International Civil Aviation Organization

MIDANPIRG AIM Sub-Group

Sixth Meeting (AIM SG/6)
(Cairo, Egypt, 21-23 January 2020)

Agenda Item 4: **AIM Planning and Implementation in the MID Region**

OUTCOME OF THE DIGITAL DATASETS IMPLEMENTATION AD-HOC WORKING GROUP
(DDI AD-HOC WG)

(Presented by UAE)

SUMMARY
This Paper presents the outcome of the Digital Datasets Implementation Ad-hoc Working Group (DDI Ad-hoc WG).
Action by the meeting is at paragraph 2.

REFERENCES
- AIM SG/5 Report
- MIDANPIRG/17 Report

1. **INTRODUCTION**

1.1   The outcome of the Digital Datasets Implementation Ad-hoc Working Group (DDI Ad-hoc WG) is presented through PPT/1, PPT/2 and the attachment in **Appendix A** (Proposal of Regional Implementation Plan for Digital Datasets).

2. **ACTION BY THE MEETING**

2.1   The meeting is invited to:

a)   review the outcomes of the DDI Ad-hoc WG;

b)   discuss the identified challenges associated with the implementation of digital datasets as at **Appendix B**;

c)   review and update, as deemed necessary, the proposed Regional Implementation Plan for Digital Datasets; and

d)   agree on the way forward.

REGIONAL IMPLEMENTATION PLAN FOR DIGITAL DATASETS (DDS)

Proposal

MID Digital Datasets Implementation Ad-Hoc Working Group (MID DDI Ad-Hoc WG)

Version 1.1
13 January 2019

1. INTRODUCTION

1.1   ICAO Annex 15 *"Aeronautical Information Services"* (16th edition) and 1st edition of Doc. 10066 *"Procedures for Air Navigation Services – Aeronautical Information Management"* (PANS-AIM) represent a paradigm shift for the role and importance of aeronautical data/information provisions as performed by a State AIS.

1.2   The new edition of Annex 15 denotes a major restructuring of the prevision Annex in order to facilitate the incorporation of new technical requirements and how to manage Aeronautical Information (AI) within a modern and technological AIM environment.

1.3   The first edition of Doc. 10066 has incorporated the existing provisions in Annex 15 that were appropriate for a PANS document in order to span the gap between the guidance in Doc. 8126 *"AIS Manual"* and the Annex 15 SARPS.

2. PROBLEM STATEMENT

2.1   Beyond doubt, presently, AIS world is in an extensive process of transformation by transitioning from traditional product-centric provision to a data-centric and system-oriented solution.

2.2   The previous 15th edition of Annex 15 identified three (3) main digital dataset categories: Terrain, Obstacle and Aerodrome Mapping datasets while in the new document edition two (2) other classes have been added: AIP and IFP datasets respectively.

2.3   The major consequences for AIS community of the transitional process AIS – (A) IM – IM are the paradigm shift within condensed period as follows:

(1) Mind-set change from "handle" towards "understanding/manage the data",
(2) Emerging of the technology in AIS day-to-day operations (tools, database) and,
(3) Knowledge of and acquaintance with "external" activity domains: Instrument Flight Procedures Design (IFPD), industry ARINC 424 coding, RTCA DO-272, 291 and ARINC 816 standards, Terrain and Obstacles data (TOD) and Aerodrome Mapping Database (AMDB).

2.4   It should be acknowledged that besides the "heavy" technological system aspect, the implementation of datasets is also reliant on cooperation between the industry i.e. commercial vendors offering AIM solutions and the AIS Providers.

2.5   The most demanding activity for States AIM appeared to be the digital datasets implementation. This challenge is related to various factors, namely operational, institutional, financial and technical aspects.

2.6   The problem statement resides in the risk for States not being capable to deliver a consistent solution for aeronautical datasets, hence resulting in a proliferation of different ways of providing digital information and, consequently, jeopardizing the (SWIM) interoperability of data exchanges.

2.7   However, the fact that Annex 15 suggests a partial and progressive provision of the datasets (notably the AIP data set) indicates that the focus is on "starting the ball rolling" rather than requesting a complete, fully-fledged solution.

2.8   Definitively, ICAO focus is on a harmonised, interoperable provision of the datasets, based (ideally) on common implementation strategies, community specifications or acceptable means of compliance e.g. in Europe, where there is a regulatory framework oriented in this direction.

Important Note:

*The Implementation Plan proposal and timelines are considering the "**DDI - Challenges, Best Practices and Proposals**" document which explains in great details the issues identified within (1) institutional, (2) financial and (3) technical areas respectively related to digital datasets provisions. The document intention was to outline and provide guidance on what issues should be resolved prior to and during the implementation of digital datasets.*

3.   DIGITAL DATA SET DEPLOYMENT CONSIDERATIONS

3.1   General Considerations

3.1.1   The implementation time is highly dependent on how ready the user community is and how interested is to use and to deal with digital data alternative, instead of continuing processing State AIP packages in the form of electronic or paper support. Therefore, the implementation success should be seen as "binomial" i.e. both actors prepared and ready to exchange the data.

3.1.2   The proposed timelines for the implementation plan are based on the pre-requisite that respective State owns an up & running AIM system because digital data sets provision should be a completely automated process.

3.1.3   For those States not employing such a system so far, the proposed timeline for the AIS datasets provision and management is not applicable because it does not include the "stretch" from system acquisition, testing and in-operation time, which, in a practical sense, may take several years.

3.1.4   One of the conclusion resulted from a recent user survey conducted by European Organization for the Safety of Air Navigation (EUROCONTROL) is that the three (3) specific user categories (IFR, VFR and Data-houses) are interested in using digital datasets in relatively short term i.e. now or in the next two (2) years.

3.1.5   The timeframe of two (2) years gives an indication for an overall "lead period" that should be considered for the implementation plan timeline.

3.1.6   Another important aspect is the need for States to establish a "transition period" in order to give the chance to their AIP subscribers reaching the technical capability for handling digital datasets.

3.1.7   Regarding (especially) AIP datasets, the transition period would imply a "duplication of information" i.e. published AIP tables available in parallel as digital file and that may raise legal concerns related to which is the "primary source" i.e. liability/authoritative status on the information, particularly, at Data-Houses level.

3.1.8   However, based on EUROCONTROL survey, a significant part of the AIS customers have confidence that the State AIP should continue to include the tabular data even if the same data is available as digital file.

3.1.9   At general level, the implementation plan actions should also be contingent to the latest developments of the ICAO Roadmap to SWIM environment for which the Airspace System Upgrade Blocks (ASBU) consider a transition up to 2025.

3.1.10 It is commonly understood by ICAO, AIS community and their "next intended user" that the deployment of the AIS datasets should be performed in a coordinated manner within the region, inter-regional and worldwide level.

3.2   Specific Factors considered for Implementation Timeline

3.2.1   The provision of the digital AIS datasets requires dedicated series of specifications and precise coding rules. Simply this can ensure data inter-operability and provide assurance to the end-users/service consumers that the data can be used safely and efficiently.

3.2.2   As an informative detail, EUROCONTROL has already initiated the development of specifications for digital dataset that cover: (1) Coding guidelines (2) DDS business rules and (3) DDS distribution services (refer to paragraph 3.2.5 below). The coding guidance includes mapping of PANS AIM data set subject/properties into AIXM 5.1.1 features attributes and associations.

3.2.2.1 However, out of the three (3) categories enumerated above, the BRs seems to be the most relevant and complex.

3.2.3   To date, work is in progress regarding Obstacle dataset as well as the initial effort has started for the Instrument Flight Procedure (IFP) dataset coding rules which is dependent on the new AIXM 5.2 version (in preparation) modelling the PBN concept and satellite-based procedures.

3.2.4   The provision of the AIP data set implies that the data is converted into AIXM 5.1/5.1.1 and that the system has the capability to extract and pack the data according to the rules and packing requirements contained in the AIP data set specifications.

3.2.4.1 The AIXM format version requirement – refer to paragraph above - is considering interchangeably either AIXM 5.1 or 5.1.1 version because, from the temporality and data definition points of view, they are the same. Therefore, for practical reason, the AISPs that just acquired or plan to acquire shortly an AIXM based-system should not (unnecessarily) be limited to have the upgraded system limited to AIXM 5.1.1 only.

3.2.5   Also it may be worth noting that together with the AIP data set specification, there is a "data set distribution service" specification that paves the way to implementing a SWIM Service in this context.

3.2.6   Therefore, the States owning an AIM system will have to make sure with their supplier that this new capability i.e. system upgrades will be in place and when it will be available.

3.2.7   Mindful of complexity and "newness" of the AIS data sets, a phased approach is recommended for implementation as follows:

(1) AIP dataset i.e. digital data is available in local systems + forthcoming specs,
(2)/ (3) Obstacle & Terrain dataset (relatively similar situation),
(4) AMDB (requirements and product specification already existing) and,
(5) IFP dataset i.e. very new (few States have already digitally coded procedure data and specifications are pending).

Note: The Terrain data set is in a way set apart from the other DDS based on the format of the exchange model; if the other four (4) are and will be based on AIXM, the terrain data set does not have a similar means of exchanging specified.

3.3   Development plan of formal EUROCONTROL Specifications (*Extracts from Action Paper, AIM/SWIM Team-17/AP06*)

3.3.1   As mentioned in paragraph 3.2.2 above, EUROCONTROL has defined a plan for the development of formal Specifications to be applied by the European Civil Aviation Conference (ECAC) States for a harmonized deployment of Digital AIS Datasets and Provision Services respectively.

3.3.2   The Digital Dataset Specifications are the central and essential element i.e. "working tool" for guaranteeing the implementation in a coherent manner.

3.3.3   Clearly, the current Specifications deliverables timelines are to be considered as a helpful reference as well as the driving component for the MID implementation plan proposal for the sake of an inter-regional operation consistency.

3.3.4   Explicitly, EUROCONTROL Specifications calendar is summarized as follows:

Preparation **AIP & Obstacle DDS**	**Q4 2019**
Public Consultation + Workshop	**Q1 2020**
Publication **AIP & Obstacle DDS v1.0**	**Q2 2020**
Starting **IFP DDS** process	**Q3 2020**
Finalization **IFP DDS**	**2021**

3.3.5   Besides the Specifications delivery timeline as outlined above, the AIM system capability is another element to be taken into account for a realistic implementation timeframe.

3.3.6   EUROCONTROL has coordinated with ICAO IMP/WG-A that the Vol. 4 of newly structured Doc. 8126 "*Aeronautical Information Manual*" will reference the EUROCONTROL Digital Dataset Specifications, Coding Rules, Examples, Explanations, etc., for ensuring harmonization of data set content and scope within the regions and, ultimately, globally wise.

3.4   Summary of the factors considered in the DDS Implementation Timeline

3.4.1   The DDS Implementation plan is illustrated in form of matrix listing the needed implementation activities as detected throughout the analysis of the MID DDI Ad-Hoc Working Group. In principle, there were examined three (3) main domains: institutional/regulatory, financial and technical, each area having identified the challenges and issues, which have triggered the necessary actions.

3.4.2   However, in addition to these three (3) threads "officially" identified by ICAO, there is a fourth one: operational thread because there should be some considerations of the (AIS) workflows associated with the provision and distribution of the DDS, interactions with the current processes, etc. A kind of a "Concept of Operations" (CONOPS) around the datasets should also be considered.

3.4.3   The scope of the CONOPS should be to achieve the common understanding and harmonisation, for instance: agreeing on a set of business rules to govern the DDS, establishing common coding guidance and interpretation, the designation of the "authoritative source" (when both DDS & AIP is provided), etc.

3.4.4   Succinctly, the leading factors affecting the plan timeline estimates are the missing guidance e.g. Doc. 8126, Vol. 4, imminence of AIXM 5.2 model, readiness and schedule of EUROCONTROL Specifications, AIM system upgrades, SWIM interoperability and clients awareness and capability to use the datasets.

3.4.5   To be highlighted that the proposed timelines apply only to States already employing an AIM system.

- END -

Appendix 1
This matrix is intended as a template for the States to be used in their national implementation plans

			Estimated Time Frame	
No.	**Implementation Activity**	**Description of the Proposed Action**	**Start**	**End**
1.	**ICAO**	ICAO to publish new Doc 8126, Vol. 4. as guidance material on Digital Datasets (DDS) implementation requirements;		
2.	**Regional Plan (ICAO MID)**	ICAO MID to update and adopt the Regional Plan to enforce States for completion of Integrated AIM Database Step (Phase II) as prerequisite condition for DDIs;		
3.	**Institutional/Regulatory (National Level)**	State Regulator to establish an AIM Task Force Group (Inspectors, AIM units' focal points) for assessment of new ICAO SARPS;		
		State Regulator to elaborate and approve the necessary amendments for the AIM national regulatory framework (rules, regulatory obligations and local instructions);		
		State Regulator to be engaged for updating the national Roadmap, Phase 3 "Information Management" with the new "Datasets" step;		
		Plan (actions and timelines) for introduction of digital datasets.		
		AIS units to amend the procedures and processes in accordance with the new procedural changes;		
4.	**Financial**	State AIM to initiate and conduct a financial evaluation/assessment for an AIM system implementation and/or evolution, AIM processes adaptation, resources anticipation;		
		State AIM to consider the adequate budget for further resources i.e. adequate qualified AIS personnel and relevant training;		
		State AIM to ensure that in the project budget are including costs for technical specifications, tender procedure, procurement and contract finalization, system implementation/operation, maintenance/bugs fixing, staff hiring, etc.		
		In case of existing system enhancement, it should be treated as a full iteration process of the initial financial/investment stage.		

MATRIX OF PROPOSED ACTIONS RELATED TO DDI AND THE TIMETABLE

5.	Technical	Avoid Data Duplication: State to examine the conclusion of a Service Level Agreement (SLA) between neighbouring/adjacent States as a collaborative mechanism for defining an "authoritative source" in order to avoid duplications i.e. referencing the neighbouring data;		
		Distribution Services: Implementing DDS as SWIM services (registry, service description, discoverability, user management, security, etc.) thru SWIM interfaces;		
		Dataset Format: Implementation of AIXM 5.1/ 5.1.1 as a minimum support for temporality mechanism i.e. compatible with perm + tempo data; future version AIXM 5.2 for full-scale handling of all five DDs e.g. IFPD dataset.		
6.	Implementation Transition Plan	State Regulator to perform a national survey of operators, aviation entities, AIP subscribers and other users for assessing their capability in ingesting digital data and for understanding their plan and deadline.		
		ICAO to advise/recommend States a dedicated survey questionnaire with a specific set of questions (web-based or paper template).		
		State AIM to set up a transition plan time for provisions of eAIP in parallel with digital Dataset(s) and determine a "sunset date" based on the survey conclusions.		
		ICAO to propose a (general) text for the content of the Aeronautical Information Circular (AIC) describing State plan regarding datasets (partially or fully) implementation and stating the decided "grace period" after when the datasets are provided in digital format only.		

Notes:

1)   Most of the implementation activities can be performed in parallel, like for example, in case of an existing and operational AIXM 5-based system, the technical challenges can be handled concurrently. In addition, mindful of the project complexity, the AIXM system acquisition or upgrade should be started well in advance once the State Regulator has set up the high-level implementation plan.

2)   Besides and based on the progress of SWIM concept, other potential solutions may be considered as service-oriented rather than system purchase and/or its upgrade. The service-oriented solutions can be developed or acquired independently or on top of the AIM system; e.g., having the (SWIM) interfaces may be sufficient for accessing and collecting the aeronautical data for developing a data set service.

DIGITAL DATASETS IMPLEMENTATION (DDI)

Challenges, Best Practices and Proposals

MID Digital Datasets Implementation Ad-Hoc Working Group (MID DDI Ad-Hoc WG)

Version 2.2
23 June 2019

1. INTRODUCTION

ICAO Annex 15 *"Aeronautical Information Services"* (16th edition) and 1st edition of Doc. 10066 *"Procedures for Air Navigation Services – Aeronautical Information Management"* (PANS-AIM) represent a paradigm shift for the role and importance of aeronautical data/information provisions as performed by a State AIS.

The new edition of Annex 15 denotes a major restructuring of the prevision Annex in order to facilitate the incorporation of new technical requirements and how to manage Aeronautical Information (AI) within a modern and technological AIM environment for paving the way to SWIM implementation.

The first edition of Doc. 10066 has incorporated the existing provisions in Annex 15 that were appropriate for a PANS document in order to span the gap between the guidance in Doc. 8126 *"AIS Manual"* and the Annex 15 SARPS. The PANS-AIM is complementary to the SARPS contained in Annex 15 and Annex 4 respectively and it includes provisions in support of the transition from product-based AIS to data-centric AIM.

2. PROBLEM STATEMENT

Generally, the main areas subject to Annex 15 and PANS-AIM changes are related to digital data exchanges, to Quality Indicators, to integration of modern aeronautical information products (Digital Data Sets) and to the scope of aeronautical data/information (Aeronautical Data Catalogue).

The Data Quality Specifications have been expanded by adding four (4) data characteristics i.e. timeliness, completeness, traceability and format to the existing three (3) parameters i.e. accuracy, resolution and integrity. All seven (7) parameters are defined and consolidated from other Annexes into a "one-stop shop" PANS-AIM. However, the data quality parameter list has not only been extended to seven (7) parameters, but the application guidance is now in industry standards i.e. the State challenge is directed now to the prerequisite of an automated system implementation.

The description of the AIM data scope is contained in the Aeronautical Data Catalogue (ADC). The Catalogue provides detailed explanation on the data subjects, properties and sub-properties and the data quality requirements applicable from origination through to publication.

The Aeronautical Information Products have been enlarged with the provision of five (5) Digital Data Sets: AIP, Terrain, Obstacle, Aerodrome Mapping and Instrument Flight Procedure (IFP) Dataset.

Also, a new point of view was introduced with the new Annex 15 i.e. the division of the Aeronautical Information Products into two (2) basic categories: Aeronautical Information in a standardized presentation (Aeronautical Information Publication (AIP), AIP Amendments, AIP Supplements, AIC, NOTAM and aeronautical charts) and Digital data sets.

The previous 15th edition of Annex 15 identified three (3) main categories: Terrain, Obstacle and Aerodrome Mapping datasets while the new document edition has been added two (2) other classes: AIP and IFP datasets respectively.

From the perspective of transposing the Annex 15/PANS-AIM requirements, the most demanding activity for States appeared to be the digital datasets operational implementation. This challenge would be related to different factors, namely institutional, financial and technical issues as well as lack and/or insufficient guidance material.

Consideration is also given that, despite the yearlong provision requirements and adequate assistance and support, as of today, in many regions there is (still) an inconsistent or lack of delivery of terrain, obstacle and aerodrome mapping datasets. However, the experience gathered in the provision of the first three categories of data may have a constructive influence on the new ones delivery.

In summary, the problem statement resides in the risk for States not being capable to deliver a consistent or complete provision of aeronautical datasets, hence resulting in a proliferation of different ways of providing digital information and, consequently, jeopardizing the interoperability of data exchanges.

3. CHALLENGES

In regard of national planning and implementation, the general consent is that States should follow a general strategy covering (1) institutional, (2) financial and (3) technical aspects related to digital datasets provisions.

Also, a potential challenge may reside in the specific status of the AIS organization within the Aviation Administration as well as the operation structure i.e. working arrangements with other national service providers which can be different from one State to another.

Typically, the State AIS HQs is covering the provisions of "GEN and "ENR" type of data in the respective AIP sections while airport AISs and/or other ANSPs should cover the airport(s) related data/information. Hence, digital datasets provision is subject of the "split" in respect of responsibility for data gathering and, most important, for the data quality.

The classical example of "splitting responsibility" is inside the Terrain and Obstacle Data Sets where Area 1 (entire State territory) is part of central AIS while the Area 2 to 4 data have to be covered by ANSPs/Airports. Moreover, the IFP Datasets provision may be more complex in cases where the IFPD process is not "centralized", but dispersed among several regional CAAs/ANSPs and/or airports. Mindful that the IFP datasets would imply a "consolidated" file of all procedures in the country, the integration (technical) challenge is to be highly considered i.e. different AIXM file versions or paper base documentation that have to be converted/encoded by the AIM HQs staff.

The initial impact assessment of the above listed factors has identified the following high-level challenges, issues and open questions:

3.1 Institutional/Regulatory Challenges

The transposing of the new Annex 15 and PANS-AIM requirements is not only a simple task of identifying the references in the existing national regulations and updating the processes to notify or stop notify significant differences to ICAO in the AIP GEN section.

The regulatory approach should comprise the following stages:

1) Update of AIM rules, instructions, operational procedures, add new processes for, especially, new AIP & IFP datasets,
2) Review by the Regulator of the national AIM roadmap and,
3) Update/ establishment of the responsibilities among the AIM as prerequisite for successful Dataset publishing which may include:

- Established rules for Data originators to participate in the data chain. For example, to have guidelines for airport how to manage and create aerodrome mapping database and how to exchange this information with regulator/ANSP.

- Establish the environment for the end-user to participate in the data-chain to define the use-cases for the data and Data Quality Requirements. For example, the airlines requesting the declared distances to input data for the performance calculation software or ATC to receive the information for ATC controllers in order to enhance situation awareness.

The Regulator's strategic engagement and directives should trigger the track of AIM "operational" implementation. Needless to say, this should be a well-founded and important activity, but, in the same time, it is a bureaucratic and lengthy process.

Moreover, to be well noted that Amendment 40 is endorsing new categories of datasets among which the IFP dataset is a complete "new world" for AIM. This is adding much more complexity to the "picture", not only on the technical implementation side, but in the regulatory update process as well.

In brief, following institutional issues could be encountered:

- Absence of National Policy for digital datasets, hence there is no clear assignment of responsibilities concerning origination, processing, managing and distributing the digital data;
- Lack of National Strategic Plan originated by the Regulator and identifying the major milestones for DDI and an uniform AIM evolution across the country;
- Bureaucratic and time-consuming process for the Regulator strategic involvement and directions;
- Deficiency of establishing the responsibility for the datasets as 'authoritative data source" in regard of the end-users;

The ICAO regional and implementation plan is deemed for update as a top-down approach for the national evaluation (regulatory framework, financial & technical) and set up of the implementation plan. To date, the ICAO Global AIM roadmap does not contain the "digital datasets" step. The datasets are interlinked with some of the roadmap Phase I *("Consolidation"),* Phase II "*Going Digital*" and (mostly) with Phase III "*Information Management*".

The setup of Quality Management (QM) system could be strongly connected to the updates of the database, from which the datasets are being published.

The QM should present the overview picture on how the organizations will work and establish the structure that enables data flow like, for example:
- Receiving the requests from originators,
- How to make data accessible effectively for end users.

This step could prepare the base for the working environment and AIM departments for dataset provisions.

It is obvious that the existence of an "integrated database" (Phase II) is a pre-requisite for the datasets implementation as the dataset is the logical, natural result derived from database and automation. Other transition steps (Phase 3) are directly related to datasets, like the aeronautical data exchange/system interoperability, Service Level Agreement (SLA) and training.

3.2   Financial Challenges

Evidently, the DDS provisions are intrinsically dependent on a functional and up-and-running AIM system. Therefore, consideration should be given by States on the financial impact, economical effort amount and investment strategy aspects when transitioning to a full A(IM) environment.
Definitively, the financial effort for a State is quite significant in terms of equipment and resources regardless of the level of implementation i.e. the economical factor is different for States having already AIM systems in operation compared to those who have not, but, in both cases, the investment may be considerable. Therefore, a phased-approach investment strategy may be envisaged.

Nowadays, with the releasing of new scenarios like digital datasets etc., the investment to upgrade an existing system is very complicated. For this purpose, a use-case oriented investment should be considered, as follows:

Situation:
The already established AIM system has its database and the data inside are only partial and there is no connection between data originators and end-users.

Goal:
AIM system is able to produce datasets directly from database and these datasets are ready to be used by end-user with complete information from Data originators.

What is missing?
The systems which should be able to fit into existing environment in order to cover the entire data chain i.e. from data originator integration to dataset export and publishing.

Example of the steps:
Prepare environment research, prepare requirements for the industry, make market research, formulate the strategy for multiple/single providers and prepare the financial planning.

However, the implementation of datasets (fully or partially) cannot start without an operational AIM database. This prerequisite demands already a large investment, resources and training.

Moreover, the process for having a new AIM database/system operational is a multi-year activity. To name a few, the budget approval, technical specifications, tender procedure, selection and contract finalization, system implementation/operation, bugs fixing, staff training, capability enhancements are a "long way" from "zero to full" system running. This is also the case if some States decide to do a one-time Commercial Off-the Shelf (COTS) acquisition, the "real life" experience has shown that, actually, there is no key-turn solution.

Just as importantly, for an existing AIM system, the technical "adaption' for handling the datasets provision implies an extra (significant) financial effort mindful of the necessary technical enhancements e.g. SWIM as delivery mechanism, AIXM 5.1 model and its temporality concept update.

One State best practices have shown that the financial effort and investment may be surmounting the initial system setup costs due to "heavy" modules (required) implementation as SWIM services/infrastructure, business rule engine, possible migration/exchange within regional databases, data visualization (graphic) capabilities, etc. compared to the initial system setup envisaging, mainly, eAIP application only.

Concisely, following financial issues can be identified:

-   **States without an AIM system**: Lack of financial resources i.e. large investment and multi-year activity for implementation from "scratch" of an AIM system, even in case of COTS purchase or,
-   **States with AIM system in place**: Serious effort in allocation of additional investments for enhancing/adapting the existing AIM system capabilities, for example, SWIM infrastructure, in order to technically handle the datasets provision;
-   Consideration for further resources i.e. adequate qualified AIS personnel and relevant trainings;
-   Lack of cost-recovery policy for producing the digital datasets;

Currently, the challenge is to establish complete AIM data chain, which is fulfilling the end-user requirements. So, without satisfied customer (end-user) and active supplier (data originator), it is demanding to financially evaluate the business case and the investor (ANSP/Regulator/ buyer of the AIM system) may not satisfied with the investment into the such business.

Integration of the data into other systems could play another very important role in cost-benefit analyses. Preliminary step for this could be the integrated set of practical use cases.

3.3 Technical Challenges

3.3.1 General considerations

Openly said, the commercial vendors are not following closely and in full the AIM "technological" developments, but rather in a "selective mode" due to their business-driven decisions. To date, there are some "datasets" already implemented by industry like Aerodrome Mapping Database as this has a commercial benefit within the cockpit-based Airport Moving Map application. Same situation is with eTOD, but from data integration aspect only i.e. not from "raw" terrain and obstacle package side.

At the lower end in respect of implementation progress by industry, there is the IFP dataset due to the lack of the specific expertise for producing/encoding and providing the datasets associated with the procedure design and charting.

A better position for the industry support should be for AIP dataset implementation as many AIM vendors have developed an eAIP application generated from a Static Database repository (SDO).

Therefore, the general opinion may well be that the industry might bring their support i.e. helping States to have an AIM system operationally dealing with DDI in a long run only and lesser during the initial implementation phase.

This practical aspect is particularly difficult in respect of implementation challenges. The "deep-dive" technical analysis has resulted in, but not limited, following issues that are grouped below per each dataset type:

3.3.2 AIP Dataset Technical Challenges

The AIP Dataset (AIP DS) is a new requirement and one of the most challenging topics among the five (5) digital sets. It covers the extent of information as provided in the AIP including the core data necessary for flight planning and en-route navigation (waypoints, navaids, routes, airspace, airport and runway data). The PANS-AIM document contains an explicit list of the minimal features and properties that should be included in an AIP DS.
Specifically, following challenges have been identified:

- **Cross-border data duplication** (common FIR boundaries, route segments, navigational aids, terminal procedure segments/routes): Some feature are listed "twice" and non-consistent in neighbouring State AIPs. More explicit, as example, for AIP Data Sets, the level of AIS coordination between the neighbouring States can range from none to full. By lack of coordination or due to operational needs, some data might be duplicated in the data sets provided by different States. In addition, there is a risk that each (neighbouring) State will code the same data based on their own interpretation of the data exchange format/model.
  Following below are some issues that require special attention in case of "shared" data:
  Airspace borders that refer to State or other natural e.g. along the river, along common border, etc.

  - Shared waypoints on the border w/ different coordinates,
  - Cross-border route segments;
  - Terminal navaids used for procedures that extend in the neighbouring State airspace;
  - Mixed versions of AIXM model (mapping necessary for AIXM 4.5 versus 5.x),
  - Common/agreed between States of encoding specifications;
  - Same data is present in more than one dataset: It should not be an issue, as long as there is a possibility to verify that it is the same data i.e. either by a "natural key" or by a unique identifier (e.g. UUID).

- **Information inconsistency:** The AIP DS description is provided in two places in PANS-AIM. The paragraph 5.2.1.1.3 mentions the AIP sections that may be left blank when AIP DS are available. Totally, the list contains nineteen (19) AIP sections e.g. GEN 2.5, ENR 2.1, ENR 3.1, 3.2, 3.3. & 3.4…AD 2.19, 3.18 and 3.18.
  The paragraph 5.3.3.1.1 describes the data subjects and properties minimum list like, for example, ATS airspace, Special activity areas, ATS Routes, Waypoints, Runway, etc.
  By comparing and crosschecking both information, some sections listed in 5.2.1.1.3 are missing in the subjects list of paragraph 5.3.3.1.1 and vice-versa as follows:

  - GEN 2.5 (List of Radio Navigation Aids) – *missing;*
  - ENR 3.6 (En-route Holdings) – *missing;*
  - ENR 4.1 (Radio Navigation Aids – en-route) – *missing;*
  - ENR 4.5 (Aeronautical Ground Lights – en-route) – *missing;*

  In reverse:

  - Aerodrome/Heliport Information (AD 2.1/2.2 AD 3.1/3.2) – *missing;*
  - Runway, Runway direction, Declared Distances, FATO/TLOF (AD 2.12, 2.13, 2.16 and AD 3.12, 3.13 & 3.18) – *missing*;
  - Radio Navigation Aids En-route (ENR 4.1) – *missing;*

- **AIP Data Set or Data Sets:** According to Annex 15, paragraph 5.3.2.2 "*Recommendation*", a State may provide a data sub-set instead of the complete AIP Dataset. Mindful of the ultimate intention i.e. data feed of end-user applications, one question is arising:
  The grouping of the available data sub-set does or doesn't have to follow certain criteria for a logical combination?
  Yet, the grouping of the available data sub-set is not defined in order that the file should be of value for the end-users/consumers. For example, if a State decides to provide lower ATS Routes, En-route holdings and AD 2.2 information, it would be theoretically filing compliance, but is the digital "package" of any (end) use?

- **Delivery mechanism:** There is no guidance in PANS-AIM of the delivery solutions (manual processing of existing data, queries?) or, most preferably, as SWIM service on AIS website and WFS interface (expose current export HMI, push/pull interfaces, ICD, etc.) including service description, discoverability, user management, security thru Internet Protocols.

- **Missing Metadata**: Regarding the technical challenges for delivery mechanism – refer above, the clarification on the required minimum set of metadata (Annex 15, paragraph 5.3.2) at the Timeslice level is missing.

- **Data Set Format:** There is no specific recommendation for an AIXM version suitable to digital datasets exchange. PANS-AIM is continuing to require like in the former Annex 15 that aeronautical data exchange model should apply a commonly used data-encoding format, covering all the classes, attributes, data types and associations and provide an extension mechanism. A new AIXM version might introduce new data items, additional properties to existing data, different coding capabilities (such as a new type of time slice), etc.
  Therefore, mixing data from different AIXM versions might lead to incompatibilities/errors.

- **Allowed Feature Types**: PANS-AIM contains in paragraph 5.3.3 the following note: "A *data subject may appear in multiple data sets."* The question is to which extent a Data Set can contain features that are not explicitly specified by ICAO as being part of that dataset? For example, can an AIP Dataset contain also obstacles or SID/STAR procedures?
  The provisions for obstacle, airport mapping and terrain data sets existed already in the ICAO SARPS before the new Annex.

The common understanding is that an obstacle data set shall contain obstacles only, neither terrain, nor other AIS data. However, by the fact that Annex 15 provides separate specifications for the AIP and for the Instrument Flight Procedures data sets respectively, it indicates that the intention would not be to mix these topics. The classical example is that the procedure design expert has the obligation to provide on charts the obstacle(s) considered critical per one procedure segment. Would that not mean that obstacles & terrain "may appear in multiple datasets" i.e. IFP, Obstacle and Terrain?

- **Provision and Update Process**: AIP Data Set "*shall contain the digital representation of aeronautical information of lasting character (permanent information and long duration temporary changes) essential to air navigation.*" i.e. AIP AIRAC Amendment + AIP SUPPs (refer to PANS 5.3.3.1.1, Note 2). Therefore, States have the option either to re-issue the complete data set or to publish an update that contains only the differences.
  The AIXM Temporality Concept supports both options i.e. baseline or Permdelta. When a State starts providing an AIP dataset, there should always be an initial data set that is complete, in the sense that it includes all the data provided by that State. The provision of just listing the differences puts the effort of compiling the actual data set on the end-users which task would become increasingly complex.
  Regarding the content validity requirement (Baseline + 3 month-time Tempdelta), this would be feasible from the AIXM 5 temporality perspective, but it triggers a change in the way the State AIM database is handled i.e. the maintenance process should be modified in order to include updates of the static data (SDO) component + AIP SUPP.

- **Prefix *#AIP-DS#* and *#OBS-DS#*:** PANS-AIM, Appendix 2, Note 1 states that: "*The information elements prefixed with "#AIP-DS" may be left out when available through the AIP data set (as specified in Chapter 5, 5.2.1.1.3)*". An analysis of AIM database versus eAIP application should be performed i.e. eAIP specifications need to be updated for revising the template with *#AIP-DS#* annotation;

3.3.3 Terrain, Obstacle and Aerodrome Mapping Datasets

For all three (3) datasets, the requirements were already defined in the "old" Annex 15 i.e. Chapter 10 *"Electronic Terrain and Obstacle Data"* and Chapter 11 *"Airport Mapping Database"* respectively. Basically, they were relocated and split between new Annex 15 as well as in the PANS-AIM.

There are no significant changes (area definition, collection surfaces, data quality requirements and product specifications) introduced by the new Annex 15 and PANS-AIM. Among the three (3) datasets, Terrain & Aerodrome mapping information never had a "dedicated" section within the AIP i.e. not part before of the AIP section, but Obstacles only. However, a special note for an inconsistency regarding Obstacle Dataset. PANS-AIM states in paragraph 5.2.1.1. 4, that:

"When Obstacle Data Set (as specified in 5.3.3.2.2) is provided, the following sections of the AIP may be left blank and a reference to the data set availability shall be provided:
17. ENR 5.4 Air navigation obstacles
18. AD 2.10 Aerodrome obstacles;
19. AD 3.10 Heliport obstacles;

PANS-AIM preferred to simply copy-paste the existing text related to ETOD from old Annex 15 without clarifying the "link" between obstacles data Area 1 to 4 provisions per se and the respective AIP sections. Consequently, it is not clear which obstacle dataset would be fulfilling State compliance for Aerodrome/Heliport obstacles? Are the Area 2 and 3 or only Area 2? If only Area 2, would the minimum set of Area 2a + T/O flight path area + OLS obstacle data be sufficient?

3.3.4   Instrument Flight Procedure Dataset

The implementation of IFP dataset should be the most demanding process for AIS among the five (5) Datasets accomplishments. However, the guidance material dedicated in PANS-AIM is the briefest from all guidance material dedicated to other datasets.
There are several reasons for the IFP dataset implementation challenge:

- By structure, IFP was never, in essence, within AIS responsibilities and functions;
- AIXM 5.x model does partially cover IFP dataset elements i.e. procedure coding only. Therefore, a new AIXM extension to capture IFP dataset should be necessary;
- IFP content is a combination of charting elements required by PANS-OPS for procedure promulgation as well as Procedure Designer (specific) data, typically parameters/entry data. This type of information (free text or non-AIM related) is not "digitizable" or to a certain extent only.
- There is no Obstacle requirement in the IFP DS, but PANS-OPS & Annex 4 publication & charting respectively clearly requires the design expert to identify for charting purpose, the obstacle(s) considered critical for the respective procedure;
- IFP dataset includes data subjects (procedure designator, procedure segment, procedure fix, holding, etc.) and their properties according to AIXM 5.1 model together with aeronautical data publication requirements contained in the Doc. 8168 PANS-OPS, Vol. II, Part III, Section 5, Chapter 2. Consequently, this source 'mixture' has the result that not all IFP dataset features are covered entirely by the latest exchange model version AIXM 5.1.1, therefore the existing standard has to be adapted and/or supplemented with extensions in order to fully respond to the ICAO requirements.

  With other words, the IFP dataset implementation necessitates for information mapping a supporting model, either being AIXM 5.2 or the existing 5.1.1 plus the appropriate extensions. Besides the option of "upgrading" AIXM model which requires a long formal process thru its CCB mechanism, one (quicker) alternative would be to assess the output of Procedure Design Tools (PDT). Some tools on the market have the capability to generate the designed procedure in an AIXM 5 format (including metadata) which can be ingested by the compatible AIM (AIXM 5-based) system. The PDT suppliers may seek to assess/align their product with the respective ICAO SARPS in Doc. 10066 PANS-AIM and EUROCONTROL specifications (to date, in preparation).

3.3.5   Summary of Technical Issues

Throughout the assessment, there are several technical aspects associated with digital datasets that need to be addressed for direction and clarification:

- Most challenging topics are AIP and IFP Data Sets respectively;
- Provision of an AIP sub-dataset is recognized, however there is no PANS-AIM guidance on the logical grouping of the subjects. A random selection would be resulting for end-user/consumers in a useless dataset;
- Missing details on digital datasets delivery method from AIM (modern) perspective. The options are paper or electronic distribution only, but not digital, i.e. making certain the " *full move into an automated data-centric environment*";
- Suitable (AIXM) dataset format in order to handle files containing information with permanent status combined with temporary data (SUPPs);
- Missing detailed coding specifications for datasets resulting in the risk that each State AIS may code differently same type of data;
- Possible disconnect between States and industry (vendors) supportive plan for DDI AIM system;

- IFP dataset should also attempt to support charting generation as one of many endeavours in the effort of providing a data-driven charting solution;
- IFP dataset provisions need guidance in respect of content i.e. one or sub-group of airport procedures or all procedures for all airports within the State integrated in one file?

3.3.6 Distribution of Datasets

The 16th edition of Annex 15 recommends that: *"Global communication networks and Web services should, whenever practicable, be employed for the provision of Aeronautical Information Products."*

In the dedicated paragraph 5.4 "Distribution Services", PANS-AIM does not provide any further details on this topic. Actually, the following paragraph 5.4.1.1 is considering two delivery options to the next intended user i.e. (a) physical distribution and (b) direct electronic distribution.

Based on the method description for option (b), it is not very clear if the automatically link "*through the use of a direct electronic connection between the AIS and the next intended user"*, it is meaning the employment of web-based services or not?

3.4   Implementation Transition Plan

The implementation time is highly dependent on how ready the user community is to dealing with / ingesting digital data. Therefore, the implementation success shall be seen as "binomial" i.e. both actors prepared and ready to exchange the data. An important aspect regarding the impact for States is the need for establishing a "transition period" in order to give the chance to AIP users to reach the technical capability for handling digital datasets. The typical example should be mentioning an airline dispatch office who is relying on paper/eAIP published information. Once the State AIP is "made of" co-existing published/paper + digital datasets, the reference *#AIP-DS#* would simply mean, "missing information".

No.	Implementation Activity	Description of the Proposed Action	Estimated Time Frame
4. MATRIX OF PROPOSED ACTIONS RELATED TO DDI
1.	**Regional Plan (ICAO MID)**	• ICAO to update the regional AIM Roadmap with new steps of Digital Datasets;	
		• ICAO to update the Regional Plan to enforce States for completion of Integrated AIM Database step (Phase II) as prerequisite condition for DDIs.	
2.	**Institutional/Regulatory (National Level)**	• State Regulator to establish an AIM Task Force group comprising of Inspectors and AIM units' representatives for assessment of new ICAO SARPS.	
		• State Regulator to elaborate the necessary amendments of the AIM regulatory framework (rules, regulatory obligations and local instructions);	
		• State Regulator official approval of the AIM-related national regulations and Means of Compliance (MoC);	
		• Plan (actions and timelines) with introduction of digital datasets.	
		• State Regulator is engaged for updating the national Roadmap, Phase 3 "Information Management" with the new steps of "Datasets"	
		• AIS units to amend the procedures and processes in accordance with the new procedural changes;	
3.	**Financial**	• State Regulator to initiate and conduct a financial evaluation/assessment for AIM system evolution, AIM processes adaptation, resources anticipation;	
		• Irrespective if the State have/not have an AIM system in place, the investment is serious. Therefore, based on best practices, the envisaged investment strategy should be as phased-approach: Establish a stabile platform of basic system functionalities, for example, ensuring the State eAIP creation, integrated terrain and obstacles database, plugging in charting tool, etc., then gradually invest for system abilities enhancement to handle AIP & IFP datasets, upgrade model temporality and adaptation of SWIM interfaces for datasets inter-change.	
		• State to consider the adequate budget for further resources i.e. adequate qualified AIS personnel and relevant training;	
		• State to ensure that in the project budget are including costs for technical specifications, tender procedure, procurement and contract finalization, system implementation/operation, maintenance/bugs fixing, staff hiring, training;	
		• The system capability enhancements (next phases) should be treated as a full iteration process of the initial financial/investment steps.	

4.	**Technical**	• Data Duplication: State to examine the conclusion of a service level agreement (SLA) between neighbouring/adjacent States as a collaborative mechanism for defining an "authoritative source" i.e. SLA should avoid the duplication of information and it should establish which source should be accessed;
		• AIP Dataset Grouping: The grouping for data sub-set, if decided, should follow certain logical criteria mindful of service consumers' needs and data utility, like for example:
		  – All ENR sections content, and/or,
		  – All AD sections content, and/or,
		  – By data type: Complete Airspace data, complete Route network, complete Airport pertaining information, etc., and/or,
		  – A "serving a purpose" sub-set: ATS Routes + En-route Holding + Navaids + Significant Points or ENR Controlled + Restrictive Airspaces, and/or,
		  – Particular mapping of AIP sections combining e.g. GEN 2.5, ENR 2.1, ENR 4.4 and AD 2.19.
		• Delivery Mechanism: Primary delivery mechanism to be SWIM service (registry, service description, discoverability, user management, security, etc.) thru SWIM interfaces i.e. exposing current export HMI, push/pull interfaces, ICD, etc. The "quick solution" of manually processing/generating from a SDO/posting on the AIS website is to be discouraged.
		• If a "quick fix" manual processing would be envisaged, the metadata should be based on Eurocontrol two-way mapping AIXM 5.1/AIP Dataset and follow the coding guidance of the same document.
		• Dataset Format: AIXM version 5.1.1 should be the best suitable from temporality mechanism standpoint i.e. compatible with the required combination of perm + tempo data.
		• IFP Dataset: The AIXM 5.1 file output from PD tools on the market can facilitate an effective/quick solution, but State AIS assessment i.e. mapping with PANS-AIM should be conducted subsequently.	

4.	**Implementation Transition Plan**	• State Regulatory Authority to perform a national survey of operators, aviation entities, AIP subscribers and other users for assessing their capability in ingesting digital data and for understanding their plan and deadline. • ICAO to recommend States a dedicated survey questionnaire with a specific set of questions (web-based or a paper template). • State to set up a transition time for provisions of eAIP in parallel with Dataset(s) and determine a "closing date" based on the survey conclusions. • ICAO to propose a (general) text for the content of the Aeronautical Information Circular (AIC) describing State plan regarding datasets (partially or fully) implementation and stating the decided "grace period" after when the datasets are provided in digital format only.	

- END -