

ELEVENTH AIR NAVIGATION CONFERENCE

Montreal, 22 September to 3 October 2003

**(DRAFT) REPORT OF COMMITTEE A
ON AGENDA ITEM 1**

The attached draft report on Agenda Item 1 is presented for approval by Committee A for submission to the Plenary.

**Agenda Item 1 Introduction and assessment of a global air traffic management (ATM)
: operational concept**

1.1 INTRODUCTION

1.1.1 Under this agenda item, the meeting reviewed and assessed a global air traffic management (ATM) operational concept and several enabling concepts. Other issues related to the future ATM system such as the need to develop ATM requirements, the role and function of the *Global Air Navigation Plan for CNS/ATM Systems* (Global Plan, Doc 9750), the role of airborne collision avoidance systems (ACAS) and the planning mechanisms necessary to progress toward implementation of a future ATM system based on the ATM operational concept were discussed.

1.2 THE GLOBAL ATM OPERATIONAL CONCEPT

1.2.1 The meeting reviewed the global ATM operational concept (operational concept) as developed by the Air Traffic Management Operational Concept Panel (ATMCP) under the guidance of the Air Navigation Commission. The meeting recalled that, in follow-up to the Tenth Air Navigation Conference (Montreal, 5 to 20 September 1991), States, international organizations and ICAO, at the global level and regional level through planning and implementation regional groups (PIRGs), had embarked on communications, navigation, and surveillance/air traffic management (CNS/ATM) systems planning and implementation programmes intended to improve aviation operations by making use of CNS/ATM technologies. Although good progress had been made, it was later recognized that a comprehensive concept of an integrated and global ATM system, based on clearly-established requirements, would facilitate the implementation programmes. This concept, in turn, would form the basis for the coordinated implementation of CNS/ATM technologies and progression to a more global and interoperable ATM system.

1.2.1.1 The meeting was informed that the operational concept presented to the Conference had been initially reviewed by the Air Navigation Commission in follow-up of the first full panel meeting of the ATMCP (18 to 28 March 2002). After the Commission's review, the operational concept had been circulated to States and international organizations for assessment and to make recommendations for improvement. The comments received had been reviewed by the ATMCP in accordance with the instructions of the Air Navigation Commission which led to several changes. The Air Navigation Commission then had reviewed the revised operational concept and had agreed that it should be presented to the conference for assessment. The Commission had agreed to take further action on the operational concept on the basis of the recommendations of the conference.

1.2.1.2 The meeting was informed that the issue of sovereignty was an important cornerstone of the operational concept, recognizing that the operational concept should neither infringe upon nor impose restrictions on States' sovereignty, authority or responsibility for the control of air navigation.

1.2.1.3 The meeting noted that the planning horizon used for the development of the operational concept was up to and beyond the year 2025 and that the operational concept outlined a range of conceptual changes that would evolve through the planning horizon. Key to the philosophy adopted within the operational

concept was the notion of global information utilization, management and interchange. This was seen as the enabler of significant change in the roles of all participants within the ATM system, which would facilitate enhancements in safety, economy and efficiency across the ATM system. The goal, therefore, was an evolution to a holistic, cooperative and collaborative decision-making environment, where the expectations of the members of the ATM community would be balanced to achieve the best outcome based on equity and access. It was noted that this was in contrast to the present day principle of “first-come, first-served” and would better achieve an incentive-based approach to investments for the improvement of ATM.

1.2.1.4 The benefits which could be expected from implementation of an ATM system based on the operational concept were recognized by the meeting. From an airspace user perspective, greater equity in airspace access, greater access to timely and meaningful information for decision support and more autonomy in decision-making including conflict management, would result in optimum system outcomes with minimum deviation from user-requested flight trajectories. From a service provider perspective, including that of airport operators, the ability to operate within an information-rich environment, with real-time data, as well as system trend and predictive data, fused with a range of automated decision-support or decision-making tools, would enable optimization of services to airspace users. From a regulator perspective, safety systems were envisaged to be robust and open, allowing safety not only to be more easily measured and monitored, but also compared and integrated on a global basis.

1.2.1.5 The meeting agreed that the operational concept provided a vision that would allow States and regions to align their planning processes, allow system solution engineering to be directed toward a harmonized and interoperable outcome, allow airspace users and service providers to share data and information to best mutual outcome, and enhance levels of safety, economy and efficiency, for the good of all members of the ATM community.

1.2.1.6 The meeting recognized that the section of the operational concept dealing with conflict management would lead to the most significant changes in the future ATM system and that much more work had to be accomplished and consensus reached in order to safely implement the techniques envisaged. Also, evolution to the concept component of conflict management should occur in a careful, considered and evolutionary fashion, with full participation of the ATM community. Among several issues raised was the need to ensure that the ATM system needed to respect the different nature of the three layers of conflict management identified in the operational concept (i.e. strategic conflict management, tactical conflict management and collision avoidance) and that they must be incorporated appropriately into the ATM system design. It was agreed that clearly-established principles of operation had to be developed that did not lead to system users having to respond to conflicting and contrary demands.

1.2.1.7 The meeting agreed that the conflict management process, as described in the operational concept, would enable the ATM users to collaboratively interact to achieve the best overall outcome for ATM as a whole, and that this attribute of collaboration would bring with it a responsibility on each user that should be characterized by cooperation and trust. The meeting agreed that the above issues, and others raised, should be forwarded to the bodies that would be involved in the continuing work on conflict management.

1.2.1.8 The meeting was presented with the activities of several States, regions and sub-regions toward improving ATM systems and procedures, which included collaborative efforts across regions. This included a report on the significant efforts underway in Europe toward establishment of the European Upper

Flight Information Region as part of the implementation of the single European sky, which, it was noted, was aimed at eliminating the fragmentation of airspace in Europe. The meeting was also presented with a significant effort underway in the Commonwealth of Independent States (CIS) to ensure the realization of the main benefits of the operational concept through regional and sub-regional harmonization of air navigation systems and eventual integration into the global ATM system.

1.2.1.9 During the discussions, the meeting was made aware that such regional solutions could cause difficulties to neighbouring regions if coordination with, and participation of, all affected States and regions was not thorough. The need for adequate inter-regional planning and coordination was therefore stressed.

1.2.1.10 In addition to the above, the meeting agreed that the global ATM system must meet the differing requirements of the various regions and States. The operational concept should therefore, not be seen as a uniform solution. Scalability would have to be taken into account in future work on scenarios, transition strategies and planning for implementation. In the same context, it was recognized that States with less developed aviation or ATM systems would also play an important role in the development of an integrated global ATM system and that such States could benefit significantly from full integration into a global ATM system. Therefore, these States should be afforded full participation in development of regional and global ATM systems. Due importance must therefore be attached to the development of ATM systems in such States through the provision of technical support and financial and funding mechanisms to address imbalances in economic development.

1.2.1.11 The meeting agreed that it would be essential that transition strategies based on a roadmap detailing the migratory path necessary for all members of the ATM community to manage their activities in parallel would be useful. In this context, the meeting was informed that the ATMCP already had this item in its work programme and that the panel would likely resume its work in April of 2004 in follow-up to the conference. A roadmap offered by the International Air Transport Association (IATA) would therefore be forwarded to the ATMCP for use in its further work.

1.2.1.12 Based on the discussions on the operational concept, the meeting expressed its full support for the operational concept and agreed that there was a need for all CNS/ATM partners to rally around one global ATM operational concept. In consideration of the above, the meeting endorsed the global ATM operational concept and agreed on the following recommendation.

Recommendation 1/1 — Endorsement of the global ATM operational concept

That:

- a) ICAO, States and planning and implementation regional groups (PIRGs), consider the global ATM operational concept as the common global framework to guide planning for implementation of ATM systems and to focus all ATM development work;
- b) the global ATM operational concept be used as high level guidance for development of ICAO CNS/ATM related provisions;

- c) States and industry undertake work to validate the ideas in the global ATM operational concept;
- d) ICAO develop transition strategies for implementation of ATM systems based on the global ATM operational concept; and
- e) ICAO align its technical work programme to facilitate future work related to the global ATM operational concept.

1.2.1.13 The meeting considered the significant effect of military activity on the ATM system and expressed its view that processes should be put in place to minimize the effect of military aviation activity on safety and commercial operations. The meeting agreed that the issue of discretionary military activity and its effect on civil aviation would be best addressed at the national and regional levels through the normal planning and coordination processes. However, it would be in the best interest of international civil aviation if military authorities were fully briefed on activities related to planning and implementation of the operational concept and were involved and integrated into long-term planning and implementation efforts. The meeting therefore agreed on the following recommendation.

Recommendation 1/2 — Coordination with military authorities

That States take appropriate action to coordinate the global ATM operational concept with their military authorities with a view to procuring maximum cooperation and integration in an effort to implement a flexible and cooperative approach to airspace organization and management.

1.2.1.14 The meeting was reminded that CNS/ATM systems were intended to accommodate the needs of all airspace users, including general aviation (GA) and aerial work (AW) operations and that often, airspace design, aircraft equipment requirements and operational procedures did not address the needs of GA/AW operators. The meeting agreed that while CNS/ATM systems must be designed to provide services to the majority, user provisions must also be made to accommodate the needs of GA/AW operators as well. It was noted that this could be accomplished by instituting procedures and employing technology that would permit access to valuable airspace segments without either unnecessarily excluding GA/AW operations or requiring on-board equipment effectively excluding them. In this context, the vision statement in the operational concept was recalled which made reference to all users, as well as the operational concept expectation of “access and equity” which also addressed this issue. However, it was agreed by the meeting that, as work toward planning for implementation of an ATM system based on the operational concept, or any future work emanating from the concept or the conference, progressed, the needs of the GA/AW community should be fully considered.

1.2.1.15 Several additional issues were discussed and the meeting agreed that although there was strong support for the operational concept, it was understood that these issues, which were not addressed in great depth in the operational concept, would have to be more fully dealt with in the ensuing work emanating from the conference. These included legal, financial, environmental and security issues. Additionally, the meeting stressed that, although beyond the scope of its deliberations, there was a need to stress the criticality

of frequency spectrum to the successful implementation of the future ATM system and that this requirement should be raised in appropriate fora.

1.2.1.16 In concluding its discussions on this item, the meeting agreed that the operational concept should be considered as a “living” document that would have to be revisited from time to time to take into account the changing nature of technology as well as other factors; however, it was also necessary to consider the operational concept as a completed body of work at this point, in order to have a common basis to continue work toward a global ATM system.

ATM requirements

1.2.1.17 The meeting was presented with a framework in which a future ATM system based on the operational concept could develop, which included the interrelationships and dependencies of the various activities involved. The meeting noted that the framework used by the ATMCP for the development and evolution of the global ATM system stipulated the development dependencies as follows:

- a) **ATM community expectations**. The needs and expectations of the ATM community would guide operational concept development.
- b) **ATM operational concept**. The operational concept would provide the vision to direct the development of the global ATM system.
- c) **ATM requirements**. The ATM requirements would specify the scope, characteristics and attributes forming the ATM system environment. The ATM requirements collectively would provide for the development of a functional architecture and system specifications.
- d) **Global ATM system design**. The global ATM system design would be driven by ATM requirements, taking into account external factors identified in the Global Plan. The design would include the functional architecture needed to achieve the required system performance (performance is addressed under Agenda Item 3). The system design would provide the basis for a scalable response to achieve explicit expectation outcomes (expectations were contained in the operational concept). The review and development of necessary Standards and Recommended Practices (SARPs) and Procedures for Air Navigation Services (PANS) would complete the design process. It was important that SARPs and PANS were traceable to the ATM requirements which originated from the operational concept.
- e) **Balancing requirements**. The operational concept would envisage the balancing of the concept components which were integrated to achieve different expectation outcomes. From the guidance and planning criteria, specific technological solutions could be selected for implementation.
- f) **Implementation**. The implementation of facilities and services would be based on guidance and transition strategies that identified all requirements. The regional air

navigation plans would then provide the transition blueprint for implementation of system changes that must occur on a region-wide basis.

- g) **ATM community operations.** The implementation of facilities and services would allow for operations that met the expectations of the ATM community.

1.2.1.18 The meeting was made aware that the dependencies identified above would allow a coordinated framework for the work that must be done. Furthermore, a structured framework would provide the means to ensure that the development of ATM requirements, SARPs and procedures, would proceed in a thorough and well-documented manner.

1.2.1.19 The meeting noted that the process of developing ATM requirements would be accomplished through the derivation of the functions that the operational concept envisioned that the ATM system would provide, followed by specification of the ATM requirements for those functions. It was noted that a concept component function was a characteristic action or activity that must be performed in order to achieve a desired ATM community expectation or objective. The identification of the concept component functions was an iterative process and would continue until all functions and sub-functions necessary to describe the expected performance of the concept component had been derived.

1.2.1.20 It was further noted that the operational concept component functional requirements did not describe the full set of ATM requirements. Operating requirements must also be derived to describe the ATM system operating environment and the performance it must meet to achieve the functional interactions described in the scenarios. It was stressed that aeronautical information services (AIS) and meteorological services (MET) were subsets of the ATM information requirements and therefore, would need to be fully addressed when developing ATM requirements.

1.2.1.21 The meeting recognized that a balance was required between the need for global safety and interoperability requirements and that safety should be considered as paramount when developing ATM requirements. Additionally, the meeting considered that interoperability requirements should not be exclusively considered only as an issue of requirements between facilities, States or regions, but should also be considered on a smaller scale, for example, between air traffic control units in a single State.

1.2.1.22 The meeting considered that in order to progress toward implementation of a global ATM system as envisaged in the operational concept, several follow-up activities must take place. These included specification, design and planning of the ATM system as well as development of SARPs, procedures and guidance material necessary for implementation. The next step in the development process should therefore be the development of a clear set of ATM requirements. Based on this, the meeting endorsed the following recommendation.

Recommendation 1/3 — Development of ATM requirements

That ICAO develop a set of ATM functional and operating requirements for a global ATM system on the basis of the global ATM operational concept.

Development of SARPs from the operational concept

1.2.1.23 In follow-up to the above discussion on ATM requirements and the review of the ATM development process, the meeting was presented with a framework for the review and development of SARPs in relation to the operational concept. It was noted that the framework was developed by the ATMCP to facilitate the complete development process of a global ATM system. The meeting agreed that SARPs development would be a critical element when considering progression to implementation of a global ATM system. The meeting agreed that as part of the planning activities necessary to implement facilities and services that would meet ATM requirements, the need for relevant SARPs must be identified and the nature and objective of the SARPs described and that, ultimately, CNS/ATM related SARPs should be traceable to ATM requirements. The meeting recognized that such a process would be progressively implemented on an evolutionary basis. In order to ensure a thorough and traceable ATM development process, the meeting agreed on the following recommendation.

**Recommendation 1/4 — Development of Standards and
Recommended Practices (SARPs) from the
global ATM operational concept**

That ICAO, when developing new CNS/ATM-related SARPs, ensure that such SARPs are traceable to ATM requirements.

Interoperability and seamlessness

1.2.1.24 The meeting was presented with a paper which identified the need to come to a clear understanding of the terms “interoperable” and “seamless”, noting that the two terms were often used when referring to the future ATM system and, in particular, when attempting to convey the expectations of that system. It was agreed that because interoperability was such an important factor when considering the future ATM system, and due to the need to ensure interoperability and seamlessness in that system, common understandings of these notions were necessary. Therefore, there was a need to develop these notions within the context of an ATM system, which included operators, pilots, air traffic controllers and procedures, as well as systems and other agents.

1.2.1.25 The meeting was made aware of the explanation of the terms intended to assist in the development of the operational concept as follows:

- a) *Interoperability* within the ATM system might be described as the ability to transfer information, or effect functionality, across any discontinuity, in order to enable operations; and
- b) *Seamless* within the ATM system might be described as the property that would allow a transition across any discontinuity which, from the perspective of the transiting agent, did not require a considered action to facilitate the transition. It should be noted that, in this context, seamless did not imply ATM systems convergence into singleness.

1.2.1.26 It was recognized that interoperability was primarily associated with the need for systems, people and procedures, among other things, to operate effectively across disparate systems, whereas seamless was primarily associated with the needs of the users or operators of a system. An important objective of a seamless ATM system was therefore to ensure that, as aircraft operated across different regions where various levels of service existed, those services would be delivered in a manner that allowed the aircraft to operate seamlessly, with a consistent level of safety being provided.

1.2.1.27 On the basis of the above, the meeting agreed that when developing ATM requirements, it would also be essential that corresponding requirements for interoperability and seamlessness be defined.

1.2.1.28 It was cautioned however, that there must be an effort to avoid prescribing excessively prescriptive requirements with respect to interoperability and seamlessness and that the goal should be toward achieving a transparency of functions, procedures and operations. Thus a balance was needed which would also ensure accommodation of existing systems while allowing emerging systems and new technological solutions to be integrated in the air navigation infrastructure. The meeting stressed that the goal should not be to develop a single system, but to develop a global ATM system that consisted of many interoperable systems.

1.2.1.29 On the basis of the discussions and considering the importance of interoperability and seamlessness with respect to the future ATM system based on the ATM operational concept, the meeting agreed on the following recommendation:

Recommendation 1/5 — Interoperability and seamlessness

That ICAO, when developing ATM requirements, define a corresponding minimum set of requirements for interoperability and seamlessness.

1.2.2 Enabling concepts in support of the global ATM operational concept

Automatic dependent surveillance (ADS-B) concept of use

1.2.2.1 The most recent work of the Operational Data Link Panel (OPLINKP) concerning development of a concept of use for automatic dependent surveillance — broadcast (ADS-B) was presented. In this context, the meeting was informed that the fifth meeting of the Automatic Dependent Surveillance Panel (ADSP/5, October 1999) had reported to the Air Navigation Commission on the progress of States and had provided information on the potential for ADS-B to satisfy identified requirements, as well as a detailed breakdown of the outstanding issues before such an application could be implemented. The Commission had amended the panel's work programme to include the development of operational requirements for the use of a system to increase traffic situational awareness, the development of a concept of use and operational requirements for the application of ADS-B, and a monitoring role in the development of the use of systems providing airborne separation assistance in order to develop a concept of use. The first step in this work programme therefore involved the development of an ADS-B concept of use.

1.2.2.2 The meeting noted that an ADS-B concept of use, defined as a detailed description of how a particular functionality or technology could be used, was completed during the first quarter of 2003 by the OPLINKP. ADS-B was seen by OPLINKP as a potential key data link application in a future ATM environment, providing new surveillance capabilities to both aircrew and air traffic services. It was noted that several entities within the aviation community were investigating this technology with a view to providing a cost-effective replacement of current systems and technology.

1.2.2.3 It was further noted that ADS-B was seen in many quarters as a potential application to address the need for increased airborne traffic situational awareness and to provide for airborne separation assistance. However, it had also been recognized that, within the wider context of its potential, including a new sharing of responsibilities between the flight crew and controller, the application of ADS-B-related procedures was indeed complex.

1.2.2.4 The meeting recognized that the material presented in the ADS-B concept of use was not a final product, but rather, a compendium of matters that were being considered and reflected upon to a large extent within the aviation community. In addition, it was noted that as the ATM operational concept matured and a set of ATM requirements were developed, the role of ADS-B as an important data link application and concept element in the future system would become clearer.

1.2.2.5 It was agreed that ADS-B would serve as an important enabler of several of the ATM operational concept components including traffic synchronization and conflict management, and that work on the ADS-B concept of use should be continued. It was also stressed that any existing concepts of use as well as any new ones, needed to be aligned with the ATM operational concept and meet the ATM requirements emanating therefrom. Therefore, the meeting agreed to endorse the ADS-B concept of use and formulated the following recommendation aimed at encouraging and guiding further work.

Recommendation 1/6 — Endorsement of the automatic dependent surveillance-broadcast (ADS-B) concept of use and recommendations for further work

That ICAO:

- a) follow research and development work in the area of ADS-B applications, and update/maintain the ADS-B concept of use as necessary;
- b) work cooperatively with other international bodies to ensure that the ADS-B concept of use is properly aligned with existing operational and technical documents;
- c) utilize the ADS-B concept of use, in its current form and as it matures, as a basis for development of SARPs and guidance material for air-to-air and air-to-ground surveillance applications; and
- d) ensure that all future work on the ADS-B concept of use is aligned with the ATM operational concept and meets the emerging ATM requirements that emanate therefrom.

1.2.2.6 The meeting was presented with work being accomplished by several States to take advantage of the opportunities afforded by ADS-B. It was agreed that this rapidly developing technology would be critical to the success in implementing a more advanced and global ATM system and that States which did not have comprehensive radar surveillance coverage should recognize the potential for early benefits from using ADS-B as an alternative to radar to support en route and approach traffic control, using existing avionics packages. Early adoption of this technology would particularly assist in improving air traffic services in areas where a cost/benefit analysis could not justify an expensive radar infrastructure. Furthermore, it was agreed that ADS-B could provide significant safety benefits when used for air-to-ground surveillance, compared to procedural air traffic control (ATC) without radar surveillance and that ADS-B data could support automated safety tools such as short-term conflict alert, level and route adherence warnings, and danger area infringement warnings, which would improve safety and security.

1.2.2.7 The meeting was presented with a plan for implementing an initial package of ADS-B services in the United States which consisted of two phases. It was noted that the first phase concentrated on developing ADS-B applications and establishing pockets of implementation to enable initial operational use of ADS-B and stimulate user equipment, while the second phase would focus on the development and deployment of ADS-B ground infrastructure nationwide.

1.2.2.8 The Roadmap of Operational Improvements (OIs) to be implemented as part of the overall European ATM system enhancement up to the year 2020 which described the contribution of the envisaged ADS-B related applications was introduced. The meeting noted that the European approach would consist of applications which had been organized into three packages and that each package consisted of a number of ground and airborne ADS-B applications. The meeting was informed that for each subsequent package

the airborne ADS-B applications would permit an increased level of transfer of aircraft separation responsibility to the cockpit.

1.2.2.9 In the context of the above, the meeting was informed that the United States and Europe were corroborating on a joint European/United States development and implementation package. Further discussions to achieve maximum cooperation and alignment were on-going.

1.2.2.10 The meeting was informed that Australia was in the process of conducting an operational trial using “ADS-B for ATC surveillance whereby a single ADS-B ground station had been installed, a number of aircraft had been equipped with ADS-B avionics, and Australia’s operational ATM system had been upgraded to process and display ADS-B tracks. A safety case supporting the use of a radar-like 5 NM minimum separation had been prepared. It was noted that the performance being achieved by the ADS-B system in the Australian environment had exceeded expectations, that coverage was excellent and exceeded the performance that would be expected from a secondary radar installed at the same site. Manoeuvre performance was better than from radar, the update rate was higher, and identity data were reliably received.

1.2.2.11 Encouraged by the performance of the trial system, Australia planned to install a network of approximately twenty ADS-B ground stations across its non-radar areas to provide nationwide coverage at and above flight level 300.

1.2.2.12 The meeting was informed of ongoing work in ICAO’s Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) which had established an ADS-B Implementation Task Force to plan the implementation of ADS-B in the Asia/Pacific Regions. In this regard, it was noted that the ADS-B concept of use recommended that any decision to implement ADS-B by a State should be based on consultation with the wider ATM community. Moreover, the implementation should also be coordinated between States and Regions, in order to achieve maximum benefits for airspace users and service providers.

1.2.2.13 Mongolia, the Russian Federation and the Commonwealth of Independent States all reported on the significant activities underway in their States or regions with respect to trials and implementation of ADS-B to improved their ATS systems.

1.2.2.14 The meeting agreed that the above developments would promote the achievement of global interoperability for both future ADS-B applications and supporting data links. Based on this progress, the meeting agreed that maximum use should be made of global developments and therefore, endorsed the following recommendation.

Recommendation 1/7 — Initial automatic dependent surveillance-broadcast (ADS-B) applications for global interoperability

That ICAO and States:

- a) recognize ADS-B as a key enabler of the global ATM operational concept bringing substantial safety and capacity benefits;
- b) support the cost-effective early implementation of ADS-B, noting the early achievable safety and economic benefits from new ATM applications; and
- c) ensure that implementation of ADS-B is harmonized, compatible and interoperable with respect to operational procedures, supporting data link and ATM applications.

Airborne separation assistance system (ASAS)

1.2.2.15 An update of progress achieved by the Surveillance and Conflict Resolution Systems Panel (SCRSP) with development of an airborne separation assistance system (ASAS) was presented. It was noted that ASAS had been defined by SCRSP as an aircraft system based on airborne surveillance that provided assistance to the flight crew supporting the separation of their aircraft from other aircraft. It was further noted that ASAS might support a part of the conflict management and traffic synchronization functions of the operational concept.

1.2.2.16 It was noted that a range of ASAS applications had been envisaged which encompassed increasing flight crews' situational awareness related to traffic, and assisting the flight crews in maintaining separation from other aircraft. The meeting was made aware that ASAS applications would require a surveillance capability, based largely on ADS-B and traffic information service — broadcast (TIS-B).

1.2.2.17 Four categories of candidate ASAS applications had been identified by the SCRSP as traffic situational awareness applications; airborne spacing applications; airborne separation applications; and airborne self-separation applications.

1.2.2.18 In concluding its discussions on this item, the meeting was reminded that significant work was underway within several ICAO panels of the Air Navigation Commission to enable implementation of ADS-B and ASAS applications. This work consisted, inter alia, of development of operational requirements and separation minima for ADS-B. Additionally, the meeting recalled the work that would be undertaken in follow-up to the recommendations of the conference with respect to the ATM requirements which would further support and guide implementation of ADS-B, including airborne separation applications. Therefore, the meeting agreed that the papers presented under this item, as well as the report and recommendations of the conference with respect to this agenda item, should be forwarded to the relevant ICAO panels to guide their further work. This structured and step-wise approach was a necessary part of consensus-building.

Aeronautical information management

1.2.2.19 The meeting was presented with an envisioned computerized aeronautical information services (CAIS) system concept that was developed with the aim of supporting the global ATM system by establishing conditions for the provision, in real-time, of high quality aeronautical information (in a common exchange format) to any airspace user, any time, anywhere. The meeting noted that the system concept envisioned a system consisting of a database, servers and clients; a publisher-subscriber type system; the capability to maintain aeronautical information publication (AIP) information of all States in an electronic format, referred to as an aeronautical data package (ADP); and the promulgation of changes to the ADP to States and other subscribers in an electronic format.

1.2.2.20 The meeting was informed that several fundamental principles had been taken into account when developing the CAIS system concept, e.g. existing Annex 15 — *Aeronautical Information Services* provisions concerning the autonomy and responsibility of States for the provision of quality aeronautical information. The concept was based on data exchange while ensuring that network traffic was minimal, and the system was expandable and modular. By focussing on the exchange process, Annex 15 and the *Aeronautical Information Services Manual* (Doc 8126) would be used to develop an extensible mark-up language (XML) -based exchange format. The meeting noted that a prototype had demonstrated that currently available technology could be used to exchange electronically aeronautical information and that a full working system could be developed along the same lines.

1.2.2.21 The meeting was also presented with the developments and activities within EUROCONTROL in the area of aeronautical information which demonstrated that there was a clear need to migrate to a digital environment and which called for the adoption of a platform-independent common data exchange model to enable interoperability at the system level. It was noted that, to be effective, aeronautical information management (AIM) must incorporate, at a high level, the structure, delivery and critical nature of all information relevant to ATM, such as aeronautical and meteorological information, flight planning, planned and real-time status of ATM and CNS systems and airspace configurations. Specifically, the decisions taken by controllers, pilots, dispatchers, flight planners, weather forecasters, etc. represented information that were used by others as inputs to their own planning and decision-making processes. Therefore, the full benefit of information management would only accrue if pertinent information were made available to all appropriate participants when and where needed.

1.2.2.22 Furthermore, it was noted that the quality of aeronautical information such as availability, relevance, accuracy, integrity, timeliness, security and confidentiality was important, and might well be flight critical. Consequently, the processing of aeronautical information from origination, through publication to incorporation into an end-user system must be managed throughout the whole process under strict quality management procedures. EUROCONTROL studies had shown that integrity requirements specified in Annex 15 could significantly be improved by automating end-to-end processing of aeronautical information.

1.2.2.23 The meeting also noted that the development of an electronic AIP (eAIP), a fully digital version of the paper document, was well underway by EUROCONTROL and that the European AIS Database (EAD) had become operational in June 2003, which were both essential milestones in the realization of the digital environment. The EAD had been developed using the Aeronautical Information Conceptual

Model (AICM) and Aeronautical Information Exchange Model (AIXM). It was noted that the AIXM was the only exchange model currently in operational use, on a trial basis.

1.2.2.24 The meeting recognized that in the global ATM system environment envisioned by the operational concept, aeronautical information service (AIS) would become one of the most valuable and important enabling services. As the global ATM system foreseen in the operational concept was based on a collaborative decision-making (CDM) environment, the timely availability from authorized sources of high quality electronic aeronautical, meteorological, airspace and flow management information would be necessary.

1.2.2.25 To achieve the future ATM objective of making informed collaborative decisions for the most efficient operations and business practices, aeronautical information must be managed efficiently and shared on a system-wide basis by making it available for access by any participant in the ATM environment when and where required. It was therefore agreed that quality-assured aeronautical information should ultimately be available in real-time, through the seamless interchange of relevant aeronautical information between parties in an interoperable, flexible, adaptable and scalable manner. To ensure the cohesion and linkages between different components of the operational concept and to accomplish the role of AIS, consideration must also be given by AIS to the interchange and management of aeronautical information to be used by different services and users, while taking into account interoperability of existing and future systems.

1.2.2.26 The meeting recognized that there were issues that had to be considered as the aviation community moved to a digital environment. Among these was the need to ensure that as more and more data became available through electronic means, obtaining such data should remain affordable. Additionally, it was recalled that a large portion of the aviation community continued to use paper products and that not all would immediately embrace the digital age. Therefore, it was necessary to ensure that this portion of the aviation community continued to have access to necessary data and that their needs were considered. Finally, it was pointed out that developing States had particular needs as they would not always be in a position to move quickly to a digital environment and this had to be considered from a global perspective

Recommendation 1/8 — Global aeronautical information management and data exchange format

That ICAO:

- a) when developing ATM requirements, define corresponding requirements for safe and efficient global aeronautical information management that would support a digital, real-time, authenticated and secure aeronautical information environment;
- b) adopt a common aeronautical information exchange format, taking into account available systems or concepts of data interchange, including AICM/AIXM, and their mutual interoperabilities; and
- c) develop, as a matter of urgency, new specifications for Annexes 4 and 15 that would govern provision, electronic storage, on-line access to and maintenance of aeronautical information and charts.

1.2.3 The role and function of the *Global Air Navigation Plan for CNS/ATM Systems*

1.2.3.1 Under this agenda item, the meeting discussed the role and function of the Global Plan in the overall planning process. In this context, it was recalled that in order to progress implementation of CNS/ATM systems, a plan of action was needed. The first such effort towards developing a plan was the *Global Coordinated Plan for Transition to ICAO CNS/ATM Systems* (Global Coordinated Plan) which was included as an appendix in the *Report of the Fourth Meeting of the Special Committee for the Monitoring and Coordination of Development and Transition Planning for the Future Air Navigation System (FANS Phase II)* (Doc 9623). The objective of the Global Coordinated Plan was to provide a progressive and coordinated worldwide implementation of the elements of the future air navigation system in a timely and beneficial manner.

1.2.3.2 The meeting was informed that in 1996, the ICAO Council determined that a more concrete plan which would include all developments, while placing the focus on regional implementation, was required. The Council directed the ICAO Secretariat to revise the Global Coordinated Plan as a “living” document comprising technical, operational, economic, financial, legal, human resource development needs and institutional elements, offering practical advice and guidance to PIRGs and States on implementation and funding strategies, which should include technical cooperation aspects.

1.2.3.3 On 13 March 1998, the Council reviewed and accepted the revised Global Coordinated Plan, which was re-titled the *Global Air Navigation Plan for CNS/ATM Systems* (Global Plan, Doc 9750). The Council also agreed at the time, that future updates of the Global Plan should be carried out by the ICAO Secretariat based on ongoing work of ICAO at both the global and regional levels.

1.2.3.4 Since the acceptance of the first edition of the newly-revised Global Plan by the Council in 1998, the Secretariat, the Committee on Aviation Environmental Protection (CAEP), several panels of the Air Navigation Commission, and the PIRGs had recognized the increasing utility of the Global Plan in relation to their work, and its relevance in the overall ICAO CNS/ATM documentation structure. The need to update the document was subsequently recognized. Based on the above, the Secretariat conducted a review of the Global Plan and a comprehensive proposal for amendment to several parts of the document was developed. In June 2001, the Council accepted the first amendment to the Global Plan and, subsequently, the second edition was published in 2002.

1.2.3.5 The meeting focussed on the future role of the Global Plan and discussed the relationship between the Global Plan and the operational concept and, in particular, their respective roles in planning for implementation of a future ATM system. In this respect, the meeting agreed that planning for implementation of ATM systems based on the operational concept would be facilitated through the Global Plan, regional plans and State implementation plans, which would describe the progressive intermediate steps toward the end result. The meeting agreed, therefore, that the plans of all States and regions needed to be aligned to ensure, to the greatest extent possible, that solutions were internationally harmonized and integrated.

1.2.3.6 In the context of the above, a proposal was made to elevate the status of the Global Plan to a level that would require review and agreement by States. This was based on the premise that the Global Plan was a significant component in the development of regional and national plans and that together with the operational concept, the Global Plan could provide an effective architecture or roadmap for the future ATM system and that ICAO provisions were more effective when there was a formal review process. The meeting was informed, however, that raising the status of the Global Plan would not be an easy process as it was neither a procedural document, nor did it contain requirements for facilities and services. Furthermore, even if agreed to within the ICAO process, the Global Plan contained many subject areas covering a broad spectrum of aviation issues and the circulation and amendment process could be cumbersome and difficult to manage. Also, it was noted that this could go against the philosophy of maintaining the Global Plan as a living and dynamic document. In any case, the meeting agreed that the issue should be given further consideration and therefore agreed to the following recommendation:

Recommendation 1/9 — Raising the status of the *Global Air Navigation Plan for CNS/ATM Systems* (Doc 9750)

That ICAO study the desirability and feasibility of developing a formal approval process for the Global Plan.

1.2.3.7 The meeting recognized that, as technologies proliferated and more options became available, it might serve the planning purposes of the international civil aviation community if the Global Plan was used as the basis for considering options and making other decisions. In this way, States and PIRGs would consult the Global Plan and, using the ATM operational concept as the basic planning premise and base the choice of technologies, models or systems, on clearly-established requirements and the additional guidance provided therein. At the same time, ATM system design would take into account external constraints which were also

identified in the Global Plan (e.g. environmental issues, training needs, legal, financial and organizational aspects).

1.2.3.8 The regional air navigation plans (ANPs) would then provide the transition plans for implementation of system changes that must occur on a region-wide basis as well as contain a listing of the facilities, services, procedures, and technologies, including human factors considerations, based on the guidance provided in the Global Plan. On this basis the meeting agreed that the Global Plan could play an important role as a catalyst for change by its mere existence and would not be seen as a tool to discipline, manage or control the evolutionary process. Although the relationship between the regional plans and the Global Plan was evident, the regional plans would continue to maintain the independence necessary to meet the specific and unique needs of the various regions. Based on the above, the meeting agreed to the following recommendation:

Recommendation 1/10 — Status of the *Global Air Navigation Plan for CNS/ATM Systems* (Doc 9750)

That the *Global Air Navigation Plan for CNS/ATM Systems* be considered as the catalyst for change, providing a global safety and interoperability framework while allowing regional or local adaptation to efficiently meet regional and local needs.

1.2.3.9 A proposal was made to include the core portion of the operational concept in Chapter 4 of the Global Plan and replace the material that was currently contained therein. However, the meeting felt that as the material contained in the operational concept document was created as a single and complete package, it was important that the material contained in the operational concept document should be maintained as a single entity and not be divided and placed in separate documents. Therefore, it was agreed that the format of an ICAO manual would serve as the most suitable location for the operational concept within the ICAO documentation structure. On this basis, the meeting agreed on the following recommendation:

Recommendation 1/11 — Placement of the Global ATM Operational Concept

That ICAO publish the global ATM operational concept in a new ICAO manual.

1.2.3.10 The meeting then considered that Chapter 4 of the Global Plan was in need of an update and that it was necessary to establish the linkage between the Global Plan and the operational concept. In this context, the meeting agreed to the following recommendation:

**Recommendation 1/12 — Amendment of Chapter 4 of the *Global Air Navigation Plan for CNS/ATM Systems*
(Doc 9750)**

That ICAO take action to amend Chapter 4 of the Global Plan, clearly establishing the linkage to the Global ATM Operational Concept.

A regional framework for the implementation of a global ATM system

1.2.3.11 The meeting recalled previous discussions related to the need to address several activities, primarily at the global level, in follow-up to endorsement of the operational concept, in order to progress to a global ATM system in a progressive, cost-effective and cooperative manner. However, it was also observed that new regional initiatives, if pursued, could augment the considerable efforts already made by the regional planning groups and ICAO Contracting States toward implementation of CNS/ATM systems. In this context, the meeting was informed that a number of States were coming together to forge joint ventures on a subregional basis, to implement air navigation systems.

1.2.3.12 The meeting was unanimous that harmonized implementation of air navigation systems would enhance airspace capacity while producing additional benefits in the way of more efficient flight profiles and increased levels of safety. Therefore, it was agreed that States should implement the regional air navigation plans, recognizing the longer-term vision of the operational concept and the Global Plan to secure convergence towards a uniform gate-to-gate ATM system and that any implementation plans should fully consider the needs of the airspace users.

1.2.3.13 In addition to the above, the meeting considered that in light of the new impetus which would likely be gained from the recommendations of the conference and the endorsement of the operational concept, it would become necessary to reconcile the differences both within regions and between neighbouring regions. It was agreed that greater efforts should therefore be made toward cooperation and consensus-building, as well toward utilizing harmonization tools and techniques.

1.2.3.14 Based on the above, the meeting agreed on the need to explore putting into place a mechanism which would consist of the process and tools for harmonization and integration of air navigation systems resulting in a global continuum of airspace that would allow implementation of the operational concept and the fulfilment of the benefits expected therefrom. Such a mechanism, if pursued, should consist of an implementation strategy guided by the operational concept and the expectations of the ATM community; an implementation process which would be based on groupings of States and service providers based on homogeneous ATM areas and major traffic flows, and an implementation mechanism to support the ICAO planning processes. Based on the above, and in order to ensure that an effective planning mechanism was established to facilitate implementation of the operational concept, the meeting agreed on the following recommendation.

Recommendation 1/13 — Harmonization of air navigation systems

That ICAO and the CNS/ATM partners explore the possibility of developing a mechanism for addressing the interregional interface issues with a view to facilitating the harmonized implementation of air navigation systems giving rise to a global ATM system in an evolutionary fashion.

ICAO air navigation plan database

1.2.3.15 In the context of planning for implementation of the future ATM system based on the operational concept, the meeting noted that there was already a well-established interrelationship between the regional ANPs and the Global Plan. However, there was a pressing requirement to make up-to-date air navigation planning information more available and functional for all those involved in the planning process. It was noted that ICAO had already developed air navigation planning databases and related publication and charting systems that supported CD-ROM and hard copy ANP publication formats, and which were extensible to take advantage of recent Internet database and mapping technologies. Furthermore, recent technology advances allowed not only for the timely dissemination of ANP information through a central Web server, but also for efficiencies in maintaining an up-to-date ANP database that could be extended to include interregional and global planning information. The functionality of this information could be significantly increased through an associated Web-based charting/GIS system.

1.2.3.16 The meeting agreed that electronic access to the ANP material and related planning and implementation data of the CNS/ATM partners would constitute an invaluable analytical planning tool. Therefore, steps should be taken so that electronic versions of the tabular material from all ANPs were accessible to States in order to allow for updates to be made in real time.

1.2.3.17 The meeting therefore agreed that an air navigation plan database and associated Web-based information and charting service would provide several benefits including improved access by States, PIRGs, participating CNS/ATM partners, regional offices and Headquarters to ANPs and the data upon which they are based. The development of the Global Plan and ATM system planning through enhanced information availability and charting, with particular regard to interregional homogeneous ATM areas and major traffic flows and the charting of data and forecasts, would also be facilitated.

1.2.3.18 In order to provide an ICAO air navigation plan database and associated Web-based information and charting service, it was considered that a central Web server should be developed under ICAO auspices and thus have proximity to current ANP databases, production resources, and information technology support.

1.2.3.19 The meeting was informed that, for ANP material, the currency of the Web site would be maintained by authorized ICAO regional office and Headquarters staff who would input most amendments through standardized tables and text formats which would include database filters to limit erroneous entries. A technical review of submitted ANP material and verification of formal approval would take place at ICAO Headquarters before the material was posted as an ANP amendment. This would essentially follow the same paper/e-mail based process that now occurs when amendments were submitted for inclusion in the hard copy

ANP publication. For other material that may be entered in the database, such as ANP-related implementation information and traffic flow forecasts, it was agreed that this material could be evaluated by authorized regional office staff for their direct entry.

1.2.3.20 The meeting proposed that ICAO develop a suitable name for the ICAO air navigation plan database which conveyed its true purpose and objectives which was to facilitate planning at the global and regional levels and that took into account the fact that it would be comprised of a conglomeration of regional plans. Finally, it was agreed that the Web-based information and charting service would directly support the regional, interregional and global planning elements in support of the operational concept and therefore the meeting agreed upon the following recommendation.

**Recommendation 1/14 — Development of an ICAO air navigation
plan database and associated Web-based
information and charting service**

That ICAO develop and maintain a database containing all tabular material from all the regional air navigation plans, both Basic Operational Requirements and Planning Criteria (BORPC) and the Facilities and Services Implementation Document (FASID), together with the major traffic flows and other regional data from Part II of the *Global Air Navigation Plan for CNS/ATM Systems* (Doc 9750), and make this database and associated charts available through the Web.

**1.2.4 The role of airborne collision avoidance systems (ACAS)
technologies**

1.2.4.1 Under this agenda item the meeting reviewed ICAO provisions relating to the operation of airborne collision avoidance system II (ACAS II) and discussed the role of ACAS in the future ATM system.

1.2.4.2 The meeting was informed that, following the publication of an accident investigation report dated 12 July 2002 concerning a near mid-air collision over Japan on 31 January 2001, the Air Navigation Commission reviewed ICAO provisions relating to the operation of ACAS II. This accident involved two wide-bodied aircraft equipped with ACAS II and resulted in injuries to passengers and crew. It was also noted that there was an on-going accident investigation of a mid-air collision over Germany on 1 July 2002 which involved two aircraft equipped with ACAS II.

1.2.4.3 Factors common to both accidents were that ATC had issued instructions which conflicted with an ACAS II resolution advisory (RA), and flight crews had manoeuvred their aircraft in the opposite sense to the RAs that had been issued.

1.2.4.4 The meeting noted that in follow-up to the Air Navigation Commission's review, amendment proposals to ICAO provisions had been developed, which were widely supported by States. The amendments to the ICAO documentation had been adopted by the Council in March 2003 and were to become applicable on 27 November 2003. The meeting was presented with an outline of the steps taken by ICAO to strengthen

and clarify provisions in ICAO documentation concerning the operation of ACAS II, particularly provisions on pilot responses to resolution advisories, in light of the safety recommendations of the investigation report of the near mid-air collision over Japan on 31 January 2001.

1.2.4.5 The meeting was unanimous that ACAS played an important role in the resolution of encounters between aircraft where there was a risk of collision and agreed that safety studies and operational experience had confirmed the significant safety benefit provided by ACAS. However, it was also recognized that the safety benefits were seriously degraded by an incorrect response to RAs or when there was confusion by the flight crew as to what action to take. Considering the importance of the new ICAO provisions in this respect, the meeting agreed on the following recommendation.

Recommendation 1/15 — Implementation of airborne collision avoidance system (ACAS) provisions

That States take immediate action to implement, in appropriate national documentation, the ACAS provisions contained in Amendment 28 to ICAO Annex 6 — *Operation of Aircraft, Part I — International Commercial Air Transport — Aeroplanes*, and in Amendment 12 to the *Procedures for Air Navigation Services — Operations* (PANS-OPS, Doc 8168), Volume I.

1.2.4.6 During the discussions, the meeting was reminded of the roles of ACAS and ADS-B and the differences between them, noting that ACAS provided a collision avoidance function that must remain independently available in case separation assurance was lost. It was further agreed that:

- a) ACAS should be kept as a last resort, collision avoidance safety-net;
- b) the availability of ADS-B data on cockpit displays would increase the pilot situational awareness, thus improving the surveillance function in a way that is expected to reduce the probability that collision avoidance systems will be activated; and
- c) ICAO provisions should ensure that ACAS retains independence so as not to compromise the safety-net function of the collision avoidance system;

1.2.4.7 In the context of the above, the meeting agreed that it was important that collision avoidance systems remain independent from separation provision and that in the selection of datalink technologies for surveillance technologies, the consequences on of selection on collision avoidance systems should be taken into account through appropriate safety assessments.

1.2.4.8 The meeting discussed the possibility of making available to the air traffic controller, a display of the “aircraft RA status” as it was considered that this might enhance the awareness of ground personnel that aircraft under their control may deviate from a cleared flight profile in response to an ACAS command. Several technical considerations were noted in this respect. During the discussions it was noted that there may be significant human factors considerations involved with implementation of such technology and these should be thoroughly investigated and taken into account prior to implementation.

1.2.4.9 In view of the need to reduce the delay between the occurrence of an RA and its ensuing notification to a ground station, it was agreed that if such technology was to be used, an increase of the report rate to a technically feasible value in the order of not less than one report per second should be considered.

1.2.4.10 In addressing the problem of receiving conflicting instructions from ACAS and ATC, the meeting also recognized that with respect to certain ATC techniques, such as approaches to closely-spaced parallel instrument runways where a precision runway monitor was used, training of both air traffic controllers and pilots would be necessary. In the same way, it was stressed that account should also be taken of the possibility of spurious actuation of ACAS under which the flight crew would also react.

1.2.4.11 In view of the above, and considering that new technologies such as ADS-B would improve situational awareness and could have an effect on collision avoidance, the meeting agreed that studies should address the place and role of each safety and situational awareness system, as well as the principles for their integrated interoperability. It was agreed that training of air traffic controllers with respect to ACAS and the development of suitable training material were important aspects of the successful utilization of ACAS. The meeting was informed that ICAO was currently addressing several issues aimed at enhancing ACAS. In particular, it was noted that SCRSP was addressing the following:

- a) the feasibility of down linking resolution advisories to air traffic control, using such technologies as secondary surveillance radar (SSR) Mode S and automatic dependent surveillance-broadcast (ADS-B); and
- b) the feasibility of an automatic indication to air traffic control that an aircraft has received a resolution advisory, using conventional radar (SSR Mode A).

1.2.4.12 Finalizing the discussions on this issue, the meeting agreed on the following recommendation:

Recommendation 1/16 — Provisions related to airborne collision avoidance systems (ACAS)

That ICAO review current provisions and investigate the need to develop new provisions to enhance the effectiveness of ACAS as follows:

- a) provisions in Annex 6, Part II concerning training of general aviation pilots in the operation of ACAS;
- b) provisions concerning the training of air traffic control personnel;
- c) the registering by the parametric flight recorder of resolution advisory commands; and
- d) air traffic control provisions in ICAO Annexes 2 and 11 and the PANS-ATM procedures.

1.2.4.13 The meeting was presented with a paper which was prepared as additional supporting material to assist in the discussions on the role of collision avoidance in the future ATM system. It was recalled that the role of collision avoidance as defined in the operational concept was described under the concept component of conflict management, wherein three layers of conflict management were defined. These were: strategic conflict management, separation provision and collision avoidance and were stated in the operational concept as follows:

“Collision avoidance is the third layer of conflict management, and must activate when the separation mode has been compromised. Collision avoidance is not part of separation provision, and collision avoidance systems are not included in determining the calculated level of safety required for separation provision. Collision avoidance systems will, however, be considered part of the ATM safety management. The collision avoidance functions and the applicable separation mode, although independent, must be compatible.”

1.2.4.14 The meeting was made aware that in the context of the above, collision avoidance was seen as the last layer of conflict management and was activated in order to avoid disaster. It was stressed that separation provision and collision avoidance were not the same, that there was a functional difference and that the operational concept definition of a third layer was deliberate.

1.2.4.15 Most importantly, the meeting agreed with the notion that collision avoidance systems should be considered part of overall ATM safety management. However, it was further recognized that in line with today’s understanding, collision avoidance systems should not be mixed with separation provision, nor be included in determining the calculated level of safety required for separation provision.

1.2.4.16 The meeting recognized that the subject of how the ATM system was ultimately designed to meet all of the requirements of the conflict management functions would take a great deal of work. However, work on the ATM requirements could begin to address the functional and operating requirements of such a system.

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