Organización de Aviación Civil Internacional
Grupo Regional de Planificación y Ejecución CAR/SAM (GREPECAS)
Sexta Reunión del Subgrupo de Gestión del Tránsito Aéreo / Comunicaciones, Navegación y Vigilancia (ATM/CNS/SG/6) - Comité ATM
Boca Chica, República Dominicana, 30 de junio - 4 de julio de 2008

Cuestión 4
del Orden del Día: Cuestiones relativas a la organización del Comité ATM
4.2 Revisión del futuro plan de trabajo del Comité ATM

SEGUIMIENTO A LAS ESTRATEGIAS Y ACTIVIDADES DE IMPLEMENTACIÓN RELACIONADAS CON LOS OBJETIVOS DE LA PERFORMANCE ATM APROBADOS POR GREPECAS

(Nota presentada por la Secretaría)

RESUMEN

Esta nota de estudio presenta a la Reunión un análisis de requisitos de planificación para el Sistema ATM, según los objetivos de performance aprobados por GREPECAS 14.

Referencias:

- Informe de la Decimocuarta Reunión del Grupo Regional de Planificación y Ejecución CAR/SAM (GREPECAS/14), San José, Costa Rica, 16 al 20 de abril de 2007.

Objetivo Estratégico: D

1. Introducción

1.1 Para fines de una eficaz planificación e implantación de las Iniciativas del Plan Mundial (IPM), GREPECAS tomó nota que la Secretaría revisaría los datos contenidos en las tablas de los planes regionales de navegación aérea (ANP), a fin de facilitar la incorporación de las IPM dentro del proceso de planificación y maximizar su utilidad como parte de la base de datos utilizable del ANP. Asimismo, a la luz del concepto operacional ATM y las IPM, la Secretaría revisará los Requisitos de Planificación e implementación. De igual manera, la Secretaria revisará otros elementos de los sistemas CNS y ATM a fin de alinear los programas de trabajo con el Plan Mundial de Navegación Aérea.

1.2 Con este fin, la Reunión CAR/WG/1 formuló su Conclusión 1/1 recomendando que se debería elaborar un plan de acción regional para un sistema ATM sin costuras, tomando en consideración los trabajos elaborados por el C/CAR WG, E/CAR WG y Centroamérica.

2. Análisis

Perspectivas de Sistema ATM Sin Costuras

2.1 Al analizar estar cuestiones, salió a la luz que las cuestiones tecnológicas están dentro de los límites de nuestro conocimiento y entendimiento lo que incluye la normativa y normas que apoyan la infraestructura. Si se pudiese lograr la sincronización en el desarrollo de nueva tecnología en las afluencias de tránsito principales, la implantación de IPM se convertiría en realidad rápidamente. Las 23 IPM tienen una relación directa con el espacio aéreo sin costuras, como se identificó en el Doc 9854- *Global Air Tránsito Gestión Operational Concept*.

2.2 La capacidad finita del espacio aéreo se ha discutido en varias ocasiones como la preocupación principal de la comunidad de la aviación al haber una demanda en aumento de la capacidad y performance de la gestión del espacio aéreo conforme aumenta la cantidad de aeronaves.

2.3 Los objetivos de performance, medición e indicadores en el contexto del sistema general ATM buscan lograr las expectativas de la comunidad ATM. El Enfoque Basado en Performance puede utilizarse para alcanzar mejor dichas expectativas así como mejorar el desempeño de negocio de las aerolíneas, proveedores de servicio, etc. Para lograr esto, se podría identificar las expectativas con respecto a la performance de las operaciones de vuelo, uso del espacio aéreo/aeropuerto y servicios a la navegación aérea en áreas tales como:

- seguridad operacional,
- seguridad,
- impacto en el ambiente,
- relación rentabilidad-eficacia,
- capacidad,
- eficiencia de vuelo,
- flexibilidad,
- predecibilidad,
- acceso y equidad,
- participación y colaboración,
- interoperabilidad.

2.4 Esta evolución y mejora del Sistema ATM estará directamente relacionada con la habilidad de la comunidad ATM para definir claramente sus expectativas de performance, establecer un marco de referencia de performance relevante, establecer metas alcanzables e implementar el cambio de manera eficaz a nivel rentabilidad, con base en las capacidades en cualquier momento particular a través del horizonte de planificación.

2.5 La performance lograble de las expectativas se hace posible a través de:

- servicios y procedimientos,
- recursos humanos,
- infraestructura física
- sistemas y tecnología,
- normatividad y estandarización.

2.6 El Enfoque Basado en Performance puede y debería ser aplicado en cada uno de estos niveles con objeto de comprender el impacto sobre las once áreas de expectativas.

2.7 Toda vez que muchas de las prácticas y procesos para el Sistema ATM continúen a través del horizonte de planificación, el Doc 9882-*Manual on Air Traffic Management System Requirements* refleja esta realidad actual e identifica los requisitos en donde se necesitará un cambio significativo a las prácticas de operación. Los requisitos del Sistema ATM generalmente serán estables en el tiempo, es decir que representan las características/atributos fundamentales requeridos del Sistema ATM.

2.8 El conjunto de requisitos, que aparecen en el **Apéndice** (versión en inglés únicamente) a esta nota de estudio, no pretende ser exhaustivo y es relativamente pequeño comparado con otras fuentes de documentación de requisitos a través del espectro de operaciones previstas en el Doc 9854. Estos requisitos deberían utilizarse por los Grupos de Trabajo así como por los Estados para elaborar estrategias y planes de implementación a niveles regional y nacional.

2.9 La performance del sistema ATM no avanzará solo como resultado directo de los requisitos; más bien el sistema está dirigido a la performance, y los niveles de performance diferirán en respuesta a la demanda de diferentes ambientes operativos, en particular, un Estado, grupo de Estados, o Regiones.

2.10 Los requisitos de performance apoyan a la comunidad ATM al establecer un sistema basado en performance armonizado mundialmente en su servicio, en conformidad con planes regionales y nacionales, pero que concuerde con el Doc 9854.

2.11 Cada declaración de requisito está relacionada con los componentes ATM definidos en el Doc 9854. Estos requisitos también pueden reproducirse directamente o adaptarse a áreas de componentes específicos para que califiquen como requisitos específicos de un componente particular. En muchos casos, se incluye texto aclaratorio para responder a las preguntas que puedan tener los lectores al leer los requisitos.

3. Acción Sugerida

3.1 Se invita a la Reunión a:

a) tomar nota de la información presentada en esta Nota de estudio;

b) identificar los requisitos que representen características/atributos principales requeridos por el sistema ATM en las Regiones CAR y SAM; y

c) proporcionar comentarios para mejorar los objetivos de performance ATM hacia un sistema ATM sin costuras entre las Regiones CAR y SAM.

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APÉNDICE A
ATM SYSTEM REQUIREMENTS

1 PERFORMANCE AND EXPECTATIONS

1.1 General

The Global ATM Operational Concept envisions a system that is service oriented, performance driven and predicated on the guiding principles described in the OCD (Global Air Traffic Management Operational Concept, Doc 9854).

To fulfil this vision, the ATM system shall:

a. Ensure that performance forms the basis for all ATM system development;

b. Treat performance as a whole, that is, considering all the ATM community expectations and their relationships;

Explanatory Text: The holistic treatment of performance should be done by means of a system performance approach resulting in performance cases. A performance case can be seen as the combination of the various cases that together address and balance all areas in which the ATM community has expectations e.g., the safety case, together with the business case, together with the environment case, etc.

c. Ensure the establishment of performance cases (safety, business, environmental, etc.) before implementing changes;

d. Ensure that performance targets are defined, regularly reviewed and monitored;

e. Establish interchange of global benchmarking performance data as a cornerstone of ATM system management;

f. Ensure that all information for performance management is available to the concerned parties transparently and that information disclosure rules are in place;

g. Ensure that any performance management system establishes rules for, among other things, performance measurement, performance maintenance, performance management, and performance enhancement;

h. Establish Quality of Service requirements to support provision of services within the ATM system;

i. Ensure that Quality of Service includes performance requirements related to availability, continuity, reliability and integrity; and

j. Balance the expectations of the ATM community.

Explanatory Text: The ATM system will consider the trajectory of a vehicle during all phases of flight and manage the interaction of that trajectory with other trajectories or hazards to achieve the optimum system outcome with the minimal deviation from the user-requested flight trajectory, whenever possible. The ATM system will provide seamless service to the user at all times and will operate on the basis of uniformity throughout all airspace. Uniformity embodies both application of common ATM system rules and procedures across all airspace and use of common core, technical functionality in the systems used.

It is not intended that this will establish an all-embracing requirement for identical equipment or systems, although minimizing system duplication or reducing equipment or systems needed to operate in a global ATM system environment is an obvious goal.

It is intended that agreed required minimum levels of aircraft equipment, performance, and ATM system network capabilities will be matched by defined levels of service. It is intended that the ATM system should provide all users, at a minimum, the same level of access to runways and airspace when compared to a regionally agreed baseline year.

1.2 Safety

Safety is a key and constant performance expectation of the ATM system. To meet this expectation, the ATM system shall:

a. Be based on the principle that the safety of the ATM system, or its components and parts, is evidence based;

b. Define common safety indicators to be used by all States;

c. Ensure that safety data will be recorded, processed, and analyzed centrally within a State, region, or group of States, taking into account the experience of existing State incident reporting schemes; furthermore, safety data will be shared globally;

d. Ensure a consistent approach to the collection, evaluation and review of safety-related data, including the understanding of causes and effects that can be applied over time and across segments of the community for the purpose of making informative comparisons;

Explanatory Text: This does not mean that all community members use the same approach but rather, that they can communicate by sharing a wide, diverse, and yet common set of models, assumptions, definitions, and so on.

e. Support system safety with lead indicator and causal factor analysis, in addition to traditional lag indicator statistical analysis in the ongoing monitoring of safety;

f. Ensure application of the System Safety Approach to all life-cycle phases of the ATM system and its elements, supported by Safety Cases;

g. Ensure that all safety practices and processes are explicit and that they comply with the safety requirements and standards of ICAO, state regulatory and other appropriate parties;

Explanatory Text: ATM system performance requirements should be based on the key understanding that the ATM system is a collective integration of parts, including, humans, information, services and technology. When contemplating or undertaking a change to a particular part of the ATM system, whether at the local, State, regional, or global level, one must give due consideration to the potential effect on adjacent parts of the system through a safety case. The decision regarding the level of assessment will be made pragmatically, but transparently. In establishing safety management systems, determining safety targets, and in conducting safety cases, the accumulated effect—in addition to the individual effects— on safety of those parts should be taken into account.

h. Ensure that ATM system safety is maintained during any transition;

i. Establish contingency plans at all levels of operation to deal with anomalies/disruptions and to ensure safety and appropriate level of operations;

j. Be designed so that the operation and continued evolution of the ATM system incorporates mechanisms so that information and/or actions concerning emergency and/or unexpected events involving any of the airborne or ground-based ATM community members can be communicated to all ATM system participants who need to respond to or be aware of the event or actions;

Explanatory Text: An enhanced capability will be provided to disseminate information regarding emergency situations to appropriate ATM community members so that the necessary response actions and intervention can be initiated more effectively.

k. Accommodate the determination of levels of safety and risk which may be expressed in various manners;

Explanatory Text: There is no single and universally valid way of expressing the level of safety or risk. It is however desirable to express safety and risk in a manner that provides reference over time despite system changes.

l. Ensure that the target level of safety is the minimum level of safety to be achieved;

Explanatory Text: The ATM system recognizes that absolute safety cannot be achieved; however, it should always be a desired goal. In the evolution of the ATM system, safety targets will be established reflecting a continuing desire to improve current levels of safety. In setting safety targets from time to time, each organization, State, region, or global group should generate a better safety outcome than the previous target within practicable limits; that is, all components of the ATM system should strive to reduce incidents and accidents and increase positive safety indicators.

m. Recognize that there are three safety risk bands: intolerable, As Low As Reasonably Practical (ALARP), and broadly acceptable;

Explanatory Text: *The safety industry generally recognizes that there are situations in which the continuous range of possible levels of safety cannot be divided into only two bands, "intolerable" and "broadly acceptable". There is a third, intermediate region between these two levels. Where such an intermediate region exists, the question becomes how to make decisions if the level of risk falls within that region. To make such decisions, the safety industry generally uses the so-called ALARP. This means that measures to reduce risk must be taken until the cost of further risk*

reduction would be grossly disproportionate to the reduction in risk that would be achieved; hence, the "ALARP region".

n. Ensure that safety risk is calculated with scientific rigor, however accommodate the determination of safety risk acceptability by value judgement;

Explanatory Text: A distinction should be made between both activities (safety risk calculation and acceptability determination) and their respective boundaries and logic.

o. Be designed so that the human is never in doubt as to the ongoing status of the ATM system or the flight environment as appropriate to the human task undertaken; and

p. Be designed so that collision avoidance systems remain a safety net independent from separation provision.

1.3 Security

Performance of the ATM system depends on security related to both the internal elements of the ATM system—including personnel, infrastructure, and data—and the external expectations of the broader community, including national security interests. To meet these expectations, the ATM system shall:

a. Be based on the principle that the operation of the ATM system will not compromise the sovereignty of any State;

b. Ensure appropriate levels of security;

c. Recognize that the requirements associated with security may vary from time to time and according to location; and

d. Coordinate these requirements through strategic, pre-tactical and tactical collaborative decision making to allow agreed performance parameters to be met by ATM system partners.

1.4 Cost-Effectiveness

To meet the expectations of the ATM community regarding cost-effectiveness, the ATM system shall:

a. Ensure that where they are required, validation and cost-benefit analysis[1] are achieved through focused research and development and establishment of business cases[2] prior to implementation of the changes.

1.5 Access and Equity

To meet the expectations of the ATM community regarding access and equity, the ATM system shall:

a. Ensure that, in the design of the ATM system, the principles of access and equity are taken into account;

b. Be designed to accommodate all types of airspace user missions and all types of vehicles and associated characteristics; and

Explanatory Text: Any type of user mission will be accommodated, and an appropriate type/level of service will be provided. Different types of mission will- or may have- different planning horizons. The ATM system will accommodate and be able to handle different planning horizons.

It is intended that the ATM system will be able to accommodate a wide variety of vehicles, with a similarly wide variety of characteristics and capabilities, not only based on current knowledge, but also for the evolutionary future. The expectation is that these new types of vehicles, characteristics, and capabilities should be accommodated in a manner that achieves the optimum system outcome with minimal deviation from the user requested flight trajectory when they may appear in the future.

It is expected that unmanned aerial vehicles will be operated either remotely by a human operator or execute their pre-programmed mission automatically, and that some vehicles may not be able to dynamically change their trajectory. It is intended that the ATM system will accommodate such pre-programmed missions after strategic collaboration.

It is intended that the ATM system will provide services according to the maximum level of vehicle capabilities.

c. Be designed to minimize restriction of access to airspace.

1.6 Capacity

To meet the expectations of the ATM community regarding capacity, the ATM system shall:

a. Provide the collaboratively agreed level(s) of capacity;

b. Ensure that sufficient capacity is provided through Collaborative Decision Making (CDM);

c. Ensure that the ATM community works collaboratively to plan and implement the capacity needed to cost-effectively meet the forecast demand;

Explanatory Text: Through collaboration, ATM community members will determine the appropriate investments and associated commitments to make available the desired capacity of ATM system resources. The investments and commitments include those by both users and service providers. (e.g. "matched" commitments include infrastructure deployment by service providers and equipage or training.)

d. Ensure that all available capacity is fully and efficiently used; and

Explanatory Text: The intent is not to create capacity for its own sake, but to ensure that the available capacity is efficiently used given existing demand.

e. Minimize the impact of adverse weather on the total ATM system, so as to ensure that maximum throughput is generated in all meteorological conditions.

1.7 Environment

Environmental considerations are increasingly important in ATM system design, and will continue to be so through future development of the ATM system. To meet the expectations of the ATM community regarding environment, the ATM system shall:

a. Ensure that environmental issues are considered in the design, development, and operation of all aspects of the ATM system;

b. Establish and monitor agreed environmental performance targets to ensure that the expectations of society for the aviation industry contribute to the reduction of impacts on the environment, including noise, gaseous emissions, and effect on the amenity of particular areas is met; and

c. Facilitate collaborative decision making between the appropriate community members and appropriate environmental authorities to ensure that an appropriate balance exists between the need to mitigate the effects of the ATM system on the environment and the economic benefit to States derived from operation of the ATM system.

Explanatory Text: ATM system components and the ATM community, when agreeing performance targets, will consider measures that will not only contribute to a sustainable environment from a purely ATM system perspective, but also in the context of the complete transport value chain as imposed on the ATM community.

1.8 Predictability

To meet the expectations of the ATM community regarding predictability, the ATM system shall:

a. Ensure that ATM community members provide past, current, and predicted information as required by the system for predictability of services; and

b. Provide the ATM community with data essential to the planning of their operations.

1.9 Community Participation

To meet the expectations of the ATM community regarding community participation, the ATM system shall:

a. Be designed in such a way as to ensure that all pertinent ATM community members are included in relevant CDM and have easy access to the associated necessary information.

1.10 Flexibility

To meet the expectations of the ATM community regarding flexibility, the ATM system shall:

a. Implement and operate in such a way that the varying and diverse user requirements will be met as closely as technically possible within the defined equity and access; and

b. Enable all airspace users to adjust departure and arrival times and modify flight trajectories dynamically, where necessary renegotiating trajectory agreements, thereby permitting them to exploit operational opportunities as they occur.

1.11 Efficiency

To meet the expectations of the ATM community regarding efficiency, the ATM system shall:

a. Address the operational and economic cost-effectiveness of gate-to-gate flight operations from a single-flight perspective; and

Explanatory Text: Airspace users want to depart and arrive at the times they select and fly the trajectory they determine to be optimum in all phases of flight.

b. Modify the airspace user's preferred trajectory:

i. when required to achieve overall ATM system performance requirements; and/or

ii. collaboratively with the airspace user, in a manner that recognizes the airspace user's need for single-flight efficiencies.

1.12 Global Interoperability

To meet the expectations of the ATM community regarding global interoperability, the ATM system shall:

a. Be based on global standards and uniform principles, ensure the technical and operational interoperability of ATM systems and facilitate homogeneous and nondiscriminatory global and regional traffic flows; and

b. Establish common operational procedures within similar operational environments.

2 INFORMATION MANAGEMENT AND SERVICES

2.1 Information Services

Managing information and providing information services are critical to the development of the ATM system envisioned in the OCD. These activities ensure cohesion and linkages between the various ATM components described in the OCD as well as performance expectation areas described in previous sections of this document. To meet the expectations for the ATM system regarding information services, the ATM system shall:

a. Implement system wide information management;

b. Provide a global, common aviation data standard and reference system to allow fusion and conflation and provide comprehensive situational awareness and conflict management;

c. Establish information exchange protocols and procedures to ensure that appropriate performance can be achieved within the agreed rules;

Explanatory Text: These "agreed rules" would be determined through collaborative decision making.

d. Provide to the ATM community accredited, quality-assured, and timely information meeting the identified standards of performance, including quality of services;

Explanatory Text: It is essential that information does not change character or value as it travels through various systems. It is assumed that information may be combined, segregated, or reformatted in accordance with the needs of the end user; however, the content (i.e., character, data values, and so on) should not change the context (the environment from which the information originated). In summary, received information content is exactly the same as the information from the originator.

The differences brought about by evolution in technology are not expected to have any impact on the efficient transmission of the information among the ATM community members. The requirements of seamlessness and interoperability dictate that systems— whether proprietary or not—conform to openly available standards regarding the format and character of transmitted or transferred information. It is intended that there will be development of fully interoperable information systems capable of seamless information transfer throughout the ATM system.

e. Provide information systems that identify the nature of the information in terms of timeframe - historical, current, or planned;

f. Ensure that a relevant validity period of ATM system information is evident to the user of that information;

Explanatory Text: Information that is expected to change over short intervals must have a validity period that is evident to the user of the information. Conversely, information elements that are not expected to change except after system design changes should not need to be repeated at short intervals. The information management system is expected to explicitly reveal the validity period for the demanded information.

g. Be capable of collecting and integrating information from diverse sources to produce a complete and accurate view of the ATM system state;

Explanatory Text: The originator of information is the ATM community member at the first point of entry where the information can be acquired. To ensure that the information is properly accredited and a quality assurance framework is in place, the responsibility for timely acquisition of information meeting quality parameters must rest with the ATM community member closest to the information event. The intention is that there will be tracking and quality assurance mechanisms that will ensure the integrity of information through transfer as well as through developing compliance mechanisms for information quality standards.

h. Support a reduction in transactional friction for transmission of information across systems;

Explanatory Text: Information management systems will be capable of collecting, storing, and aggregating vast amounts of information from, and for use by, ATM community members. It will be necessary to ensure that information needs are legitimate and validated to allow for transparent access to information without being compromised by confidentiality and proprietary interests. Any restrictions on information access should be identified and mechanisms developed and employed for resolution based on balancing access against the legitimate needs of users.

i. Assemble the best possible integrated picture of the historical, real-time, and planned or foreseen future state of the ATM system situation and relevant, quality-assured and accredited information shall be made available to the ATM system;

j. Ensure that the airspace user makes available relevant, operational information to the ATM system;

k. Use relevant, airspace user operational information to optimize flight operation management;

l. Use relevant data to dynamically optimize 4-D trajectory planning and operation;

Explanatory Text: The global exchange of information (from individual aircraft performance to ATM system resources) will allow full use of 4-D trajectory management/operation. The 4-D trajectory management optimization may be a function of either ground or air systems or both.

m. Provide the status of ATM system resources;

Explanatory Text: The ATM system will monitor the status/availability of all resources within the system and make them readily available, within security constraints, so that entities, operators, or agents may use the information to their best advantage in support of their operational objective. For example, based on ATM system resource reports, an operator whose objective is to perform photographic land survey is able to amend its work schedule in response to changes in the availability of specific airspace or navaids necessary for the mission. (Since the activity is linked to the physical surface, the option of negotiating another route to avoid the resource limitation is not available, but the operator's work plan, under its control, is amended at the operator's discretion. That is, the activity day/date is amended.)

n. Make available to the ATM system flight parameters and aircraft performance characteristics;

o. Establish standards for meteorological model accuracy and resolution and agree performance requirements;

p. Provide timely access to all relevant meteorological information; and

Explanatory Text: It is expected that within the constraints of authorized access, the ATM community will be permitted to obtain the information required for the discharge of responsibilities. For example, it is expected that historical meteorological data will be available for strategic planning, preplanning, and tactical planning.

q. Utilize meteorological data, and information derived from it, to assist in analysis and evaluation of agreed environmental performance targets.

Explanatory Text: It is expected that increasingly more accurate and timely meteorological and climatological information and analysis material will be available to the ATM community. This information will be increasingly integrated strategically with historical aircraft performance and other data, and tactically with meteorological data from onboard sensors and "down-linked" actual aircraft performance parameters and other data. The enhanced information will allow appropriate members of the ATM community to:

- *Predict environmentally optimum trajectories, which, when integrated with other operational factors, will allow generation of ATM system optimum trajectories (this includes use of dynamic wake vortex spacing), including monitoring of execution;*
- *Facilitate operations of aircraft along environmentally optimum trajectories;*
- *Allow establishment of pragmatic environmental performance targets; and*
- *More accurately measure and report the effect of air operations on the environment.*

2.2 Collaboration

To meet the expectations for the ATM system regarding collaboration, the ATM system shall:

a. Ensure that ATM system design, development, implementation, and operation are determined by collaborative decision making, system safety, and system wide business cases;

b. Ensure that decisions affecting the evolution of the ATM system are made in consultation with all affected ATM community members;

c. Ensure that the airspace user community is able to participate in collaborative decision making;

d. Ensure mutual exchange of relevant and timely data:
– for the benefit of situational awareness;
– for conflict-free trajectory management; and
– to allow collaborative decision making concerning consequences of airspace user system design changes; and

Explanatory Text: Increased data sharing between all members of the ATM community will enhance both situational awareness and conflict management. This means that both Airspace Users and Service Providers should be able to develop their situational awareness and conflict management tools making full use of appropriate exchange of data. The intention is to make available, to each ATM system user, comprehensive information to support situational awareness and subsequent decisions based on the user's location in real time.

e. Employ collaborative decision-making to reconcile differences between information needs and the availability of, or access to, information.

Explanatory Text: It is essential that the information needed by an ATM community member to fulfil an ATM system function is acquired and disseminated for use by that member. It is intended that individual ATM community members will be able to access the information relevant to their specific needs.

3 SYSTEM DESIGN AND ENGINEERING

Consistent and coherent system design and engineering is critical to achieving the performance expectations; the ATM system shall:

a. Be based on common global standards and procedures;

b. Be based on elements that ensure global interoperability;

Explanatory Text: The expectation is that ICAO will, in a timely manner, be responsible for adoption/approval of SARPs and PANS in order for the ATM community to progress the evolution of the ATM system.

c. Utilize systems standardized at a functional level; and

d. Incorporate interoperability during the design of any changes to ATM system.

3.1 Interoperability, Seamlessness, and Infrastructure

To meet the expectations for the ATM system regarding interoperability, seamlessness, and infrastructure, the ATM system shall:

a. Establish a global ATM system vocabulary with a well-defined form (syntax) and meaning (semantics) such that each participating entity in the exchange will be able to interpret the information provided in precisely the same way. In this context, information is considered to encompass voice, text, data, and imagery elements;

Explanatory Text: Interoperable and seamless global ATM system capability cannot be achieved through application of agreed technical requirements alone; they must also be addressed at the institutional and operational levels.

b. Ensure that each participating ATM community entity in any transaction uses the global ATM system vocabulary to describe the ATM services that they provide within their area of service provision;

c. Ensure that each participating ATM community entity provides a means for other participating entities to identify and access its services. The means for determining and accessing service shall be based on a common description framework and associated method(s) that the participating entities can use to facilitate the introduction and transition to new technologies;

d. Ensure that the communication media/protocols used to support interoperability— in both determining and providing services across discontinuities—are agreed in conformance with internationally approved, open and non-proprietary standards. That is, the specification of the media/protocols and their operational performance must be freely available;

Explanatory Text: The specific call for use of open, non-proprietary standards will apply to their use regionally or globally. It is not intended to preclude the notion of agreements between a limited number of service providers that may rely on "closed" or proprietary mechanisms separate from the global standards—provided that they impose no cost or other burden on those not party to the specific agreement.

e. Ensure selection and adoption and, where necessary, the development of interoperability standards and related materials that enable mutual exchange of relevant and timely data; and

Explanatory Text: The expectation is that the ATM community will be responsible for selection and, where necessary, the development of candidate global standards (and related material) on interoperability for the ATM system. However, given that the ATM community will rely on these standards (and related material) to progress in the evolution of the ATM system, and given that the proliferation of standards (and related material) may impact performance, the expectation is:

(a) that only some of the candidate standards (and related material) will become ICAO Standards (and related material, such as, Recommended Practices, procedures, guidance material, etc.); and

(b) that the selection process will be based on the ICAO processes.

f. Provide a collaboratively agreed minimum notice period in which a State or region intends to change or withdraw existing infrastructure and/or services.

Explanatory Text: Continuity of service provision requires strategic agreement on facilities and services. Significant investments are made to achieve continuity—they must be protected.

3.2 Human Design and Automation

To meet the expectations for the ATM system regarding human design and automation, the ATM system shall:

a. Give due consideration to the interaction of humans and technology; for example, the "human machine interface" in design of the ATM system or its parts;

b. Demonstrate this consideration in the safety analysis accompanying the system design;

c. Guard against the potential to create a safety hazard by information overload; and

Explanatory Text: The human is an essential part of the ATM system. Both in the aircraft and on the ground, the role of the human is to manage the system and supervise control functions. It is intended that in the design of the ATM system or its parts, due consideration will be given to factors that affect human performance, human roles and responsibilities, and the potential for errors so that automation shall be seen as supporting areas of human weakness and complementing areas of human strength.

d. Use automation collaboratively where deemed appropriate to achieve the ATM system performance targets.

3.3 Spectrum

To meet the expectations for the ATM system regarding spectrum, the ATM system shall:

a. Ensure that in supporting ATM system expectations, the developers of telecommunications systems ensure that harmful interference will neither be caused by, nor received from, other authorized users;

b. Establish and maintain frequency and spectrum allocation and management assistance programmes; and

c. Provide frequency and spectrum management assistance to all new and existing programmes to ensure that national and international standards are complied with and that no new items of equipment are introduced that would interfere with existing systems.

Explanatory Text: Formal programmes will be established to ensure that frequency and spectrum development activities for new systems being conducted by States are compatible with current

and projected use by national and international aviation interests. Frequency allocation proposed for new transmitting and receiving equipment at a site should be coordinated to ensure electromagnetic compatibility with existing systems present or planned for that site. Coordination with external (non-aviation) agencies is required to prevent electromagnetic compatibility problems and resolve out-of- band interference problems with other new or existing national or international systems.

3.4 Aircraft Design

The aircraft is a key element of the ATM system. The aircraft should be totally integrated in the collaborative decision making of the airspace user operation, and its design should allow it to comply with all relevant ATM system requirements. To meet the expectations for the ATM system regarding aircraft design, the ATM system shall:

a. Make the best use of aircraft capabilities;

Explanatory Text: ATM system design will be capable of fully exploiting flight deck systems and aircraft design.

b. Ensure that the interrelationship and the interdependencies of aircraft design with ATM performance is a key consideration in aircraft design; and

Explanatory Text: The design of an aircraft to provide maximum efficiency of ATM system operation relates to the performance in specific areas; the notion of design for overall effectiveness relates to the effect of the aircraft across a range of performance areas to enhance total system performance. In this case, there may be tradeoffs between an aircraft's overall effectiveness and its ability to provide maximum efficiency in one particular area.

It is expected that aircraft design will:

- *Reduce the occurrence and/or effect of wake vortexes;*
- *Take into account environmental considerations such that noise and emissions are reduced;*
- *Enable aerodrome operation without requiring changes to the infrastructure; and*
- *Facilitate cooperation and integration with the ATM system through the flight deck, including avionics and overall aircraft system design.*

The design of the ATM system will reflect the business case process described in the OCD. Cost-benefit assessments should consider the effects of the proposed changes at an overall level, and for the typical main groups of interests, to ensure that the changes proposed are both viable and affordable. ATM system design will be capable of fully exploiting flight deck systems and aircraft design.

c. Ensure that aircraft capabilities will be totally integrated in the collaborative decision making process of the ATM community and allow them to comply with all relevant ATM system requirements.

Explanatory Text: Flight crews are deeply involved in the ATM system, in addition to traditional aircraft handling. It is intended that flight deck design should enable better integration with the total ATM system.

4 ATM SYSTEM COMPONENTS

4.1 Airspace Organization and Management

Airspace organization establishes airspace structures to accommodate the different types of air activity, volume of traffic, and differing levels of service. Airspace management is the process by which the airspace options are selected and applied to meet the needs of the ATM community. To meet the expectations of the ATM system deriving from airspace organization and management, the ATM system shall:

a. Recognize that operation of the ATM system will not compromise the sovereignty of any State;

b. Establish agreements to ensure that sovereignty of airspace is respected without imposing inefficiencies on ATM airspace management;

Explanatory Text: ATM system services will be provided supra-State or extra-State, in whole or in part, subject to agreement of the appropriate authority within the State or States concerned.

c. Define, through collaborative decision-making, airspace structures and procedures to accommodate all types of air activity;

d. Utilize the collaborative decision-making process across state boundaries to support homogeneous traffic flows and seamless airspace;

Explanatory Text: Airspace should be organized to be simple and easily understandable.

e. Ensure that airspace users are included in all aspects of airspace management via the collaborative decision-making process;

f. Recognize that airspace will be managed on the basis of flexible allocation;

g. Recognize the principles of access and equity in the organization, flexible allocation, and use of airspace;

h. Manage airspace dynamically and flexibly based on services demanded;

i. Recognize that any restrictions on airspace availability will be minimized, and none will be permanent;

Explanatory Text: All ATM system users will be able to present a safety, business, or personal outcome requirement for use of the airspace, increasing information flow and ability to manage use of all airspace efficiently and effectively. More efficient and transparent ATM system user objectives will be achieved and made known to the system. The principles of access and equity will be realized in a practical way.

j. Adapt airspace organizational boundaries, divisions, and categories based on traffic patterns, changing situations, and unplanned requirements, supporting efficient operation of the other ATM services while not being constrained by national or facility boundaries;

k. Allocate volumes that enable safe and efficient trajectory allocation and modification, from strategic to tactical;

l. Manage all airspace, and where necessary, shall be responsible for amending priorities relating to access and equity that may have been established for particular volumes of airspace. Where such authority is exercised, it shall be subject to rules or procedures established through collaborative decision-making;

Explanatory Text: It is accepted that certain volumes of airspace may be established to meet certain ATM system user expectations, including security (or national interest). This may be deemed the primary use. Where that primary use is not operationally required, the ATM system should provide access to those members of the ATM community who were subject to access restriction, until prioritization is required again. It should also be accepted that there will be situations in which priority access is required in response to abnormal operations, such as emergency situations or deviations around severe weather.

m. Accommodate mixed equipage without unduly constraining the primary use of a given volume of airspace;

n. Determine through collaborative decision-making the level of service for a particular airspace volume, whether determined strategically, pre-tactically, or tactically;

o. Facilitate, as feasible, provision for tactical or pre-tactical approval of preferred routing or re-routing in those areas where approvals are required for civil or State aircraft to operate over, into, or from a particular State;

Explanatory Text: Currently, many States require significant advance notice before approving overflight; this is particularly true of State aircraft operations. The information-rich environment of 2025 should render such restrictions redundant. Additionally, the ATM system should enable enhanced civil and military cooperation and coordination regarding airspace usage and ATM services. Furthermore, it should support models where the military ATM services are already integrated into the civil ATM services.

p. Operate on the principle that all airspace is the concern of the ATM system and is a usable resource, and any restriction on the use of any airspace will be considered transitory; and

q. Operate on the principle that all airspace will be managed and all related activity within airspace will be known to the ATM system to the degree necessary to meet performance expectations.

4.2 Aerodrome Operations

As an integral part of the ATM system, the aerodrome must provide the needed ground infrastructure including, *inter alia*, lighting, taxiways, runways, and precise surface movement guidance to improve safety and to maximize aerodrome capacity in all meteorological conditions.

The ATM system will enable the efficient use of the capacity of the aerodrome airside infrastructure. To meet the performance expectations of the ATM system stemming from aerodrome operations, the ATM system shall:

a. Provide a facility and/or procedure, as required, to monitor or manage aircraft operations safely and expeditiously within the confines of the aerodrome and its immediate surroundings;

Explanatory Text: In considering the need for a service facility, such as a control tower, careful thought should be given to the volume and complexity of traffic. Where required, such facilities should enable direct or individual visual monitoring and/or control. However, increasing needs for (vertically) higher visual control rooms to enable direct sighting requirements may lead to alternative methods of surveillance or control. Cost efficiency of services may also become an influencing actor. This may lead to implementation of procedures, such as pilot autonomy (e.g. self-separation) rather than establishment or refurbishment of a facility.

b. Provide collaboratively agreed aerodrome capacity;

Explanatory Text: At all aerodromes, a commonly/collaboratively agreed-to target level of safety will be established, which is subsequently non-negotiable by an individual party. It must be accepted that though performance may be measured on an individual basis, the relationship between each aerodrome will result, by necessity, in a compromise. Performance criteria may be established at the regional or local level; however, consideration should be given to aerodrome performance impact on the ATM system as a whole. The freedom of the performance level to termination per aerodrome may be constrained by the performance level of the overall ATM system. It may be easier to consider aerodrome operations within an "en route-to-en route"[3] perspective in determining its role within the ATM system.

It is intended that sufficient airside infrastructure be provided so as to optimize the efficiency of the ATM system and provide predictability.

c. Ensure through collaborative decision-making, that the most effective means of surface management are employed to respond to demand;

d. Ensure that the position and intent of all aircraft and vehicles operating on the movement area are precisely determined;

Explanatory Text: Precise surface movement guidance will be required in all conditions. This may not necessarily be met by high-level technology but should be appropriate to the operations (i.e. traffic volume, complexity of traffic movements, traffic mix and so on). Information on the position, to an appropriate level of accuracy, and intent of all aircraft and vehicles operating on the ground will be available to the appropriate ATM community members. Any activities that take place on the movement area can have a direct influence on the ATM system.

e. Ensure that the aerodrome community, including emergency and essential services, provide and receive relevant information in order for dynamic, tactical, and strategic decisions to be made;

f. Ensure that flight parameters and aircraft performance characteristics are available to the ATM system;

Explanatory Text: As is the case across the whole ATM system, in relation to aerodrome operations, the availability and exchange of information will facilitate management by trajectory. It is expected that the collaborative exchange process and respective facilities will allow for efficient management of air traffic flow through use of information on a system wide basis of air traffic flow, weather, and assets. This process will also allow, for example, allocation of entry/exit times for aerodromes and subsequent dynamic changes to mitigate for any imbalance.

g. Determine through collaborative decision-making, suitable aerodrome facilities to enable efficient maintenance of capacity in all meteorological conditions;

h. Support the same throughput in all meteorological conditions at aerodromes where benefits can be demonstrated;

Explanatory Text: *Planned ATM system optimum throughput should be maintained through meteorological conditions that do not present safety limitations and have been agreed by the affected ATM community members.*

i. Consider environmental issues in design, development, and operation of the aerodrome;

Explanatory Text: The aerodrome operations through the ATM system should contribute to the protection of the environment by considering all environmental impact areas to the extent that safety is not compromised.

It is expected that in the design of terminal area procedures, responsible authorities will work closely with local agencies to mitigate, to the extent possible, the effect of aviation on communities living within the terminal area of an airport. In so doing, all parties should strike an appropriate balance between the need to mitigate the effects of aviation on the environment and the significant economic benefit to States of promoting a healthy aviation industry.

It is expected that airspace users, in determining and executing user-preferred trajectories, will incorporate requirements to ameliorate unnecessary gaseous emissions. The ATM system should recognize and accommodate such trajectories wherever practicable to reduce environmental impact.

Meteorological information, both current and forecast, will be an important contributing factor in managing environmental issues. It is expected that while aerodrome operations will not be responsible for determining environmental constraints, they will comply with local and national requirements.

As one of the sources of environmental pollution, aerodrome layouts and operations will through collaboration alleviate environmental concerns. (For example, reduction of holding will assist aerodromes in complying with emission controls as will the reduction in taxiing times.)

j. Establish, through strategic, pre-tactical, and tactical collaborative decision-making, processes for facilitating throughput of passengers and/or cargo and freight at airports that will allow agreed performance parameters to be met by the ATM system partners;

Explanatory Text: It is expected that landside operations will become an integral part of this process. Although not directly part of the ATM system, landside operations will have an impact on aerodrome operations, and a downstream effect on other parts of the ATM system. Data on such areas as modal transportation systems, customs, security, baggage handling, fuel supply, and so on, shared through collaborative information exchange, will optimize operations.

Real-time data, together with system trends and forecasts, fused with a range of automated decision support or decision making tools, will enable optimization of services. A common understanding of needs and capabilities of all parties will instigate a better response to a given situation. Gate management will benefit from the ability to tactically and collaboratively modify sequences to optimize aerodrome operations. It is expected that those ATM community members interfacing with landside operations will manage/mitigate the effects of landside operations so that impacts on the ATM system are minimized or eliminated.

k. Ensure appropriate levels of security, recognizing that security is most visible in the aerodrome environment and that the requirements associated with security may vary from time to time and according to location;

Explanatory Text: It is expected that increasingly, law enforcement agencies will require flight identification and trajectory data as well as general information concerning traffic at aerodromes. Data exchange will be subject to agreement among interested parties and may be influenced by commercial and regulatory factors. It is noted that, in some instances, access to certain areas may be restricted to only those who are willing to provide a minimum level of information (e.g. specific aircraft flying into certain aerodromes and airspaces).

l. Establish procedures reducing any need for departing or arriving aircraft to spend ground time holding for services with engines operating; and

m. Establish procedures to accommodate arrivals without aircraft having to enter airborne holds for aerodrome service accommodation as a routine.

4.3 Demand and Capacity Balancing

Demand and capacity balancing will strategically evaluate system-wide traffic flows and aerodrome capacities to allow airspace users to determine when, where and how they operate, while mitigating conflicting needs for airspace and aerodrome capacity. This collaborative process will allow for the efficient management of the air traffic flow through use of information on system-wide air traffic flows, weather and assets.

To increase service predictability, maximize capacity utilization, and achieve collaboratively agreed performance targets for the ATM system in those areas to which the ATM system component of Demand and Capacity Balancing contributes, the ATM system shall:

In relation to the Provision of Information

a. Provide timely and accurate information regarding projected demand and capacity levels;

b. Facilitate, as appropriate and on request, conduct of capacity and demand projections, and make the results of that analysis available to the ATM service delivery management function; and

c. Facilitate provision of ATM system demand and capacity projections to relevant ATM community members for up to an agreed/specified time in advance.

Explanatory Text: In relation to the provision of information for demand and capacity balancing (DCB), the ATM system will be capable of projecting the current and future capacity of, and demand on, specified operating sectors or airspace volumes or routes/route segments using all available data and information. This includes the actual and forecast meteorological conditions, navigation equipment operational status, aerodrome operational status, runway configuration, and aircraft performance characteristics.

The ATM system will also monitor and use information pertinent to demand projections, including, stored flight plan information, filed flight plan information, aerodrome operational status, historic demand profiles, scheduled special events, and military operations.

In relation to Access to Information

d. Provide timely access to all relevant information, including meteorological information; and

e. Provide all users the same level of access to collaborative decision-making concerning ATM resources, realizing the diverse need to balance the expectations and interests of all members of the ATM community in achieving equity and access.

In relation to the Use of Information

f. Facilitate collaboration on projections and responses regarding demand, capacity, predictability, capacity utilization, and cost-effectiveness;

g. Utilize historical and forecast meteorological information, including seasonal pattern and major meteorological phenomena;

h. Use information on changes in infrastructure status to increase predictability and maximize capacity utilization to meet performance targets;

i. Ensure collaboration on post-event analysis to support strategic planning;

j. Utilize projected traffic demand and planned trajectories;

k. Accommodate revisions to trajectory requests and resources status;

l. Ensure collaboration on projections and responses;

m. Facilitate collaboration on trajectory changes and traffic demands; and

n. Consider current and predicted airspace conditions and projected demand as well as past performance.

Explanatory Text: In relation to use of information for DCB, it is intended that within the constraints of authorized access, the appropriate ATM community members will be permitted to obtain as much of the information required to perform their responsibilities.

For example, it is intended that historical meteorological data will be available for strategic planning of long-term capacity and demand balancing. This will be coupled with predicted and current meteorological information to facilitate determination of the level of demand and effect on capacity.

It is intended that tactical information from onboard sensors will be integrated into the data stream. Where there is a conflict regarding access to information, it is expected to be resolved within the Service Delivery Management function.

It is intended that strategic evaluation of available information—including system wide traffic flows, aerodrome capacities and active runways, meteorological information, and flow management information—will facilitate determination by airspace users of when, where, and how they operate. It is intended that collaborative use of common data, information, and decision support tools will:

- *Ensure the most efficient use of all available and potential resources;*
- *Provide the greatest possible access to aerodrome services*
- *Provide equitable access for all airspace users;*
- *Accommodate user preferences; and*
- *Ensure that demand on an aerodrome and other services will not exceed its capacity.*

In relation to provision of service

o. Provide a capability to meter traffic to achieve a balance between traffic demand and capacity of the ATM system;

p. Establish a collaborative process to allow for efficient management of the air traffic flow through use of information on system wide air traffic flow, weather, and assets;

q. Utilize system wide balancing techniques to collaboratively resolve local demand and capacity balancing problems; and

Explanatory Text: In relation to providing services for DCB, while principles of access and equity will apply throughout the ATM system, it is intended that operators of an aircraft not being compatible with the majority of users in a given operational scenario will not be granted the right of equity and access without due consideration of the impact on the performance of the ATM system as a whole. It is intended that arbitration of access and equity issues, at least at a tactical level, will be conducted through the Service Delivery Management function.

It is intended that the Demand and Capacity Balancing function within the ATM system will support the Service Delivery Management function in conducting strategic planning- (e.g. airspace, optimal staffing, and routing); pre-tactical planning- (e.g., adjust staffing, forecast initiatives [fine-tune routing, etc.]; airspace user schedule adjustments); and tactical planning- (e.g., flow initiatives [rerouting, sequencing, and spacing of aircraft, etc.] and airspace user schedule adjustments), all based on forecast and known demand and capacity and analysis of historical performance data.

It is intended that with increased reliability of and access to information, potential saturation of airspace or aerodromes will be predicted sufficiently in advance to ameliorate—or negate—the impact of that saturation event. It is intended that the ATM system will enable a capability to determine actual or potential saturation of any selected airspace and/or aerodromes. In accordance with other ATM system requirements, it is intended that any such information will be made available to relevant ATM community members.

r. Provide a capability to evaluate the effectiveness of flow restrictions implemented in the ATM system. Effectiveness criteria shall include overall system performance measures.

Explanatory Text: The ATM system will include the capability to monitor its performance and effectiveness in meeting the range of performance targets. This applies particularly to Demand and Capacity Balancing, where there is a high degree of criticality to overall ATM system performance and where decisions—strategic and tactical—are made largely on the basis of historical data and observed performance.

4.4 Traffic Synchronization

Traffic synchronization refers to the tactical establishment and maintenance of a safe, orderly, and efficient flow of air traffic. To meet the performance expectations, the ATM system shall:

a. Provide for an orderly flow of traffic from gate to gate by dynamically renegotiating the 4D trajectory contract;

b. Apply traffic synchronization for the purpose of maximizing throughput of a particular ATM environment in the most effective and efficient manner;

Explanatory Text: It is possible to achieve high throughput inefficiently. It is expected that Traffic Synchronization will be applied to achieve high throughput and high efficiency, whether or not 4-D trajectories are being applied.

c. Maximize, through the use of traffic synchronization, throughput to meet ATM performance requirements;

d. Manage 4-D trajectory contracts to achieve safe and efficient trajectories;

Explanatory Text: Agreed 4-D trajectory contracts will be dynamically updated and communicated to the ATM community. Safety and efficiency in collaboration are key to the changes regardless of whether the service is done from the air or the ground. Negotiation and control will make use of the best available automated tools for communication, analysis, and action.

It is expected that through dynamic renegotiations of agreed 4-D trajectory contracts— and subject to the appropriate business case to ensure cost-effectiveness—the ATM system will not experience "chokepoints." Potential ATM system chokepoints should be increasingly more predictable as 4-D trajectories become available together with automated tools for mitigation. The balancing of traffic density with variations in demand should be based, where appropriate, using the 4-D trajectory contracts received from demand and capacity management.

It is expected that automation both in the air and on the ground will be used fully in order to create an efficient and safe flow of traffic for all phases of flight. The ATM system, through full use of available automation, will be able to analyze and accurately predict future situations in order to achieve the best performance.

Requirements for the airspace user to adhere to the agreed trajectory, within agreed tolerances, will remove much of the uncertainty regarding the future positions of aircraft.

e. Support the discharge of traffic synchronization by both airborne and ground-based systems;

f. Use 4-D trajectory control and/or flight deck delegation for aircraft spacing;

g. Utilize the 4-D trajectory for traffic synchronization applications to meet the ATM system performance targets, unless under certain conditions other means are determined to be more effective;

Explanatory Text: It is expected that the separation mode, including wake vortex separation minima will determine the minimum possible aircraft spacing. It is expected that flight parameters, as part of the 4-D trajectories management, will be available to the ATM system to dynamically allow for spacing and sequencing of arriving as well as departing aircraft. It is

expected that as flight parameters are available on airborne systems, they will be used continuously and dynamically, both between aircraft and between aircraft and ground, to maximize utilization of the best information available. This will constitute/facilitate a safer and more efficient use of available airspace and will increase aerodrome throughput.

It is expected that flight plans will be replaced by 4-D trajectory contracts for all phases of flight. 4-D trajectory contracts will constitute a prerequisite for dynamic control of aircraft and vehicles. Negotiations will take place dynamically, as total awareness will be available to the complete ATM community. Agreed 4-D trajectories will increase predictability as well as reduce the need for current traditional path-stretching methodologies.

It is expected that spacing between aircraft will be done through the use of 4-D trajectories, which will be updated and interacted upon collaboratively. The 4-D trajectories will be provided as 4-D trajectory contracts and will be modified and acted upon dynamically and according to at least the criteria defined by conflict management to create a safe and orderly flow of traffic.

It is expected that when traffic density becomes a critical factor affecting performance — whether of an aerodrome or an airspace — application of traffic synchronization will be used and tailored for best performance. The decision to apply traffic synchronization in this case may be taken in advance of flights. In any case, it will be closely coordinated with the demand and capacity balancing function to ensure timely and accurate application of traffic synchronization.

h. Ensure that traffic synchronization throughput actions are matched by aerodrome low visibility throughput capacity where this is determined to be cost-effective by the appropriate business case;

Explanatory Text: It is expected that traffic synchronization will be applied to achieve high throughput and high efficiency across the entire ATM system. This will include working collaboratively with both Aerodrome Operations and Airport Landside Operations to ensure that ground throughput does not become an obstacle to overall ATM system efficiency.

i. Recognize that traffic synchronization encompasses both the ground and the airborne part of the ATM system and constitutes a flexible mechanism for capacity management; and

Explanatory Text: It is expected that traffic synchronization will contribute to optimized aerodrome operations performance. This will be done through increased awareness and predictability for the ATM community as well as through fulfilment of collaboratively agreed actions leading to achievement of best performance.

j. Manage surface, departure, and arrival and en route flow of traffic dynamically to optimize traffic flow or throughput.

4.5 Airspace User Operations

The ATM system is primarily established to service the needs of the airspace user community. Increasingly, the capabilities of the user community are such that they participate as active components of the system. ATM system performance is directly influenced by the performance of the airspace user. To meet the performance expectations of the ATM system stemming from airspace user operations, the ATM system shall:

a. Recognize and exploit airspace user capabilities to generate, negotiate, and adhere to user-preferred 4-D trajectories;

b. Consider the trajectory of a vehicle during all phases of flight and manage the interaction of that trajectory with other trajectories or hazards to achieve the optimum system outcome with minimal deviation from the user-requested flight trajectory, whenever possible;

c. Provide, consistently with available ATM system resources, airspace users the capability to fly dynamic user-preferred 4D trajectories;

Explanatory Text: It is expected that user-preferred trajectories will provide the most efficient flight operations and that the airspace users will provide these trajectories to the ATM system. These trajectories should be the key/core element of the (shared) information management. The expectation is that the global exchange of information (from individual aircraft performance up to ATM resources) should allow full use of 4-D trajectory management/operation. The expectation is that the 4-D trajectory management optimization could be a function of either the ground or the air or both.

d. Provide, through its evolution, incentives to upgrade to new capabilities;

e. Provide benefits commensurate with the level of aircraft capabilities or performance;

Explanatory Text: It is expected that
- *operational benefits and incentives will accelerate the evolution of the ATM system;*
- *incentives will ensure consistent and interoperable evolution of the ATM system; and*
- *the degree of benefits and incentives will be different depending on the type of users.*

It is further expected that
- *a level of ATM system benefits will be defined in accordance with a level of aircraft capabilities;*
- *ICAO will develop global Standards for new ATM systems in a timely manner;*
- *States, recognizing global Standards, will file minimal differences; and*
- *even during the transition phase, global interoperability will be ensured/managed through benefits commensurate with the aircraft capabilities.*

f. Utilize relevant airspace user operational information to meet performance targets;

g. Operate on the basis that airspace users will make available the relevant operational information to the ATM system and vice versa;

h. Operate on the basis that airspace users will provide information on individual aircraft performance;

i. Operate on the basis that airspace users will provide information on the individual operating environment as experienced (real time);

Explanatory Text: - It is expected that the ATM system will provide the necessary information for mission planning and coordination, and that mission planning will first interact with airspace organization and/or aerodrome operations for long-term planning and then with airspace management and demand and capacity balancing.

j. Operate on the basis that airspace users will establish and execute operational control of their missions;

k. Accommodate operational control activity; and

Explanatory Text: - It is expected that operational control, where utilized, will be exercised over individual missions from initiation to termination. The division between operational control and the flight authority's (captain's or commander's) responsibility for the safety of the flight mission is considered to be a key contributor to the safe operation of the flight.

l. Allow airspace users to fly user-preferred trajectories that are consistent with the applicable airspace management requirements and aircraft capabilities.

4.6 Conflict Management

Conflict management limits, to an acceptable level, the risk of collision between aircraft and hazards. Hazards from which an aircraft will be separated are: another aircraft, terrain, weather, wake turbulence, incompatible airspace activity and when the aircraft is on the ground: surface vehicles, and other obstructions on the apron and maneuvering areas.

Conflict management will consist of three layers:

a) strategic conflict management;
b) separation provision; and
c) collision avoidance.

To meet the performance expectations of the ATM system stemming from conflict management, the ATM system shall:

a. Implement the conflict management function;

b. Define the predetermined separator prior to commencement of separation provision; however, the role of separator may be delegated;

c. Provide rules and means to delegate the role of separator;

Explanatory Text: When the role of separator is delegated then the conditions for both start and end of the delegation shall be defined in advance of the delegation. Changes of delegation shall be by agreement.

d. Determine the separator for each renegotiated 4-D trajectory;

e. Provide separation provision service when required by safety or ATM system design;

f. Designate the airspace user as the predetermined separator, unless safety or ATM system design requires a separation provision service;
g. Define separation modes for separation from all hazards, including weather, applicable to all airspace and movement areas;

Explanatory Text: The selection of separation minima within ATM system performance constraints seeks to balance the need for appropriate levels of safety performance with other performance expectations, including cost-effectiveness, capacity, and efficiency. While it may be possible, for example, to select small (distance/time) separation minima to be applied in a

particular operational area, the requirements for supporting navigation, surveillance, communications, and intervention capability performance may be prohibitively expensive, or they may not permit the expected capacity enhancements (e.g. because of communication volume limitations, etc.). The choice of appropriate separation minima and supporting infrastructure would be determined through collaborative decision making.

h. Select the applicable separation modes and separation minima for conflict management that best meet the ATM system performance targets;

i. Support strategic, pre-tactical and tactical conflict management. The selection of the type of conflict management shall be based on meeting ATM system performance targets, both before and after departure;

j. Apply tactical conflict management when strategic conflict management cannot be used efficiently;

k. Apply separation provision only when strategic conflict management cannot be used effectively;

l. Limit, to an acceptable level of safety, the risk of collision between aircraft and hazards; and

m. Ensure that collision avoidance systems activate when the separation mode has been compromised.

Explanatory Text: The risk of collision is maintained at an acceptable level of safety by selecting and applying appropriately defined separation minima (displacements between an aircraft and a hazard). It is intended that the "acceptable" level of safety will be determined from the perception of safety needs by society and the international community, related to the trust required from the ATM system. It is intended that the target level of safety will be based on risk assessment and acceptance criteria and be equal to or better than the "acceptable" level of safety. It is intended that the collision avoidance function not be included in determining the calculated level of safety required for separation provision, although it constitutes the third layer of conflict management and, hence, part of ATM safety management.

4.7 ATM Service Delivery Management

ATM service delivery management will operate seamlessly from gate to gate for all phases of flight and across all service providers. The ATM service delivery management component balances and consolidates the decisions of the various other processes/services, as well as the time horizon at which, and the conditions under which, these decisions are made. Flight trajectories, intent, and agreements will be important components for delivering a balance of decisions. To meet the performance expectations of the ATM system stemming from conflict management, the ATM system shall:

a. Optimize system-level performance as its highest priority with individual component performance subject to that prioritization;

b. Provide services predicated on management by trajectory and monitor compliance with the agreed trajectory;

c. Define the predetermined separation responsibility;

Explanatory Text: System wide optimization is a high priority and individual component optimizations operate within the constraints of that priority. The hierarchy of decision-making is consistent with these principles. Every decision has an identified responsible party.

d. Operate on the basis that the airspace user will provide flight and aircraft intent to the ATM system for use in planning and managing 4-D trajectories;

e. Approve execution of 4-D trajectory agreements through issuance of clearances;

f. Monitor and alert when the clearance is inconsistent with the agreement;

g. Monitor and alert when indications are that an aircraft will not be in conformance/compliance with the agreement;

Explanatory Text: Flight intent forms the basis for an ATM system agreement, and changes to the flight intent represent a request for modifications to the agreement. Aircraft intent forms the basis for ATM system confirmation of compliance with the agreement. The allowable variation from the agreed threshold is locally adaptable. Generating an agreement does not imply authority to execute. Initiating the agreement or any portion thereof requires a clearance. Clearances may not represent the entire agreement; the system shall alert the appropriate party when this is the case. The intent is to preclude an inadvertent entry into holding or inability to make the next trajectory point due to unintentional failure to provide follow-on clearance. The greater flexibility inherent in management by trajectory requires automated monitoring of adherence to and variance from the agreed trajectory. All ATM data will be available for accessing and use. The ATM system will automatically monitor, alert, and develop responses

h. Utilize flight trajectory, flight intent, and individual aircraft performance characteristics in providing ATM services;

Explanatory Text: It is expected that the 4-D trajectory will be globally shared and used by the ATM community in all aspects of its operations. The requirement recognizes the difference between the tolerances associated with the 4-D contracts and what may be more stringent performance capabilities of the individual aircraft. For example, aircraft providing the ATM system with knowledge of their very accurate performance capabilities would, as a result, provide the ATM system opportunity to identify conformance/compliance irregularities that could be used in providing such services as conflict management, security notification/response, and so on.

i. Operate on the basis that all operations are “known to the system”;

Explanatory Text: While aircraft may not be subject to any particular service, their participation in the ATM system must be announced either strategically, or pre-tactically by notification of intent, or tactically by immediate notification of intent or operation of identification devices or by operation in predetermined areas. As an example, an aircraft classified in 2000 as a VFR aircraft operating in Class G airspace will be able to operate with the same degree of freedom in the future ATM system, either by notifying intent to operate in a particular way, by carriage and operation of an identification device such as a transponder, or by operating in predesignated airspace, such as the equivalent of Class G.

j. Predict potential saturation of airspace or aerodromes in advance and to a level of accuracy to meet ATM system performance objectives;

Explanatory Text: It is expected that the ATM system will be able to determine actual or potential saturation of any selected airspace and/or aerodromes. It is intended that information will be generated that will summarize the problems regarding saturated airspace. If airspace or aerodromes are or will be saturated, the capacity management function shall have the capability to allocate available airspace or aerodrome capacity, determine flight restrictions for specific aircraft, and communicate these restrictions and alternate courses of action to users

k. Provide a capability to evaluate effectiveness of flow restrictions implemented in the ATM system. Effectiveness criteria shall include overall system performance measures;

Explanatory Text: It is expected that the ATM system will provide recommendations for future runway selection based on forecast meteorological conditions, traffic, and other conditions that influence the best system solution

l. Establish an on-request basis for ATM service delivery;

m. Manage distribution of responsibilities for the various services and their seamless performance, including designation of the predetermined separator for separation provision;

Explanatory Text: Where ATM system technological solutions and infrastructure are provided across a region or globally by one or more States or organizations, long-term use and operational arrangements shall be established via the CDM process with the affected ATM community members on behalf of, or for the benefit of, multiple users, States, and/or organizations.

n. Work to reduce voice communications as far as is practicable in delivery of ATM services;

Explanatory Text: Clarification of the strategic provision of service (i.e. publication of rules for a specific airspace; the publication constitutes the communication). This should apply equally for NAVIGATION, SURVEILLANCE, and AIRSPACE. Depending on the phase of flight and the requirements associated with any separation mode being applied at the time, provision shall be available for direct or indirect voice or data link communication between the aircraft and the ground air traffic management authority and vice versa. Where communication performance requirements are established, they shall be determined on the basis of the urgency of the communication and whether or not the proposed transmissions are related to command and control-type (i.e. intervention capability) communication. Communications media consist of voice communication (direct or indirect), data link communication, or other means, including visual, aural, or sensory signals, to provide or exchange information, data, or alert or acknowledgment messages. The media or combination of media to be used for a particular application or function shall be determined from the appropriate Concept of Use in a region or State. However, in all cases, the selection of communications media shall be based on the principle of global seamlessness and harmonization. Where seamlessness cannot be achieved for technical or cost-effective reasons, communications media must be interoperable.

o. Be based on self-contained navigation supported primarily by onboard and/or space-based systems, as far as is practicable;

Explanatory Text: Precision navigation guidance within terminal areas, on final approach, on the ground, and/or in the initial departure phase, may be provided by dependent or independent self-contained onboard navigation systems or independent ground-based systems. Depending on the phase of flight and requirements associated with any separation mode or minima being

applied at the time, navigation performance requirements may be established. These may be based on predicted and/or anticipated performance (contained navigation performance) or actual and/or observed performance (actual navigation performance).

p. Operate on the basis that services to airspace users will be based on the actual navigation performance of the users at the time of service. Where navigation performance requirements are specified, they will be determined on the basis of the navigation accuracy required in a given volume of airspace and/or through specific procedures to maintain appropriate levels of safety with respect to other hazards;

Explanatory Text: It is expected that as is the case with current Instrument Landing System categorization (i.e. Cat I, II, III, etc.), having defined a particular performance expectation for a given volume of airspace, or other delineation, it will be the airspace users who will determine both how they achieve the requirement and/or whether they can meet the requirement at the time of operation. In the ILS scenario, it is the meteorological conditions at the time of arrival that dictate the minimum performance requirement; and the airspace user determines if the entire system (aircraft equipage, pilot training, ground systems, etc.) is sufficient for the user to attempt an approach.

q. Demonstrate an increased responsiveness across the spectrum of ATM services to real time changes in airspace users' needs. Furthermore, the ATM system should provide the user with at least one alternative in case of changes imposed by the ATM system;

Explanatory Text: It is expected that changes imposed by the ATM system will be defined to include changes of status of individual ATM system elements (e.g. revised status of special use airspace or meteorological conditions).

r. Operate on the basis that where surveillance performance requirements are specified, they will be determined on the basis of the accuracy of position determination (and subsequent display) required in a given volume of airspace and/or specific procedure to maintain appropriate levels of safety with respect to other hazards;

Explanatory Text: Depending on the phase of flight and the requirements associated with any separation mode or minima being applied at the time, surveillance requirements and surveillance performance requirements may be established. When specifying these requirements or performance expectations, consideration should be given to the potential inaccuracy of position derived from either dependent or independent surveillance (as a result of the uncertainty of position of the aircraft in the case of dependent surveillance or the system inaccuracies engendered by independent surveillance systems) and to the ability of the various systems to either predict future position or provide intent.

s. Operate on the basis that where there is a conflict between access and equity, allocation of priority to airspace users will be based on the principle of maximizing ATM system performance;

Explanatory Text: Existing practices relating to access and equity, particularly the "first come-first served" paradigm, should be amended to reflect the overall intent to improve ATM system performance. This is not intended to prohibit or block access to airspace; it is intended to allow establishment of procedures through collaborative decision making that optimize use of runways and/or airspace.

t. Operate on the basis that ATM service delivery will participate in determination of airport capacity and will be aware of the available airport capacity at relevant airports at all times to be able to maximize use of that capacity; and

Explanatory Text: ATM system capacity at and around airports should not act as a constraint on airport scheduling. It is expected that the ATM system will be capable of projecting for specified aerodromes and runways the numbers of arrivals and departures that can be handled and the numbers of planned arrivals and departures. The number of arrivals and departures of IFR traffic that can be handled by a specific aerodrome, and the number of planned arrivals and departures of IFR traffic projected in the future at a specific aerodrome or runway, will be provided through effective information management by the ATM system.

It is expected that factors such as runway surface conditions, surface meteorological conditions, winds aloft, local acceptance rate data, and terminal navigation equipment status will be monitored and used to determine actual capacity projections. It is expected that information will be delivered upon request to the level of detail specified by the user.

u. Ensure that appropriate mechanisms are established and maintained to ensure appropriate authority, responsibility, and data control of all ATM system information so that the various parties use a coherent set of data.

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