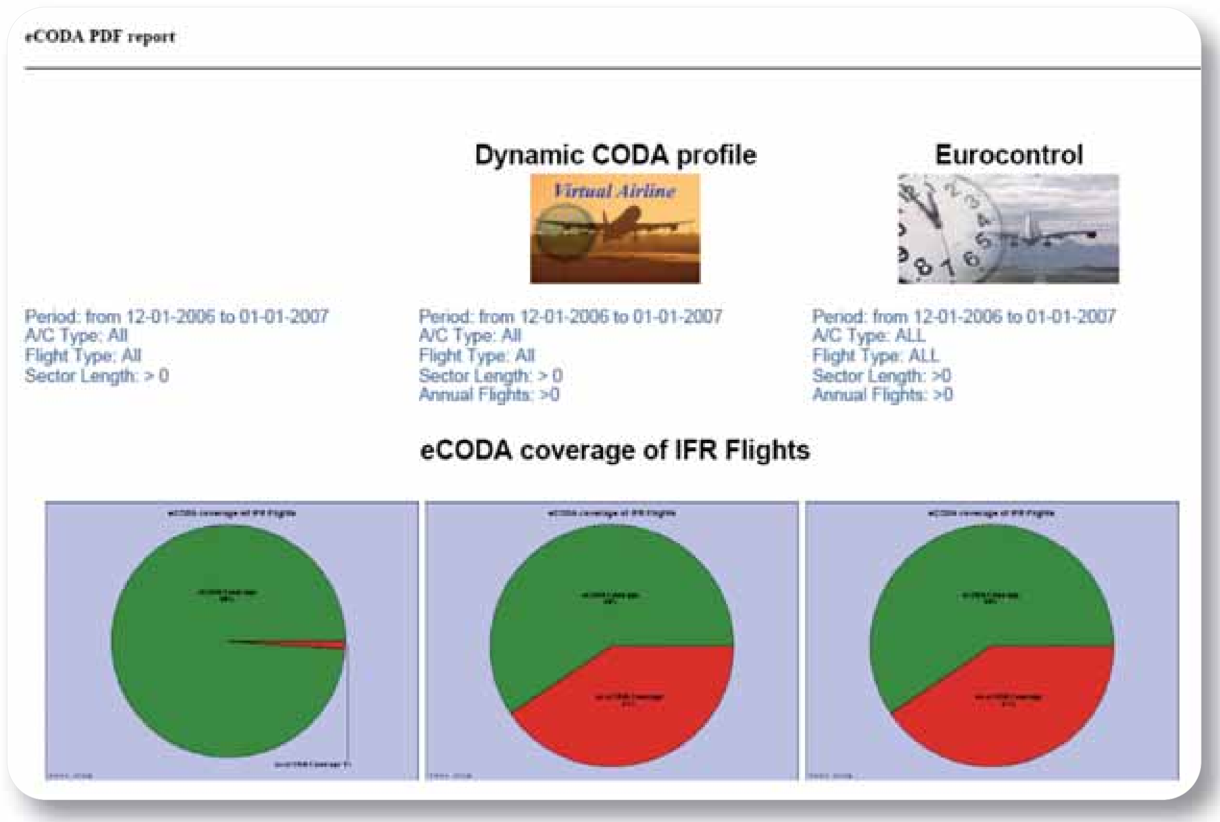
Analysis Tool interface



CORE interface



CORE pdf report example



List of Abbreviations

ACARS	Aircraft Communication Addressing and Reporting System
ACI	Airports Council International
AEA	Association of European Airlines
AHM	IATA Airport Handling Manual
ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
CFMU	EUROCONTROL Central Flow Management Unit
CODA	EUROCONTROL Central Office for Delay Analysis
EATM	European Air Traffic Management Programme
ECAC	European Civil Aviation Conference
IACA	International Air Carriers Association
IATA	International Air Transport Association
IFR GAT	Instrument Flight Rules General Air Traffic
LHR	London Heathrow
PRC	Performance Review Commission
PRISME	Pan-European Repository of Information Supporting the Management of EATM
OOOI	Out/Off/On/In
STATFOR	EUROCONTROL Statistics and Forecast Service
SESAR	European Single Sky Programme

References

1. 'EUROCONTROL Medium Term Forecast: IFR Flight Movements 2007-2013'
   STATFOR Doc.230 v1.0 March 2007

2. 'European Medium-Term ATM Network Capacity Plan Assesment 2008-211'
   April 2007

3. www.eurocontrol.int/cef

4. 'Evaluating the True Cost to Airlines of One Minute of Airborne or Ground Delay'
   University of Westminster, May 2004

5. 'Digest-Annual 2006: Delays to Air Transport in Europe'
   www.eurocontrol.int/ecoda

Web: http://www.eurocontrol.int

ISSN 1993-1425

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