TWELFTH AIR NAVIGATION CONFERENCE

Montréal, 19 to 30 November 2012

Agenda Item 1: Strategic issues that address the challenge of integration, interoperability and harmonization of systems in support of the concept of "One Sky" for international civil aviation
1.1: Global Air Navigation Plan (GANP) – framework for global planning
f) Aeronautical information management (AIM) roadmap

INFORMATION MANAGEMENT (IM) ROADMAP

(Presented by the Secretariat)

1. INTRODUCTION

1.1 As described in the *Global Air Traffic Management Operational Concept* (Doc 9854), information management is a function that provides accredited, quality-assured and timely information used to support air traffic management (ATM) operations using information-sharing mechanisms involving all relevant actors within the ATM community. Information management is distinct from the seven operational concept components, existing instead as a pervasive and overarching dimension linking the concept components and the broader ATM community. As a fundamental enabling element of the global ATM operational concept, the timely availability of pertinent information provides the basis to make informed and collaborative decisions for best business and operational outcomes that are a key feature of the future system. To do this the information management (IM) roadmap will need to facilitate the assembly of the best possible integrated picture of the historical, real-time and planned or foreseen future state of the system-wide operating environment.

1.2 The objective of information management, within the context of the foregoing, is to manage the acquisition, processing, storage, and delivery of data and information to ensure that each actor or agent within the global ATM community is able to receive, obtain, or provide, information relative to the combined needs for situational awareness and decision making. This will allow the future ATM system to operate within an information-rich environment allowing performance gains through increased levels of collaboration. This information is sourced and accessed from multiple information domains. The domains themselves define information realms of common character, source and handling requirements.

1.3 The high-level requirements that outline the fundamental characteristics and attributes that the future ATM system will be required to exhibit to achieve the vision of the global ATM operational concept are articulated in the *Manual on Air Traffic Management System Requirements* (Doc 9882).

2. ROADMAP

2.1 The development of capabilities needed for information management have been integrated into the aviation system block upgrade (ASBU) framework. Modules within the blocks that are

oriented towards information capabilities have been organized within the global air navigation capacity and efficiency plan in an information management roadmap. This is intended to provide a timeline for development and deployment of technologies that will support the requirements of the global air navigation system and provide guidance for infrastructure planning. The roadmap itself gives a broad view of the concurrent progression of system-wide information management (SWIM), flight and flow – information for a collaborative environment (FF-ICE), aeronautical information management (AIM), and meteorology (MET). Each one of these elements is the subject of significant expert development and the roadmap can be seen as a means to look at the need for further information integration.

3. SYSTEM-WIDE INFORMATION MANAGEMENT

3.1 The global ATM operational concept envisions that collaborative decision-making (CDM) and system-wide ATM information sharing will enable significant benefits in terms of safety, efficiency and capacity. The ATM system will provide an information-rich environment where relevant data and information across a number of information domains is fused to facilitate a comprehensive situational awareness relative to the needs of the ATM community and its members. The implementation of SWIM is the premier requirement, as indicated in the *Manual on Air Traffic Management System Requirements* (Doc 9882), as the basis to achieve the needed level of information sharing and exchange. As a result, SWIM has been incorporated into the ASBU framework as a critical capability.

3.2 SWIM will provide the means to allow information to be acquired, referenced, discovered, assembled, and addressed, allowing users and decision makers the best possible view relevant to their roles and responsibilities. SWIM is envisioned to allow seamless communication by eliminating the need for fixed network connections and dedicated, closely coupled, point-to-point interfaces to connect systems. As well as allowing access to the same information set by air and ground ATM actors, SWIM also will enhance the performance of the ATM system by allowing airborne information “nodes” not only to receive, but to provide information relevant to the improvement of the overall ATM system performance.

3.3 SWIM can be described as the infrastructure necessary to allow a seamless and interoperable sharing of information across a diverse set of domains and locales. In doing so, it will be applied through an architecture that is service oriented and application-centric. The SWIM infrastructure will enable systems and applications to discover and obtain needed information, subscribe for automatic delivery, and provide information in accordance with the needs of the overall ATM system.

3.4 A great deal of study and research has already taken place to begin the development of the necessary SWIM architecture. Work on an ATM information reference and service model (AIRM) is progressing along with the definition of exchange services based on the principles of service-oriented architecture (SOA). A prototype SWIM technical architecture has been simulated and tested. A major goal of SWIM is to leverage the availability of existing technical infrastructure and to provide progressive and scalable applications introducing new capabilities.

3.5 SWIM provides a tangible and clear example of the seamless and interoperable services envisioned in the global ATM operational concept. Given the level of work now underway in a number of States as well as the global reach of SWIM, the key strategic activity during Block 0 is the development of a SWIM concept of operations. The attainment of a global consensus on the benefits to be achieved, system participation, technical operations, and a functional architecture is an essential precursor to the implementation of capabilities in the later blocks.

3.6 In Block 1, SWIM capabilities supporting ground-to-ground information exchanges will be introduced and become available. The development and implementation of SWIM infrastructure will begin the shift from dedicated point-to-point information transfers using application specific modalities to a net-centric operation where the ATM network is considered as a series of nodes, providing or using information. SWIM will provide the underlying enabling framework to allow the development of information applications supporting the most demanding and advanced features of the performance-based air navigation system.

3.7 Block 2 will see full implementation of capabilities that will enable transfers of flight and flow information, flight intent, flight objects, and interactions to support the strategic, pre-tactical and tactical management of air traffic. This will allow the aircraft to be fully connected as an information node in SWIM, enabling full participation in collaborative ATM processes. Additionally, the data exchange capabilities will allow the aircraft not only to receive a wider set of information but also become an important source of information, including meteorological data. The creation of the ground SWIM infrastructure, the information reference model, and processes and applications for ground users will have been developed and implemented in Block 1. The extension of SWIM to cover the airborne nodes will complete the SWIM framework and enable the system to be prepared for the fully advanced system capabilities that will become available with Block 3.

4. FLIGHT AND FLOW INFORMATION

4.1 As outlined above, SWIM will provide a technical infrastructure to transmit information and allow its access and assembly across multiple domains. In order to realize advanced capabilities within the ATM system, shared awareness of flight and flow information becomes increasingly relevant as system and operational complexity increases. Consequently, flight and flow information is a primary information domain and its integration within a SWIM infrastructure an absolute requirement to achieving increased system performance.

4.2 Within the Block 0 timeframe, concept development is already complete. The FF-ICE concept has been developed and outlines the information required for flow management, flight planning, and trajectory management associated with the ATM operational components. FF-ICE recognizes the limitations of the present day flight plan mechanism based on a point-to-point communications system and presents a transition to a system where operational performance targets are more easily achieved through improved access to information relative to managing the performance of an individual flight as well as overall traffic management. The full FF-ICE concept will be realized through the implementation of FF-ICE features in transition “steps”. These steps have been incorporated into the ASBU framework.

4.3 Within Block 1, strategic management of traffic flows will become increasingly effective with the ability to submit early flight information (notice of flight intent). This will become feasible with the introduction of the globally unique flight identifier (GUFI) which will act as the “tag” and “container” to identify and reference every new flight intended to operate in the ATM system. Implementing a common flight information reference model will enable ATS units to facilitate exchange flight intent information between ATM service providers (ASPs), airspace user operations and airport operations. FF-ICE implementations will focus on pre-departure information requirements.

4.4 Already under development is the flight information exchange model (FIXM). FIXM will provide a data interchange format for sharing information about flights throughout their lifecycle utilizing extensible mark-up language (XML) standard formats.

4.5 The next step of extending FF-ICE capabilities will occur in Block 2 where a further performance increase will be enabled by exchange and distribution of information after departure in support of trajectory-based operations. This will be facilitated by a protocol to support exchange and distribution of information for multi-centre operations and the implementation of flight objects. The full integration of the aircraft in Block 2 as a SWIM node will allow a transfer of information both to and from the aircraft enabling further capabilities in trajectory management.

4.6 FF-ICE will be fully implemented in Block 3. Flight and flow information for all relevant flights will be shared pre-flight and exchanged during flight between the air and ground systems through the SWIM infrastructure. The best possible integrated picture of the past, present and future ATM situation will be brought together in support of collaborative ATM and the system-wide availability of dynamic flight and flow information will support 4D trajectory management.

4.7 The implementation of full FF-ICE will be achieved through globally standardized definitions of data elements and the availability of the SWIM infrastructure to facilitate their exchange. Flight object will be fully implemented in the ground systems and will support the flight information and trajectory sharing through SWIM during all phases of flight between air and ground. All messages between air and ground systems will use standardized formats based on XML to facilitate development and evolution.

5. **AIS/AIM**

5.1 The evolution of the aeronautical information service (AIS) from a product-centred, paper-based and manually transacted system to a digitally enabled, network-centred and service-oriented information management system has been underway since the AIS/MAP divisional meeting in 1998. The need to migrate to a modern system of aeronautical information management (AIM) also was a subject of discussion at the Eleventh Air Navigation Conference in 2003.

5.2 The AIM domain provides the underlying geospatial reference for the information assembled across the SWIM infrastructure. The information provided within the domain consists of the features required to fully describe the air navigation infrastructure and the underlying terrain and cultural (human created) features. A distinguishing feature of the AIM base information is a lack of dynamic changes. What changes do occur are in response to evolutionary development of the ANS infrastructure as well as due to development activity. Closely related to this base information is the more dynamic information on the status and condition of the infrastructure features described in the base information.

5.3 In the Block 0 timeframe, the evolution of AIS to AIM is already underway guided by the roadmap for the transition from AIS to AIM. The envisioned end state of that roadmap is the AIS currently outlined in Annex 15 — *Aeronautical Information Services*, provided as digital products and services.

5.4 The current progress of redefining and providing AIS products and services in a digital form will be enhanced by the eventual restructuring of the role of AIS from a product-centred mission to a focus more compatible with the service-oriented architecture provided by SWIM. Concept development for this phase of AIM evolution is being finalized. The AIM Operational Concept will see the digitization of AIS products as a foundation for a comprehensive reworking of the AIS mission to focus on the information management role central to acquiring, storing, formatting, and making available timely, quality assured aeronautical information. In this role the outputs of AIM are focused on the needs of information users accessing through SWIM as well as ensuring the continuity of certain AIM information products. The AIM Operational Concept will build on the foundation established by the roadmap for the

transition from AIS to AIM and guide the development of a succeeding roadmap where the next phase of AIM development beyond the digitization of current AIS is more completely outlined and will integrate AIM within the SWIM framework.

5.5 An important feature of the evolution has been the development and implementation of the aeronautical information exchange model (AIXM) enabling information exchange utilizing standardized formats based on widely used information technology standards (UML, XML/GML). Further improvements to AIXM are envisioned throughout the succeeding blocks ensuring that AIM information can be accurately captured to provide a data-modelled facsimile of the ANS infrastructure.

5.6 During Block 0, AIP has also been undergoing an important evolution. AIP serves an important function to provide the base reference and "source" for authenticated information within a States domain of responsibility. With the advent and availability of high quality databases the role of a traditionally provided AIP is being challenged and needs to evolve. Nevertheless given that databases are easily replicated and distributed, there still remains the core function of determining the correct "source" of information and ensuring that the information relied upon by users is a mirror of that source. The function of AIP is not envisioned to change but its method of delivery and management is undergoing progressive enhancement. AIP has been evolving from a manually assembled, paper-issued document, to a document assembled by electronic means from a database. The document is available for printing or distribution through electronic media. Further change will see AIP expressed and maintained as a specific temporal instance of an enhanced digital data and information product, presented and maintained as electronic media.

5.7 Block 1 will allow the exploitation of the digital information resource created by the application of the technologies introduced in Block 0. This will allow the re-engineering of most AIS products in digital form available through electronic media. The availability of quality assured, digital data will allow the current mechanisms for information delivery to be re-developed to meet the functional and operational requirements of users as opposed to being structured to fit available media. A digital NOTAM is under development and trial and is expected to be widely deployed in Block 1. Fully digital AIP reference will be updated more frequently and presents opportunities to move information away from traditional NOTAM distribution.

5.8 AIM evolution in Blocks 2 and 3 will largely follow the availability of SWIM and improved distribution. In Block 0 the focus of AIM development is to vastly improve the sourcing and supply of information, ensuring that quality management extends over the entire chain of acquisition and that the information is "fit for purpose". In Block 1 the focus is to ensure the information is formatted, stored, and maintained in a digital format allowing for standardized exchange protocols and the availability of digital data. In contrast, the focus in Blocks 2 and 3 will be to prioritize the development of applications that will exploit the communication channels made available by SWIM. This will include the development of improved briefing capabilities, in-flight information delivery, and electronic charts.

6. METEOROLOGY

6.1 The development of improved meteorological information delivery is similar to AIM and closely follows many of the core developments.

6.2 In Block 0, work is under way to develop a MET concept of operations to outline the support that MET will contribute to improved ATM operations. As is the case with AIM, a focal point of current work is the development of an information and exchange model. Effort has been concentrated on preparing to transition the distribution of meteorological information to digital data. The development of a

meteorological information exchange conceptual model, a meteorological information exchange model, and an XML schema is similar to work on the development of the aeronautical conceptual information model (AICM) and AIXM models. This will allow much of the data currently structured for teletype transmission to be provided instead as digital data. Again as with AIM, a primary focus is to improve the timeliness and quality of the data.

6.3 In Blocks 1 and 2, the availability of MET information as digital data will allow for the development of new applications. In particular, the availability of digital data will enable the expanded use of MET information displayed as digital graphics.

6.4 The trend of increasing availability of digital data will continue in Block 3 with the expectation that MET information will now be delivered routinely to aircraft in-flight and displayed using digital graphics.

7. INTEGRATION AND OPERATIONAL REPORTING

7.1 For the most part, the ASBU threads in the IM roadmap and development programmes now underway essentially redevelop existing information products as digital ones. The individual threads of flight and flow, AIM, and MET map the evolution of capabilities as a domain-specific progression of existing technologies. This is most clearly evident in the AIM and MET domains. Information delivery as it is available today closely follows this progression and is provided by products that are very domain specific. That is to say that MET information is provided by MET products, AIM information by AIS products, FF-ICE information by the ICAO flight plan (FPL), etc. Given the technology that has previously existed, it is logical that the expertize in a given realm of information developed “stovepipes” of information processes covering source, collection, processing, formatting, and delivery.

7.2 The availability of modern communication capabilities and the advent of SWIM architecture afford the opportunity to re-engineer how information will be delivered to, and processed by, the end user. Nowhere is this more apparent than in how flight operations utilize information pre-flight. The base case today sees a myriad of information products, NOTAM, SNOWTAM, ASHTAM, SIGMET, METAR, SPECI, TAF, and other products that must be searched, sorted, and integrated to develop the necessary awareness of the operational picture. This has become increasingly burdensome as the need for the best possible information has resulted in adding other information sources and as the volume of information has increased.

7.3 Efforts to manage the “information avalanche” have resulted in improvements to parse the relevant information from the general supply. The development of digital NOTAM is the latest and most advanced of these efforts. Digital NOTAM will support and eventually will augment the graphical display of NOTAM information. However, these streams of information will still need to be integrated with other products to get the “total picture”.

7.4 As a development of the current roadmaps, the process under which users access information pertinent to their operational needs must be examined. Delivery applications enabled under SWIM should be developed such that users can access the status and condition of the appropriate ANS system component(s) integrating information across domains. For example, arriving and departing aircraft should be able to access a runway-focused report integrating applicable information currently found in NOTAM, SNOWTAM, METAR, SPECI, and other sources. This should be the same for other phases of flight, organized according to operational purpose rather than by domain source.

7.5 The integration of information for user purpose at the delivery end of the information chain will have its greatest near-term impact for the reporting of operational status and conditions applicable at aerodromes followed by the availability of status and hazard reporting applicable to the en-route phase of flight. Although this would seem to be a natural consequence of SWIM implementation, it will nevertheless require a thorough reconsideration of the role of specialized information products such as the NOTAM, SNOWTAM, etc.

8. CONCLUSION

8.1 ICAO is planning a divisional meeting in early 2015 that will focus on information management. The meeting will afford the opportunity to review the results achieved by the on-going AIS to AIM initiative as well as other areas. The meeting will also provide a forum to find consensus on the ways to mitigate the shortcomings noted in this paper and to agree on further roadmap development.

8.2 The Conference is invited to note the above information in relation to the information roadmap included in the global air navigation capacity and efficiency plan and to give consideration to the need for near-term improvements in the integrated delivery of operational status and condition information.

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