European Organisation for the Safety of Air Navigation

EUROCONTROL

FROM AIS TO AIM

A STRATEGIC ROAD MAP FOR GLOBAL CHANGE

European Air Traffic Management Programme

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EXECUTIVE SUMMARY

The need for a Strategy for Management of Aeronautical Information

Air transport has evolved to become a key enabling component of the world economy contributing 1% to the global gross domestic product (GDP). As the global economies expand, the demand for air transportation grows apace. Airspace and airport capacity must be increased to absorb this demand. Since traditional methods of increasing capacity are near exhaustion, new and improved methods and concepts are needed to maximise the exploitation of existing capacity and to add capacity wherever possible. In order to release the latent capacity in the Air Traffic Management (ATM) system and to create new capacity, ATM is required to evolve and implement the means to provide the necessary capacity in a safe, timely, efficient and cost-effective way.

ATM will depend extensively on the provision of timely, relevant, accurate, and quality assured information that allows the ATM Community to make informed decisions. These decisions will need to be taken on the basis of Collaborative Decision Making (CDM) rather than in isolation. When shared on a system-wide basis and using advances in the corresponding technologies, information will allow the ATM Community members to conduct their business and operations in an efficient and cost effective way.

The traditional product centric provision of Aeronautical Information has to be replaced by a data centric and systems oriented solution, one in which timely and reliable data is made available permanently and dynamically for use in applications that perform the required tasks, be it flight planning, flight management, navigation, separation assurance, CDM or any other strategic or tactical ATM activity. One key enabler of the ATM system is interoperability. It is essential that the new definition of aeronautical data is provided in a common, system and platform independent format (or a set of harmonised formats) within a virtual information management system. The objective is to ensure consistency, authenticity and appropriate coverage of the data, and to provide accessibility to the data by all users of the ATM network, both on the ground and in the air. The enlarged scope of Aeronautical Information Management (AIM) includes all categories of information required to support the new ATM system.

Under the ICAO ATM Concept, global airspace will continue to evolve to become a virtual continuum to be efficiently organised and managed for the benefit of all airspace users, civil or military. Its management will fine tune airspace and airport operations to maximise the use of available runway and terminal area capacity and to deliver further increases in safety and efficiency for all phases of flight. In consequence, the providers of aeronautical information face a new challenge in having to serve ever more prevalent computer based navigation applications and decision support tools, all of which are data reliant. Traditional AIS will need to make the transition to AIM and then to Information Management, a process characterised by the increasing application of the "all embracing" System Wide Information Management (SWIM) principles. Information Management will be fully SWIM based, in fact it will become the instantiation of SWIM in the aeronautical environment.

The Scope of the "Road Map for Change"

This "Road Map" has been derived from the requirements of stakeholders, both civil and military, within the context of the ICAO ATM Concept. At the same time, it also reflects the world-wide dimension which is an essential feature of aeronautical information. While the "Road Map" is built on the recognition that AIM and IM are the defined goals of the future aeronautical information environment, it also reflects the urgent need for current AIS to evolve to AIM and become an integral component of the new aeronautical information management concept.

Road Map for Change - From AIS through AIM to Information Management

The proposed Strategic Objective of change is:

To achieve a uniform and efficient aeronautical information management structure, based on system wide information management, to support all phases of flight.

A number of Directions for Change are proposed which have been derived from this Strategic Objective. These give rise to suggested Strategic Actions, which cover not only technical and procedural issues but also identify ancillary legal, financial and organisational aspects that will need to be addressed.

Executing the Strategic Actions should first guide the transition of traditional AIS to AIM. The principles of SWIM form the basis of AIM, though given its scope is limited to ATM, AIM may not necessar-

ily implement all of the SWIM principles. The transition to AIM and AIM itself are considered as the proving ground and live validation of the SWIM principles in the aeronautical environment. In consequence AIM can be considered to be “SWIM-lite”. Once AIM is fully established and confidence in SWIM has been built, the system can evolve further to IM, which shall be SWIM implemented in the aeronautical environment.

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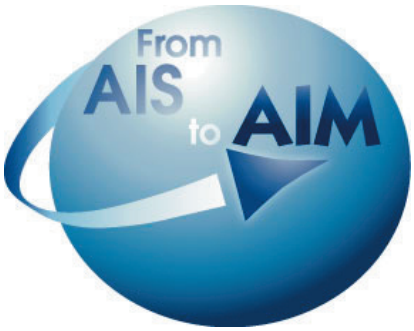

FROM AIS TO AIM

A STRATEGIC ROAD MAP FOR CHANGE

1. INTRODUCTION

1.1 Background

The overall Objective of the future ATM network is described thus: *"For all phases of flight, to enable the safe, economic, expeditious and orderly flow of traffic through the provision of ATM services which are adaptable and scalable to the requirements of all users and areas of the global airspace. The services shall meet demand in a cost-effective way, be globally inter-operable, operate to uniform principles, be environmentally sustainable and satisfy national security requirements".* The objective is to ensure that AIS will be improved and developed to provide a harmonised, co-ordinated service delivering quality assured most up-to-date information for all phases of flight and all users. In consequence AIS must make the transition from supply of predetermined products to the management of aeronautical information to serve future ATM needs.

This proposed Strategic *"Road Map for Change"* reflects the global nature of Aeronautical Information, which transcends all National and Regional boundaries and every effort has been made to accommodate the need for global interoperability.

1.2 The Need for a Strategy for Management of Aeronautical Information

The new ATM systems, concepts and techniques now under development will contribute to improved safety, increased efficiency and greater cost-effectiveness to users. All airspace will progressively be regarded as a continuum, organised on the basis of air traffic management requirements and through the evolution of collaborative civil-military airspace planning. Present and future navigation and other ATM systems are data-dependent, all requiring access to global broad based Aeronautical Information of a considerably higher quality and timeliness than is generally available to-day. The provision of Aeronautical Information is a core process that underpins all elements of ATM. In consequence, the role and importance of aeronautical information is taking on an even greater significance than was the case in the past.

Aeronautical Information has therefore become a crucial and critical component of the present and future ATM system and has to be developed to support seamless air traffic and navigation services covering all phases of flight and all related procedures.. The developments should be such as to facilitate the ability to plan and operate flights with maximum flexibility, flight efficiency and cost effectiveness, with minimum constraints and with no degradation in safety.

States' AIS have evolved over the years to meet the needs of airspace users for comprehensive information on airspace configuration, aerodrome and navigation facilities and other details needed by pilots. This development is ongoing and much effort is being devoted to enhance and refine the provision of Aeronautical Information even more over the next few years. However, to satisfy the new requirements arising from the ICAO ATM Concept, AIS has to make the transition in the medium and longer term to Aeronautical Information Management (AIM), a significantly different method of information provision and management given its data centric nature as opposed to the product centric approach of AIS. AIM can meet the future needs of airspace users in a cost effective way. A carefully developed and agreed strategy is needed to guide the transition process.

This *"Road Map for Change"* has therefore been compiled to define the development of aeronautical information management necessary to support implementation of the ICAO ATM Concept. It considers the nature of the future ATM operational environment and proposes the means by which its needs should be met.

1.3 The Definition and Context of Aeronautical Information Management

Aeronautical Information Management (AIM) describes the global and interoperable provision of aeronautical data of the required quality. It covers the needs of the present and future ATM system and all phases of flight, in a data oriented, holistic approach.

The role of AIM is to monitor and control the quality of the shared data and to provide mechanisms that support the ATM Community in establishing and managing information sharing in a collective effort of all suppliers of data. It provides the basis for improved decision-making by all ATM Community members during the strategic, pre-tactical and tactical planning processes.

User applications, which may be external to AIM, will interface with it to pull data that will be converted and organised into aeronautical information for use by pilots, air traffic controllers and other data users. Within the concept, it is the information itself that is of significance and not the technology that supports it.

The ultimate goal of AIM is to evolve into generic Information Management which is the full implementation of System Wide Information Management (SWIM). This will be a global, distributed aeronautical data management environment, managing the aeronautical content (format, timeliness, collection, checking, distribution, etc.) as well as the technical elements (storage, consistency of data bases, global interfacing, etc.). Information Management will fully include AIM while also encompassing all other ATM information management functions not already incorporated in AIM.

Achieving full SWIM based Information Management operation will take time. Proof(s) of concept will be needed to achieve the required buy-in. In this respect AIM can be seen as the proof of concept for Information Management, the evolution of which is foreseen in Europe in the 2008-2012 time-frame. In consequence and to give time to build the necessary consensus, Information Management will probably be implemented in the 2018 and beyond time-frame. The transition is illustrated on Figure 1.

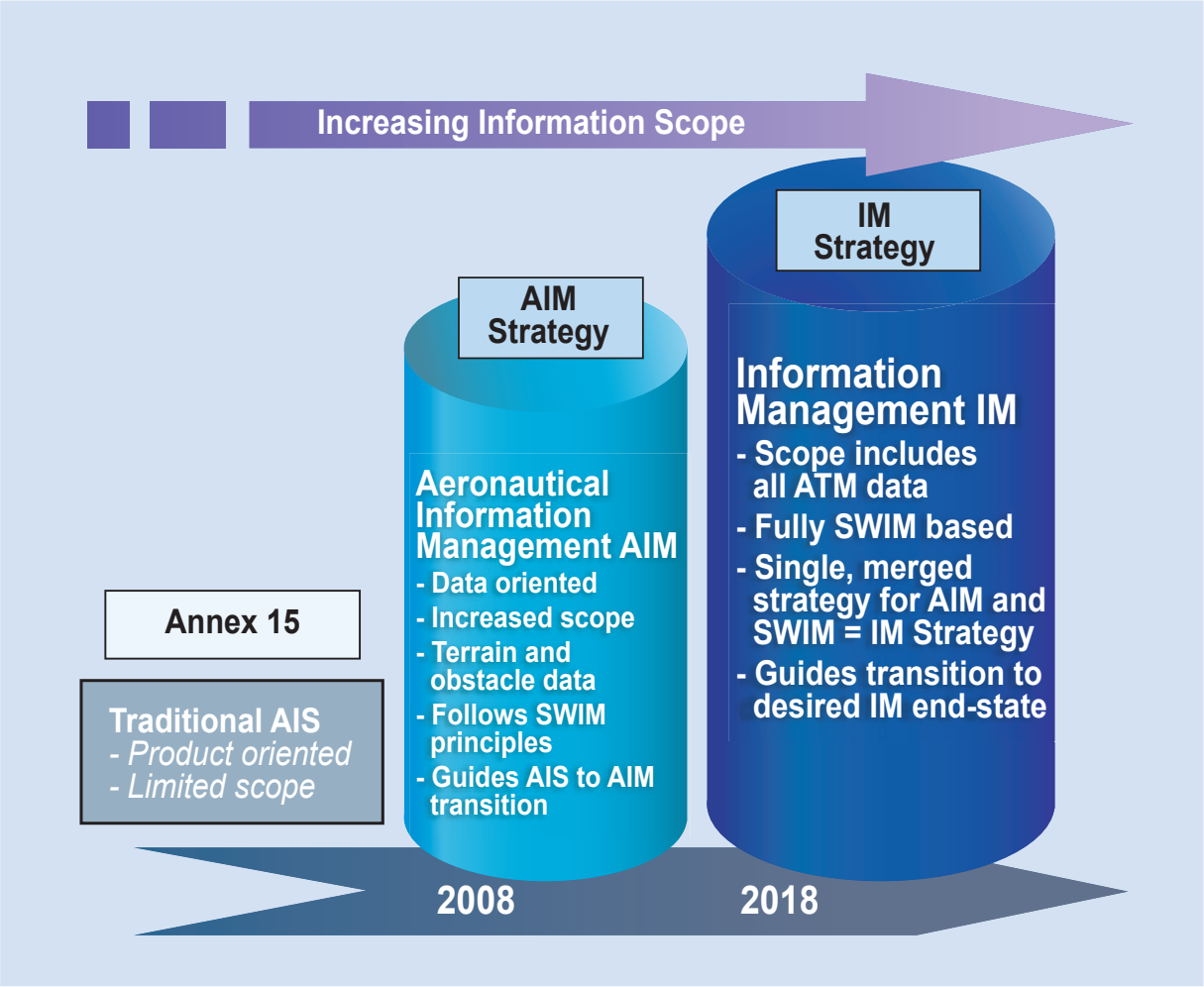

Figure 1

AIM is therefore the all important intermediate step ensuring the transition of AIS to a system better suited to the evolving needs of ATM whilst creating the basis for the global implementation of a fully SWIM based Information Management Strategy.

1.4 Approach

As previously explained, the ultimate goal is to achieve global Information Management in order to fulfil all information management needs of ATM in a seamless and completely interoperable way. AIM is an important intermediate step to drive the achievement of that goal. The *"Road Map for Change"* is the instrument to guide this intermediate step. The Strategy was developed using a top-down approach, as illustrated on Fig. 2. A further iteration will need to be developed to cover the steps to Information Management.

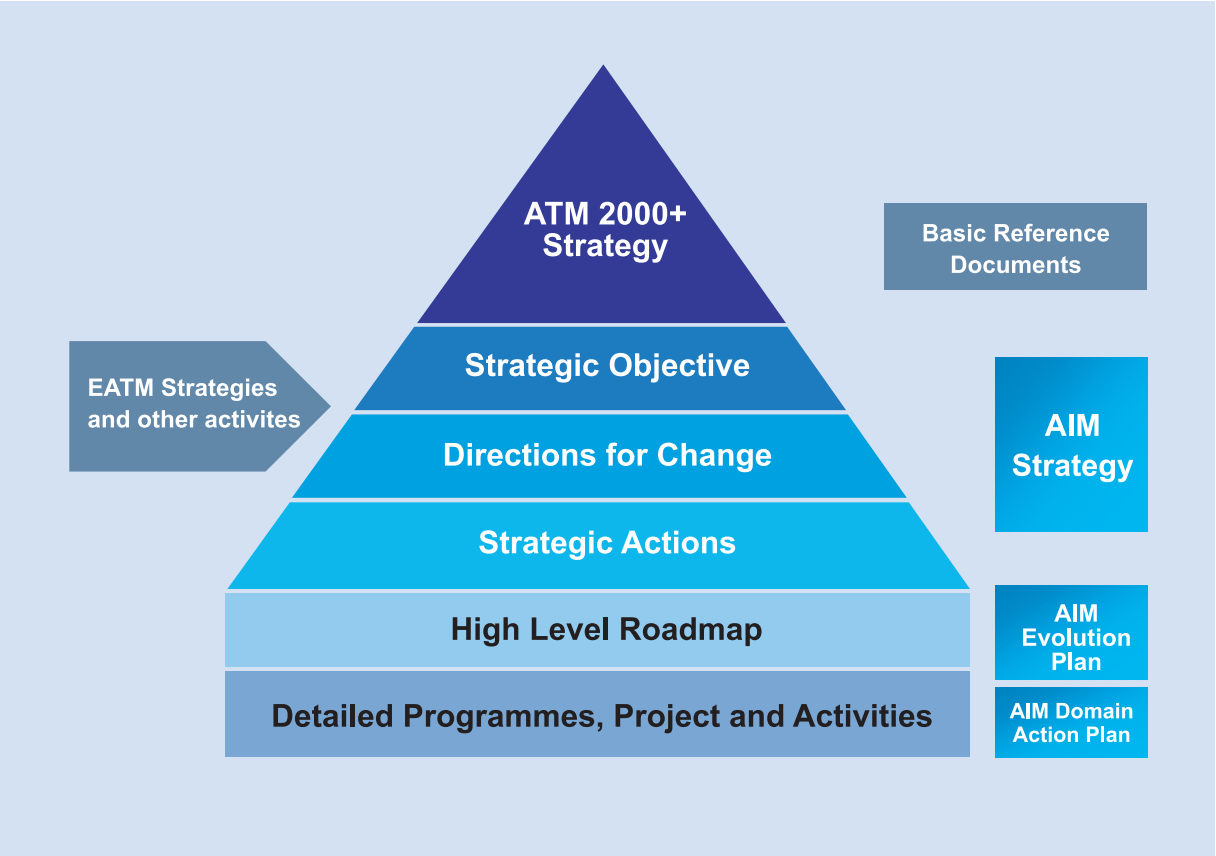

Fig. 2 "Road Map for Change" development approach

The primary drivers for the "Road Map for Change" are the requirements expressed by the users of Aeronautical Information, for the management of Aeronautical Information in a globally consistent and coherent way and for all categories of Aeronautical Information.

These primary drivers have been condensed and expressed in the form of a Strategic Objective.

The proposed Directions of Change required to realize the Strategic Objective are identified and the Strategic Actions to implement the strategy are defined. Each Strategic Action is directly traceable to one or more Directions of Change.

1.5 Scope

The global scope of the "Road Map for Change" reflects the need for interoperability. It covers all phases of flight, from planning (6 months or more ahead of the date of flight), through execution, to post flight activities. This is illustrated in Fig. 3.

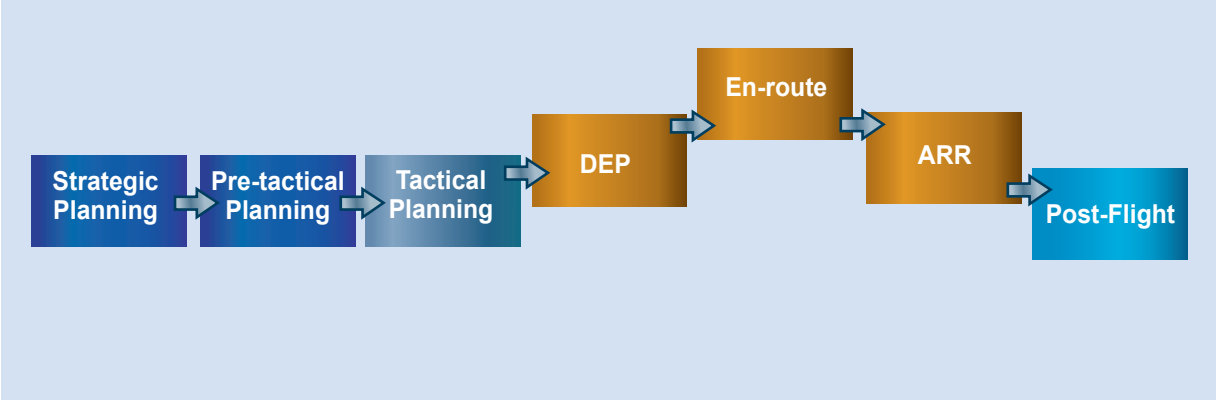

Fig. 3 Phases of Flight embraced by the "Road Map for Change"

The user's needs for management of all categories of Aeronautical Information are catered for within the overall strategy framework. There will be a cascade benefit to all Aeronautical Information stakeholders from the introduction of AIM, as this will provide the organizational and technical capability to enable all classes of user to access relevant aeronautical information by a variety of means.

Traditional AIS does not provide the complete range of information required for Gate-to-Gate operations or to support Collaborative Decision Making. The scope of AIM rectifies this by including all categories of information required to support the new ATM environment (including both airspace and airport operations). Accordingly, MET, FIS, ATM system status, demand and capacity management, etc. are all of concern to AIM alongside the other traditional AIS information categories.

For the purposes of AIM, a number of targeted exchange models are being created, intended for computer to computer exchange of aeronautical information. The use of standardized, backwards compatible and extensible data models means that the scope is open and new categories can be added to the scope as required to cater for future developments.

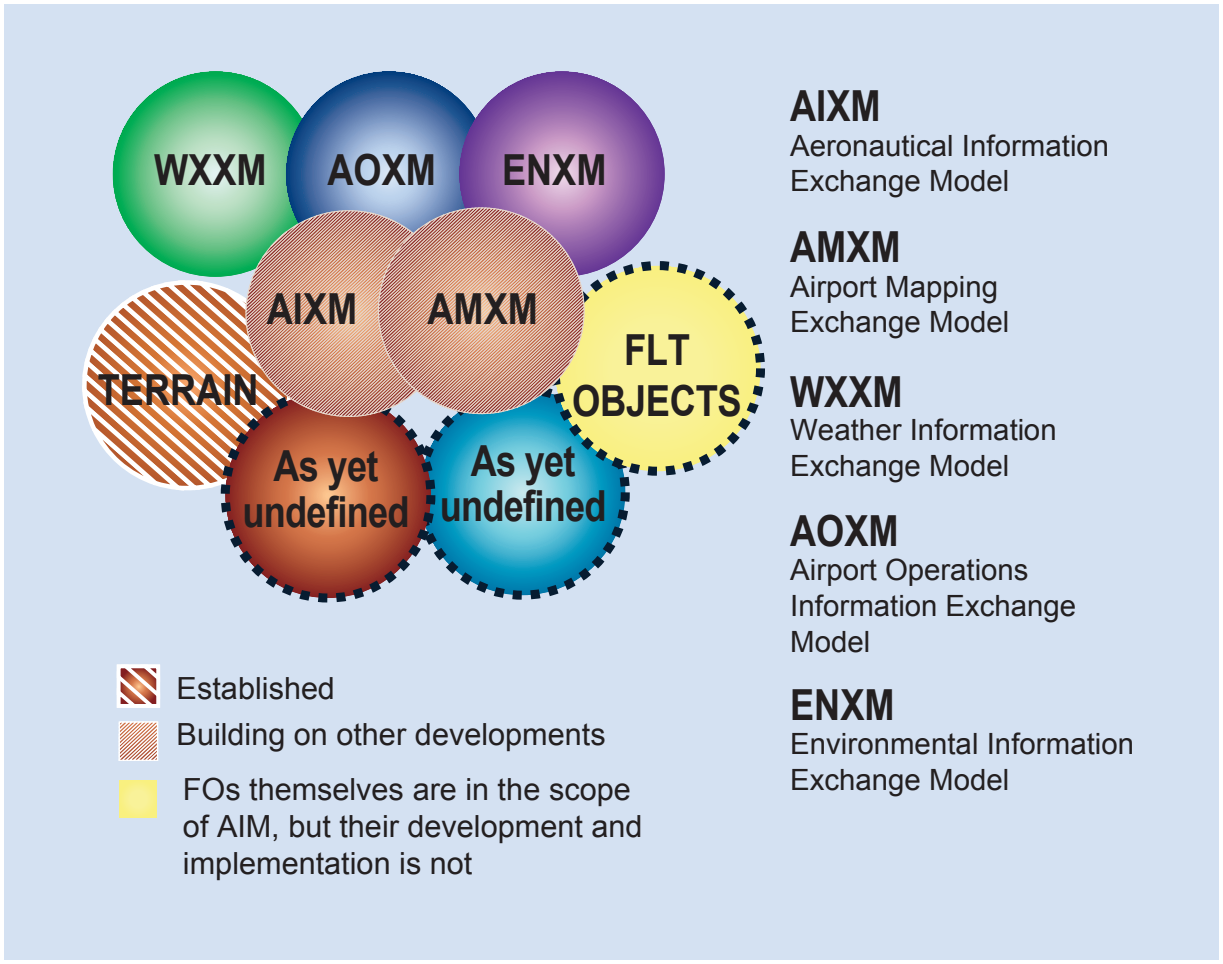

Fig 4. The AIM concept in terms of the exchange models

The scope changes also in a technical sense. AIM in general specifies the scope of aeronautical information to be covered, the data models, the aeronautical content of the data and its characteristics, including amongst other qualities accuracy, consistency, timeliness, access rights, authentication, etc. The list is very long. Evolution towards SWIM means that the proper management of data in terms of synchronising data bases and other information technology (IT) related aspects will become more and more embedded and all-encompassing. This is an extremely significant development, as it entails also the addition of certain IT related elements to the *"Road Map for Change"*.

The *"Road Map for Change"* is a concept document and defines "WHAT" must be achieved and "WHERE" to go in the long term. It does not specify the "WHO" as it is considered that the providers of information to-day will continue to be the same also in the future and eventual new information providers can be accepted in a seamless manner.

AIM has a direct relationship with the other Domains that collectively constitute ATM. For some, notably the Navigation, Airspace, Surveillance, Flight Data Management and Airport Operations Domains it is an essential enabler. Whilst at the same time the Communications Domain is an enabler for AIM, providing the communications infrastructure upon which the AIM is based. These domains for which AIM is an enabler define requirements for AIM expressed as their data input and output needs. AIM on the other hand imposes requirements upon those strategies in specifying the data models and exchange formats to be used. AIM's open scope and standards ensure that requirements from other strategies can be met without changing the AIM concept itself, but it is essential that other strategies accept and comply with the AIM open standards and exchange models. The general context is shown on Figure 5.

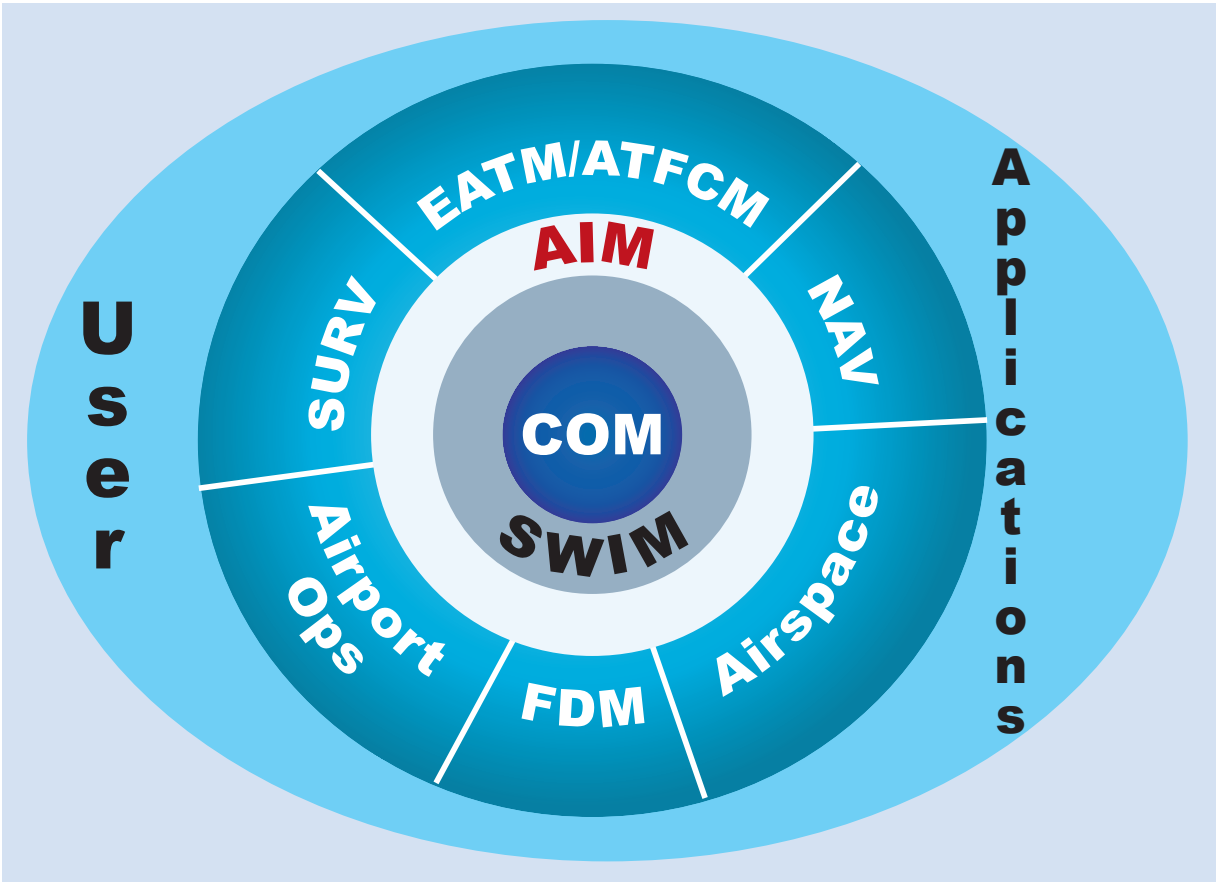

Fig. 5 Strategy Context

The “Road Map for Change” describes an open framework capable of evolution to meet changing needs.

1.6 Methodology and Principles

The general principle that has governed the development of the *"Road Map for Change"* is to define Directions for Change and corresponding Strategic Actions, along with an overview of the essence of AIM and the key areas to be considered.

The *"Road Map for Change"* provides an effective framework for the evolution of AIS to AIM and in time to fully SWIM based IM within which the means for global harmonisation and national projects can be developed for the next 15 years and beyond. The *"Road Map for Change"* must remain sensitive to and evolve from the continued recognition of the needs and priorities of both users and providers of Aeronautical Information as defined by its enlarged scope.

Based on these general principles and guidelines, this Strategy aims at achieving consensus on the future of Aeronautical Information. It seeks to maintain coherence in the development activities on a global basis, while ensuring compatibility and coherence between the ICAO Regions, in line with the provisions of ICAO SARPs and plans.

This *"Road Map for Change"* recognises that a certain infrastructure and services already exist or are contemplated as a result of policies and plans developed by individual States and by various international bodies such as ICAO, EUROCONTROL, IATA, etc. Accordingly, it acknowledges the considerable investment that stakeholders have made or plan to make and that these investments will need to be supported for many years to come. In consequence future developments shall be backwards compatible when required. Nevertheless, it is important to stress that such support for existing investments should not be allowed to slow down or stall the transition to AIM.

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2. AERONAUTICAL INFORMATION PROVISION - CURRENT SITUATION

2.1 The Role of AIS

The major task of AIS, as defined in Annex 15 to the Chicago Convention, is to ensure the flow of aeronautical information necessary for the safety, regularity and efficiency of international air navigation. Annex 15 describes the extent of information required and the means by which it should be made available in the form of the Integrated Aeronautical Information Package. Each ICAO Contracting State is responsible for ensuring that these obligations are discharged, whether a State itself directly provides the services defined in Annex 15 or whether this is undertaken by non-State organisation(s).

The AIS and MAP situation of today can best be described as a semi-automated process which requires significant manual intervention and remains wedded to the principle of a master, paper reference document, even though the information may in many cases be maintained and transmitted electronically. Moreover, the provision of Aeronautical Information is mainly focussed on the requirements of pre-flight briefing rather than the whole spectrum of Gate-to-Gate requirements.

The needs of other information users and their systems, such as Flight Data Management (FDM), are clearly recognised though they are not explicitly addressed.

2.2 Recent and Current Developments

There is ongoing action to improve AIS in the ICAO Regions including the increased use of automation though the provision of AIS is and will remain a State obligation.

The development of an Aeronautical Information Conceptual Model (AICM) and Exchange model (AIXM) will provide a foundation for further enabling development for the “Road Map for Change”. The intention is to lead to the global adoption of common and consistent data exchange models covering all aspects of AIM and data integrity will be progressively improved in some States

by regulatory initiatives that are under way today.

It is important to note that the enhancements and developments described above are basically improvements to the traditional AIS environment, without changing its conceptual basis. With the broad portfolio of ATM requirements for aeronautical information evolving at an increasing rate, even this improved AIS falls short of meeting all the defined requirements.

3. REQUIREMENTS

In the following, a description is given of the most important requirements as stated by users. It should be noted that these have been expressed in terms of desired end-user functionality rather than concrete requirements against AIM itself. Later in the strategy it is described how AIM will support the realisation of the required functionality.

3.1 Users

The aeronautical information user community encompasses a wide range of interest groups (Aircraft Operators, Airport Operators, Air Traffic Services etc). ECAC airspace users are diverse, such as Military air, sea and ground forces, Airlines, General Aviation, Aerial Work and Sports Aviation, with extensive and sometimes conflicting needs and expectations.

Generic to all users is the requirement that the future aeronautical information services, together with the associated systems and infrastructure, are developed to support seamless air traffic and navigation services covering all phases of flight and all associated activities. The developments should be such as to facilitate the ability to plan and operate flights with maximum flexibility, flight efficiency and cost effectiveness. These should be achievable with minimum constraints and with no degradation in safety. They should form a common set of processes and procedures applied uniformly world-wide.

Expressed end-user requirements for future developments include but are not limited to the following examples:

- *timely, accurate, complete and up-to-date information concerning all components of the Air Navigation System and their operational status, to be available in standardised formats to allow automatic processing, storage and retrieval;*
- *up-to-date MET and AIS information prior to and during flight operations. This also includes air traffic density forecast data when available for effective pre-flight planning;*

- *all relevant pre-flight information should be distributed, in standardised formats that are easily understood/processed, in an unambiguous and timely manner. All users should have access to pre-flight information which should be user selectable to meet their own specific requirements;*
- *make available airport mapping information, obstacle and terrain data;*
- *make available data, including accurate taxi times, relevant to collaborative decision making to improve the predictability of operations;*
- *make available accurate delay times by airport and ATC sector for improved planning, including, alternative route selection.*
- *for pre-tactical flight planning purposes, achieve the linking of AIS/ ATFCM networks to enrich Aeronautical Information with corresponding traffic (density)/congestion forecasts and flow restrictions.*

3.2 Requirements Arising from Other Domains of ATM

The overall ATM requirement specifies that Aeronautical Information shall fully support the conduct of flights under new, flexible procedures in all types of airspace. Ultimately, airspace users will be able to operate their flights on their preferred trajectories.

The ICAO ATM concept identifies the need for the ready availability of timely Aeronautical Information that includes the current status of the air navigation facilities, MET information, airspace status and traffic/congestion forecasts and flow restrictions. It supports transition towards a unique reference database of quality-assured AIS and digital MAP information, which is required for the precise guidance of operations gate-to-gate using airborne and ground based computer systems. The introduction of Collaborative Decision Making in the en-route environment will make the availability of timely Aeronautical Information even more important.

The progressive introduction of the Area Navigation (RNAV) and Required Navigation Performance (RNP) concepts in particular require the availability of high quality aeronautical information. The introduction of Ground and Space Based Augmentation Systems (GBAS, SBAS) Cat I and in time CAT II/III approach

procedures will bring additional requirements for status information related to those new systems.

Provision of Aeronautical Information must be developed to support the following strategic programmes and requirements:

- *The exploitation of the full benefits of B-RNAV implementation en-route and in Terminal Areas (TMA);*
- *The implementation of free routes, to increase airspace capacity and, together with RNAV, to improve user preferred trajectories in all phases of flight;*
- *Enable the use of the advanced 4D navigation capabilities of modern aircraft and to support the implementation of 4D RNAV;*
- *Support for the development and subsequent utilisation of real-time decision support tools.*

Developments in Airport Operations also highlights the increasing importance of AIM as a means of improving integration between airports and ATM. AIM is recognized as an essential enabler for all Airport CDM applications and for system supported surface guidance to aircraft and ground vehicles. Inclusion of MET in AIM meets an important airport operations requirement for improved meteorological data availability for, among others, wake vortex and wind shear forecasting and detection. All together they will form an airport element of the Time-Ordered ATM system.

And the extended use of Global Navigation Satellite Systems (GNSS) gives rise to a need to promulgate the serviceability status of satellites and all the information required for GNSS1/ EGNOS and for GNSS2.

The need for an inclusive and transparent collaborative decision making process between all partners based on a global ATM awareness is necessary to ensure the planning of the required capacity and the optimisation of airspace. The achievement of the collaboration relies on the exchange of accurate ATM data and on the sharing of information.

Communication on the other hand is an enabler and as such, does not generate requirements for AIM. Nevertheless, several of present and proposed developments such as digital data link may be considered as prerequisites to the realization of the *"Road Map for Change"*. In passing it should be noted that at the same time the communications technology available may constitute a constraint (e.g. the band-width of the air/ground digital link) in respect of the scope and format of aeronautical information that can be exchanged with aircraft in flight.

3.3 Requirements Arising from other ATM Activities

The Flight Data Management (FDM) Concept has been developed on a trans-Atlantic basis to overcome the current situation in which flight data for the same flight made available to stakeholder systems is often inconsistent and/or incomplete. This results in inefficiencies in operations and may have a safety implication if misunderstandings occur. Equally important is the fact that the new capacity enhancing tools and methods proposed for the future ATM system require completely consistent flight data if their benefits are to be realized.

The FDM Concept proposes that for each flight which is planned, is currently active, or has taken place, there will be a 'flight object' which contains the latest confirmed information about the flight, including its trajectory (estimated and/or actual), equipment, performance data, mass, etc. The flight objects exist in a Common flight object environment, which is a logical concept and is not intended to imply any particular physical architecture. High level rules and processes for managing the Common flight object environment are deemed as essential. It is recognised that most of the data elements required for the flight objects are part of the AIM data set. AIM must therefore ensure that the data timeliness, accuracy, consistency and authenticity requirements posed by the FDM concept are fully met.

3.4 Conclusion

Analysis of the above requirements demonstrates that they far exceed the scope of traditional AIS and that most of them cannot be satisfied by traditional AIS products, even in their newer digital format. The needs of the users and the requirements posed by their concepts and Strategies and other activities all represent requirements for data of the appropriate quality, which is then fed into user applications performing the necessary functions. This is a clear indication of the overriding need for AIS and its product oriented concept to transition to the holistic, data oriented approach of AIM.

4. CURRENT SHORTCOMINGS

As evidenced by its name, the Integrated Aeronautical Information Package is a complete product. The “static” information in the AIP is consulted and then reference is made to any “dynamic” variations to the normal situation during the relevant time period, as notified via NOTAM and Supplements. Whilst the NOTAM format enables some degree of filtering of information to suit individual requirements, the extraction of information from the Integrated Package as a whole entails a considerable amount of manual selection.

Short notice AIS change information is provided to end users through NOTAM. These cannot currently support the transmission of extensive digital and/or graphical information, because of limitations in rules, application, flexibility and message size. In consequence, change information entailing extensive text and/or graphics is promulgated by printed AIP Supplement, although attention might be drawn briefly within a NOTAM to the existence of this information.

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Graphics and text have tended to be regarded as separate rather than complementary techniques for presentation of Aeronautical Information. This has been conditioned by the limitations of communications technology used in AIS (as instanced above in the comparison between NOTAM and Supplements). Yet today there is the rapidly evolving GIS technology.

At present, the extent of the co-ordination that can be conducted between the parties involved in the planning and operation of flights is constrained by the inherent limitations of existing procedures, technical systems and lack of harmonisation and standardisation. AIS data transmission is based on AFTN which, in addition to message rules, also constrains the speed and capacity of information exchange. Other information is subject to postal transmission time.

These inhibit the exchange of the up-to-date information needed to ensure that, e.g., all of the parties involved in processing a flight can react to real-time events and implement timely changes to their plans. Though recognising the digital world, ICAO still builds on a concept where output on paper is required and where the facilities offered by the Internet are recognised but only as a secondary means of output.

Military AIS arrangements vary between States: in some cases, Aeronautical Information is provided by civil AIS, in others by a separate military AIS organisation. Exchange of Aeronautical Information between civil and military often entails a manual process, resulting in duplication of effort and scope for transcription error. Differing data collection, storage and security procedures may be involved.

The current absence of uniform global mechanisms to define the roles, responsibilities, quality requirements of data and the means of cost recovery for and the regulation of Aeronautical Information products and services is hampering the evolution of a capable and sufficient service.

Aeronautical information is created at the source as individual data and the current AIS and MET concept package this data into products that are only an estimation of what users will need, based on several years' of experience. The products form part of a closed system which is extremely difficult to change hence they cannot keep up with the emergence of new requirements. Users are forced to disassemble the products into the component data if they wish to use the information in user applications. This process is often impossible to automate, resulting in the loss of benefits automation may otherwise provide.

Even though the ICAO definition of the Aeronautical Information Service does not restrict the scope of services provided, AIS in general do not appear to have evolved their portfolio of services and products to meet the evolving needs of ATM. The product oriented, closed system approach in any case does not lend itself easily to extensions in scope. This is the most serious potential shortcoming AIS has today.

In consequence, the AIS system as it exists today has serious limitations which increasingly and negatively impact its ability to meet the requirements placed upon it by the ATM system. Most of the shortcomings cannot be eliminated within the confines of the AIS concept and hence major changes will be needed to enable progress in the future. This was recognised by the ICAO 11th Air Navigation Conference held in Autumn 2003, which recommended an urgent review of Annexes 4 and 15.

Whilst noting the limitations of AIS today, it should be recognised that the ATM system itself is facing serious shortcomings when it comes to dealing with aeronautical data. While the various specialised domains developed their own requirements and solutions to meet air traffic demand, giving also full recognition to the need for data and the global management of data in the new ATM system no real, coordinated

effort was undertaken to address data management issues on a Global basis. Clearly, with AIS in general unable to presently fulfil this role, urgent steps are needed to rectify the situation.

The fragmented nature of Global ATM has been clearly identified as a major shortcoming and impediment to growth. It is only natural that the approach to aeronautical data also reflects this fragmentation. Local solutions and incompatible data definitions constitute a serious impediment to proper data exchange between the various elements of the ATM system.

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5. THE FUTURE ATM ENVIRONMENT

5.1 Enhancement of ATM techniques

Significant changes in ATM techniques and concepts are being developed in order to accommodate the forecast growth in European air traffic demand. The ICAO ATM Concept specifies the operational concept to ensure that the system will be capable of providing capacity according to demand whilst allowing aircraft operators maximum flexibility, flight efficiency and cost effectiveness in planning and performing flights with minimum constraints.

The future air navigation system will require the application of the ICAO Required Navigation Performance (RNP) concept, based on the use of Area Navigation (RNAV). Other developments include Flexible Use of Airspace (FUA), Free Route Airspace), airborne separation assistance systems, cooperative air traffic services (COOPATS), Collaborative Decision Making (CDM) based on the concept of collaborative information sharing, multi-sector planning, ATC decision making aids and gate-to-gate planning of flights. Aircraft will navigate on the airport surface and in the air using on-board systems that can calculate precise position and optimum trajectories based on the latest information. Taken together, these activities will be merged to create a “Time Ordered ATM System” based on collaborative information provision and its use for executive and collaborative decision making.

To support and facilitate the transition to the new global ATM/CNS system, aeronautical information and the graphical depiction of such information, including 4D displays, will be further developed and oriented towards global requirements while also meeting regional and national needs covering civil and military operations interaction. Gate-to-gate planning and navigation will be reliant on new requirements for airport mapping.

Airspace users, airports and ATM service providers will conduct their business and manage operations using increasing amounts of digitised information. Data will be provided faster and in more automated and integrated ways using appropriate networks. The integration,

interoperability and availability of timely quality information, in the air and on the ground, will be key elements of more efficient planning and decision making.

5.2 Technological Developments

Aviation's progressive transition to digital, network based systems will bring important enhancements of capability and release of latent capacity constrained by current technologies.

Open systems architecture will enable ready interchange of data between systems, irrespective of their individual hardware or software specifications.

Geographical Information System (GIS) technology enables integration of graphical and textual data, by the graphical and selectively layered presentation of Aeronautical Information referenced by geospatial co-ordinates (geo-referencing).

Broad-band air/ground data-link, with the necessary bandwidth to transmit significantly larger volumes of Aeronautical Information than is presently possible, may be in routine use by all users of airspace, enabling real-time (or nearly so) in-flight update of the aeronautical database.

Note: At the time of writing, there is extensive and growing activity in both Europe and the United States aimed at the development of standards for AIS and MET air/ground data link applications.

General mobile communications technology, both wired and wireless will continue its development, enabling access to data from a variety of devices and via different connection options. Such devices include the Electronic Flight Bag (EFB) as well as generic computing platforms, such as Personal Information Managers (PIM), running specialised user applications.

This extensive enhancement of connectivity and access to data, introduced to meet operational requirements, requires proper management of the content and is one of the main drivers of AIM.

5.3 Civil/Military Information Sharing

Developments in free route airspace and other new ATM techniques will lead to further enhancement of the already close co-operation between civil and military authorities. The principles of this "Road Map for Change" are therefore equally applicable to civil and military flight operations and will facilitate greater flexibility in air operations, arising from improved availability of information and of airspace. Nevertheless, there will continue to be operational, training or other missions, which, by their nature, may be incompatible with civil requirements or practices. The degree of civil/military ATM integration within an individual State remains a national issue and military participation in a regulated Aeronautical Information infrastructure will accordingly be subject to national security considerations.

5.4 Confidentiality and Sensitivity of Information

A global, networked aeronautical information management system with the scope envisaged for AIM must recognize that some of the data it contains will be sensitive from military, security, airline and airport commercial or industrial perspectives. Full support of all stakeholders can only be achieved if such sensitivities are taken into account and proper measures are taken to protect data from unauthorized use. Methods for restricting access, merging and de-identification of source, release from supplying and so on, will therefore be required and implemented in such a way that they do not adversely impact the overall aims of aeronautical information management.

5.5 Environmental Considerations

As noted in the ICAO ATM Concept, environmental considerations are becoming increasingly important, particularly in respect of noise and gaseous emissions. ATM improvements can make a significant contribution to preservation of the environment and the sustainability of aviation in general, by reduction of delays, shorter and more fuel efficient routes and, where possible, a lessening of the noise impact around aerodromes. Expansion of the range of Aeronautical Information provided will enable those improvements, as will the availability of terrain, population, noise profiling and noxious emission dispersion attributes.

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6. STRATEGY

6.1 Overcoming the Shortcomings - From AIS to AIM

In order to appreciate the fundamental, conceptual changes that transition from AIS to AIM entails, it is necessary to consider a few basic tenets of information management. It is also essential that the difference between data and information be clearly understood. Data is the carrier of information but the information content is only substantiated when the data is processed by a system or human being. "*Information is data within a context*". Take the example of an aviation object, like RUNWAY. It is clear that it can be described by a series of data elements giving its physical dimensions, location and orientation. More data can be attached to it, expanding the description with pavement condition, open or closed status, applicable runway visual range, available length and the traffic planned for that runway in any given period of time. What is immediately clear is that to fully describe the object RUNWAY, data from a variety of disciplines is required, these ranging from surveying and mapping to operational and meteorological.

One of the shortcomings of the traditional approach is that data relating to the same object, the runway in this case, though available, is scattered among the source disciplines and their products. Physical dimensions and load bearing capacity in the AIP, surface conditions (e.g. wet or snow contaminated) from MET, latest operational status from NOTAM and eventual congestion from ATFM. Only by consulting several sources is the pilot able to accumulate the aeronautical information that would answer his question: can I land there?

In the past, this process of extracting information from data was mainly a human activity and the limitations were absorbed by and compensated for by the individual. With the increasing use of automation and the need for information carried by data to be used by other systems (e.g. the FMS, CDM applications, etc.), the rigid, product centric approach of AIS is no longer appropriate.
AIS must make the transition from the

supply of predetermined products to the management of data from which Aeronautical Information in its entirety can be extracted and subsequently customised in a variety of ways to serve future ATM needs.

This challenge will be met by the transition to AIM. AIM will be responsible for both the content (including formats, timeliness, collection, checking, distribution, etc.) and the proper management of the data (storage, consistency between databases, interfacing with other systems, etc.). AIM will manage data on the basis of the System Wide Information Management (SWIM) concept which is a globally all-encompassing, structured but open approach to data management. Progressive implementation of the SWIM principles in AIM can be seen as the evolution of AIM to *Information Management* that is fully SWIM based and which is the ultimate goal.

Underlying the SWIM concept and hence also AIM is the network layer which will ensure delivery of data, and this aspect is covered in global requirements for COM. The scope of AIM is not limited by any pre-determined constraints, and it includes all data categories and sources considered relevant to the future ATM system (e.g. terrain, obstruction, airport, flow and capacity management, etc.) and all phases of flight. Furthermore, data can be added as long as the rules imposed by the SWIM concept are respected.

User applications are an important new element of the concept. Although not covered by this Strategy, user applications are a logical consequence of the global and flexible availability of quality assured aeronautical data in standardized format. AIM will ensure that user applications can access data immediately and from any location, including aircraft in flight or on the ground, where appropriate connectivity is available. The role of user applications is to transform data into aeronautical information, customised to the specific requirements of a given user at a given time. User applications for self-briefing, flight planning, operational control, CDM and in-flight use (e.g. Electronic Flight Bag - EFB, 4D displays for taxiing) can be envisaged among others. These applications will also be system independent, scaleable and will cover the needs of a broad spectrum of aeronautical information users.

In AIM, the frontier between textual and graphical formats will dissolve. Only data of the required quality will be managed and made available, and it will be the role of the applications to select and then intelligently use and if required display information in whichever format (textual or graphical) is the most appropriate and as requested by the user.

Processes for collaboratively defining and validating common Aeronautical Information specifications and for the registration and management of these specifications will be developed. Specifically, these will address the organisation, collection, quality assessment, standardisation, sponsorship or ownership, and disposition of aeronautical meta data, where metadata (data about data) is defined as the description of information contained in an individual data standard, namely the data's definition, structure, content, format etc. The results shall be

submitted for incorporation into ICAO SARPs.

AIM will be able to meet users' needs on several levels. It will be a significant driver of the transition also on the user side. It will offer superior data service and total flexibility for users via the user applications concept. It will also retain the ability to offer traditional AIS products to users who have yet to make the transition (AIS is one component of AIM). This will be progressively achieved by the introduction of digital information provision in accordance with the recommendations of the 11th Air Navigation Conference (2003).

AIM should not be seen as a proposal for a specific physical architecture. It is a concept for managing the content of aeronautical data and the data itself, providing quality assured data to user applications for the benefit of all aviation stakeholders. Its open standards and common data exchange models will ensure platform independence and Interoperability.

Implementation of AIM does not imply the creation of a completely new infrastructure. Rather, it will be based primarily on the networking of existing and planned data base components to form a virtual information pool as part of the regulated ATM internet concept. However, the SWIM based AIM requirements in terms of scope, content, quality, exchange models and the like must be strictly imposed, supervised and regulated (where regulation is deemed appropriate).

AIM's comprehensive coverage of aeronautical data means that data sources will be varied and include also disciplines not previously considered to be part of AIS (e.g. MET). Also, users, via their applications, will in time become data sources (for instance, a pilot using a briefing application, filing a flight plan or CDM application at an airport, receiving flight data and inputting calculated taxi times, etc.). Appropriate rules and procedures will be developed to ensure that all data sources meet the AIM requirements for data quality.

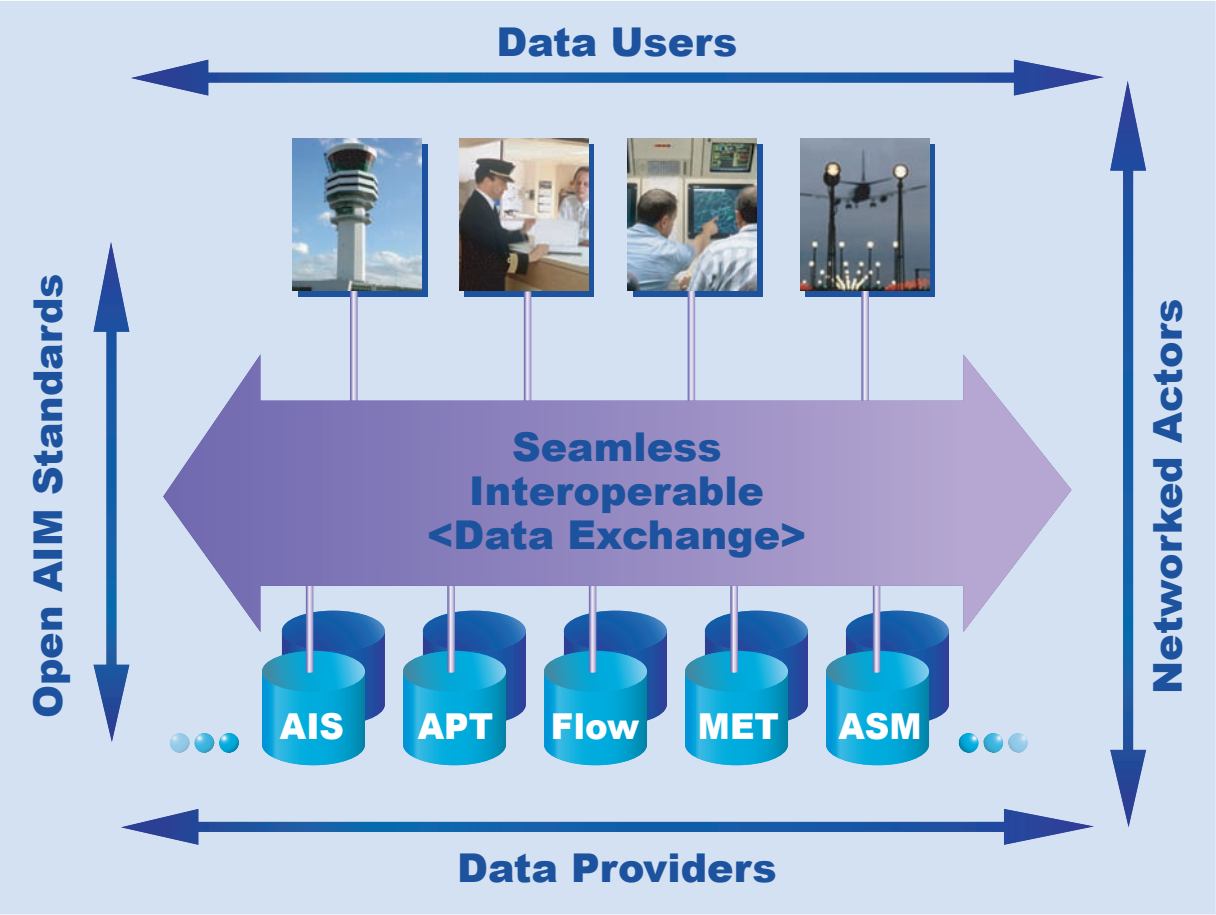

Fig. 6 AIM and its Context

The *"Road Map for Change"* will, in its forthcoming iterations, also adapt to the information management needs expected to emerge from the evolution of the ICAO ATM Concept.

6.2 The Strategic Objective of Aeronautical Information Management

The strategic objective of AIM has been defined on the basis of, and is directly traceable to, the Major Strategic Objectives in the ICAO ATM Concept. In particular, AIM will be an essential enabler to realize the uniformity objective.

Accordingly, the Strategic Objective of AIM is:

To achieve a uniform and efficient aeronautical information management structure, based on system wide information management, to support all phases of flight.

6.3 Key Drivers

The ICAO ATM Concept is the high level framework for the evolution of global ATM and provides at a very high level the specialised elements needed to realize. The Concept recognizes the importance of information management and this provides the overall driver for this Strategy and for the earliest possible implementation of AIM.

As will be clear from the requirements section (para. 3 refers), the new and enhanced functionality being requested by the users and the realization of the Concept and the regional and national strategies and other activities that so obtain are predicated on the provision of quality assured, timely and properly managed aeronautical data sufficient to cover all phases of flight.

This all encompassing need for data that underpins all aspects of the future ATM framework is the key driver for AIM.
The quality and accessibility requirements in turn dictate an AIM that is able to deal with the content and the management of the data in an integrated operation. Comprehensive content and data management requires an AIM framework that is built to properly cover both, while requiring distinctly different expertise (aeronautical and IT, respectively) for management and implementation. This ensures that AIM satisfies both the aeronautical and the SWIM based information management requirements and is the key driver for an AIM (and in time IM) that includes both types of expertise.

6.4 Expected Benefits

AIM will bring benefits to all parts of the ATM system by enabling the provision of aeronautical data of the required quality, accessible by all users (human as well as systems) at all times. As such, it will especially contribute to:

Safety – Timely and accurate aeronautical data of the appropriate scope is essential for the safe use of modern ATM and navigation techniques. ATC decision making aids, advanced surface movement guidance and control systems, Terrain Awareness and Warning Systems (TAWS),airborne separation assistance systems all contribute to enhancement of safety and they all rely on accurate and timely data. Advanced information presentation modes (e.g. 4D displays in the cockpit) enabled by the data provided through AIM improve safety in a direct way.

ATM performance – AIM is an essential enabler for concepts like CDM and enhanced airspace management. These in turn improve the predictability and efficiency of the ATM network and serve to reduce the loss of capacity through system inefficiencies to release latent capacity to meet air traffic demand. Since they all need aeronautical data, AIM is an essential enabler for better ATM performance.

Flight Efficiency – Airspace user ground systems and airborne systems can only exploit fully the capabilities offered by the new ATM system if their need for aeronautical data is properly satisfied. AIM is the means for achieving this. Data provided to aircraft in flight is especially significant in this respect. The interaction of all elements of gate-to-gate activities will be harmonised to create the "Time Ordered ATM System", to efficiently exploit the full capacity of airports and airspace.

Enabling User Applications – A basic tenet of the AIM concept is the provision of aeronautical data of the required quality in standard format, without prejudice as to how the data will be used. Specific rules and procedures for ATM and aircraft operation will ensure proper usage. This flexible approach enables the development of user applications that collect and collate data and present information to users in a way best suited to their purpose and circumstances. The availability of aeronautical data with the scope and quality that AIM represent will be an important driver for the development of new and innovative user applications that could not even be envisaged in the traditional AIS environment.

Uniformity and interoperability of systems – One of the major shortcomings of the current ATM system, is the fragmented and non-interoperable development of National ATC systems. By imposing standard data descriptions and exchange formats and being fully in line with the Overall ATM/CNS Target Architecture, AIM acts in the direction of improved uniformity and interoperability on a global scale.

Cost effectiveness - Progress is not necessarily halted completely by the

lack of aeronautical data of the proper scope and quality. Workarounds and local solutions are sometimes possible and implemented. This increases fragmentation and costs. AIM obviates the need for such solutions and offers a cost effective, uniform data management environment meeting the needs of all users in an open and interoperable networked system.

6.5 Proposed Directions for Change and corresponding Strategic Actions

Directions for Change describe the series of complementary and evolutionary improvements that will be required to progress the current aeronautical information service environment until it reaches the strategic objective. The directions of change in the *"Road Map for Change"* have been developed to meet the ICAO ATM Concept.

The Directions of Change can only be realised via a set of strategic actions, each directly related to one or more of the directions of change. In view of the complexity and time scales of AIM, with the end state called for by the strategic objective still 15 or so years away, not all strategic actions that will be required can be identified and described at this stage. However, it is possible to deduce an initial set based on which the transformation of the current environment can commence and which lays the foundation for later actions. These actions will have to be defined on a rolling basis, but always consistent with earlier steps, as improvements are introduced.

The Strategic Actions already identified are shown after the Direction of Change they are most closely related to.

It should be noted that in respect of some of the Strategic Actions, the corresponding activities are already ongoing.

To establish SWIM based AIM as a core enabler of ATM

This requires that the concept of SWIM based AIM be fully understood and accepted by all stakeholders globally. Action is required to ensure that the regions of the world progress along the same path or at least are able to cooperate with one another to provide global interoperability on the basis of agreed rules and procedures. This includes the development and approval of new ICAO SARPS and/or amendments to existing ones as well as addressing institutional, legal and technical issues as required.

Related Strategic Actions

SA1.1 *Define and agree the open scope and nature of AIM*

The scope of traditional AIS has been limited to information describing the environment in which aircraft operate. Developments in air traffic management require that its supporting information management function, AIM, covers all the data relevant to the environment as well as the conduct of flights and air traffic services operations. The meaning of the term “aeronautical data” needs to be redefined to reflect the enlarged scope AIM represents. Agreements and common understanding must be reached as a matter of priority.

SA1.2 *Develop and implement proof-of-concept AIM*

To facilitate the logical evolution of AIS to AIM to IM, a proof-of-concept for the AIM environment needs to be validated by 2008 and progressively implemented by 2012. This development and implementation activity will also be the validation and progressive refinement of the SWIM concept, forming the basis of implementing fully SWIM based IM in the 2012-1018 time frame. (It should be noted in passing that work in Europe has been initiated in this field).

To ensure an enlarged scope of AIM in order to encompass all aeronautical data

For SWIM based AIM to fulfil its role, an enlarged scope of aeronautical data will have to be agreed. Any data that carries information describing or relating to the environment (technical, geographical, atmospheric, operational, institutional) in which flights operate and the flights themselves, irrespective of flight phase, should be considered as aeronautical data and hence of concern to AIM. The consequence is that traditional divisions between, for instance, the provision of AIS and MET should progressively disappear, provided that the relevant legal and institutional issues are addressed. At the same time the enlarged scope opens the way for the easy introduction of new requirements, including those arising from Amendments to Annex 15. The need for change was recognised by the ICAO 11th Air Navigation Conference in September 2003 which recommended an urgent review of Annexes 4 and 15.

Related Strategic Actions

SA2.1 *Incorporate meteorological data within the scope of AIM*

Alongside traditional AIS, the other mainly product base service is aeronautical meteorology (MET). These products include reports on actual conditions and forecasts, specifically customized for en-route, terminal and aerodrome use. The service is typically bought in from specialized agencies of various status and some major airlines even operate their own service using data supplied by a specialised agency. In the world of MET, a clear differentiation already exists between production of the basic data (observations) and the production of MET information (reports on actual conditions, forecasts, warnings) using that data. MET services have their own version of system wide information management enabling world-wide data exchange and cooperation. It is possible to purchase the output of MET in the form of standardized products (METAR, VOLMET, SIGMET, etc.) or raw data to create own products as required. This latter option is used by several airlines, as mentioned above. MET has also progressed to the point where certain end-user services are completely automated, ATIS being just one example. At the same time, aircraft are also increasingly used as observation platforms. Traditionally pilot reports especially in oceanic and remote areas were an important input to MET forecasters. More recently aircraft of major airlines have been equipped with sensors measuring temperature and humidity, with the data being transmitted automatically via air/ground data link to the airline AOC and from there to the MET service. Meteorological services also develop and maintain other information, such as climatologic data and statistics, which have an increasing relevance to ATM especially to ENV.

Accurate MET reports and forecasts have always been essential to the safe operation of aircraft. This will not change in the future while at the same time, with the fine tuning of the ATM system, the influence of weather on ATM capacity is fast becoming an important consideration. Achieving this will involve the resolution of a number of complex issues, both institutional and technical. The technical issues will probably be less difficult to solve as the MET environment is already of a highly digitized nature. Development of a common data exchange model also for MET is however required. This will necessitate the involvement of the MET domain as well as the World Meteorological Organisation (WMO). The key challenge will be the institutional issues which are inherently more difficult to resolve. Different organizational, corporate and commercial cultures, liability issues and MET by recognition of its global nature will have to be brought together for progress to be made

SA2.2 *Implement Annex 15 Chapter 10*

Chapter 10 introduces terrain and obstacle data into the scope of Annex 15. Issues associated with data acquisition, format, ownership, temporality, etc. are very complex. In consequence appropriate actions will be needed to meet the requirements posed by these new provisions.

To transition from a product-based approach to an interoperable data based one

In the current AIS concept, users of information are provided pre-defined "products" with very little or no room for customization. With the scope of AIM encompassing all aeronautical data, and all the data being made available to users in accordance with their needs and access privileges, pre-defined products impose unnecessary constraints and are also against the flexibility principle. AIM therefore should provide data in standard format, as input to user applications the output of which is customised according to particular user needs. Hence, AIM becomes a facilitator of meeting user needs rather than imposing limitations. From AIM's point of view, the difference between text and graphics becomes irrelevant, since AIM provides only the data which can then be processed and displayed by the user application as text or graphics, as needed. Nevertheless, though this transition from a product-centric to data centric service is essential, it is foreseen that AIM will still have to cater for the provision of traditional AIS products during the transition to a global, data based service. These traditional products will also benefit from the improved data quality AIM imposes.

Related Strategic Actions

SA3.1 *Define the requirements by which aeronautical information should be maintained as individual data elements, so as to enable electronic storage, exchange, provision, update and interrogation of aeronautical information databases forming part of AIM.*

Each State publishes permanent Aeronautical Information in the AIP. This paper-based document contains text, tables and charts. A growing number of States are now publishing the information in CD-ROM format as a complement to the AIP. Transition to an electronic AIP (e-AIP,) in accordance with the EUROCONTROL Specification, may provide a true digital instantiation of the AIP information that can be applied globally, as soon as ICAO adopts the specification. The AIM concept requires that all aeronautical information, including that currently held in AIPs, be stored as individual standardized data elements to be accessed by user applications. The requirements to be developed will have to cover the AIM interfaces with the data sources and the user applications as well as the handling of data inside AIM. User applications may be implemented on the ground but also in airborne systems. Interfacing the AIM framework with airborne systems will have to be given special consider-ation.

To ensure the provision of Aeronautical data of appropriate quality and timeliness, for all phases of flight and to all users.

System Wide Information Management implies all the rules, procedures, processes and underlying connectivity that ensure the availability of the required data for all users according to their specific needs. However, the scope of AIM means that both the range of data managed and the range of users will include ATC and flight critical elements. In consequence the quality, consistency, availability and timeliness of data must meet stringent new requirements, substantially exceeding those currently considered as acceptable.

Related Strategic Actions

SA4.1 *Ensure that Collaborative Decision Making (CDM) is fully supported by AIM*

Collaborative Decision Making is one of the important operational improvements described in the ICAO ATM Concept. As the name implies, CDM is about ATM partners making decisions while working together, based on more accurate and higher quality information that has the exact same meaning for every partner involved. This is enabled through structured and managed collaborative information sharing. The information concerned covers a very wide range, from movement data through facility availability to weather. Opportunities for better use of resources, improved punctuality and predictability is the result of applying collaborative decision making techniques.

Use of CDM in the airport environment is fairly well developed in Europe, the United States and in some other States. Some of the more advanced applications specify close cooperation between the airport, ground handlers and airspace users. In the future, increasing use of CDM will also be made in the en-route phase of flight and research effort to this effect is already underway.

It is clear that CDM requires and generates data that is within the scope of AIM. Efforts to implement airport CDM early in the current environment have necessarily resulted in the re-use of existing data processing facilities at airports and in a few cases in the development of completely new facilities. While these can be cost-effective solutions and the systems are locally interoperable and able to perform message exchange with remote partners they are not built as elements of a projected global system. Obviously, CDM to meet all user requirements within the gate-to-gate context will benefit from AIM. AIM's scope, data quality and cost-effective management of data will provide the foundation upon which CDM applications can be built by the relevant domain of expertise for airport, en-route and environment management purposes.

Nevertheless it is essential to remember that CDM is not a “system”. It is a way of working, a culture of sharing information and making improved decisions based on shared information. Consequently, implementation of CDM means first and foremost the applications of the CDM principles in each of the specialised domains in a way most appropriate for the domain concerned. Supporting applications are then developed to meet the identified needs, as is happening in Airport CDM.

Without AIM, implementation of CDM and the development of applications require individual solutions to cater for the management of CDM data. With AIM, this is no longer the case. AIM will provide both the data coverage and data management functions required by CDM applications, both en-route and for the airports. For AIM, CDM applications will be like any other user application and AIM will have to consider the requirements arising from them. Conversely, CDM applications will be required to adhere to and use the applicable data exchange models which are the foundation of AIM.

SA4.2 *Define and develop the ways and means by which AIM can provide all required support to the most cost-effective implementation of the Flight Management (FDM) concept.*

In today’s ATM environment, the flight data available to stakeholder systems is often inconsistent and flight data related to the same flight consequently may describe the flight differently in the various systems. This can lead to uncertainties in planning, loss of confidence in the data and even safety may be affected if misunderstandings occur. Such inconsistencies would have an even bigger negative impact in the future ATM environment, where decision support tool and new concept will rely even more on consistent flight data. The FDM concept aims to improve the current situation and also to ensure that in the future, inconsistencies in flight data do not form an impediment to safe and efficient ATM.

The scope of AIM does not include operational flight data as such, however, it shall include all aeronautical data from which a large part of operational flight data is generated.

It is therefore essential that AIM fully supports FDM in providing aeronautical data of the appropriate quality and consistency. This is a significant requirement, as FDM is dealing with mission and safety critical data and therefore imposes very strict requirements on other services with which it is connected.

SA4.3 *Expand the means of access to Aeronautical Information*

Access to Aeronautical Information is mainly via designated facilities, whether

corporate systems (providers or major users) or at aerodrome briefing offices. Action is required to enable a variety of means of access to information, as appropriate for large corporate stake-holders down to individual private pilots.

An important element of the AIM conceptual framework is the user application that accesses AIM for data and generates the output in a variety of ways, best suited to the particular user's needs. For instance, with AIM encompassing all aeronautical data, a properly built user application becomes the desired "One Stop Shop", providing all the functions for flight preparation, planning, conduct and post flight activities. User applications will have to be scaleable so that they may be installed on a variety of platforms, from desktop PCs and laptops to handheld devices. The Electronic Flight Bag (EFB) forms an important new target for AIM. Class 1 and 2 EFBs are based on COTS products that may be used also when not on the aircraft. Class 3 EFBs are integrated with the aircraft avionics (with some Class 2 products also providing links to the avionics bus) and as such can host user applications to access the AIM framework in flight.

Activities aimed at developing the standards for AIS and MET air/ground data link applications are an important element in establishing the basis for AIM access in flight.

Connectivity to the AIM framework will have to be given special consideration. The internet provides a cost-effective and globally available resource to connect while on the ground. Appropriate security schemes are now available for both wired and wireless internet access to support the exchange of mission critical data. In flight access can be via the aircraft's own data link capability, which however will have to be able to support secure communications and also have the bandwidth required.

SA4.4 *Develop cost-effective ways for the provision of traditional AIS products during the transition to AIM*

Although the need to support the overall ATM strategy will drive the earliest possible transition to full AIM, it will nevertheless evolve over a number of years in a managed and facilitated way. Moreover, it shall be noted that the realisation of the transition to AIM may take different lengths of time in Europe and the other parts of the world and some areas may not transition at all. It is therefore not realistic to plan for an environment where traditional AIS products are no longer provided. The need for them will doubtless shrink, but they will have to be provided for during a substantial part of the transition period. Cost-effective ways will have to be developed to ensure their continued availability. This should however not be allowed to have a negative impact on the transition to AIM. It is anticipated that enhancements may include the implementation of the xNOTAM concept and possible adaptations required in the frame of the ICAO ATM Concept.

In addition, the power of GIS will be harnessed to provide effective applications to integrate and deploy aeronautical information in end-user defined intelligent applications. Such developments will be based on and incorporate the global standards being developed by the International Standards Organisation (ISO) under the 19100 series of standards.

To adopt harmonised data content, structures and procedures on a global basis for a fully digital Aeronautical Information environment

This entails the acceptance, on a global basis, of the use of compatible data standards by all relevant parties, so as to ensure interoperability of data. A prerequisite is the adoption by ICAO of a standard common data exchange model in accordance with the recommendations of the 11th ANC.

Related Strategic Actions

SA6.1 *Undertake further development of existing data exchange models and development of new ones to form the basis for world- wide adoption.*

An essential pre-requisite for the development of AIM is a uniform modelling of aeronautical information. The Aeronautical Information Conceptual Model (AICM) has been produced and a consequential Aeronautical Information Exchange Model (AIXM) necessary to enable any database, regardless of structure or language, to communicate with another was developed. Likewise, the Airport Mapping Exchange Model (AMXM) has been published. The specification, maintenance and further enhancement of these models are critical to the future development of AIS and its transition to AIM. Equally important is the timely development of other necessary models (e.g. Terrain, Obstacle and MET exchange models.) It is imperative that efforts continue to be made to achieve ICAO adoption of the common data exchange model, in accordance with the recommendations of ANC 11 and its subsequent enhancement to embrace the complete scope of AIM.

SA6.2 *Identify the content of amendments of ICAO SARPs, as necessary to achieve the objectives, and progress them through ICAO in line with the relevant conclusions of the 11th ANC*

Global adherence to common standards is a key element of AIS and will be even more so under AIM. Data will come from many global sources and output

from AIM will also be used world-wide. The data will need to be published in commonly agreed electronic formats to facilitate the ease of collection, verification and processing. Endorsement of the common exchange model by ICAO is one of the objectives for this action. Other amendments to ICAO SARPS as needed by the AIM framework will also have to be developed and endorsed to become ICAO provisions.

SA6.3 *Review the present NOTAM concept in the light of development towards a fully digital Aeronautical Information framework providing automated access to user-selected data on status of facilities and services*

The use of the NOTAM format to distribute short-term changes to AIS information has served the industry well. The introduction of the System NOTAM resulted in the ability to be more selective in tailoring AIS information to specific requirements. However, the future of NOTAM needs to be considered for two reasons. Firstly, the current format is not suited to full digital data exchange and processing. Secondly, it constitutes a product, whereas the new style of operation will be data management. As a first step, the introduction of the (EUROCONTROL/FAA) xNOTAM concept will provide NOTAM information in a digital format suitable for automated processing, while being backward compatible with current NOTAMs to enable a staggered transition of NOTAM provider and user applications. The xNOTAM will enable improved information selection capabilities and better availability, including in-flight. Once implemented and whilst remaining fully serving the needs of legacy systems the xNOTAM can progressively replace traditional NOTAM messages wherever possible and as compliant systems evolve. The initial xNOTAM concept will evolve as AIM matures, to ensure the intelligent and reliable servicing of ground based and airborne user applications with the latest facility and service status information.

SA6.4 *Progressively exploit the capabilities of GIS*

The ISO 19100 series standards facilitate the interoperability of geographic information systems. This interoperability opens up the way to new possibilities of using geospatial data and this must be fully exploited in the context of AIM.

To define the human resource activities necessary to achieve the future AIM

The strategy cannot be fulfilled by technological means alone, even taking

into account ergonomic factors in system design. A major task will be to facilitate the detailed identification and resolution of human resource issues arising from strategic development. This will entail identification of the future skills base required, the mechanisms for validating individuals' competence (whether by licensing or some other means of formal assessment), extensive briefing and consultation with participants at all levels and a need to devise appropriate training and retraining programmes. This will also be needed to meet the service provision regulatory elements of the Single European Sky. In addition, Human Factors issues will need to be addressed.

Related Strategic Actions

SA7.1 *Define the human resource considerations required to be taken into account in formulating technical and procedural development towards the future Aeronautical Information Management environment.*

Evolution from AIS to AIM will occur over an extended period, with present and future styles of operation proceeding in parallel, until staff eventually cease to be involved in detailed day-to-day information product provision. In the coming years, AIS organisations will need to undertake retraining of existing staff, and take the new skill requirements into account during recruitment, so as to reflect the management of the overall information process in the future, rather than the information product of today. Future skills requirements once AIM future functions are identified shall be defined so as to form a basis for:

- planning transitional training and recruitment;
- support to regulation for service provision:
- developing requirements for competency management related to all AIM functions, and
- licensing or other formal means of assessment for safety related AIM functions.

This is an essential task upon which the success of the AIM strategic objective itself is predicated and as such, must proceed in parallel and in some cases even precede the other strategic actions.

To resolve institutional, organisational, legal, financial and intellectual property issues associated with the system wide management of Aeronautical Information

Information management processes require mechanisms to be agreed whereby originators can retain ownership and control of their data for various

reasons including liability, security, financial and commercial aspects. Institutional issues to be taken into account include the impact of increasing corporatisation and privatisation of service providers together with the European requirement for separation of service provision and regulation. A coherent overall policy framework is needed to avoid individual organisational policies inhibiting the ready interchange of data. Some of the issues to be resolved are outside the competence of the AIM Domain. Those will have to be addressed by the other, relevant domains as part of their activity to incorporate the SWIM principles.

Related Strategic Actions

SA 8.1 *Identify and resolve the legal and financial aspects of data origination, exchange and exploitation*

The information sharing environment that AIM enables, requires that a number of issues be clarified, resolved and solutions formalized. In particular, the following aspects will need to be considered:

- Legal (information ownership, control and liability aspects in an information sharing environment);
- Institutional (regulatory aspects of information sharing);
- Business (aspects of information sharing related to cost efficiency, licensing, cost recovery etc.);
- Organisational (mechanisms for managing the rules, roles and responsibilities of the stakeholders participating in information sharing);
- Regulation of service provision (on a global, regional or individual State basis).

The definition of aeronautical data will have to be agreed and applied to a globally “Regulated Aeronautical Data Environment”. ICAO will be required to monitor this “Environment” to ensure compliance with ICAO SARPs.

A phased and managed implementation of AIM is conditional upon critical issues being resolved at or by appropriate stages of development. Consideration to these and other relevant factors will need to be given by the AIM community within its sphere of influence, including reference to other Domains’ expertise as appropriate, so as to maximise the benefits to be obtained from the implementation of the AIM conceptual framework in its entirety.

To harmonise and integrate, as appropriate, military and civil Aeronautical Information

Though ICAO has no mandate for matters military, State aircraft are considerable users of airspace. Clearly there is a need for enhanced civil/military coordination. An important enabler of this is the harmonisation and integration of civil and military aeronautical information. For national security and sovereignty reasons, the particular way in which this is achieved within any State is a matter for itself. Nevertheless, the "Road Map for Change" advocates further harmonisation of all non-security sensitive information to enable its exchange.

Related Strategic Actions

SA 9.1 *Identify how harmonisation and even integration of civil and military Aeronautical Information can be achieved*

Though military issues are outside the remit of ICAO State aircraft are extensive users of airspace and military airports are increasingly being used to service civil needs. Military AIS is adapted to national military needs and there are varying arrangements within States for exchange of civil and military information, mostly entailing manual conversion from one system to the other. Military aspects will remain a sovereign matter for individual States but action should be taken to explore and define principles for much greater interoperability to be provided in line with the AIM concept.

7. RISKS AND DEPENDENCIES

7.1 Risks

The major risk in the implementation of this strategy is that the speed of progress, both in enhancement of data quality and in introduction of digital data handling technology, will vary significantly between States. In consequence, the need to reach timely common agreement on the SARPS and procedures to be adopted as well as the institutional issues is imperative. Of equal importance is that the potential subdivision and corporatisation of ATM service provision will have critical impact. Different States have different priorities for their limited financial and physical resources and the transition of AIS to AIM may not in all cases be accorded the necessary priority.

In particular, failing to achieve rapid progress in implementation would adversely affect also Airport CDM, with the inevitable development of local, potentially non-interoperable, solutions proliferating. Further enhancement of CDM for other phases of flight requires that AIM is at least partially in place.

7.1 Dependencies

Successful implementation of AIM is dependent on the timely availability of the appropriate network infrastructure, including dedicated and public (Internet) ground networks and air/ground data-link. It is therefore essential that the Communications Strategy takes due account of the stringent communications requirements posed by AIM.

AIM requires agreements on technical standards as well as institutional issues, most of which have global implications. It is therefore essential that, as part of a single global Programme, all the standards and institutional issues are addressed and resolved as early as possible.

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Appendix 1 : REFERENCES

ATC Data Link Manual for LINK2000+ Services (V1.0 2004)
EUR ANP - European Air Navigation Plan, ICAO Doc 7754
ICAO Annex 2 - Rules of the Air
ICAO Annex 3 - MET
ICAO Annex 4 - MAP
ICAO Annex 11 - Air Traffic Services
ICAO Annex 15 - AIS
ICAO EUR DOC 010 “Harmonised Access to AIS and MET ...”
ICAO Global Plan for the implementation of CNS/ ATM Systems
FAA Guidelines for the Certification, Airworthiness and Operational Approval of Electronic Flight Bag Computing Devices (AC 120-76A, 2003)

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Appendix 2 : GLOSSARY

Definitions and Abbreviations

When used in this Strategy, the abbreviations shown here shall have the following meaning.

AFTN	*Aeronautical fixed Telecommunications Network*
AI	*Aeronautical Information*
AIC	*Aeronautical Information Circular*
AICM	*Aeronautical Information Conceptual Model*
AIM	*Aeronautical Information Management*
AIP	*Aeronautical Information Publication*
AIS	*Aeronautical Information Service*
AIXM	*Aeronautical Information Exchange Model*
AMXM	*Airport Mapping Exchange Model*
ANC	*Air Navigation Conference*
AOC	*Airline Operational Control*
AOXM	*Airport Operations Information Exchange Model*
ARTAS	*ATM Surveillance Tracker and Server*
A-SMGCS	*Advanced Surface Movement Guidance and Control [at Airports]*
ARO	*ATS Reporting Office*
ASM	*Airspace Management*
ATFCM	*Air Traffic Flow and Capacity Management*
ATFM	*Air Traffic Flow Management*
ATIS	*Automatic Terminal Information System*
ATM	*Air Traffic Management (ATS+ASM+ATFM)*
ATS	*Air Traffic Services*

ATSU	Air Traffic Services Unit
B-RNAV	Basic Area Navigation
CBA	Cost-Benefit Analysis
CDM	Collaborative Decision Making
CNS	Communications-Navigation-Surveillance
COM	Communications
DfC	Direction for Change
e-AIP	Electronic AIP
EFB	Electronic Flight Bag
EGNOS	European Geostationary Navigation Overlay Service
ENXM	Environmental Information Exchange Model
ETFMS	Enhanced Traffic Flow Management System
FDPS	Flight Data Processing System
FIC	Flight Information Centre
FMS	Flight Management System
FO	Flight Object
FRAP	Free Route Airspace Programme
FIS	Flight Information Service
4D	Four Dimensional
GBAS	Ground Based Augmentation System
GIS	Geographical Information System
GNSS	Global Navigation Satellite System
GtG	Gate to Gate
HMI	Human/Machine Interface
IAOPA	International Council of Aircraft Owner and Pilot Associations
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
ISO	International Standards Organisation
IT	Information Technology
MAP	Maps and Charts
MET	Meteorological or Meteorology
NAV	Navigation
NOTAM	Notice to Airmen
OAT	Operational Air Traffic
OCD	Operational Concept Document
OSED	Operational Service and Environment Definition
PIB	Pre-flight Information Bulletin
PIM	Personal Information Manager

P-RNAV	Precision Area Navigation
RNAV	Area Navigation
RNP	Required Navigation Performance
R&D	Research & Development
RNAV	Area Navigation
RNP	Required Navigation Performance
RRR	Rules, Roles and Responsibilities
RVSM	Reduced Vertical Separation Minimum
SA	Strategic Action
SARPS	Standards and Recommended Practices (ICAO)
SPR	Safety and Performance Requirements
SWIM	System-Wide Information Management
TAWS	Terrain Awareness and Warning System
TMA	Terminal Control Area
U/A	User Application
WAFC	World Area Forecast Centre
WG	Working Group
WMO	World Meteorological Organisation
WXXM	Weather Information Exchange Model
XML	Extensible Mark-up Language
xNOTAM	Electronic NOTAM

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