ELEVENTH AIR NAVIGATION CONFERENCE

Montreal, 22 September to 3 October 2003

Agenda Item 1: Introduction and assessment of a global air traffic management (ATM) operational concept
1.2 Enabling concepts in support of the global ATM operational concept :

DELEGATION OF SEPARATION, BENEFITS AND REQUIRED CHANGES

(Presented by Sweden)

SUMMARY

This paper discusses the benefits of introducing airborne separation minima to be used when responsibility for separation between specific aircraft is delegated to the air crew of a succeeding aircraft. The merits of time-based separation minima as compared to distance-based minima, as well as the changes to the air transport system that will be required, are also discussed.

Proposed action by the Conference is in paragraph 5.

1. INTRODUCTION

1.1 Since the introduction of radar into air traffic control (ATC) in the 1950's, the controllers have been able to visually observe the traffic and its flow. This fact and its natural limitations has until now divided the air traffic management (ATM) system into two strictly segregated worlds, one being the world of ATC and the other the airborne world. The systems used on the two sides have developed more or less without any coordination and consequently without any means for exchange of information. One of the cornerstones for cooperation is to have a common mental picture of the current situation. Today, the only source available for pilots to build this mental picture of the traffic situation is to listen to the radio. This means that cooperation between pilots and ATC is rather limited and would be further reduced when controller-pilot data link communications (CPDLC) become more widespread.

1.2 This will drastically change with the introduction of automatic dependent surveillance – broadcast (ADS-B) where each aircraft transmits its position autonomously via a data link. With the addition of a cockpit display of traffic information (CDTI), pilots and controllers will have the same mental picture of the traffic situation. This is the basis for a number of new applications, among them airborne separation assistance system (ASAS) applications, where the spacing or separation task under specific circumstances can be delegated to the pilot. This redistribution to the pilots of tasks which best can be performed by the flight deck will provide a number of benefits to the air transport system.

1.3 To make delegation of separation possible, a number of building blocks in the current air transport system have to be adapted to the new applications. Examples of these are infrastructure, airborne equipment, ATM equipment, new separation minima, procedures and phraseology.

2. CONCEPT OF DELEGATION

2.1 ASAS applications are aimed at enhancing the ATM system through an increased involvement of the flight deck. Flight information service, alerting service, air traffic advisory service, and air traffic control service could be enhanced based on improved flight crew knowledge of the surrounding traffic and increased involvement of the flight crew in aircraft separation.

2.2 Delegation of separation can be described in terms of task redistribution within the air transport system. Today, except under special conditions like visual approach, the responsibility for providing separation within controlled airspace rests with the air traffic controller. By equipping the aircraft with a CDTI, which provides the flight crew with a visual presentation of the traffic situation, along with proper tools, responsibility for separation to specific aircraft can be delegated to the flight deck. Delegation of separation is possible during all phases of flight; climb, en route and approach, as well as on the ground.

2.3 Within the cooperation between EUROCONTROL and the Federal Aviation Administration (FAA/EUROCONTROL R&D) an approach has been made to divide the ASAS applications into packages related to the characteristics and probable implementation schedule of the applications. The applications described in Package 1 are all related to spacing, which is logical, but what is also logical is the roadmap to evolve towards separation applications. The reason for this is that, to get the full benefits and flexibility with ASAS applications, the responsibility for separation to specific aircraft must be transferred to the flight deck.

3. EXPECTED BENEFITS

3.1 When introducing delegation of separation, benefits to the air transport system are expected in the fields of safety, user flexibility, flight efficiency, increased throughput, increased capacity and the environment.

3.2 Safety benefits

3.2.1 The following may assist in the prevention of collisions with traffic in the air or on the airport surface.

a) The situational awareness of the pilots will improve as compared to the current situation where they have to build their mental picture of the traffic solely based on radio transmission, to a situation where the pilots will have a clear view of the traffic. This will assist the controllers in their work and act as an additional safety net if the ATM system fails to detect a potential hazard. If CPDLC is introduced, the situational awareness provided by the party line, i.e. pilots overhearing instructions issued to other traffic, will disappear. However this negative effect will be more than compensated for by the visual presentation of the traffic situation.

b) When separation is provided through an ASAS application, the surveillance of an individual separation will improve drastically. Instead of one controller being responsible for separation between all aircraft, there will normally be two pilots at the flight deck that, with the aid of automated support tools and safety nets, supervise the separation. In addition, the controller will have an improved monitoring function through the use of high-accuracy ADS-B positional data along with the addition of new as well as improved existing safety nets, such as short term conflict alert (STCA), medium term conflict detection (MTCD), conflict resolution assistance (CORA) tools, selected altitude via aircraft derived data (ADD), etc.

c) When performing tactical control today the control loop is long and cumbersome. The steps of the control loop are:

1) the discrepancy has to be displayed on the radar screen;

2) the controller has to notice the discrepancy;

3) the controller has to decide on an action and transmit instructions to the flight deck; and

4) the flight deck has to follow the instruction.

Furthermore, the frequency may be occupied when the controller intends to transmit the instruction. This introduces a delay in the control loop, which may have safety implications. With the introduction of delegation of separation, the control loop will be substantially shorter since the person responsible for maintaining the separation is the pilot controlling the aircraft.

3.2.2 Increased throughput/capacity benefits

a) The controller workload will decrease when the responsibility for separation is delegated to the flight deck. The reason is that the separation distances do not have to be supervised, and the number of instructions per aircraft and, consequently, radiotelephony load, will decrease. This reduced workload can transform the controller task from the intense tactical role to a more planning intense role where the task is to find the optimum traffic sequence based on aircraft type, equipment, optimum profile, etc. The improved planning can be directly translated into better overall efficiency.

b) The flight crew is likely to be able to maintain the delegated separation minimum more exactly than the controller is able to do today. One of the reasons for this is the short control loop. In the approach phase this is directly translated into higher runway throughput. One example where pilots using a time-based separation would be able to improve the throughput is in cases of high winds. Today, the controller skills in using radar to establish the appropriate minimum distance between aircraft have an immediate effect on the capacity. With the appropriate tools, pilots would be able to adhere more closely to the established time-based minima. In this context it should be noted that, in modern flight management systems, time is used as reference. In 33 flight trials where the required time of arrival was predicted before departure, the ability was demonstrated to arrive over the approach fix within +/- 4 seconds and to land within +/- 7 seconds.

c) A number of facts point in the direction that it is possible to establish airborne separation minima close or equal to ATC separation minima when the separation responsibility rests with the flight deck instead of the controller. The reason is that current ATC separation minima are based on technology originating from the 1950's and the current distribution of tasks within the air transport system. In the future it is not impossible that airborne separation minima, under specific circumstances, can be even lower than the ATC separation minima.

3.2.3 **User flexibility and flight efficiency**

a) One of the limiting factors for the amount of traffic that can be handled by a sector is the radiotelephony load. The controller cannot handle a larger amount of traffic than can be safely addressed by radio i.e. there is an acceptably low risk that the frequency is occupied by another aircraft when or if an instruction for an evasive manoeuvre has to be issued. To maintain a safe and orderly flow, the controller in each sector often has to impose initial altitude restrictions for aircraft entering the sector in order to maintain procedural separation. Since the controller and radiotelephony load will decrease by delegation of separation, the sectors may be increased in size. This, in turn, means that the air crew will need to level out less frequently, and will be allowed to fly closer to the optimum profile. Another possible effect would be to maintain the sector size and allow a higher traffic density. The tradeoffs and optimum balance have to be investigated and adapted to the local situation.

b) The introduction of agreed 4D navigational profiles as a means to control the traffic flow, will lead to a more flexible flight profile. This can be achieved through the introduction of required time of arrival (RTA) on a specified 3 dimensional position (fix, navigational aid, runway threshold, etc). In addition to providing a new way of controlling traffic and creating an orderly flow, this will allow aircraft to adapt the flight profile, normally by speed only, to the optimum profile, as long as the RTA is met. 4D navigation will also create a tool for merging traffic for eventual delegation of separation when on the same track. The ability to fly closer to the optimum profile will also have a substantial environmental impact.

3.2.4 **Environmental benefits**

a) Delegation of airborne separation will allow aircraft to fly closer to the optimum trajectory, which will reduce aircraft exhaust emissions and reduce noise since the aircraft will spend less time at low altitudes.

b) Delegation of airborne separation is likely to shorten the flight paths, which will reduce aircraft exhaust emissions.

3.2.5 **Necessary changes**

a) Automation in aircraft with coupling of flight management system (FMS) and autopilot;

b) Development of tools for the flight deck, e.g. possibility to couple the autopilot to maintain a specified time to a target aircraft;

c) Development of safety nets for the flight deck, e.g. warnings for intrusions of the delegated separation, and prediction for cases when the delegated separation will be impossible to meet due to aircraft performance;

d) Development of algorithms for the determinations of time between aircraft. This will form the basis for safety nets in the aircraft and in the ATC system. The algorithms have to be global regardless of technology, and give the exact same time regardless of the application running the algorithm i.e. alarms must be triggered by the same event and at the same time in the airborne and the ATC system. It is possible that some components of the ATC system will need to be adapted to coexist with time based separation, e.g. STCA could have separate parameters for aircraft performing ASAS applications.

e) Development of tools for ATC, e.g. a tool for indicating aircraft suitable for delegation of separation.

f) Development of phraseology for delegation of separation. Although unambiguous, it has to be short in order to maximise benefits. It can be anticipated that the delegation instructions will be transmitted over CPDLC in the future; however, the application must be efficient without CPDLC.

g) Establishment of airborne separation minima;

h) Establishment of separation minima based on time instead of distance;

i) Establishment of procedures for airborne separation; and

j) Establishment of procedures for agreed 4D based navigation.

4. SUMMARY

4.1 Delegation of separation will affect and enhance the air transport system to a great extent. For this to happen a number of changes have to be made to the current air transport system. The importance to initiate these changes and enablers to allow the introduction of airborne separation minima cannot be stressed enough. Any delay to this process may affect the concept substantially.

4.2 It may be possible that airborne separation minima can be equal to ATC separation minima. The factors that may assist are:

a) due to the risk for frequency overload, an air traffic controller may add buffers to the separation minima to ensure a safe traffic flow;

b) more actors will supervise separations;

c) the surveillance source is superior to radar, both regarding precision and update rate;

d) additional safety nets will be available both on the flight deck and in ATC; and

e) the person responsible for the surveillance of the separation is the same person responsible for its implementation.

5. ACTION BY THE CONFERENCE

5.1 The Conference is invited to:

a) note the information provided in this paper;

b) recommend that ICAO commence work to establish airborne separation minima including such minima based on time;

c) agree that procedures and phraseology for delegation of separation to the airborne component be developed; and

d) agree that procedures for 4D based airborne separation based on required time of arrival be developed.

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