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WORKING PAPER

TWELFTH AIR NAVIGATION CONFERENCE

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Agenda Item 3: Interoperability and data – through globally interoperable system-wide information management (SWIM)
3.1: Performance improvement through the application of system-wide information management (SWIM)

AVIATION SYSTEM BLOCK UPGRADE MODULES RELATING TO SYSTEM-WIDE INFORMATION MANAGEMENT (SWIM)

(Presented by the Secretariat)

EXECUTIVE SUMMARY

The 37th Session of the ICAO Assembly directed ICAO to increase its efforts to meet global needs for airspace interoperability while maintaining its focus on safety. To this end, a planning framework for global harmonization and interoperability named the aviation system block upgrades (ASBU) is proposed to the Conference for incorporation into the Fourth Edition of the *Global Air Navigation Plan.*

The ASBU framework includes modules over a series of blocks, supported by technology roadmaps, which serve to progressively enhance many aspects of civil aviation operations. This paper presents the modules relating to performance improvement through the application of system-wide information management (SWIM), which comprise:

a) B1-31 and B2-31 – Application of system-wide information management

The paper also introduces notions that are being discussed today as the potential basis for the development of a global concept of SWIM. The notions and concepts reported in this paper are a reflection of present developments by several ANC Panels and are subject to future amendment as those notions and concepts are matured.

Action: The Conference is invited to agree to the recommendation in paragraph 8.

Strategic Objectives:	This working paper relates to the Safety Strategic Objective.
Financial implications:	The cost impact for SWIM related modules is expected to be moderate, but will be felt by all sectors. However, based on preliminary indications, the benefits of implementing these modules could be substantial for global system performance and, when implemented, the benefits are expected to far outweigh the costs.
References:	Doc 9958, *Assembly Resolutions in Force (as of 8 October 2010)* Doc 9854, *Global Air Traffic Management Operational Concept* Doc 9750, *Global Air Navigation Plan* AN-Conf/12-WP/3

1. INTRODUCTION

1.1 The next edition of the *Global Air Navigation Plan* (Doc 9750, GANP), will be presented to the ICAO Assembly in 2013 for approval. The draft GANP, and the aviation system block upgrade (ASBU) strategy it establishes, proposes that future air navigation technology and procedure improvements are organized and based on a consultative strategic approach that coordinates specific global performance capabilities and the flexible upgrade timelines associated with each.

1.2 Today's air traffic management (ATM) system comprises a wide variety of applications developed over time for specific purposes. It is characterized by many custom communication protocols, each with their own self-contained information systems: on board the aircraft, in the air traffic service unit, etc. Each of these interfaces is custom designed, developed, managed, and maintained individually and locally at a significant cost. Moreover, the way ATM information is defined/structured, as well as the way it is provided and used are specific to most of the ATM systems.

1.3 The expected increase in aviation demands, economic pressure and attention to the environmental impact are relying ever more on accurate and timely information. Such information must be organized and provided by solutions that support system-wide interoperability and secured seamless information access and exchange. This methodology will result in a more cost and time efficient exchange of information between providers and users. Accordingly, a planning thread for SWIM, as described in the appendices to this paper and illustrated in the attached Figure 3, is proposed for inclusion in the ASBU framework.

2. NEED FOR A GLOBAL SWIM CONCEPT

2.1 The *Global Air Traffic Management Operational Concept* (Doc 9854) acknowledges that the shortcomings of the current provision and management of ATM related information will be addressed, in part, by improvements in information management (IM). The global improvements in information management are intended to integrate the ATM network in the information sense, not just in the system sense, and are envisioned to be applied as a system-wide information management concept.

2.2 SWIM should provide system architecture for the delivery of information services to support meeting the expectations of the ATM community in different key performance areas. As a result, and over the course of the past years, research into SWIM concepts and solutions has taken place, and are already under various stages of development in different member States in a non-harmonized way. Mature modernization programmes such as CARATS in Japan, China New Generation ATM System (CNAS), NextGen in the United States and SESAR in Europe all consider the implementation of SWIM as a fundamental requirement for the future ATM systems.

2.3 Although recognizing that one size may not fit the needs of all regions, it is of the utmost importance for the consistency of the global air transportation system to achieve some level of interoperability between the different solutions that may be developed. The development of SWIM infrastructure and services should proceed in alignment with a globally accepted operational concept that will articulate the expected SWIM implementation in terms of the benefits, enablers, features, and principles for development and transition.

2.4 This global SWIM concept should also provide a common understanding of the different domains of information such as: aeronautical information, flight and flow, surveillance, meteorology, and others, as well as their operational concepts. Some exchange models and mechanisms are already being developed for some information domains: the aeronautical information exchange model (AIXM) which

is already in use, the flight information exchange model (FIXM) and the weather information exchange model (WXXM).

2.5 The following illustration depicts examples of how some information could be organized in domains and access provided for various ATM actors. Information applications would allow access to multiple domains providing improved situational awareness.

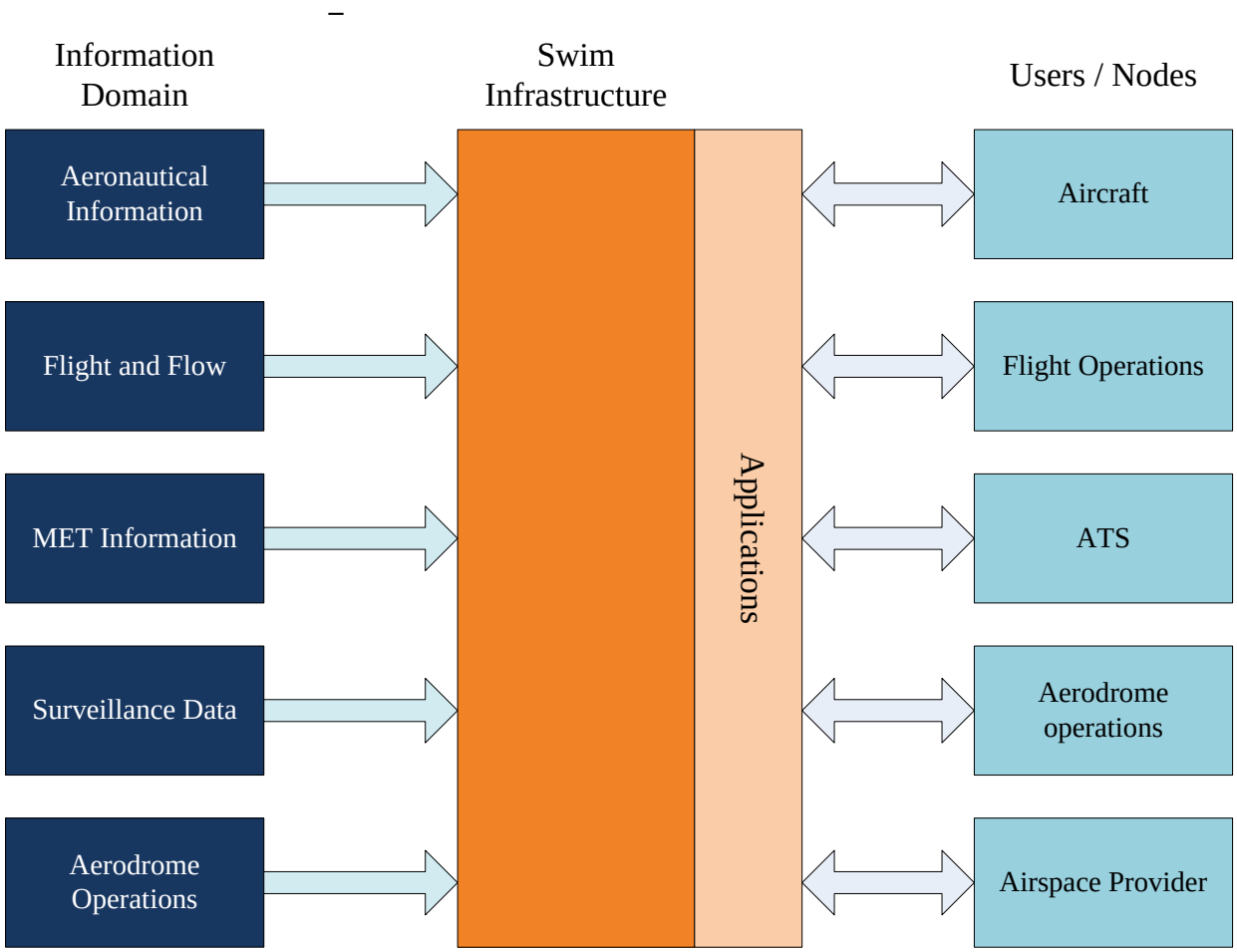

Figure 1. Example of information domains accessed through SWIM network infrastructure and applications

2.6 A global SWIM concept should describe how stakeholders will participate in SWIM, how it will be managed based on the agreed SWIM governance, and how it will be operated at the various levels (from the business and institutional level down to the technical and implementation level). The SWIM global concept will provide the foundation for further developments.

3. EXPECTED SWIM BENEFITS

The following are the benefits that are expected to result from SWIM implementation:

a) improved availability of high quality data;

b) improved shared situational awareness;

c) improved decision making by all ATM participants during all strategic and tactical phases of flight (pre-flight, real-time and post-flight);

d) increased opportunity for innovation to permit new automation potentials, e.g. automated calculation of optimal trajectories;

e) increased system performance; and

f) more flexible and cost-effective communications by the application of common standards for information exchange.

4. SWIM OVERVIEW

4.1 SWIM consists of standards, infrastructure and governance enabling the management of ATM related information and its exchange between qualified parties via interoperable services.

4.2 Envisioned components of a SWIM architecture:

a) a reference model for ATM information which will provide harmonized conceptual and logical data models covering all domains of ATM operations: aeronautical information, flight, meteorology and surveillance;

b) a reference model for information services which provides the logical breakdown of required information services and their behavioural patterns. Working towards service implementation specifications, it will include the details of services' payload, pattern of exchange, quality of service (QoS), and binding to the system-of-system data exchange infrastructure also known as SWIM;

c) principles of governance and information management functions: such as user identity management, discoverability of resources, security aspects including authentication, encryption and authorization, notification services, registration need to be defined to support information sharing. SWIM governance affects almost all the roles and their interactions within the ATM system. In addition, the management of information requires that policies related to the access and uses of information are developed. Rules, roles and responsibilities need to be defined, per stakeholder, taking into account the functional criticality of the information they handle. Data ownership, data provision and data usage rules will need to be redefined and possibly harmonized. Issues such as liability, charging and copyright principles should be proactively managed. In all circumstances, there is an increasing requirement for the definition and application of Service Level Agreements (SLA) between the different parties;

d) SWIM infrastructure is the interoperable (runtime) technical infrastructure (ground/ground and air/ground) over which the data will be distributed. Its implementation may, depending on the specific needs profile, differ from one stakeholder to another, both in terms of scope and way of implementation. It will offer SWIM technical services based as much as possible on mainstream IT technologies. It will preferably be based on commercial off-the-shelf (COTS) products and services, but it is possible that in some cases specific software may need to be developed. Typically dedicated and secured IP networks and the Internet will provide the underlying basic ground/ground connectivity; and

e) SWIM enabled applications are applications that make use of or share i\Information and information services provided through SWIM.

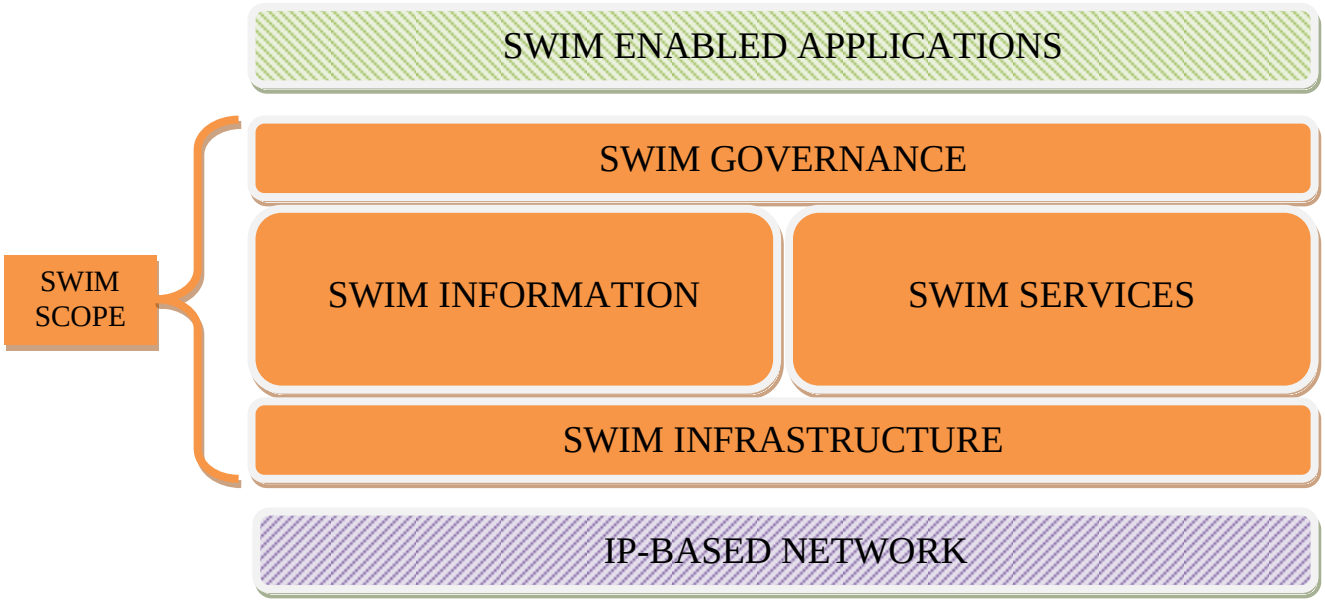

Figure 2. Envisioned SWIM components and context

5. ENVISIONED SWIM PRINCIPLES, FEATURES AND GOVERNANCE

5.1 To enable SWIM to meet the needs of global ATM it should utilize the best practices from different information communities. The aim of SWIM is to provide information to users with access to relevant and commonly understood information. This information should be of the right quality, provided at the right time and delivered to the right place, hence enabling net-centric ATM operations. In order to achieve this objective in an efficient way the following SWIM principles should be adhered to:

a) separation of information provision and information consumption. In the ATM network, almost every participant is a producer as well as a consumer of information. It is less than ideal to decide in advance who will need what information, obtained from whom and when. The key issue is to decouple producers of information from the possible consumers in such a way that the number and the nature of the consumers can evolve through time;

b) loose system coupling. Where each of its components has, or makes use of, little or no knowledge of the definitions of other separate components. By doing this the

barriers between systems and applications are removed, and interfaces are compatible;

c) using open standards. An open standard is one that is publicly available and has various rights of use associated with it. It may also have various properties describing its design phase (e.g. open process); and

d) using service oriented architecture. Driven by analysis of business processes and needs functionality is developed, packaged and implemented as a suite of interoperable services that can be used in a flexible way within multiple separate systems from several business domains.

5.2 Features of a future SWIM architecture would include:

a) addressable: information should be addressable which means that the authorized users or information consumers should be able to access it over some communication network;

b) discoverable: information should be discoverable which means that the authorized users or information consumers should be able to discover its provision by an information provider; and

c) publish/subscribe and request/reply: these two messaging patterns provide mechanisms allowing the implementation of information services (i.e. accessing and updating information).

5.3 SWIM governance issues: according to the description provided in paragraph 4.1, Standards, infrastructure and information management are envisioned to form an integral part of SWIM. All these elements need to be 'governed'. For example it is necessary to:

a) define who is involved in the approval and in the evolution of standards and which processes are to be followed;

b) define what part of the SWIM infrastructure will have to be provided by each service provider and/or consumer, consider whether some kind of national or regional SWIM authority is necessary and, if so, which components could be provided or managed by a SWIM authority;

c) define which information management functions will be executed by each service provider/consumer;

d) define the way costs will be shared by the parties participating in SWIM and the cost-recovery mechanism to be used; and

e) define and establish governance structures at global, regional and local levels.

6. ASBU MODULES – SWIM

6.1 In addition to the specific SWIM modules described in this paper, the modules relating to service improvement through digital aeronautical information management and integration (B0-30 & B1-30) as well as modules for improving operational performance through flight and flow – information

for a collaborative environment (FF-ICE - B1-25, B2-25, B3-25) are important early components of overall SWIM.

6.2 SWIM will introduce a significant change in the business practices regarding how the ATM community manages information during the entire life cycle from data origination to its usage and depreciation. As there will be a cost associated with implementing SWIM, in accordance with the *Manual on Global Performance of the Air Navigation System* (Doc 9883), regions and States will have to determine if a positive business case exists for the implementation of SWIM in their area. Consequently, the deployment of SWIM will be staggered throughout the globe.

Technology requirements

6.3 The technology requirements for deployment of SWIM are significant and essential. Harmonization of data communication infrastructure for air-ground communication at an appropriate performance level is necessary. On the ground, Internet Protocol (IP) should be available on all systems and implementation of ATS inter-facility data communications (AIDC) as the basic means for automating ground-ground communications between ATS units could be considered as a facilitating intermediate step. A common data communication baseline is essential to ensure future benefits of SWIM development. The implementation of an agreed common time reference for all systems, in the air and on the ground, is important for applications and services supported by SWIM.

6.4 At the first stage (Block 1), SWIM is composed of ground applications relying on IP networks, while most air-ground data exchanges remain based on point-to-point communication. Air-ground data link services and infrastructure are converging to ATN Baseline 2, along with development of WIMAX/AEROMACS and new commercial satellite communication.

6.5 From Block 2 and into Block 3, the aircraft should be fully connected to the network as an information node in SWIM, enabling full participation in collaborative ATM processes with access to voluminous dynamic data including meteorology. Initial implementations will be for non-safety critical exchanges supported by commercial data links.

6.6 Technology requirements and the linkages between the various blocks and modules of the ASBU framework are detailed in the technology roadmaps that constitute part of the draft Fourth Edition of the *Global Air Navigation Plan* (GANP) (AN-Conf/12-WP/3 refers).

Deployment considerations

6.7 The development of ICAO provisions for access to information and use of SWIM-enabled applications is necessary. Performance requirements for various data-communication channels in terms of safety, security, throughput and latency should also be developed. Evaluation of data transmission volumes in relation to traffic forecasts as well as future applications and services will assist infrastructure planning including spectrum and bandwidth requirements. The definition of common data formats and information exchange protocols should be considered as a priority to support progressive deployment or adaptation of appropriate ATM system architecture.

6.8 The impact of SWIM implementation on various ATM systems is likely to be complex and should not be underestimated and progressive deployments of SWIM in clearly defined phases with transition arrangements that allow for a mixture of SWIM and non-SWIM systems could be considered. As SWIM is intended as a global system, agreement on global or regional implementation milestones for some stages could be beneficial in harmonising deployment.

7. ICAO DOCUMENTATION

7.1 Changes are expected to be necessary to Annexes 3 — *Meteorological Service for International Air* Navigation, 4 — *Aeronautical Charts,* 6 — *Operation of* Aircraft, 10 — *Aeronautical Telecommunications,* 11 — *Air Traffic Services,* 14 — Aerodromes and 15 — *Aeronautical Information Services,* as well as the *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444) and the *Aeronautical Information Services Manual* (Doc 8126).

8. CONCLUSION

8.1 The ASBUs describe ways to apply the concepts defined in the *Global Air Traffic Management Operational Concept* (Doc 9854) to achieve local and regional performance improvements. The ultimate goal is global interoperability. Safety and efficiency demand this level of interoperability and harmonization, which must be achieved at a reasonable cost with commensurate benefits. The Conference is invited to agree to the following recommendation:

Recommendation 3/x – ICAO aviation system block upgrades (ASBUs) relating to performance improvement through the application of system-wide information management (SWIM)

That the Conference:

a) agree on the need for a global system-wide information management concept for air traffic management operations taking into account the proposal presented in this paper;

b) direct ICAO to undertake further work on the development of the global concept of system-wide information management and related ICAO provisions that may be necessary;

c) endorse the aviation system block upgrade module relating to performance improvement through the application of system-wide information management included in Block 1, as presented in Appendix A, and recommend that ICAO use it as the basis of its work programme on the subject;

d) endorse the aviation system block upgrade module relating to performance improvement through the application of system-wide information management included in Block 2, as presented in Appendix B, as the strategic direction for this subject;

e) request ICAO to include, following further development and editorial review, the aviation system block upgrade modules relating to performance improvement through the application of system-wide information management for inclusion in the draft Fourth Edition of the *Global Air Navigation Plan*; and

f) agree on the need to demonstrate how system-wide information management capabilities and functions will meet the needs of the future air traffic management (ATM) system.

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Figure 3. Block upgrade modules covered in this working paper