International Civil Aviation Organization

WORKING PAPER

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FOURTEENTH MEETING OF THE CAR/SAM REGIONAL PLANNING AND IMPLEMENTATION GROUP (GREPECAS/14)
(San Jose, Costa Rica, 16 to 20 April 2007)

Agenda Item 2: Analysis of global, inter and intra-regional activities

SECOND AMENDMENT OF THE *GLOBAL AIR NAVIGATION PLAN FOR CNS/ATM SYSTEMS* (DOC 9750)

(Presented by the Secretariat)

SUMMARY

In 1998, the Council accepted the *Global Air Navigation Plan for CNS/ATM Systems* (Doc 9750) (Global Plan) and agreed that future updates of the Global Plan should be accomplished by the Secretariat based on ongoing work of ICAO. In 2001, the Council accepted the first amendment of the Global Plan.

As a follow-up to the Eleventh Air Navigation Conference (AN-Conf/11) in 2003 and the sixth meeting of the Air Navigation Commission Consultation with Industry in May 2004, the Secretariat developed and presented the second amendment of the Global Plan to the Council in November 2006 for its acceptance.

Action by GREPECAS/14 is in paragraph 6.

1. INTRODUCTION

1.1 In 1996, the Council agreed that there was an established need for an updated Global Coordinated Plan for Transition to ICAO CNS/ATM Systems (Global Coordinated Plan) and that the updated plan should constitute a "living" document comprising technical, economic, legal and institutional elements. The first update to the Global Coordinated Plan was presented to the Council on 13 March 1998. The revised plan, re-titled as the "Global Air Navigation Plan for CNS/ATM Systems" (Global Plan) was accepted by the Council at that time.

1.2 Subsequently, a comprehensive proposal for amendment to several parts of the Global Plan document was developed by the Secretariat and accepted by the Council 2001 and the same was published as first amendment to the Global Plan.

2. SECOND AMENDMENT TO THE GLOBAL PLAN

2.1 In follow-up to the Eleventh Air Navigation Conference (AN-Conf/11, Montreal, 22 September to 3 October 2003), the sixth meeting of the Air Navigation Commission Consultation with Industry was held in Montreal on 18-19 May 2004. Among the topics discussed was “Global ATM — From Concept to Reality”, which resulted in a conclusion encouraging industry partners to work together toward the development of a common roadmap/global action plan for inclusion in the Global Plan. Subsequently, two roadmaps were developed by dedicated project teams established by industry for this purpose.

2.2 On 18 January 2005, the Commission (168-2) requested the Secretariat to develop a proposal for amendment of the Global Plan to incorporate relevant material from the industry roadmaps and established an ad hoc working group to support the Secretariat in its work.

2.3 On 17 January 2006, the Commission, carried out a preliminary review of a proposed amendment to the Global Plan and agreed that the proposal be transmitted to States and appropriate international organizations as well as ALLPIRG/5 Meeting for their review. The ad hoc working group reconvened to review the replies from States and also comments made by ALLPIRG/5 Meeting held on 23-24 March 2006 in Montreal. The Commission, on 19 October 2006, reviewed the comments made by States and ALLPIRG/5 Meeting, as well as associated action proposed by the Secretariat and the ad hoc working group and agreed that the proposed amendment as modified by the Commission, should be presented to the Council for its acceptance.

3. SIGNIFICANT CHANGES

3.1 The Foreword and the three chapters of the revised Global Plan (attached hereto with this working paper) describe a roadmap and guidance for the continued evolution towards a global ATM system. Most significantly, the Global Plan now contains a set of twenty-three Global Plan Initiatives (GPIs) which stem from the industry roadmap and consolidated by the Secretariat and the Commission. The initiatives are a logical progression of the evolutionary work already accomplished by the Planning and Implementation Regional Groups (PIRGs) and will integrate into the present planning framework.

3.2 The Global Plan will be supported by planning tools (e.g. software applications, planning documentation, web-based reporting forms, project management tools). As States and PIRGs consider improvements to the regional air navigation infrastructures, they will use the GPIs and associated common programme templates as the basis for establishing performance objectives and implementation timelines, as well as to develop a comprehensive schedule and programme of planning activities to accomplish the work.

3.3 The Commission considered that much of the non-air navigation material in the Global Plan continued to be valid and useful for planning purposes and, subject to appropriate updates, should be retained to provide generic guidance material on areas largely outside the air navigation domain. This material was updated in consultation with various bureaux and is now contained in Appendices A through I of the revised Global Plan (not attached with this working paper). Technical chapters dealing with aeronautical information services (AIS), air traffic management (ATM), communications, navigation, surveillance (CNS) and meteorology (MET) were integrated into the new Chapter 2 of the Global Plan.

4. PLANNING PROCESS TO MEET THE STRATEGIC OBJECTIVE OF EFFICIENCY

4.1 The Commission is in the process of reviewing an Air Navigation Integrated Programme (ANIP) to support the Business Plan. The ANIP will serve as the mechanism for the Commission to review ICAO work programmes in support of the Business Plan and provide a planning and monitoring tool to ensure that ICAO work programmes lead to a more global and seamless air navigation system. The Commission expects that the ANIP will support the Global Plan and work programmes of ICAO while allowing a more effective reporting process for the Commission and Council.

4.2 When considering the Strategic Objective of Efficiency, the Commission considers that, in follow-up to the Eleventh Air Navigation Conference, the Global ATM operational concept serves as the vision document, supported by the Global Plan at the strategic level, while a performance-based transition document, which was reviewed and approved by the Commission, offers transition strategies and guidance aimed at harmonizing transition planning on the basis of a common set of operational improvements. An ATM system requirements document, also reviewed and approved by the Commission, is aimed at industry, standards-making bodies and panels, to ensure that all ATM-related standards-making and industry work are in support of the operational concept. Finally, a performance manual is under development, the purpose of which will be to offer guidance on establishing regional performance targets associated with the eleven Key Performance Areas (KPAs) or Expectations contained in the operational concept.

5. CHANGE OF THE TITLE

5.1 As the evolution of CNS/ATM systems continues with endorsement of a global ATM operational concept and a revised Global Plan that provides a phased implementation plan to arrive at a global ATM system, it is clear that planning for implementation of such a system goes beyond CNS and ATM systems and horizontally integrates all elements of the air navigation system. Therefore, the Commission feels that the title of the document should be changed to the Global Air Navigation Plan which also allows for a more logical alignment with the regional air navigation plans.

5.2 On 30 November 2006, the Council accepted the second amendment of the Global Plan and agreed that future updates should be carried out by the Secretariat based on ongoing work of ICAO at both global and regional levels.

6. ACTION BY GREPECAS/14

6.1 The meeting is invited to:

a) note the second amendment of the *Global Air Navigation Plan for CNS/ATM Systems* (Doc 9750) now re-titled as *Global Air Navigation Plan*; and

b) develop/modify/harmonize the regional work programme and the regional air navigation plan on the basis of *Global Air Navigation Plan.*

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APPENDIX A

FOREWORD

The air transport industry plays a major role in world economic activity and remains one of the fastest growing sectors of the world economy. One of the keys to maintaining the vitality of civil aviation is to ensure that a safe, secure, efficient and environmentally sustainable air navigation system is available at the global, regional and national levels. This requires the implementation of an air traffic management system that allows optimum use to be made of enhanced capabilities provided by technical advances.

ICAO's efforts at addressing the needs of the air transport industry and international civil aviation as described above, are aimed at the coordination of the global planning processes in support of a global ATM system, as an evolution of the technology based CNS/ATM systems concept. In order to progress implementation of CNS/ATM systems, a plan of action was needed. The first such effort was the *Global Coordinated Plan for Transition to ICAO CNS/ATM Systems* (Global Coordinated Plan). A revised Global Coordinated Plan was published in 1998 as a "dynamic" document, comprising technical, operational, economic, environmental, financial, legal and institutional elements, also offering practical guidance and advice to regional planning groups and States on implementation and funding strategies. The revised document, which came to be known as the *Global Air Navigation Plan for CNS/ATM Systems* (Global Plan, Doc 9750) was developed as a strategic document to guide the implementation of CNS/ATM systems.

In the intervening years, several States and all ICAO regions embarked on implementation programmes intended to improve aviation operations by making use of CNS/ATM technologies. However, it was later recognized that technology was not an end in itself and that a comprehensive concept of an integrated and global air navigation system, based on clearly established operational requirements, was needed. Such a concept, in turn, would form the basis for the coordinated implementation of CNS/ATM technologies based on clearly established requirements. To develop the concept, the ICAO Air Navigation Commission established the Air Traffic Management Operational Concept Panel (ATMCP).

The *Global ATM Operational Concept* (Doc 9854) was subsequently endorsed by the Eleventh Air Navigation Conference in 2003. The operational concept is visionary in nature and intended to guide the high level implementation of CNS/ATM technology by providing a description of how the emerging and future air navigation system should operate. This, in turn, will assist the aviation community to transition from the air traffic control environment of the twentieth century to the performance-based, integrated and collaborative air traffic management system needed to meet aviation's needs in the twenty-first century.

This updated and revised version of the *Global Air Navigation Plan for CNS/ATM Systems*, re-titled as the *Global Air Navigation Plan* was developed in consideration of the operational concept and the Strategic Objectives of the Organization. Most significantly, the revised Global Plan was developed on the basis of an industry roadmap which was developed in follow-up to the Eleventh Air Navigation Conference in an effort to facilitate implementation of the Recommendations of the Conference and ensure that near and medium term benefits would be realized through a focused effort. The Global Plan therefore, contains near and medium term guidance on air navigation system improvements necessary to support a uniform transition to the ATM system envisioned in the operational concept. Long term initiatives will be added to the Global Plan as the technology matures and the supporting provisions are developed.

In accordance with the Global Plan, planning will be focused on specific performance objectives, supported by a set of "Global Plan Initiatives" ("initiatives"). These initiatives are options for air navigation system improvements that when implemented, result in direct performance enhancements. States and regions will choose initiatives that meet performance objectives, identified through an analytical process, specific to the particular needs of a State, region, homogeneous ATM area or major traffic flow. A set of interactive planning tools will assist with the analytical process.

A planning framework has been developed to facilitate the planning processes in support of the Business Plan of the Organization. The framework will serve as an ICAO internal tool and will help to ensure the integration of the Global Plan and the regional plans and associated work programmes. The planning framework will be supported by software and a web site to serve as a mechanism for monitoring and review by management and governing bodies of the detailed activities and time lines which should lead to the realization of the global air navigation system as envisaged in the operational concept.

There are several Global Plan related documents and planning mechanisms that form part of the overall planning framework. These are the:

- **The ATM System Requirements** Document which is intended to support the Global ATM Operational Concept. The document is aimed at industry, standards-making bodies and panels, and was developed to ensure that all ATM related standards-making and industry work will be in support of the operational concept. It provides more detail than the concept, but less detail than what would be found in an ICAO Standard or a system design document. An important characteristic of the requirements is that they reflect the holistic nature of the operational concept, emphasizing the air navigation system as a whole. Therefore, each requirement should be interpreted in the context of the other requirements and of the eleven expectations of the ATM community, detailed in Appendix D of the Operational Concept Document.

- Guidance on performance based transition planning and establishing and measuring performance targets, will be provided through a **Performance Manual** that is divided in two parts. Part One will consist of Performance–Based Transition Guidelines (PBTG). It provides guidance on how to adopt such a performance–based approach in the transition from today's system towards the future air navigation system as envisaged in the Operational Concept. Part Two, offers specific guidance on setting and measuring performance targets. This Performance Manual will provide a comprehensive understanding of the intent, expected benefits and delivery mechanisms of the performance-based air navigation system envisioned in the operational concept and will support the planning process by facilitating the development of cost-effective global and regional work programmes.

In summary, the Global ATM Operational Concept serves as the vision. The Global Air Navigation Plan with its Initiatives and associated interactive planning tools, serves as a strategic document, providing the planning methodology that will lead to global harmonization. The Performance framework will provide performance-based transition guidance, including guidance on how to choose performance objectives, set targets and measure the overall performance of the system, leading to the establishment of cost-effective global and regional work programmes in support of a global air navigation system. The table below depicts the structured planning framework described above.

ICAO documentation structure and relationships between work programmes in support of a global air navigation system

	Description	Objective	Role	Guidance
ATM Operational Concept (Doc 9854)	The ATM Operational Concept (ATMOC) presents the ICAO vision of an integrated, harmonized and globally interoperable air navigation system. The planning horizon is up to and beyond 2025.	To achieve an interoperable global air navigation system, for all users during all phases of flight, that meets agreed levels of safety, provides for optimum economic operations, is environmentally sustainable and meets national security requirements.	Vision	ATM System Requirements Document, (to ensure that all ATM related standards-making and industry work will be in support of the operational concept)
Global Air Navigation Plan (Doc 9750)	Strategic document that describes the methodology for global air navigation harmonization.	Establishes the focus for near and medium term activities.	Strategy	Performance Manual in two parts. Part I provides transition strategies and raises awareness of the way that evolution of ATM is planned at local, regional and global levels and supports the Global Plan as a transition planning document. Part II provides a comprehensive understanding of the intent, expected benefits and delivery mechanisms of the performance-based air navigation system envisioned in the operational concept and provides guidance on measuring and evaluating ATM performance
Global Plan Initiatives	A set of implementation methodologies derived from today's operational environment and available guidance materials.	Measurable progress towards the implementation of the ATMOC.	Tactics	
Regional Plans	regional work programmes including the planning and monitoring of the detailed activities and their timelines which, inter alia, lead to the realization of a global air navigation system as envisaged in the operational concept.	Contains the performance directives and associated requirements for facilities and services, established through regional air navigation agreements, in support of the global air navigation infrastructure.	Action	ICAO Business Plan ICAO Strategic Objectives

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APPENDIX B
Chapter 1

EVOLUTION TO GLOBAL PLAN INITIATIVES

INTRODUCTION

1.1 This chapter of the Global Plan describes a strategy aimed at achieving near and medium term ATM benefits on the basis of available and foreseen aircraft capabilities and ATM infrastructure. It contains guidance on ATM improvements necessary to support a uniform transition to the ATM system envisioned in the global ATM operational concept (Doc 9854). The operational concept presents the ICAO vision of an integrated, harmonized and globally interoperable ATM system. A global ATM system can be described as a worldwide system that, on a global basis, achieves interoperability and seamlessness across regions for all users during all phases of flight; meets agreed levels of safety; provides for optimum economic operations; is environmentally sustainable; and meets national security requirements.

1.2 There are many ways to present a transition map and it would be difficult to address all aspects of ATM transition in one presentation. Therefore, the Global Plan focuses on one perspective, which is the operational and technical improvements that will bring near and medium term benefits to aircraft operators. Long term initiatives, necessary to guide the evolution to a global ATM system as envisioned in the operational concept, will be added to the Global Plan as they are developed and agreed to.

1.3 On the basis of the above, planning will be focused on specific performance objectives, supported by a set of “Global Plan Initiatives” (“initiatives”). States and regions should choose initiatives that meet performance objectives, identified through an analytical process, specific to the particular needs of a State, region, homogeneous ATM area or major traffic flow. Planning tools will assist with the analytical process.

PLANNING PROCESS

Achieving a global ATM system

1.4 The basis for developing a global ATM system is an agreed-to structure of homogeneous ATM areas and major traffic flows/routing areas. These areas and flows tie together the various elements of the worldwide aviation infrastructure into a global system. Appendix I contains the Homogeneous ATM areas and major traffic flows/routing areas as identified by the Planning and Implementation Regional Groups (PIRGs). Further identification, update and analyses of these areas and traffic flows are carried out by PIRGs on an ongoing basis, in collaboration with the aircraft operators, reflecting the latter’s requirements. For an up-to-date version of the major traffic flows or homogeneous ATM areas in any particular region, refer to relevant ICAO regional offices.

Homogeneous ATM area

1.5 A homogeneous ATM area is an airspace with a common ATM interest, based on similar characteristics of traffic density, complexity, air navigation system infrastructure requirements or other specified considerations wherein a common detailed plan will foster the implementation of interoperable ATM systems. Homogeneous ATM areas may extend over States, specific portions of States, or groupings of States. They may also extend over large oceanic and continental areas. They are considered areas of shared interest and requirements.

1.6 The method of identifying homogeneous ATM areas involves consideration of the varying degrees of complexity and diversity of the worldwide air navigation infrastructure. Based on these considerations, planning could best be achieved, at the global level, if it were organized based on ATM areas of common requirements and interest, taking into account traffic density and the level of sophistication required.

Major traffic flows/routing areas

1.7 A major traffic flow refers to a concentration of significant volumes of air traffic on the same or proximate flight trajectories. Major traffic flows may cross several homogeneous ATM areas with different characteristics.

1.8 A routing area encompasses one or more major traffic flows, defined for the purpose of developing a detailed plan for the implementation of ATM systems and procedures. A routing area may cross several homogeneous ATM areas with different characteristics. A routing area specifies common interests and requirements among underlying homogeneous areas, for which a detailed plan for the implementation of ATM systems and procedures either for airspace or aircraft will be specified.

1.9 The basic planning parameter is the number of aircraft movements that must be provided with ATM services. Estimates and forecasts of annual aircraft movements over the planning period are required for high-level planning. The capabilities of the aircraft population are also important planning parameters that must be identified for the planning process. Forecasts of aircraft movements in peak periods, such as during a particularly busy hour, are needed for detailed planning. Additionally, appropriate civil/military coordination and consideration of special use airspace (SUA) is required.

1.10 Homogeneous ATM areas and major traffic flows are related primarily to enroute airspace. However, addressing capacity and efficiency improvements in the terminal control area (TMA) and at aerodromes and working on the basis of a set of common initiatives, as described in this chapter, will serve as an important building block toward achieving a global ATM system. Therefore, several of the initiatives (Table 1 refers) were developed specifically to improve TMA and aerodrome operations.

Work programme

1.11 After identifying the homogeneous ATM areas and major traffic flows, which all regions have already progressed substantially, planners should conduct a survey of the current and foreseen aircraft population and its capabilities, predicted traffic figures, and also the ATM infrastructure, including human resource availability and requirements, among other things. An analysis of the data gathered should lead to the identification of "gaps" in performance. The Global Plan initiatives would then be evaluated against these gaps to identify those that would most appropriately provide the operational improvements necessary to meet performance objective(s). This planning process would continue with development of scenarios for implementation of initiatives, cost-benefit analyses of the various scenarios and preliminary development of infrastructure support requirements. Additional steps would include development of implementation plans and funding profiles, further review of human resource requirements to support the identified initiatives, followed by further cost-benefit analyses. Finally, national and regional implementation plans would be developed or amended based on the selected initiatives. This is an iterative process which may require repetition of several steps until a final choice of initiatives is selected. The planning tools will assist planners in carrying out the above steps. Figure 1 below is an illustration of a planning flow chart.

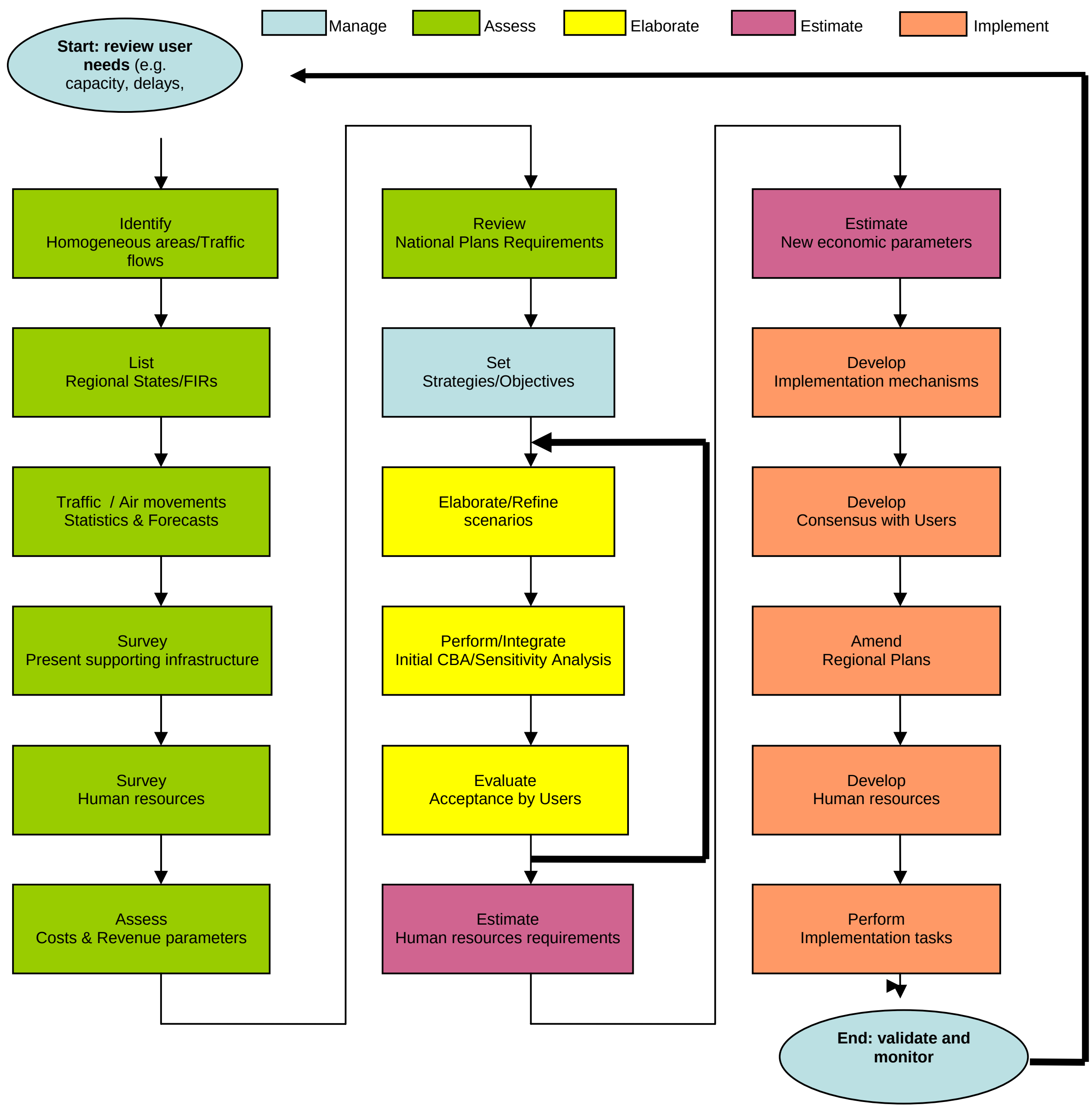

Figure 1. Planning flow chart

1.12 The planning process described in this volume of the Global Plan has been developed on the basis of the planning model contained in the previous version of the Global Plan which served as a step in the evolution toward a global ATM system. The updated process supports that evolution. Existing detailed plans are in different stages of implementation. Some plans have already identified performance objectives. The revised planning process, with its planning tools, will aid in furthering the work and provide the necessary guidance to complete the transition process.

1.13 Development of work programmes must be based on the experience and lessons learned in the previous cycle of the CNS/ATM implementation process. This Global Plan therefore, focuses efforts toward maintaining consistent global harmonization and improving implementation efficiencies by drawing on the existing capabilities of the infrastructure and successful regional implementations over the near and medium terms. Therefore, PIRGs and States are encouraged to provide feedback on experience gained and lessons learned during the evolution toward implementation of a global ATM system. Regions are also well positioned to identify shortcomings in ICAO guidance material, planning processes or Standards. This iterative approach will help to ensure a successful planning process.

Planning tools

1.14 This Third Edition of the Global Plan is supported by planning tools which take various formats (e.g., software applications, planning documentation, web-based reporting forms, project management tools, etc). As States and PIRGs consider implementation of the initiatives, they will use common programme templates contained in the planning tools as the basis for establishing performance objectives and implementation time lines, as well as to develop a comprehensive schedule and programme of planning activities to accomplish the work associated with the initiatives. In addition, the planning tools will provide links to relevant guidance material and documentation in order to assist the planner throughout the planning process. This will ensure a uniform approach to implementation of the initiatives. Appendix A describes the planning processes already in place and the relationships and interactions between the various planning bodies and documents.

EVOLUTION

Building an ATM system based on the operational concept

1.15 Achieving the global ATM system sought after will be accomplished through the implementation of many initiatives over several years on an evolutionary basis. The set of initiatives contained in this Global Plan are meant to facilitate and harmonize the work already underway within the regions and to bring needed benefits to aircraft operators over the near and medium term. ICAO will continue to develop newer initiatives on the basis of the operational concept which will be placed in this Global Plan. In all cases, initiatives must meet global objectives based on the operational concept. On this basis, planning and implementation activities begin with application of available procedures, processes and capabilities. The evolution would progress to application of emerging procedures, processes and capabilities and ultimately, migrate to the ATM system based on the operational concept. Figure 2 depicts the Global Plan evolution.

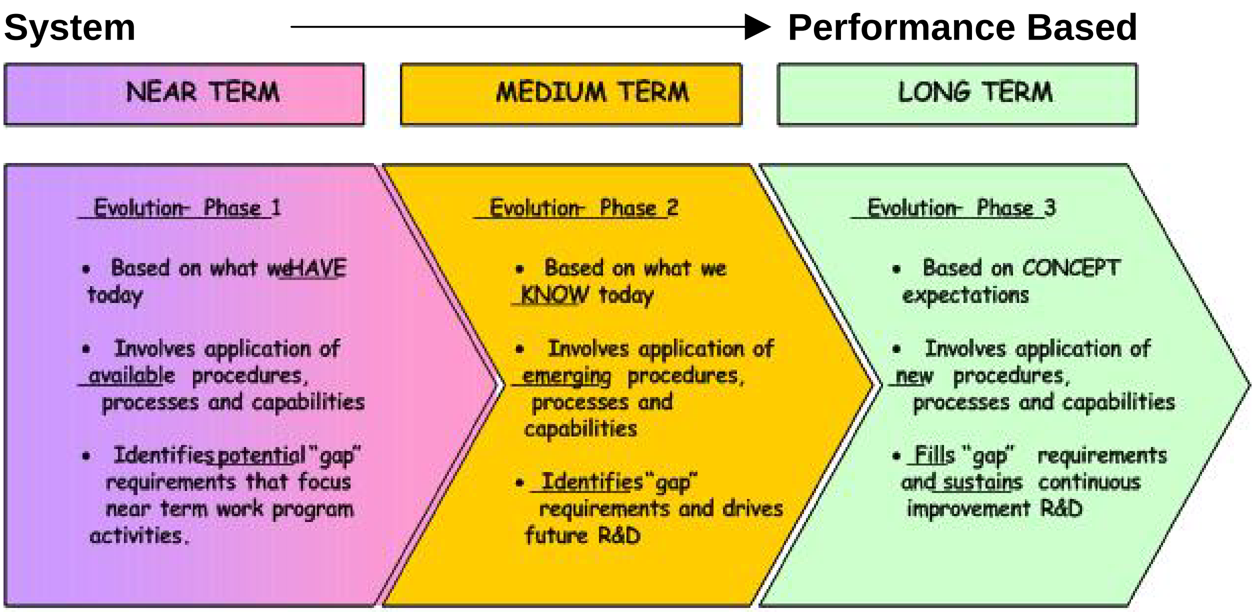

Figure 2. Global Plan Evolution

Global Plan initiatives

1.16 Global Plan Initiatives are designed to support the planning and implementation of performance objectives in the regions. Planning and implementation of performance objectives should be started in the near term and progressed in an evolutionary manner. Long term initiatives, necessary to guide the evolution to a global ATM system will be added to the Global Plan as they are developed and agreed to. Only systems and projects that meet the criteria of Figure 1 should be implemented in a progressive, cooperative and cost effective manner.

1.17 The ATM system will be based on the provision of integrated services. To better describe how these services will be delivered, seven concept components, together with their expected key conceptual changes, are described in the operational concept document (Doc 9854). Performance objectives should logically be linked to the operational concept components to ensure that all development work is aimed at achieving the ATM system envisaged in the concept. Therefore, the term: "related Operational Concept Components" when used in the initiative boxes on pages 7 through 31, refers to the seven concept components contained in the operational concept document. . These are Airspace Organization and Management (AOM), Demand and Capacity Balancing (DCB), Aerodrome Operations (AO), Traffic Synchronization (TS), Conflict Management (CM), Airspace User Operations (AUO) and ATM Service Delivery Management (ATMSDM).

Integration of initiatives

1.18 The initiatives described in the following pages are provided to facilitate the planning process and should not be viewed as stand-alone work items, but rather, in many cases, as interrelated. Therefore, initiatives are quite capable of integrating with and supporting each other. In fact, integration is a sought after goal of a global ATM system. An example would be the achievement of full integration of arrival, departure and surface traffic management which would improve aerodrome throughput through the sequencing and metering provided by the integration of arrival, departure and surface management functions. Benefits are achieved through the creation of an optimized traffic flow from the top of descent through the aerodrome to the top of climb. This could effectively eliminate ground and airborne holding, leading to a more optimum use of the airspace, the runway system and ground facilities.

1.19 Achievement of the above, would require implementation of several initiatives, or various parts of different initiatives, including decision support systems, performance based navigation, collaborative airspace design and management, terminal area design and management and aerodrome design and management.

Table 1. Global plan initiatives and their relationships to the major groupings

G P I		En-route	Terminal Area	Aerodrome	Supporting Infrastructure	Related Operational Concept Components
GPI-1	Flexible use of airspace	X	X			AOM, AUO
GPI-2	Reduced vertical separation minima	X				AOM, CM
GPI-3	Harmonization of level systems	X				AOM, CM, AUO
GPI-4	Alignment of upper airspace classifications	X				AOM, CM, AUO
GPI-5	RNAV and RNP (Performance-based navigation)	X	X	X		AOM, AO, TS, CM, AUO
GPI-6	Air traffic flow management	X	X	X		AOM, AO, DCB, TS, CM, AUO
GPI-7	Dynamic and flexible ATS route management	X	X			AOM, AUO
GPI-8	Collaborative airspace design and management	X	X			AOM, AUO
GPI-9	Situational awareness	X	X	X	X	AO, TS, CM, AUO
GPI-10	Terminal area design and management		X			AOM, AO, TS, CM, AUO
GPI-11	RNP and RNAV SIDs and STARs		X			AOM, AO, TS, CM, AUO
GPI-12	Functional integration of ground systems with airborne systems		X		X	AOM, AO, TS, CM, AUO
GPI-13	Aerodrome design and			X		AO, CM, AUO

	management					
GPI-14	Runway operations			X		AO, TS, CM, AUO
GPI-15	Match IMC and VMC operating capacity		X	X	X	AO, CM, AUO
GPI-16	Decision support systems and alerting systems	X	X	X	X	DCB, TS, CM, AUO
GPI-17	Data link applications	X	X	X	X	DCB, AO, TS, CM, AUO, ATMSDM
GPI-18	Aeronautical information	X	X	X	X	AOM, DCB, AO, TS, CM, AUO, ATMSDM
GPI-19	Meteorological systems	X	X	X	X	AOM, DCB, AO, AUO
GPI-20	WGS-84	X	X	X	X	AO, CM, AUO
GPI-21	Navigation systems	X	X	X	X	AO, TS, CM, AUO
GPI-22	Communication infrastructure	X	X	X	X	AO, TS, CM, AUO
GPI-23	Aeronautical radio spectrum	X	X	X	X	AO, TS, CM, AUO, ATMSDM

(GPI-1) FLEXIBLE USE OF AIRSPACE

Scope: The optimization and equitable balance in the use of airspace between civil and military users, facilitated through both strategic coordination and dynamic interaction.

Related Operational Concept Components: AOM, AUO

Description of strategy

1.20 The use of airspace could be optimized through the dynamic interaction of civil and military air traffic services including real-time civil/military controller-to-controller co-ordination. This requires system support, operational procedures and adequate information on civilian traffic position and intentions.

1.21 The flexible use of airspace (FUA) concept is based on the principle that airspace should not be designated purely as civil or military, but rather as a continuum in which all user requirements are accommodated to the greatest possible extent. FUA should result in the removal of large tracts of permanent or transient restricted airspace or special use airspace.

1.22 Where there are continued requirements to accommodate specific individual airspace uses, thereby blocking airspace of certain dimensions, this should be accommodated on a transient basis. Airspace should be released immediately after the operation requiring the restriction is complete.

1.23 Greater benefits associated with implementation of FUA will be obtained through inter-State cooperation which may entail regional and sub-regional agreements as reserved airspace is often established along critical flight paths at national boundaries.

(GPI-2) REDUCED VERTICAL SEPARATION MINIMUM

Scope: The optimization of the utilization of airspace and enhanced aircraft altimetry systems.

Related Operational Concept Components: AOM, CM

Description of strategy

1.24 Reduced vertical separation minima (RVSM) reduces vertical separation to 300 metres (1 000 ft) above FL 290 from the current 600 metres (2000 ft), thereby providing six additional flight levels. The Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive provides specific guidance on implementation of (Doc 9574).

1.25 A great deal of experience has been gained with RVSM and all necessary Standards and Recommended Practices (SARPs) guidance material are available to support implementation.

(GPI-3) HARMONIZATION OF LEVEL SYSTEMS

Scope: The adoption by all States of the ICAO Flight Level Scheme based on feet as contained in Appendix 3 to Annex 2 – *Rules of the Air*.

Related Operational Concept Components: AOM, CM, AUO

Description of strategy

1.26 The majority of ICAO Contracting States have chosen to use the imperial measurement system for referencing altitudes and levels, however, some States continue to use the metric system. To compound matters, some States that use the metric system, have adopted different vertical spacing standards than what is contained in ICAO Annex 2 — *Rules of the Air*.

1.27 Aircraft registered in States that have adopted the imperial system have altimetry systems calibrated in feet. Those registered in States that have adopted the metric system generally have altimeters calibrated in metres. Aircraft operating across boundaries into States with differing systems are required to carry additional altimeters, or to use conversion charts. Air traffic controllers handling such flights are also required to use conversion charts.

1.28 The implementation of RVSM at the interface between States using the different systems has increased safety concerns and causes the loss of several levels resulting in a less efficient operation for aircraft and a loss in airspace capacity. In addition, certain States that utilize the metric system have not made certain high level cruising altitudes available; thereby, imposing significant operating restrictions on aircraft operating on long-range sectors.

1.29 Harmonization of level systems, whereby all States adopt the ICAO Flight Level Scheme based on feet, should be pursued.

(GPI-4) ALIGNMENT OF UPPER AIRSPACE CLASSIFICATIONS

Scope: The harmonization of upper airspace and associated traffic handling through application of a common ICAO ATS Airspace Class above an agreed division level.

Related Operational Concept Components: AOM, CM, AUO

Description of strategy

1.30 To the extent possible airspace should be structured as a continuum, free from operational discontinuities, inconsistencies and differing rules and procedures. Alignment of airspace classifications can help to achieve this goal. It would also facilitate the introduction and better utilization of data link communications, improved flight plan processing systems, and advanced airspace management coordination tools and message exchange capabilities, leading to progressively more flexible and dynamic management of airspace. Airspace classifications should be harmonized intra-regionally and, where possible, across several regions.

1.31 Air transport and most business aircraft operations should be contained within airspace within which positive air traffic control services are provided to all aircraft (i.e. Class A, B, C or D).

1.32 ATM provided in various airspace volumes should be based on the ICAO airspace classification system as defined in Annex 11 — *Air Traffic Services* (i.e. Class A to G), and those classifications should be implemented on the basis of a safety assessment, taking into account the volume of nature of the air traffic.

(GPI-5) RNAV AND RNP (PERFORMANCE-BASED NAVIGATION)

Scope: The incorporation of advanced aircraft navigation capabilities into the air navigation system infrastructure.

Related Operational Concept Components: AOM, AO, TS, CM, AUO

Description of strategy

1.33 The implementation of the concept of performance based navigation will lead to increased capacity and enhanced efficiency through reductions in separation minima, bringing benefits to aircraft operators that equip to meet performance requirements. Performance-based navigation will also improve safety, particularly on approach through a reduction of controlled flight into terrain.

1.34 A significant number of aircraft are capable of area navigation (RNAV) and required navigation performance (RNP). Where warranted, these capabilities should be further exploited to develop more efficient routes and aircraft trajectories that are not directly tied to ground-based navigation aids. Certain RNAV equipped aircraft also have a significantly enhanced capability to achieve sequencing requirements to runways, particularly through the use of the “required time of arrival” function within the flight management system (FMS).

1.35 The performance-based navigation concept, which comprises RNAV and RNP operations recognizes that a clear distinction must be made in the designation of operations, between those aircraft operations that require onboard self-contained performance monitoring and alerting and those that do not.

1.36 In accordance with the performance-based navigation concept, all phases of flight are addressed including enroute (oceanic/remote and continental), terminal and approach. The concept, its implementation processes, navigation applications, as well as the operational approval and aircraft qualification requirements is described in the performance-based navigation manual which will be published as a new edition of Doc 9613.

(GPI-6) AIR TRAFFIC FLOW MANAGEMENT

Scope: The implementation of strategic, tactical and pre-tactical measures aimed at organizing and handling traffic flows in such a way that the totality of the traffic handled at any given time or in any given airspace or aerodrome is compatible with the capacity of the ATM system.

Related Operational Concept Components: AOM, AO, DCB, TS, CM, AUO

Description of strategy

1.37 The implementation of demand/capacity measures, commonly known as air traffic flow management (ATFM), implemented on a regional basis where needed, will enhance airspace capacity and improve operating efficiency.

1.38 In the event that traffic demand regularly exceeds capacity, resulting in continuing and frequent traffic delays, or when it becomes apparent that forecast traffic demand will exceed the available capacity, the appropriate ATM units, in consultation with aircraft operators, should consider implementing steps aimed at improving the use of the existing system capacity, and developing plans to increase capacity to meet the actual or forecast demand. Any such planning to increase capacity should be undertaken in a structured and collaborative manner.

1.39 Where warranted, States and regions should evolve to a collaborative based approach to capacity management. The ATM Operational Concept envisages a more strategic approach to ATM overall, and through collaborative decision-making, a reduction in the reliance on tactical flow management. It is inevitable that tactical flow intervention will continue to be required; however closer coordination between airspace users and ATM service providers can reduce the need for routine tactical intervention which is often disruptive to aircraft operations.

(GPI-7) DYNAMIC AND FLEXIBLE ATS ROUTE MANAGEMENT

Scope: The establishment of more flexible and dynamic route systems, on the basis of navigation performance capability, aimed at accommodating preferred flight trajectories

Related Operational Concept Components: AOM, AUO

Description of strategy

1.40 The implementation of ATS route structures that avoid concentrations of aircraft over congested points and implementation of an ATS routing environment that meets the needs of the airspace users to operate along preferred and dynamic flight trajectories, will increase capacity and increase aircraft operating efficiency.

1.41 RNAV routes are not restricted to the location of ground-based aids and provide benefits to aircraft operators and the ATM system. All modern aircraft are RNAV capable and efforts should be made to design and implement RNAV routes.

1.42 Dynamic route management involves the aircraft in the planning process. Typical scenarios include the generation of change-of routing requests by the dispatch functions of the aircraft operators, the processing and approval of these requests by ATS providers and transmission of the change-or-routing approval to the aircraft. Advanced scenarios would have the aircraft making requests directly to ATS providers who would process and modify the request if necessary and then forward the approved route to aircraft and affected service providers along the route of flight.

1.43 Random routing strategically or pre-tactically defines areas within which fixed routes are not designated and where aircraft determine an appropriate track from an entry point to an exit point.

1.44 User-preferred routes make use of the capability of aircraft operators to determine optimum tracks, based on a range of flight parameters. In accordance with this concept, ATS routes or tracks would not be fixed to pre-determined routes or waypoints, except where required for control purposes, however, trajectories would be available to ATM staff.

1.45 User-preferred routing requests are generated by the airspace user or their dispatch functions and submitted to the ATS provider for approval or renegotiation if a conflict is determined followed by their transmission to aircraft. Advanced scenarios would have the aircraft making requests directly to ATS providers who would process and modify the request if necessary and then forward the approved route to aircraft.

(GPI-8) COLLABORATIVE AIRSPACE DESIGN AND MANAGEMENT

Scope: The application of uniform airspace organization and management principles on a global basis, leading to a more flexible airspace design to accommodate traffic flows dynamically.

Related Operational Concept Components: AOM, AUO

Description of strategy

1.46 Collaborative airspace design and management is aimed at organizing airspace in a cooperative manner involving all users so that airspace is managed to accommodate the preferred trajectories of the users. States and regions should take advantage of aircraft capabilities when designing airspace. In designing and implementing airspace changes, account needs to be taken of the fleet capabilities among airspace users within a given airspace. Furthermore, collaboration with airspace users will identify procedures and/or solutions that make use of available aircraft capabilities.

1.47 Other emerging developments such as collaborative decision-making, the “required time of arrival” function in the flight management system (FMS), the endorsement of the global ATM operational concept and the implementation of data link applications, will also allow improved airspace design and management.

1.48 Over an evolutionary period, dynamic airspace management should be applied where significant benefits would be gained. Dynamic airspace management comprises integrated decision making; demand-based capacity (see air traffic flow management, paragraph 1.36); and user preferred routes (see dynamic and flexible ATS route management, paragraph 1.39).

1.49 Integrated decision making is an extension of the principles of the flexible use of airspace concept to include airspace users in flight in decision making with respect to tactical assessment of the use of reserved airspace and requirements for transit times of special use airspace.

1.50 Aircraft FMSs can provide information on estimated time enroute for proposed route changes. In addition, data link communication through CPDLC, providing the ability to uplink and downlink flight planning information, can support deployment of integrated decision making.

(GPI-9) SITUATIONAL AWARENESS

Scope: Operational implementation of data link-based surveillance. The implementation of equipment to allow traffic information to be displayed in aircraft supporting implementation of conflict prediction and collaboration between flight crew and the ATM system. Improve situational awareness in the cockpit by making available electronic terrain and obstacle data of required quality.

Related Operational Concept Components: AO, TS, CM, AUO

Description of strategy

1.51 The further implementation of enhanced surveillance techniques (ADS-C or ADS-B) will allow reductions in separation minima and an enhancement of safety, increase in capacity, improved flight efficiency, all on a cost-effective basis. These benefits may be achieved by bringing surveillance to areas where there is no primary or secondary radar, when cost-benefit models warrant it. In airspaces where radar is used, enhanced surveillance can bring further reductions in aircraft separation minima and improve, in high traffic density areas, the quality of surveillance information both on the ground and in the air, thereby increasing safety levels. The implementation of sets of quality assured electronic terrain and obstacle data necessary to support the ground proximity warning systems with forward looking terrain avoidance function as well as minimum safe altitude warning (MSAW) system will benefit safety substantially.

1.52 Implementation of surveillance systems for surface movement at aerodromes where weather conditions and capacity warrant will also enhance safety and efficiency while implementation of cockpit display of traffic information and associated procedures will enable pilot participation in the ATM system and improve safety through greater situational awareness.

1.53 In remote and oceanic airspace where ADS-C is used, FANS capabilities exist on many air transport aircraft and could be added to business aircraft. ADS-B can be used to enhance traffic surveillance in domestic airspace. in this respect, it should be noted that 1090 extended squitter is both available and should be accepted as the global choice for the ADS-B data link.

1.54 At terminal areas and at aerodromes surrounded by significant terrain and obstacles, the availability of quality assured terrain and obstacle databases containing digital sets of data representing terrain surface in the form of continuous elevation values and digital sets of obstacle data of features, having vertical significance in relation to adjacent and surrounding features considered hazardous to air navigation, will improve situational awareness and contribute to the overall reduction of the number of controlled flight into terrain related accidents.

(GPI-10) TERMINAL AREA DESIGN AND MANAGEMENT

Scope: The optimization of the terminal control area (TMA) through improved design and management techniques.

Related Operational Concept Components: AOM, AO, TS, CM, AUO

Description of strategy

1.55 There are many ways that a well designed and managed TMA can have an important impact on safety, capacity and efficiency. TMA design should be implemented uniformly across all TMAs within a State or Region and should provide benefits while minimizing pilot/controller communications and optimizing pilot and controller workload. TMA arrival acceptance rates should be based tactically on a collaborative decision-making process involving tower, TMA and en-route sectors, while strategically involving airspace users, to ensure optimum traffic handling.

1.56 The enhancement of TMA management includes:

1) Complete the implementation of WGS-84 (see WGS-84, paragraph 1.89 below);
2) Design and implement optimized RNAV and RNP arrival and departure procedures (see also RNAV and RNP (Performance-based navigation GPI-5);
3) Design and implement RNP-based approach procedures (see also Performance-based navigation in paragraph 1.34 above); and
4) Enhance traffic and capacity management.

1.57 The implementation of dynamic TMA management procedures may comprise several elements such as dynamic wake vortex detection and mitigation, and collaborative capacity management

1.58 At those locations where a business case supports implementation, decision support tools should be developed and implemented to provide a more structured and efficient management of arrival and departure traffic flows and more efficient use of the runway(s); more fuel-efficient trajectories and reduced noise exposure.

(GPI-11) RNP AND RNAV STANDARD INSTRUMENT DEPARTURES (SIDS) AND STANDARD TERMINAL ARRIVALS (STARS)

Scope: The optimization of the terminal control area (TMA) through implementation of improved ATS route structures based on RNP and RNAV, connecting the enroute phase of flight with the final approach, based on improved coordination processes.

Related Operational Concept Components: AOM, AO, TS, CM, AUO

Description of strategy

1.59 The implementation of optimized standard instrument departures (SIDs), standard instrument arrivals (STARs), instrument flight procedures, holding, approach and associated procedures, taking advantage of aircraft navigation capabilities such as RNP and RNAV, as well as ATM decision support systems, will improve capacity and efficiency substantially.

1.60 The use of SIDs and STARs, will maximize system capacity and predictability while easing the environmental impact, reducing fuel consumption, and reducing ATS coordination. States should take advantage of the performance characteristics that are currently available to design such route structures. Near-term benefits can be achieved by applying RNP1 and RNAV 2 and 1 criteria to the design of SIDs and STARs allowing optimum spacing between the routes leading to greater capacity and efficiency benefits (see paragraph 1.3.2).

1.61 SIDs and STARs allow the efficient transit of aircraft from the runway to enroute flight and vice versa; the segregation of departing traffic from arriving traffic to provide safe aircraft spacing; the maintaining of obstacle clearance requirements; the meeting of environmental requirements; and provision of a predictable flight trajectory compatible with aircraft RNAV systems.

(GPI-12) FUNCTIONAL INTEGRATION OF GROUND SYSTEMS WITH AIRBORNE SYSTEMS

Scope: The optimization of the terminal control area (TMA) to provide for more fuel efficient aircraft operations through FMS-based arrival procedures and functional integration of ground and airborne systems

Related Operational Concept Components: AOM, AO, TS, CM, AUO

Description of strategy

1.62 In recent years there have been several efforts to develop flight procedures that provide the most efficient trajectory during an aircraft's approach to the destination aerodrome. These procedures allow an uninterrupted flight trajectory from top of descent until the aircraft is stabilized for landing. For the purposes of design work, it may be necessary to implement these procedures in phases.

1.63 The design of en-route and arrival air routes and associated procedures should facilitate the routine use of continuous descent procedures. Similarly, the design of departure procedures should facilitate the routine use of unrestricted climb procedures.

1.64 In order to maximize efficiency in TMA airspace, taking advantage of improved TMA design and making best use of automation is critical. Therefore, in addition to continuous descent capabilities, aircraft will increasingly be equipped with time of arrival computation. This capability will integrate with ground automation to deliver time of arrival over fixes to assist in the sequencing process allowing aircraft to remain closer to their 4-D preferred trajectory.

(GPI-13) AERODROME DESIGN AND MANAGEMENT

Scope: The implementation of management and design strategies to improve movement area utilization.

Related Operational Concept Components: AO, CM, AUO

Description of strategy

1.65 Improved aerodrome design and management activities, including coordination and collaboration between ATM providers, vehicle operators and aircraft operators can have an important impact on safety and capacity at aerodromes.

1.66 Local collaborative decision-making processes should lead to sharing of key flight scheduling data that would enable all participants (aerodrome, ATC, ATFM, aircraft operators, ground handling) to improve their awareness of aircraft status throughout the “turn around” process. This will allow minimal and precise ATFM measures to be applied and higher predictability of schedules to be achieved. Benefits would include more efficient use of aerodrome resources and ground handling, reduction in delays and higher predictability of schedules.

1.67 As an integral part of the air navigation system, the aerodrome will provide the needed ground infrastructure including, *inter alia*, lighting, taxiways, runway and runway exits, precise surface guidance to improve safety and to maximize aerodrome capacity in all weather conditions. The ATM system should enable the efficient use of the capacity of the aerodrome airside infrastructure. to ensure optimum use of aerodromes

a) runway occupancy time should be reduced where capacity and efficiency benefits would be gained;

b) the ability to safely manoeuvre in all weather conditions whilst maintaining capacity should be sought;

c) where warranted, precise surface guidance to and from a runway will improve capacity and efficiency; and

d) the position (to an appropriate level of accuracy) and intent of all vehicles and aircraft operating on the manoeuvring and movement areas should be known and available to the appropriate ATM community members at those aerodromes where a cost-benefit analysis shows that substantial capacity and efficiency gains would be had.

(GPI-14) RUNWAY OPERATIONS

Scope: Maximize runway capacity.

Related Operational Concept Components: AO, TS, CM, AUO

Description of strategy

1.68 Enhancing the performance of runway operations begins with the establishment of runway capacity benchmarks which are usually defined as the maximum number of flights an aerodrome can routinely handle in an hour for above Category I weather minimum. These benchmarks are estimates that vary with runway configurations and the mix of aircraft types. Where warranted, it should be an objective to utilize aircraft capabilities and available runways in the most appropriate manner to move the all weather throughput as close to the visual throughput as possible.

1.69 Achieving the optimum capacity for each runway is a complex task involving many factors, both tactical and strategic. In order to effectively manage that task it is essential to measure the effects of changes and to monitor performance of the airspace users and ATM providers. The latter case will be applicable to the analysis of pilot and controller performance and must recognize the requirement to maintain the confidence of the users and to work within the existing culture of safety. A system of performance indicators that forms the basis of measurements and analyses should be devised. Tactical factors affecting runway occupancy include flight operations and ATM factors. The flight operations aspects include operator performance; effects of company procedures; use of the airfield infrastructure; and aircraft performance issues.

1.70 Runway capacity constraints are defined by, inter alia, procedures, runway physical characteristics, aircraft performance capabilities, surveillance capabilities, aircraft spacing, weather limitations, environmental restrictions and surrounding land use management aspects. Improved procedures for minimizing spacing such as reduced runway separation, precision runway monitoring (PRM) and RNP+-approaches for closely-spaced parallel runways will optimize spacing capability.

(GPI-15) MATCH IMC AND VMC OPERATING CAPACITY

Scope: Improve the ability of aircraft to manoeuvre on the aerodrome surface in adverse weather conditions.

Related Operational Concept Components: AO, CM, AUO

Description of strategy

1.71 It should be an objective of the ATM system to utilize all airborne and service provision capabilities to maintain VMC capacity during IMC conditions to the greatest practical extent. More use should be made of the capability of modern aircraft systems and ground systems in evolving toward this objective. Taxiway design and guidance capability may then be matched to those conditions.

1.72 Implementation of A-SMGCS, decision support tools and associated procedures offer the best solution for aircraft to operate in all weather conditions. At those locations where benefit/cost analysis indicate a positive value, the improved guidance and control of taxiing aircraft and moving vehicles on the movement area as well as impending conflict alert may be fully automated.

1.73 Synthetic vision, based on detailed aerodrome map, can enhance situational awareness under adverse weather conditions where runway/taxiway markings may be obscured. Head-up display and guidance systems that can synthesize enhanced vision sensor data and synthetic vision images can offer an integrated solution to enhance situational awareness.

1.74 Enhanced conflict detection and alerting technologies and procedures will improve the aerodrome surface movement throughput while meeting established levels of safety. Controllers should also have access to systems to help them develop and maintain situational awareness of all traffic on the movement area in all weather conditions.

(GPI-16) DECISION SUPPORT AND ALERTING SYSTEMS

Scope: Implement decision support tools to assist air traffic controllers and pilots in detecting and resolving air traffic conflicts and in improving traffic flow.

Related Operational Concept Components: DCB, TS, CM, AUO

Description of strategy

1.75 Decision support systems facilitate early resolution of potential conflicts, provide basic levels of explorative probing to optimize strategies and reduce the need for tactical action. The executive role of controllers is thereby enhanced, giving scope for management of more traffic within acceptable workload limits.

1.76 Several tools are available that have the ability to substantially enhance safety. These include minimum safe altitude warning systems, short term conflict alert and runway incursion alerting tools. Tools that can improve efficiency include automated flight data processing systems, longer term conflict prediction and sequencing tools and online data interchange systems.

1.77 Conflict prediction tools span several sectors and permit improved sectoral planning, thereby providing the advantage of more expeditious traffic flow and less potential conflicts within established arrival schedules. This will allow sector teams to operate more effectively and will result in more optimum and efficient arrival flows.

1.78 The automation of coordination tasks between adjacent sectors improves the quality of information on traffic transiting between sectors and makes it more predictable, thereby allowing reduced separation minima, decreased workload, and increased capacity and more efficient flight operations.

(GPI-17) DATA LINK APPLICATIONS

Scope: Increase the use of data link applications.

Related Operational Concept Components: DCB, AO, TS, CM, AUO, ATMSDM

Description of strategy

1.79 The implementation of less complex data link services (e.g. pre-departure clearance, oceanic clearance, D-ATIS, automatic position reporting, etc) can bring immediate efficiency benefits to the provision of ATS. Transition to the use of data link communications for more complex safety related uses that take advantage of a wide variety of Controller Pilot Datalink Communication (CPDLC) messages, including ATC clearances is already being successfully implemented.

1.80 Use of CPDLC and implementation of other data link applications can bring significant advantages in terms of workload and safety over voice communication for both pilots and controllers. In particular, they can provide efficient linkages between ground and airborne systems, improved handling and transfer of data, reduced channel congestion, reduced communication errors, interoperable communication media and reduced workload. The reduction of workload per flight translates into capacity increases and enhances safety.

1.81 Communication data link and data link surveillance technologies and applications should be selected and harmonized for seamless and interoperable global operations. ADS-C, ADS-B and CPDLC are in service in various regions of the world but lack global harmonization. Current regional initiatives, including utilizing unique message subsets and CPDLC procedures, hinder efficient development and acceptance for global aircraft operations. Existing and emerging technologies should be implemented in a harmonized global manner in the near term to support long-term goals. Harmonization will define global equipage requirements and therefore minimize user investment.

1.82 FANS-1/A and ATN applications support similar functionality, but with different avionics requirements. Many internationally operated aircraft are equipped with FANS-1/A avionics initially to take advantage of data link services offered in certain oceanic and remote regions. FANS-1/A equipage on international business aviation aircraft is underway and is expected to increase.

(GPI-18) AERONAUTICAL INFORMATION

Scope: To make available in real-time, quality assured electronic information (aeronautical, terrain and obstacle).

Related Operational Concept Components: AOM, DCB, AO, TS, CM, AUO, ATMSDM

Description of strategy

1.83 RNAV, RNP, computer-based navigation systems and ATM requirements introduced a need for new corresponding AIS requirements for quality and timeliness of information. To be able to cope and manage the provision of information and satisfy these new requirements, the traditional role of aeronautical information service should change into a system-wide information management service with changing duties and responsibilities.

Electronic information

1.84 To facilitate coordination, improve efficiency and safety and ensure that the ATM Community shares the same information when collaborating on decisions, availability, in real-time, of quality assured electronic information (aeronautical, terrain and obstacle) is essential. Electronic information will enhance pilots' situational awareness during enroute, terminal and aerodrome operations by loading onboard equipment with geo-referenced data sets containing enroute, terminal and aerodrome information. The same information may be made available at different ATC positions, pre-flight planning units as well as for access by airlines flight planning departments or private/general aviation users. The electronic information can be tailored and formatted so that it satisfies ATM user requirements and applications. Standardized data formats will be used in creating the information databases which will then be populated with quality assured data sets.

(GPI-19) METEOROLOGICAL SYSTEMS

Objective: To improve the availability of meteorological information in support of a seamless global ATM system.

Related Operational Concept Components: AOM, DCB, AO, AUO

Description of strategy

1.85 Immediate access to real-time, global operational meteorological (OPMET) information is required to assist ATM in tactical decision-making for aircraft surveillance, air traffic flow management and flexible/dynamic aircraft routing which will contribute to the optimization of the use of airspace. Such stringent requirements will imply that most meteorological systems should be automated and that meteorological service for international air navigation be provided in an integrated and comprehensive manner through global systems such as the world area forecast system (WAFS), the international airways volcano watch (IAVW) and the ICAO tropical cyclone warning system.

1.86 Enhancements to WAFS, IAVW and the ICAO tropical cyclone warning system to improve the accuracy, timeliness and usefulness of the forecasts issued will be required to facilitate the optimization of the use of airspace.

1.87 Increasing use of data-link to downlink and uplink meteorological information (through such systems as D-ATIS and D-VOLMET) will assist in the automatic sequencing of aircraft on approach and will contribute to the maximization of capacity. Developments of automated ground-based meteorological systems in support of operations in the terminal area will provide OPMET information, (such as automated low-level wind shear alerts) and automated runway wake vortex reports. OPMET information from the automated systems will also assist in the timely provision of forecasts and warnings of hazardous weather phenomena. These forecasts and warnings, together with automated OPMET information, will contribute to maximizing runway capacity.

(GPI-20) WGS-84

Objective: The implementation of WGS-84 by all States.

Related Operational Concept Components: AO, CM, AUO

Description of strategy

1.88 The geographical coordinates used across various States in the world to determine the position of runways, obstacles, aerodromes, navigation aids and ATS routes are based on a wide variety of local geodetic reference systems. With the introduction of RNAV, the problem of having geographical coordinates referenced to local geodetic datum's is more evident and has clearly shown the need for a universal geodetic reference system. ICAO, to address this issue, adopted in 1994 the World Geodetic System – 1984 (WGS-84) as a common horizontal geodetic reference system for air navigation with an applicability date of 1 January 1998.

1.89 Fundamental to the implementation of GNSS is the use of a common geographical reference system. ICAO adopted the WGS-84 Geodetic Reference System as that datum, and many States have implemented, or are implementing the system. Failure to implement, or a decision to use an alternative reference system will create a seam in ATM service, and will delay the full realization of GNSS benefits. Completion of the implementation of the WGS-84 Geodetic Reference System is a prerequisite for a number of ATM enhancements, including GNSS.

(GPI-21) NAVIGATION SYSTEMS

Scope: Enable the introduction and evolution of performance-based navigation supported by a robust navigation infrastructure providing an accurate, reliable and seamless global positioning capability.

Related Operational Concept Components: AO, TS, CM, AUO

Description of strategy

1.90 Airspace users need a globally interoperable navigational infrastructure that delivers benefits in safety, efficiency and capacity. Aircraft navigation should be straight-forward and conducted to the highest level of accuracy supported by the infrastructure.

1.91 To meet those needs, the progressive introduction of performance-based navigation must be supported by an appropriate navigation infrastructure consisting of an appropriate combination of global navigation satellite systems (GNSS), self-contained navigation systems (inertial navigation system) and conventional ground-based navigation aids.

1.92 GNSS provides standardised positioning information to the aircraft systems to support precise navigation globally. One global navigation system will help support a standardisation of procedures and cockpit displays coupled with a minimum set of avionics, maintenance and training requirements. Thus, the ultimate goal is a transition to GNSS that would eliminate the requirement for ground-based aids, although the vulnerability of GNSS to interference may require the retention of some ground aids in specific areas.

1.93 GNSS-centered performance-based navigation enables a seamless, harmonised and cost effective navigational service from departure to final approach that will provide benefits in safety, efficiency and capacity.

1.94 GNSS implementation will be carried out in an evolutionary manner, allowing gradual system improvements to be introduced. Near-term applications of GNSS are intended to enable the early introduction of satellite-based area navigation without any infrastructure investment, using the core satellite constellations and integrated multisensor airborne systems. The use of these systems already allows for increased reliability of non-precision approach operations at some airports.

1.95 Medium/longer term applications will make use of existing and future satellite navigation systems with some type of augmentation, or combination of augmentations required for operation in a particular phase of flight.

(GPI-22) COMMUNICATION INFRASTRUCTURE

Scope: To evolve the aeronautical mobile and fixed communication infrastructure, supporting both voice and data communications, accommodating new functions as well as providing the adequate capacity and quality of service to support ATM requirements.

Related Operational Concept Components: AO, TS, CM, AUO

Description of strategy

1.96 ATM depends extensively and increasingly on the availability of real-time or near real-time, relevant, accurate, accredited and quality-assured information to make informed decisions. The timely availability of appropriate aeronautical mobile and fixed communication capabilities (voice and data) to accommodate ATM requirements and to provide the adequate capacity and quality of service requirements is essential. The aeronautical communication network infrastructure should accommodate the growing need for information collection and exchange within a transparent network in which all stakeholders can participate.

1.97 The gradual introduction of performance-based SARPs, system-level and functional requirements will allow the increased use of commercially available voice and data telecommunication technologies and services. In the framework of this strategy, States should, to the maximum extent possible, take advantage of appropriate technologies, services and products offered by the telecommunication industry.

1.98 Considering the fundamental role of communications in aviation as an enabler, the common objective is to seek the most efficient communication network service providing the desired services with the required performance and interoperability required for aviation safety levels at minimum cost.

(GPI-23) AERONAUTICAL RADIO SPECTRUM

Scope: Timely and continuing availability of adequate radio spectrum, on a global basis, to provide viable air navigation services (communication, navigation and surveillance).

Related Operational Concept Components: AO, TS, CM, AUO, ATMSDM

Description of strategy

1.99 States need to address all regulatory aspects on aeronautical matters on the agendas for ITU World Radiocommunication Conferences (WRC). Particular attention is drawn to the need to maintain the current spectrum allocations to aeronautical services.

1.100 The radio spectrum is a scarce natural resource with finite capacity for which demand from all users (aeronautical and non-aeronautical) is constantly increasing. Thus, the ICAO strategy on aeronautical radio spectrum, aims at long-term protection of adequate aeronautical spectrum for all radio communication, surveillance and radio navigation systems. The process of international coordination taking place in the International Telecommunication Union (ITU), obliges all spectrum users (i.e. aeronautical and non aeronautical) to continually defend and justify spectrum requirements. Civil aviation operations are expanding globally creating pressure on the already stressed and limited available aeronautical spectrum.

1.101 The framework of this initiative involves the support and dissemination by States of the ICAO quantified and qualified policy statements of requirements for aeronautical radio frequency spectrum agendas for ITU World Radio communication Conferences (WRC). This is necessary to maintain the current spectrum allocations to aeronautical services, ensure the continuing availability of adequate aeronautical radio spectrum and ultimately the viability of existing and new air navigation services globally.

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APPENDIX C

Chapter 2

A PERFORMANCE-BASED SYSTEM THAT MEETS USER EXPECTATIONS

INTRODUCTION

2.1 The air navigation system is increasingly being discussed in terms of performance, as corporatization and a more structured regulatory environment place increasing pressure on accountability. This chapter of the Global Plan examines the need for adopting a performance orientation when designing, planning, implementing and operating ATM systems. This relates to Chapter One as each of the Global Plan Initiatives require the identification of performance objectives to be established and monitored.

2.2 Performance may be seen from many perspectives. At the highest levels, performance relates to political and socio-economic expectations of society and/or the aviation community. The measures necessary to meet these expectations should govern the design of the system. These general expectations are relative to the effective operation of the ATM system and include *safety, security, environment, efficiency, cost-effectiveness, capacity, access and equity, flexibility, predictability, global interoperability and participation* by the entire aviation community.

2.3 The expectations often compete with each other. Some aviation community members (the *Global Air Traffic Management Operational Concept* - Doc 9854 refers) have explicit economic expectations, others efficiency and predictability, while some are concerned with access and equity; and all have safety expectations. For optimum air navigation system performance, each of these sometimes competing expectations needs to be balanced. In an integrated system, changes to one expectation area will likely have an effect on other areas. It is necessary therefore, to assess the whole system effect when planning a change in a specific area. This may require, or lead to, trade-offs in performance. This is generally acceptable with the exception of safety, wherein acceptable levels of safety must be achieved.

2.4 Safety is the most critical of the expectations and in accordance with the ICAO requirements for States to implement safety management programmes, requiring air navigation service providers, aircraft operators and aerodrome operators to establish safety management systems, any significant safety related change to the air navigation system, including the implementation of a reduced separation minimum or a new procedure, shall only be effected after a safety assessment has demonstrated that an acceptable level of safety will be met and users have been consulted. When appropriate, the responsible authority shall ensure that adequate provision is made for post-implementation monitoring to verify that the defined level of safety continues to be met.

2.5 The expectations for the global air navigation system have been discussed among the ATM community in general terms for many years. The eleven expectations listed in paragraph 2.2 above, have been agreed to and are included in the operational concept (Doc 9854) which was endorsed at the Eleventh Air Navigation Conference (Montreal, 22 September to 3 October 2003). The Thirty-Fifth Session of the ICAO Assembly (28 September to 8 October 2004), through Resolution A-35-15, Appendix B, called upon States, planning and implementation regional groups (PIRGs) and the aviation industry to use the operational concept as the common framework to guide planning and implementation and to focus all such development work. The Assembly also urged the Council to take the steps necessary to ensure that the future global air navigation system is performance-based and that the performance objectives and targets for the future system are developed in a timely manner.

Meeting user expectations

2.6 ICAO continues to develop key performance indicators (KPI's) for each of the eleven expectations as part of its work on the hierarchical performance model which includes the notion of required total system performance (RTSP) and required ATM system performance (RASP) (Agenda Item 3 of AN-Conf/11 Report refers - Doc 9828). While these KPI's are being developed, and to further assist in describing the transition to a performance-based system, any change to the air navigation system should be driven by the four operational expectations of Safety, Capacity, Efficiency and Predictability, with Cost Effectiveness and Environment as supporting expectations. These are the air navigation system dominant performance objectives and, within the performance framework identified in the operational concept, these would act at the RASP level.

Safety: any change to the air navigation system must not adversely affect acceptable levels of safety.

Capacity: any change to the air navigation system should be aimed at providing optimum capacity that meets current and forecast demand while minimizing delays. The system should be designed collaboratively, in particular through demand and capacity balancing, to limit system disruption.

Efficiency: any change to the air navigation system should be aimed at ensuring that user operating efficiency requirements are met.

Predictability: any change to the air navigation system should be designed to improve predictability and therefore, user and service provider confidence.

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APPENDIX D
Chapter 3

FACTORS AFFECTING CHANGE

INTRODUCTION

3.1 The implementation of the global plan initiatives requires addressing technical and operational aspects, as well as factors that impact the effectiveness and the economic suitability of implementation. When considering the factors that affect change, it is fundamental to the evolution of the global ATM system to recognize that from a product perspective, the two key components are the aircraft and the ground-based ATM system. Based on this, there is a need for ATM providers to develop plans that aircraft operators can rely on, make decisions against and have confidence that the operational improvements and associated benefits will be realized. Once a transition plan is agreed within the ATM Community, there needs to be confidence that the plan will be followed to completion and that aircraft upgrades will be carried out.

Coordination

3.2 Early and effective coordination and cooperation of implementation planning activities between the members of the ATM Community, particularly between ATM providers and aircraft operators, reduces proliferation of aircraft equipage requirements, facilitates cost-effectiveness in development of ATM infrastructure (e.g., communication, navigation and surveillance systems, ATC units, etc), increases levels of interoperability and seamlessness and enhances safety.

Transition

3.3 It is necessary to carefully transition to the ATM system defined in the operational concept in order to obtain the operational improvements expected from implementation of the global plan initiatives and to ensure interoperability and seamlessness. Initiatives should integrate into a continuous process of evolution of airborne and ground based systems, taking into consideration backward and forward compatibility. Such an approach would allow continued evolution to the ATM system envisaged in the operational concept, while providing benefits in the near and medium terms.

Airborne systems

Lifespan

3.4 Aircraft manufacturers have to make business case decisions, in cooperation with their customers, about future ATM requirements in order to build adequate and cost-effective capabilities into an aircraft to meet those requirements. The production life cycle of an aircraft model can span many years. In addition, aircraft have a very low rate of retirement, especially business aircraft, which tend to have even longer life spans than commercial aircraft. These factors should be considered when planning changes to the ATM system and close collaboration between ATM providers, aircraft and equipment manufacturers and operators, should be an integral part of the planning process.

Forward-fit/retro-fit

3.5 During the production life of an aircraft, changes to design are made to introduce improvements and functionality. These changes are introduced into the aircraft fleet primarily in two ways. During production they are introduced as forward fit. Concurrently, the aircraft manufacturer would produce a Service Bulletin (SB) describing changes that need to be made that would allow previously delivered aircraft to be brought up to the latest functionality. This is known as retrofit which ensures fleet commonality. This is important from a training and human factors perspective as increasing complexity of the aircraft flight deck adds to flight crew training time, which adds cost and results in the crew being unavailable for flight operations. To avoid these added costs and requirements, it is important for the provider to first identify ATM solutions that do not require major changes to aircraft or their avionics. Additionally, changes should be planned to take place over long time spans to provide predictability and stability of aircraft operations. Where aircraft system changes are required, it is more efficient for aircraft operators if those changes were coordinated globally so that when changes are made to an aircraft, it covers all likely scenarios on a global basis.

Cost of unscheduled downtime

3.6 Operators schedule downtime very critically, and depending on the extent of the retrofit or change, other maintenance work may need to be deferred. It is essential therefore, that once agreed to, ATM initiatives requiring major upgrades to aircraft, be followed through in accordance with agreed timelines.

Additional considerations

3.7 Equipage decisions are based on return on investment or, in the case of business aircraft, to preserve airspace access. Additionally, aircraft operators, manufacturers and equipment suppliers cannot afford to have a continuous rotation of equipment for modification. Therefore, structured update programmes are necessary.

Ground ATM systems

Impact of changes

3.8 Major changes to the ATM system can be lengthy processes, requiring considerable investment in new infrastructure elements and extensive retraining of ATM staff and flight crew and redefinition of procedures. Furthermore, the impact of changes on aircraft operations vary, regardless of the size of the change from the ATM perspective. For example, replacement of an instrument landing system (ILS) with the same category ILS, or installation of a completely new area control centre (ACC), may have little or no effect on aircraft operations, even if a significant investment was made by the ATM provider. Conversely, an ATS route restructuring based on required navigation performance (RNP) and area navigation (RNAV), or the introduction of reduced vertical separation minimum (RVSM) which may require little investment on the part of the ATM provider, may require major aircraft or avionics upgrades. Similarly, elimination of ground navigation aids along with the introduction of global navigation satellite systems (GNSS) procedures may require aircraft modifications and training of flight crew.

3.9 It is essential therefore, that as well as providing sufficient notice of change, there is adequate coordination to ensure that the requirements for aircraft operation across several States and regions can be accommodated in a timely, efficient and cost-effective manner. This type of coordination also results in a positive return on investment for aircraft operators who equip early to meet the new ATM requirements. Additionally, ATM providers should consider implementing systems that are readily upgradeable over a long period and capable of integrating new and advanced capabilities that may have been at, or even beyond, the limits of predicted evolution at the time of the new systems design. An efficient approach to upgrading ATM capabilities would therefore, be to specify open systems that allow integration of components from a variety of sources over a long period of time.

Long term view

3.10 The development of some new components of the ATM system can be costly requiring at least one major customer. The customer however needs the assurance that the system will be delivered on time and have long term upgrade capabilities. The ATM provider may therefore, wish to take a long term view of the nature of the initiatives that will be introduced and limit their number, for which it is easy to quantify the cost benefits and for which there is a high degree of assurance of success with implementation.

Evolution

3.11 It is possible to produce a generic product to serve certain sections of the ATM system market, but at the level of major systems this is rarely the case. Evolution of new components should therefore, take account of retro-fit or re-use requirements which may impose additional cost pressures on the development of any given system. The development of harmonized initiatives and operational procedures across States and regions would lead to the successful and cost effective implementation of a global ATM system.

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