User Requirements for Air Traffic Services (URATS)

Air Traffic Management (ATM)

Volume I
Operational Concept
Edition 1.0 Oct 2022

FOREWORD

This publication is made available to you for your convenience only. This publication contains references to various regulations, requirements and guidelines adopted by the States and governing bodies, as well as industry standards and recommended practices. The information contained in this publication is subject to constant review in light of changing governing authorities requirements and evolving practices, and you or no other person should act on the basis of any such information without referring to the official laws, regulations, guidelines, requirements and industry best practices.

Although IATA has undertaken reasonable efforts to include accurate and up-to-date information, it does not have the obligation to update, delete, edit, change, comment or add any information to this publication, or alert you of any such change or update. Nothing contained in this publication constitutes a recommendation or endorsement by IATA. IATA makes no representations, warranties or other assurances, express or implied, about the accuracy, sufficiency, relevance and correctness of the information originating from any of the sources relied upon. Our data collection and reporting are factual and neutral. Third party content and opinions do not necessarily reflect IATA's point of view. THE INFORMATION CONTAINED IN THIS PUBLICATION ARE PROVIDED TO YOU ON AN "AS IS, WHERE IS" BASIS, AND IATA DISCLAIMS ANY WARRANTY OF MERCHANTABILITY, QUALITY OR FITNESS FOR A PARTICULAR PURPOSE. IATA does not assume, and expressly disclaims, any liability, direct or indirect, to you or any person, for any losses or damages, including without limitation incidental losses, loss of opportunity and damages to reputation, resulting from your access to and use of the information contained in this publication, or caused by errors or omissions or misinterpretation of the contents of this publication, and for the consequences of anything done or omitted by you or any person in reliance thereof.

This publication and its contents are not intended to serve as the sole and exclusive basis for assessment and decision making and constitute one of many means of information gathering at your disposal. You are informed to make your own determination and make your own inquiries as you may deem necessary and suitable. You shall independently and without solely relying on the information contained in this publication, perform your own analysis and evaluation in regard to the nature and level of information you may require, based upon such information, analyses and expert advice as you may deem appropriate and sufficient, and make your own determination and decisions pertaining to the subject matter under consideration.

Director Flight and Technical Operations
International Air Transport Association
800 Place Victoria
P.O. Box 113
Montreal, Quebec
CANADA H4Z 1M1

DOCUMENT CONTROL

RECORD OF AMENDMENTS

No.	Date applicable	Date entered	Entered by

Table of Contents

1. Introduction

The air transport industry plays a major role in world economic activity and remains one of the fastest growing sectors of the world economy. In every region of the world, States depend on the aviation industry to maintain or stimulate economic growth and to assist in the provision of essential services to local communities. Aviation's track record in innovation ranges from jet engines to electronic tickets and bar-coded boarding passes. In the coming years, it is expected that aviation will see increased use of automation, robotics, Unmanned Aircraft Systems (UAS), and Artificial Intelligence (AI). The air traffic management (ATM) system must evolve, not only to be ready for future operational environments, but also to enable concepts such as Trajectory Based Operations (TBO). However, many challenges appear on the horizon, specifically due to economic impacts on investments in systems and infrastructure.

Airline, airport, and air navigation services provider (ANSP) investment cycles and plans are not always aligned and, historically, adoption of new technologies in the cockpit has happened at a much faster pace than adoption in ground systems. Without alignment of investment plans, operational benefits will be elusive and new ATM programs will not deliver promised objectives. Several regional ATM programs have been initiated, however, the fundamental principles guiding such regional initiatives are not fully aligned and by extension, nor are the solutions. There are several technical incompatibilities between ATM technologies and aircraft equipage/performance requirements, creating unsustainable business cases for airlines considering investment decisions. ATM program implementations or modernization must not be driven by equipage mandates, but rather by a validated and agreed-upon operational benefit.

To achieve on-time operations, predictability, and a low carbon footprint, current and future ATM systems must be viewed and managed as an integrated network that is harmonized and interoperable. Technological solutions must be derived in collaboration with stakeholders to ensure functional compatibility of airborne systems with the timeline of implementations.

Such solutions must also be cost-effective and supported by a positive cost-benefit analysis (CBA). In that respect, any investment shall be supported by an agreed operational improvement and based on a positive CBA.

2. Summary of Positions

This section summarizes the conclusive IATA position per ATM operational service. Each ATM operational concept is assigned into one of the following three (3) categories:

Support: The IATA position supports the implementation of these operational concepts.

Neutral: The IATA position notes some operational benefits for these concepts. Future assessment plans should be carefully considered in consultation with airspace users and operational concepts benefits should also be evaluated.

Do not support: The IATA position does not support these operational concepts for mainline commercial airline operations. Costs associated to the implementation, operation, maintenance and development of associated technologies should not be allocated to airlines.

Where appropriate, *Notes* are included providing additional information related to the operational concept, its deployment and IATA conditions and expectations.

Expanded descriptions and IATA positions on each operational concept are provided in detail in the following sections of this document.

3. Air Traffic Management

3.1. Basic definition of ATM and Global Approach

ATM[1] provides safe, economical and efficient operations through the provision of facilities and seamless services, in collaboration with all parties. ATM activities are carried out in varying geographical scales, from national territories, supra-national airspaces and by continents. Initially carried out by States, ATM is now provided by supra-national bodies, and by corporatized service providers such as ANSPs.

Continuously developing ATM operational improvements through the implementation of interoperable and harmonized systems will allow an aircraft to operate efficiently with a minimum number of avionics and performance changes across different airspaces. Air traffic control (ATC) systems have traditionally been individually developed by the International Civil Aviation Organization (ICAO) Member States concentrating on their own requirements, creating distinct levels of service and capability around the Regions. Because many ANSPs have not implemented an ATC service that matches the capabilities of modern aircraft, ICAO developed the Aviation System Block Upgrade (ASBU) program which provides each Member State with information on the global approach towards advancing their Air Navigation capacity based on specific operational requirements.

The ICAO global approach urges ANSPs, Member States and international organizations to work together to make the optimum use of new and existing technologies to achieve operational improvements, moving all stakeholders towards a seamless airspace. This transformational objective will strengthen the networks performance while considering the environmental impact of each decision. Furthermore, this approach will contribute to harmonizing ATM Systems and related procedures creating a safer and more efficient air traffic flow.

From an airspace user (AU) perspective, greater equity in airspace access, access to timely and meaningful information, and autonomy in decision making, including conflict management, will provide the opportunity to deliver better, cost-efficient business and individual outcomes within an appropriate safety framework.

[1] "**Air traffic management (ATM)**. The dynamic, integrated management of air traffic and airspace including air traffic services, airspace management and air traffic flow management — safely, economically and efficiently — through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions." ICAO Doc 4444, Air Traffic Management.

3.2. Air Space Management

Civil air transport has continually proven its importance to the global economy. The ever-growing traffic demand (barring occasional special circumstances such as financial downturn or global pandemic) requires the building of ATM networking capacity and the optimization of airspace access to support it. One way of finding that additional capacity is through more efficient and effective airspace management (ASM)[2][4], by enabling limited airspace resources to be shared optimally and predictably between civil and military AU.

ASM will support the continuous, seamless, and iterative airspace planning and management processes, which includes the sharing of civil-military airspace information. Information, if made available, can be used during the strategic, pre-tactical and tactical phases of operations, enabling the effective use of available airspace by AU. This type of coordination and sharing of information is enhanced by the effective implementation of a Collaborative Decision Making (CDM) relationship between the ATM providers and ASM stakeholders.

ASM real-time data (pre-notification, notification, activation, modification, and release of airspace), should be collected, saved and processed in a manner that can be exchanged and shared between stakeholders (ATM actors, AUs, Computerized Flight Plan Service Providers (CFSP)), and used during flight planning to support the best use of operational capabilities. The same real-time data should also be used during ATM resource planning to determine if adjustments need to be made to ensure an optimum availability of airspace and ATC capacity to accommodate the growing air traffic demand.

Furthermore, two key operational concepts form the basis for effective ASM: The Flexible Use of Airspace (FUA) and the Civil/Military ATM Cooperation (CMAC), as described below:

3.2.1 Civil/Military ATM Cooperation (CMAC)

For international aviation to operate as a safe and harmonious system, States have agreed to collaborate on a common regulatory infrastructure and on the rendering of air traffic services to accommodate both Civil and Military airspace requirements through Civil/Military ATM Cooperation (CMAC) and to optimise the availability and utilisation of shared airspace.

When military operations require the use of airspace, complex and dynamic coordination and planning processes are required to avoid unnecessary airspace segregation or restrictions and to maintain the required level of safety.

To that end, ATM systems should allow for integrated, harmonized and globally interoperable systems that meet the agreed levels of safety during all phases of flight, providing for optimum economic operations, environmentally sustainable, and meeting national security requirements. Common systems also promote economies of scales which would result in a lower cost-base for ANSPs and subsequent lower charges for AU. One of the main challenges is the management of limited airspaces in a way that safeguards both civil and military aviation requirements. A close CMAC function is an enabler to FUA which provides a resolution on sharing the limited resource.

[2] "**Airspace management**: Airspace management is the process by which airspace organization options and other options in the provision of services will be selected and applied to best meet the needs of AUs. Competing interests for the use of airspace will make airspace management a highly complex exercise, necessitating a process that equitably balances those interests". ICAO Doc 9854, Global Air Traffic Management (ATM) Operational Concept.

IATA Position on Civil/Military ATM Cooperation (CMAC):

Support an increased CMAC as enabler for an efficient and predictable use of the airspace, where limited interoperability between civil and military systems exists, improving communication and cooperation processes.

3.2.2 Flexible Use of Airspace (FUA)

Flexible user of airspace (FUA) is an ASM concept based on the principle that airspace should not be designated as purely civil or military, but rather as a continuum in which all user requirements are accommodated to the greatest possible extent [1]. Of course, there will be areas that contain specific sites that cannot be overflown, these are normally identified as "prohibited" or "restricted" areas. However, the remaining airspace and any necessary airspace segregation should be temporary, based on real-time usage within a specific period. In addition, contiguous volumes of airspace do not need to be constrained by national boundaries, this was the basis for the design of Functional Airspace Blocks[3].

Flexibly sharing airspace amongst civil and military users is a significant paradigm shift. While it is certainly important to consider the national security needs, civil air transport's role in global economies should also be considered. This economic benefit is underpinned by direct connections between cities enabling the flow of goods, people, capital, technology and ideas. States are encouraged to implement FUA in order to accommodate both Civil and Military requirements, allowing for both military critical missions and civil air transport to utilise the airspace equitably and fly most efficient routes through otherwise segregated airspace.

IATA Position on Flexible Use of Airspace (FUA):

Support the FUA concept as the enabler for a more efficient and predictable use of the airspace with the military, where full interoperability between civil and military systems is implemented supported by effective communication and cooperation processes. FUA should be considered as the final stage of CMAC.

[3] "**Functional airspace block (FAB)**" means an airspace block based on operational requirements, reflecting the need to ensure more integrated management of the airspace regardless of existing boundaries. Regulation (EC) No 549/2004 of the European Parliament and of the Council.

3.3. Airspace Organization

3.3.1 Direct Routing Operations (DRO)

Direct Routing Operations (DRO) is a series of directs between certain waypoints and can be flight planned (not tactical). DRO is an extension of the concept of published en-route DCTs (Directs) across the flight information region (FIR). Within the airspace where DRO is applied, flights remain subject to ATC. Pilots will adhere to the relevant publications for each State as stipulated in the relevant documents.

IATA Position on Direct Routing Operations:

Support safe and efficient DRO wherever applicable and beneficial, IATA reinforces that no additional requirement for a specific navigation performance on direct segments should be required and that RNAV 5 specifications would be suitable for DRO within a specific volume of airspace.

3.3.2 Free Route Airspace (FRA)

The term "Free Route" is a high-level title under which two different types of implementations can occur. Therefore, distinction is to be made between "Direct Routing Operations" (DRO) and "Free Route Airspace" (FRA) operations. Direct routings are established with the aim of providing AU with additional flight planning route options on a larger scale across FIRs such that overall planned leg distances are reduced in comparison with the fixed route network. In a Free Route environment, users can plan and fly as closely as possible to their preferred trajectory (i.e., UPR, 3.3, 3.3.3) without being constrained by fixed airspace structures, direct routings or fixed route networks. In FRA, users may freely plan a route from a defined entry point to a defined exit point subject to airspace availability. In FRA airspace, all fixed route networks can be removed. However, flights do remain subject to ATC and, in some instances, may require an intermediate waypoint to be added.

It is envisaged that DRO will precede the implementation of FRA. DRO is just but a series of direct routes between specified waypoints and can be flight planned (not tactical). DRO can also provide an opportunity for ANSPs to study, collect data and familiarize themselves with the concept of FRA, where there is an increasing trend to put in place cross border operations and to lower the base level of FRA to the maximum extent possible, representing a real improvement for AU.

IATA Position on Free Route Airspace (FRA):

Support the FRA concept which will move from current route network structures to free route airspace availability, offering significant opportunities to AU. Where the FRA is implemented, these improvements should provide considerable savings and traffic predictability thanks to more stable trajectories. ANSPs should expedite capabilities within ATM automation systems to enable safe operations in FRAs. These capabilities include, for example, route adherence monitoring and conflict detection functions. Considering regional specificities, cross-border FRA with the maximum freedom of evolution should be pursued as the goal to provide optimum flight efficiency.

3.3.3 User Preferred Route (UPR)

It is widely accepted that User Preferred Routes (UPR) represent the most efficient form of routing for aircraft. The ability to optimize the route based on prevailing environmental conditions and the actual aircraft configuration of the day can deliver enormous benefits on a per flight basis. Not only can there be a reduction in fuel burn and a reduction in environmental emissions, but also a potential increase in payload.

The UPR concept is a method of flight planning applied in an FRA environment that allows operators to choose optimum (random) routes based on individual flight requirements that are not constrained, i.e., fixed oceanic Air Traffic Services (ATS) routes. instead of following the conventional approach of flying along published routes in a predetermined network set by air navigation services (ANS) authorities, UPR creates a unique flight path for each aircraft.

Furthermore, depending upon the prevailing weather conditions at the time, UPR allows an operator to fly a route that it determines is most efficient route for each type of aircraft used. A UPR system helps to improve operational efficiencies by providing each aircraft with an optimal flight path and shortening flight times. After considering all factors, an operator would file the filled flight plan (FPL) on the most favourable route for that flight.

This system also allows operators to maximize individual route efficiency during flight planning based on daily situations, such as:

a) Preferential departure and arrival routings;
b) Avoiding restricted airspace reservations;
c) Avoiding adverse weather conditions; and
d) Utilizing most favourable wind patterns, filing an appropriate Oceanic FPL based on entry/exit points.

UPR will be future enabled and improved through strategic and pre-tactical flight plan negotiations conducted under Flight and Flow – Information for a Collaborative Environment (FF-ICE) concept.

IATA Position on User Preferred Route (UPR):

Support the evolution of DRO and FRA towards UPR, which is seen as the way to allow the AU gain more control over its trajectory. UPR needs to be supported by upskilled ATC personnel and an ATM System capable of handling complex flows and route conflictions. The ATM System should also be fitted with enhanced tracking and monitoring capability.

3.3.4 Continuous climb and descent operations (CCO/CDO)

Continuous climb operations (CCO) are aircraft operating techniques enabled by airspace structure, instrument procedure designs and facilitated by ATC. It allows an aircraft to execute a flight profile optimized to the performance of the aircraft. CCO enables the aircraft to attain an initial cruise flight level by utilizing optimum airspeed and engine thrust settings throughout the climb, thereby reducing total fuel burn and emissions. Ideally, CCO the departure design should be developed to permit arriving traffic the ability to descend via an optimum descent profile, however, considering the flight characteristics, limitations and capabilities of the range of aircraft expected to perform CCO at the subject airport, as well as the characteristics of the airspace and routes where CCO will be used, the CCO should have priority over Continuous descent operations (CDO) due the higher engine settings and related fuel burn required for a climb. Where departure and arrival flows cannot be designed to allow independent operations, there will need to be a compromise between the needs of the departure and arrival flow; this compromise should be reached collaboratively. [2]

CDOs have been adopted to embrace the different techniques being applied to maximize operational efficiency while still addressing local airspace requirements and constraints. These operations have been variously known as continuous descent arrivals, continuous descent approaches, optimized profile descent, tailored arrivals and 3D/4D path arrival management forming part of the business trajectory concept. With CDO, aircraft employ minimum engine thrust, ideally from top of descent and in a low drag configuration, prior the landing runway threshold or the point where the flare manoeuvre begins for the type of aircraft flown. Employment of these techniques reduces intermediate level-offs and results in time being spent at more fuel-efficient higher cruising levels, hence significantly reducing fuel burn and lowering emissions and fuel costs. [2], [3]

To achieve CCO/CDO, airspace design, instrument flight procedure design and ATC techniques should all be employed in a cohesive manner. This will then facilitate the ability of flight crews to use in-flight techniques to reduce the overall environmental footprint and increase the efficiency of aircraft operations. [3]

CCO and CDO operations allow arriving or departing aircraft to descend or climb continuously on their optimal profile, to the greatest extent possible.

IATA Position on Continuous climb and descent operations (CCO/CDO)

Support CCO/CDO as the means to optimize the aircraft profile during climb and descent phases of flight, in support of reducing the aircraft environmental impact. CCO/CDO should be implemented at all airports and its implementation should be balanced with the need to guarantee airport throughput.

3.4. Conflict Management

3.4.1 Separation provision

Separation standards describe the minima achieved by procedures and equipment used in the separation of aircraft in all phases of flight. [4]

Conflict management consists of three layers [5]:

a) strategic conflict management through airspace organization and management, demand and capacity balancing, and traffic synchronization;
b) separation provision; and
c) collision avoidance.

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

When working to achieve strategic separation by using airspace as a resource, a "conflict" occurs whenever the applicable separation is compromised. Tactical conflict management, referred to in this concept as separation provision, is a layer of conflict management. Defined separation minima allows not only for a single value in all cases, but also dynamic values that are determined from defined parameters, for example, by using a separation minima formula. Defined minima are necessary for the development of decision-support tools (i.e., Medium Term Conflict Detection [MTCD], Short Term Conflict Alert [STCA]), which require different values by which hazards must be avoided.

The ability to intervene to avoid hazards may produce different values for different separators (AU, ANSP, ATM automated systems) and for each separator the value varies depending on circumstances. A major reason for the different values is the total workload required. The choice of which separator is the best for a given situation is given due consideration in ATM system design. In the case of cooperative separation - Airborne Separation Assurance Systems (ASAS) require additional tasks in the cockpit, whereas currently these services are carried out by ATC service providers or automated ATM systems. For any AU activity, the predetermined separator must be defined for all hazards. In some cases, the AU may be the predetermined separator in respect of weather and terrain, and the separation service provider will be the predetermined separator in respect of other hazards. The AU, acting as the predetermined separator (i.e., ASAS-Sep, ASAS-Self Sep), should be the starting point of the design, meaning that there is no separation provision service unless safety or ATM system design requires such a service. [5]

The concept of cooperative separation (ASAS-Sep) remains an option available within a particular ATM system, but not a requirement for the separator to use. Delegation of responsibility occurs only when deemed appropriate by the current separator (i.e., ANSP) and after acceptance by the proposed delegated separator (i.e., AU). The delegation is for a defined period under defined conditions. Because separation provision is tactical conflict management, this delegation and acceptance is in many cases well-defined.

Interval management

Interval Management (IM) provides capabilities to precisely manage spacing between aircraft. IM is a component of the future TBO concept (§ 3.7.1 refers), where Air Traffic Control Officers (ATCOs) may opt to provide IM clearances to flights to manage their spacing intervals relative to other aircraft. In addition, IM may improve the management of traffic flows and aircraft spacing. Precise management of intervals between aircraft with common or merging trajectories maximizes airspace throughput while reducing ATC workload along with more efficient aircraft fuel burn.

It is expected that air and ground procedures for interval management should be improved, including conditions of application, phraseology and messages exchanges. The United States and Europe have already conducted operational trials with IM that suggested additional work on the various aspects, such as consolidation of the operational concept and development of the ground tools.

IATA Position on Interval Management:

Note: Due to different considerations related to further application of the provisions, it was considered premature to issue a position for *Interval Management*. Further developments and operational evidence associated to a potential impact for ATCO and pilots are needed, so that a position can be issued.

3.4.2 Collision Avoidance

If an identified controlled flight is in a potential conflicting path with an unknown aircraft deemed to constitute a collision hazard, a pilot decides that immediate action is necessary to avoid an imminent collision risk, and this cannot be achieved in accordance with the right-of-way provisions of ICAO Annex 2, the pilot should comply with the provisions established in the ICAO Annex 11. [6]

In a situation where the air traffic services are responsible to prevent collisions, sufficient information and data shall be presented in such a manner as to enable the controller to have a complete representation of the current air traffic situation within the controller's area of responsibility and, when relevant, movements on the manoeuvring area of aerodromes. The presentation shall be updated in accordance with the progress of aircraft, in order to facilitate the timely detection and resolution of conflicts as well as to facilitate and provide a record of coordination with adjacent ATS units and control sectors.

Self-separation methodology and technology form a natural extension to current traffic avoidance procedures (Traffic Collision Avoidance System - TCAS) and is already under development, termed as Airborne Separation Assurance Systems (ASAS). It is envisaged that implementation of ASAS concepts will provide flight efficiency and associated environmental gains due to more efficient resolution of traffic conflict scenarios, as deviation from preferred that four-dimensional (4D) flight trajectories will be reduced.

IATA Position on Collision Avoidance:

Support the current ICAO provisions related to the Airborne Collision Avoidance System (ACAS).

3.4.3 Arrival, Departure and Surface sequencing systems – (AMAN, DMAN, SMAN)

Arrival Manager, Departure Manager and Surface Manager (AMAN-DMAN-SMAN) are sequencing tools improving airport operations through departure, surface and arrival management taking advantage on advanced trajectory predictions to optimize runway throughput. It enables ATCOs to improve their situational awareness and to anticipate flow of traffic. In mixed mode runway configuration, the coupled AMAN-DMAN allows for optimization of the arrival and departure sequence.

AMAN sequences the aircraft based on the airspace state, wake turbulence, aircraft capability, and user preference. The established sequence provides the time that aircraft may have to lose before a reference approach fix, thereby allowing aircraft to fly more efficiently to that fix and to reduce the use of holding stacks, in particular, at low altitude. The smoothed sequence allows increased aerodrome throughput.

DMAN will streamline the flow of aircraft feeding the adjacent centre airspace based on that centre's constraints. This capability will facilitate more accurate estimated time of arrivals (ETA). This allows for the continuation of metering during heavy traffic, enhanced AU efficiency and fuel efficiencies. This capability is also crucial for extended metering.

Furthermore, the extension of arrival metering and integration of SMAN with departure sequencing will improve runway management and increase airport performance and flight efficiency. Additionally, DMAN will be integrated with surface management in order to augment surface surveillance information that can be selected to provide more precise departure traffic planning and timely updates. In addition, enhanced surface management will increase aerodrome throughput without compromising wake turbulence separation and other safety protocols. Aerodrome capacity and throughput is closely tied to surface surveillance and management.

IATA Position on AMAN

Support the use of the current technologies applied to assists the ATCO, when operationally justified, in facilitating efficient arrival sequences and arrival times to ensure smooth arrival traffic, less time for AU in holding while waiting to land, leading to reduced fuel consumption and therefore CO_2 emissions.

IATA Position on DMAN

Support the use of the current technologies in high density traffic airports to avoid long queues at the runways, saving fuel for AU and improving its efficiency. It should be, when required, associated with SMAN.

IATA Position on SMAN

Support the use of the current technologies for SMAN, when the airport layout and density of traffic imply a long taxi time and must be associated to a DMAN.

3.5. Demand and Capacity Management

3.5.1 Air Traffic Flow Management (ATFM)

One of the most important elements for an AU operation, is predictability. The implementation and use of ATFM associated to a CDM as demand-capacity balancing tools have enabled, among other things, stakeholders with the ability to better manage airspace by providing an optimized use of available capacity for ANSPs and a predictable operation for AU. ATFM is a major enabler of safety, efficiency, cost-effectiveness and environmental sustainability of the ATM system. States, Regions and ANSPs are encouraged to adopt and implement ATFM/CDM at the level appropriate to meet their requirements and readiness. The scope of CDM and ATFM (ATFM/CDM) continues to evolve in line with operational needs of AU and ATS providers.

In this respect, performance monitoring of a consistent flight plan database, and evaluating the balance between demand and capacity will provide users with the ability to improve trajectory forecasts and provide more accurate and consistent end to end 4D trajectories.

These tools supplement the ASM concept discussed in the previous section. Specifically, ASM – predicating on CMAC and FUA [§ 3.2.1 and 3.2.1 refer] – provides additional airspace for ANSPs to utilize, consequently enabling the maximum use of airspace capacity to support the traffic demand. ATFM comes into play when, even with added airspace accessibility, demand still exceeds available capacity and needs to be managed further. ASM and ATFM are connected, but they serve different operational purposes with different processes. Both ASM and ATFM have CDM as their foundation. Without effective collaboration between stakeholders, ASM and ATFM cannot work.

While an integrated and collaborative ASM/ATFM operation is still sparse in implementation, efforts are being made to improve the global implementation that would support the optimum availability of airspace and ATC capacity.

ATFM will also benefit from future improved Long-Range (LR-ATFM)[4] planning that enables calculations and solutions to be communicated through data-sharing across multiple FIRs on the flight path to the destination.

IATA Position on ATFM:

Support and promote the implementation of basic ATFM functionalities and procedures by States and ANSPs. For ANSPs having capacity balancing issues, there are a number of tools and systems already available on the market, as well as best practices contained within guidance materials. IATA also supports and promotes the fuel burn reduction benefits received from mature LR-ATFM programs.

[4] The concept of Long-Range Air Traffic Management (LR-ATFM) was proposed to improve the demand-capacity management by an extension of the current time horizon of regional ATFM implementations. Thus, major traffic flows could be efficiently managed across ATM regions with a long-range situational awareness (more transparent traffic management) enabled by an early provision of target times over a waypoint.

3.5.2 Airport - Collaborative Decision Making (A-CDM)

A-CDM is the use of shared information between airport stakeholders to coordinate decisions leading up to the pushback of an aircraft. The ultimate objective is to use shared awareness and predictability so aircraft are aware of when they need to push back from the gate and they only push back when they can, in principle, taxi as efficiently as possible for an immediate departure. This is done by sharing information on key milestones between airport stakeholders.

A-CDM consequently helps to improve gate management, reduce apron, taxiway, and holding point congestion by only releasing aircraft from the gate when they can optimally taxi to the runway and take-off. Sharing accurate and timely information amongst airport partners allows for optimal sequencing considering a shared set of rules along with more resilience and improving the recovery from disruptions. Implemented correctly, A-CDM can reduce operating cost attributed to fuel burn, which should contribute to environmental targets.

Currently, when A-CDM is linked to an ATFM system which covers the full route and destination airport, it also leads to greater predictability within the airspace and on the arrival time at the destination airport by passing along information about the aircraft's status. A-CDM can also be the means to apply AFTM measures at an airport and for different stakeholders to be informed and plan in consequence. A-CDM is envisioned to be fully synchronized with TBO (§ 3.7.1 refers), ensuring that all stakeholders will be fully connected. This is not the case today, as information does not necessarily flow beyond the airport and its immediate ANSP.

Any implementation of A-CDM must be based on an assessment of current operational constraints, and an analysis of the value an A-CDM implementation could contribute to mitigating such constraints and / or improve current operations. A-CDM is not a universal solution and requires significant upfront and ongoing investment. Collaborative information sharing between stakeholders does not necessarily require a full A-CDM system. A-CDM implementations must only be initiated after careful engagement between the airport, the airlines using the airport, handling agents and the responsible air traffic service provider, who should be key stakeholders during and after implementation.

The integration of A-CDM in the overall synchronization of the ATM network will contribute to a stable end-to-end, consistent and robust TBO, providing an improved level of performance. In that respect, aerodrome operations consider the enroute to enroute view and the associated turnaround process, as part of the trajectory, subsequently managing the flight on the surface to ensure that the agreed trajectory is consistent with the operational plan.

A-CDM implementations have been historically managed from a local airport perspective. While local specificities will always have to be catered for, a lack of global standards, procedures, documentation, and even terminology, has resulted in flight crews needing to adapt to the various methods of operating at each airport. In addition, local implementations often provide limited access to data for airlines who are not locally based.

IATA Position on A-CDM:

Support the implementation of A-CDM in a consistent globally harmonized approach, if and when based on a solid business case and comprehensively consulted with airport users. Clear consultation with airline stakeholders is essential to ensure all parties agree and support the objectives. The introduction of any major change to an airport operation, should not be underestimated in terms of the impact it may have on the operation of each airline.

Ensuring early engagement with stakeholders and instilling a collaborative culture will support the success of an A-CDM implementation. Without clear and agreed objectives, A-CDM implementation may not yield expected benefits and, in certain cases, may result in sub-optimal operations or inefficient investments for the airport.

3.5.3 Airport Operations Tools

Besides the *ICAO Annex 14 – Aerodromes – Volume I*, which specifies certain facilities to be provided at airports and identifies several duties to be carry-out by airports, the *ICAO Doc 9981, PANS-Aerodromes*, states that a safety assessment considers the impact of the safety concern on all relevant factors determined to be safety-significant at the airports. Among the items that may need to be considered when conducting a safety assessment at the aerodrome, the presence of an Advanced Surface Movement Guidance and Control System (A-SMGCS) is one of the most important elements to ensure that the expected level of safety during the airport operations is met. In addition, when A-SMGCS is available, it can be utilized as a supporting means to the proposed solutions, especially in low visibility conditions (LVP), ensuring safe operations during lower than standard category I (CAT I), other than standard category II (CAT II), CAT II and III approaches and low visibility take-offs.

The A-SMGCS, therefore, is expected to provide adequate capacity and safety in relation to specific weather conditions, traffic density and aerodrome layout by making use of modern technologies and a high level of integration between the various functionalities [7]. Besides all parties concerned to fully benefit from an A-SMGCS, the system should be capable of interfacing the aircraft operators when the aircraft is operating on the manoeuvring area and obstructions on that area in all visibility conditions.

Normally, a certification process is not adopted for ATS systems (*ICAO Doc 9830, Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual, 3.3.2 - Standardization and certification* refers), which often is applied to a system considering current SARPs. With the implementation of an A-SMGCS, there is a need to adopt a certification process that addresses the safety aspects of the system or services in total. The meeting of the certification criteria should lead to the granting of an approval for operational use of the A-SMGCS and for participating aircraft operators.

The main benefits to be accrued from the implementation of an A-SMGCS will be associated with, but not limited to, low visibility surface operations. Significant improvements in aerodrome capacity can also be achieved under good visibility conditions. Furthermore, an A-SMGCS can provide more precise guidance and control for all aircraft and vehicles on the movement area and should also be able to ensure spacing between all moving aircraft and vehicles, especially in conditions which prevent spacing being maintained visually.

IATA Position

Support A-SMGCS implementation where traffic numbers and ground complexity warrants it.

3.6. Most Capable Best Served (MCBS)

The principle of First-Come-First-Served has served the aviation community well for many years. However, this principle has increasingly come under question, especially as technological evolves and the significant number of less capable users. For airlines, the most important goal is for ANSPs to maintain an ATM system that supports the capacity, commensurate with demand, and for the system to operate with the best possible efficiency. The First-Come-First-Served principle is not compatible with this objective.

Recently, the expression “Best Equipped Best Served” has been used to describe a model of operations, where aircraft operators that have invested in modern aircraft equipage, would be able to take full operational advantage of their investment. However, “best equipped” is not the best indicator of a flight’s capability. Several other elements such as flight planning capability, crew training, etc. must also be considered. Enabling operations under this principle is more difficult than it may appear. The complexity caused by mixing aircraft capabilities and associated procedures within dense airspace, creates consequential workload increases on ATC which may result in a loss of capacity and efficiency.

In order to avoid imposing equipage mandates, ANSPs should instead ensure that they utilize the existing systems, and take advantage of the MCBS principle to discuss with their airspace users how to reach a desired end state with increased air and ground capabilities.

Similarly, the separate premise of Best Planned Best Served (BPBS), may be more appropriate in future ATM systems, allowing a consistent orderly implementation of new CNS/ATM systems through global interoperability, thus resulting in an integrated, seamless Global ATM system for all users during all phases of flight.

IATA Position on MCBS

Support the MCBS concept, however it is necessary for ANSPs to have an agreement with the airlines at the planning and implementation phase when MCBS concept is to be used. The ATM System must always deliver maximum capacity, commensurate with demand. While providing this optimum capacity, the ATM System has to do so with the greatest possible efficiency. This most likely requires the best possible use of aircraft capabilities.

The Most Capable Best Served concept can be an effective tool in managing the evolution towards a new equipage level which is reached either by mandate or by consensus.

3.7. Trajectory Based Operations (TBO)

3.7.1 The TBO concept

The Trajectory Based Operations (TBO) concept is designed to support an ATM environment where a flown flight path is as close as possible to the user-preferred trajectory, by efficiently reducing potential conflicts and resolving demand/capacity imbalances. [8]

The implementation of a seamless gate-to-gate trajectory management system (TBO) should be resilient, not constrained by geographical boundaries and should meet relevant requirements of diverse users in a safe, secure, efficient, sustainable and economically viable manner.

As a result, the provision of an environmentally sustainable flying experience from origin to destination would be fully adapted to the future traffic demands and user requirements. The use of trajectory Information exchanged by automation allows the provision of more accurate, consistent and operationally relevant information, which better supports the human actors in performing their roles and responsibilities using improved methods and techniques, leveraging the enhanced information. The provision of service will be adaptive to dynamic conditions (e.g., weather) and performance-based (independent of aircraft type - unmanned, manned etc.).

The TBO concept is expected to address inefficient airspace operations, and highlight limitations of current ATM Systems inability to deliver performance enhancements across multiple Key Performance Areas, such as:

- Lack of disparate information sharing between players, across participants and automation systems, which leads to inconsistent and inaccurate trajectory predictions. There is no single and consistent view of an expected trajectory.

- Decision-making neither informed, shared, or collaboratively based on a trajectory or on trajectories that are managed locally within systems;

- Tactical ATM decisions without coordination, decreasing the effectiveness of strategic decisions shifting the balance towards reduced efficiency and predictability;

- In-flight re-planning and prioritization by the operator, which is not supported by a non-automated process; and

- When capacity is limited, inaccurate trajectories driving demand that is not matched to capacity.

- Better aeronautical and meteorological information needed to increase predictability through a stepped approach resulting from technology improvements, as defined in the MET ASBU module.

TBO will support an operator by contributing to:

a) An efficiently negotiated 4D trajectory providing a reduction in direct operating costs;

b) Minimizing the gap between scheduled and actual operations will provide indirect cost reductions from irregular operations (i.e., misconnections, passenger hotels, crew overtime, cancelations, etc.); and

c) Delivering more efficient use of ground and airborne operational assets (e.g., better gate and improved aircraft utilization, etc.).

However, the benefits of TBO will be impacted by airspace capacity and flexibility constraints which will limit an operator's opportunity to achieve their best trajectory.

Several changes are required to reach the benefits from TBO. The first one is a structural change. All the stakeholders need to be able to exchange information using System Wide Information Management (SWIM) as this is the evolution that will provide more flexibility not only in the content, but also in how information is made available.

Connection to SWIM will be gradual, but for the ground-ground part, the objective should be to be able to use the internet protocol (IP) networks, being deployed by the ANSPs for ATM (e.g., NewPENS[5], in Europe, or the new Common Aeronautical Virtual Private Network (VPN) (CRV) in Asia Pacific Region). On the air-ground side, initially, the private connection that airlines are setting up to interconnect their Airline Operation Centre (AOC) with the aircraft Electronic Flight Bag (EFB) should be used and complemented, in the future, by IP connectivity with the ANSPs for safety related information exchanges.

The second change is the ability for all systems to make use of the information made available. This means adapted operator flight planning systems (i.e., Computerised Flight Plan Service Providers (CFSP)) to use the new FF-ICE capabilities to reduce dispatcher workload in the trajectory negotiation process, as well as ANSPs Flight Data Processing Systems (FDPS) to support the negotiation and more efficient handling in the trajectory information that they will receive from the operator/aircraft.

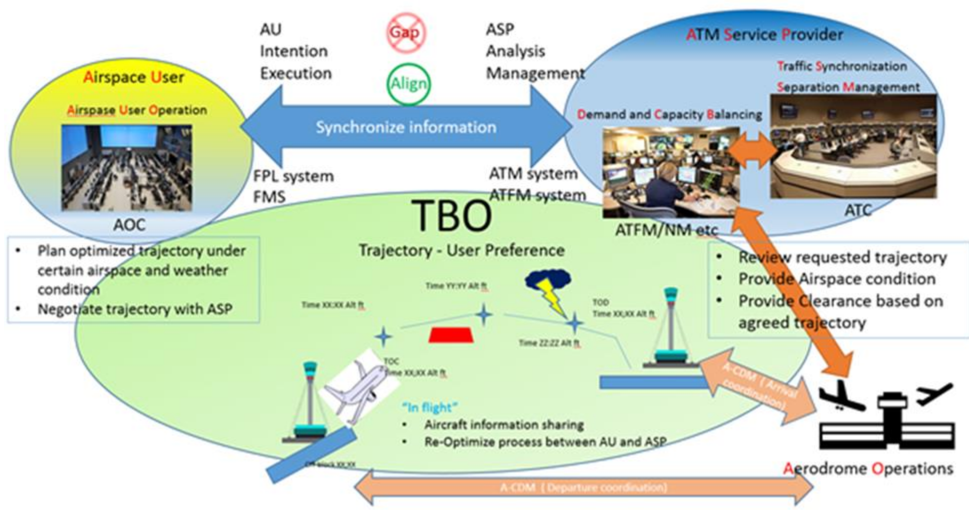

Figure 1 – Trajectory Based Operations (TBO) structure

[5] **NewPENS**, network spearheaded by EUROCONTROL, provides a robust IP-based infrastructure for exchanging critical and common aeronautical information reliably, securely and safely in a cost-efficient way. It meets both current needs for the information exchange between ANSPs and other ATM stakeholders, as well as future applications planned in the SESAR Programme, such as SWIM.

IATA Position on TBO:

Support: However, to achieve optimum flight trajectories based on a CBA, enhanced airspace capacity and access will require the following:

- **Maximize satisfaction of operator trajectory requirements;**

- **Improved ASM or better capacity (dynamic ASM, FUA), with timely information dissemination of pertinent operational information;**

- **Flexible route access (existing Overflight permissions, FIR and State boundary requirements), UPR/FRA operations without restrictions over continental, remote, and oceanic airspace;**

- **Replace as much as possible to optimized route network by free route airspace;**

- **An appropriate cross regional and traffic flow- based transition plan, should be developed;**

- **Technological implementations to support TBO, should be evaluated, and a CBA conducted to compare with alternate methods that can support the intended operation; and**

- **Plurality of the supply of the air-ground terrestrial connectivity services.**

3.7.2 Flight & Flow Information for a Collaborative Environment (FF-ICE)

The FF-ICE concept [6] has been transposed as a defined set of services, as the key enabler to accommodate Trajectory Based Operations (TBO) (§ 3.7.1 refers) between Operators and ANSPs (see details in following section). FF-ICE services will be introduced as defined functions utilizing information in support of flight planning, flow management and trajectory management. FF-ICE will replace the current FPL2012 flight plan format, and in a later step, replace the flight coordination communication mechanism (AIDC) currently used by several ANSPs.

The exchange of information via FF-ICE services is intended to provide the best possible integrated picture of the past, present, and future operational situation. This exchange of information will improve CDM between all stakeholders involved in the operation of a flight, i.e., gate-to-gate, thus facilitating 4D trajectory operations.

In order to adequately discuss the notion of FF-ICE, it needs to be clear that the future system will require a new data communication infrastructure. ICAO continues to develop provisions related to the SWIM (§ 3.8.2) and associated services. This may cause financial hurdles, but this is not the only challenge.

The FF-ICE benefits can only be achieved in a SWIM environment. It is thus important to complete trials combining SWIM and FF-ICE as a support to a robust FF-ICE cost benefit assessment (CBA). In addition, SWIM and relevant information services providing timely and good quality AIS and, meteorological should be available to assure the intended capability of operations from FF-ICE.

Because there are no mandates for SWIM or FF-ICE attached to the ICAO provisions, there is a risk that for the same flight plan, an operator will be required to submit the flight plan in both the FPL2012 and FF-ICE formats, based on what type of systems the ANSP responsible for the airspace support. For the time being, the onus for determining which flight plan format to file will be on the user. One option was to have ANSPs utilizing an “FPL translator” that would take the FF-ICE/FPL 2012 format and translate it to their appropriate version. This option was not accepted by the ICAO Panel managing this program.

In addition, the ICAO FF-ICE provisions favour a flight plan distribution done by the users, which means all negotiations related to the route and altitudes etc., will be done with each individual ANSP. Although IATA requested that the States/ANSPs agree to coordinate the aspects of the FPL with the adjacent ANSPs to limit the back and forth between each ANSP, this was not the preferred option of the State ICAO Panel members.

Therefore, the goal should be to develop and implement a plan that will encourage States in transitioning from the FPL2012 format, following validation of a CBA. The implementation of Release 1 is intended to signal the start of the transition from FPL2012, however, the sunsetting of FPL2012 is yet to be agreed. Initial discussion indicated 2034 as a target date, assuming that some States begin implementing FF-ICE when it becomes applicable in 2024. Release 2 is still under development and its implementation will take a longer period to implement.

EUROCONTROL has introduced some FF-ICE services into their IFPS system. Even as they assess the new services, they continue to support both formats. The FAA is also working on their implementation of FF-ICE services having already introduced FIXM as the data exchange model for their ATM system data exchange.

FF-ICE is expected to provide the following benefits:

a) Addresses the shortcomings of FPL2012 and support future concepts, such as TBO

b) Key enabler for TBO by providing ANSPs with more data to better accommodate operator interests, increasing schedule predictability through trajectory coordination,

c) Contain a wide range of data that may support future ATM automation evolutions, which will support airspace capacity and flexibility enhancements, and;

d) Facilitate smoother coordination between operators and ANSPs in order to improve flight efficiencies by enabling inflight rerouting around weather and airspace constraints

However, all ATM stakeholders will need to consider whether they are prepared and able to implement FF-ICE. Due to the gradual transition, we may see a mixed mode of environment of capable and non-capable ANSPs and operators. This mixed mode, will at first increase the workload for both ANSPs and airlines, and possibly reduce the expected efficiency of FF-ICE.

The flight plan information exchanges will enhance trajectory coordination via an automated process changing current processes/procedures for all. Unfortunately, although ANSPs may receive improved data, airspace capacity constraints may continue. Both ANSPs and operators will need to have the capability to handle additional flight information beyond what is currently required for FPL2012. Also, it will be important for ANSPs to remove or reduce the constraints by advancing ATM improvements utilizing the FF-ICE information.

Among the initial FF-ICE services, the “Planning Service” will allow the operators to submit a Preliminary Flight for evaluation by the ANSPs plan prior to filing an ATS Flight plan (Filed Flight Plan). This will negotiation step will facilitate the acceptability of the flight plan when submitted as the ANSPs will be able to provide feedback regarding constraints that will be applicable to the proposed flight trajectory. It should allow for a collaborative, iterative planning process, an automatic exchange of up-to-date flight trajectories associated with post-departure flight coordination, and trajectory sharing applications that can synchronize and share a common trajectory intent.

IATA Position on FF-ICE:

Support: However, although FF-ICE is expected to improve the communication between all ATM stakeholders, operational improvements will only be possible if stakeholders upgrade communication systems and ANSP Flight Data Processing Systems (FDPS) capable to utilize enhanced data and information. The IATA position on FF-ICE is conditional based on the following:

- **A SWIM infrastructure, enabling the deployment of FF-ICE services, will be required. The implementation of SWIM will support the introduction of additional new AIS and meteorological information services needed to improve operations.**
- **An appropriate transition plan from FPL2012 to FF-ICE is required in order to ensure the initial implementation of FF-ICE maximizes efficiency and minimizes workload. The transition plans should be based on regional implementations to limit the burden within a region and promote a coordinated migration to FF-ICE by ANSPs across regions for a smooth implementation affecting cross regional traffic.**
- **When an airline migrates to FF-ICE, it will send an FF-ICE flight plan to all ANSPs concerned and it will be up to the ANSP to translate from FF-ICE to FPL2012 if it is not FF-ICE capable yet.**
- **Contingency backup procedures and processes should be developed as part of the global standard (e.g., SWIM failure including infrastructure/SWIM services or other large cyber security threats cases).**
- **The benefits of FF-ICE will be limited if ANSPs do not adapt their automation systems to make use of the additional information.**
- **To maximize the FF-ICE benefit, an appropriate dynamic change of ASM and capacity improvements utilizing flight plan information will be required.**

3.7.3 FPL2012

Following the adoption and mandate of the FPL2012 standard, there was an expectation that the ANSPs would transition to the new flight plan. Unfortunately, a number of ANSPs have yet to adopt FPL2012. Although the number may be relatively small, the time that has transpired between adoption and implementation, raises concern for future implementations. As ICAO moves toward completion of the SWIM architecture and FF-ICE format, the community will face the need to transition once again, into a new FPL system. In addition to the basic concern, airlines will find themselves questioning the new requirements and whether the benefits will provide value.

IATA Position on FPL 2012 transition

Support the use of the complete FPL2012 versus translation of FPL2012 into the legacy FPL format to make use of the extra fields that FPL2012 provide, while encouraging ANSPs to migrate to FF-ICE as soon as possible (see above).

3.7.4 ATS Interfacility Data Communications (AIDC)

ATS Interfacility Data Communications (AIDC) contributes to safe and efficient FIR boundary crossing operations. It facilitates the reduction or elimination of factors that contribute to operational issues such as read-back / hear-back errors, missed coordination and flight progress updates and the loss of required separation standards as aircraft cross FIR boundaries. It significantly reduces the amount of manual coordination required by ATCOs for aircraft to cross FIR boundaries seamlessly. As such, AIDC contributes to flight efficiency.

AIDC is a data link application that provides the capability to exchange data between air traffic service units during the notification, coordination and transfer of aircraft between FIRs. It is an automated process that facilitates routine coordination by providing a reliable and timely data exchange between ATSUs in which accurate information can be derived directly from the system, thus effectively reducing controllers' workload and human errors.

IATA Position on AIDC:

Supports AIDC and its implementation, where the volume of traffic and/or airspace complexity require, as an effective means to increase seamless flight plan data coordination between ATSU.

3.8. Aeronautical Information

3.8.1 Aeronautical Information Services, Aeronautical Information Management (AIS/AIM): Towards SWIM

Aeronautical Information, a key pillar on which the Air Navigation System is reliant, is global by definition and the transition from Aeronautical Information Services (AIS) to Aeronautical Information Management (AIM) represents a paradigm shift: changing role players, data sources and related format and products, as well as the concepts of static/dynamic information and AIRAC cycles. Within the data/information driven operational environment, computing power is no longer the limitation to provide and access high quality aeronautical information for the next-generation aircraft and ANS.

Modern and future flight operations are defined by concepts increasing aircraft connectivity to each other as well as ground Air Traffic Management systems requiring harmonised: e-Enablement and Electronic Flight Bags (EFBs) powered by Safety; ATM performance; flight efficiency; user applications, and interoperability. However, aeronautical information distribution is still largely paper based, the concepts of digital data having not been fully embraced globally. Compounded by the common misconception that data digitisation is simply posting a soft copy of a document to an online site.

A transition to AIM means accepting concepts supporting the future operational environment such as increased temporality of the data and the need for harmonised end to end management of aeronautical data that is cemented in a robust quality management process as well as connecting ground systems with Air Flight Management Systems. The delineation between Flight Operations and Air Traffic Management evolves to an integrated partnership as airspace managers reliant on common harmonised data. In the near future, managing airspace limitations for the best use of efficiency, will be dependent upon a partnership with all stockholders concerned, mainly through the utilization of advanced equipment and defined business practices i.e., SWIM and the collaborative sharing of data. It is essential that governments who have the overall regulatory responsibility within their regions, be involved in the process.

AIM is recognized for the key role it plays in a digital/electronic landscape to ANS in the quest for interoperability and enhanced data quality, something AIS was not. It will provide new capabilities for airspace-users (airlines), drone operators and service providers. At the same time, AIM supports the key characteristics of the value of information (relevant, accurate, timely, reliable, complete). However, the global aviation community has yet to fully implement the AIM capabilities visualized in the ICAO Global Aviation Safety Plan, Doc. 10004, or the ICAO Roadmap for the Transition from AIS to AIM 1st, Edition 2009, which includes the foundations of AIM enabled by SWIM.

Significant effort has been made toward technical awareness coupled with recognized operational improvements. The benefits that will become available vis-à-vis a transition from AIS to AIM, include an improved data/information quality. However, it should be noted that a strict cyber hygiene will need to be considered given the enhanced technical settings that will be required to support AIM.

The objectives of AIM, as defined by recommendation 1/8 of ICAO AN-Conf/11, are very clear: "*That ICAO, when developing ATM requirements, define corresponding requirements for safe and efficient global aeronautical information management that would support a digital, real-time, accredited and secure aeronautical information environment.*"

Automated systems rely more and more significantly on digital data/information; therefore, the following improvements and features need to be considered.

1. Implement effective quality management system/process to improve and or maintain data accuracy (how close to reality), resolution (significant decimal places) and integrity (data quality, timeliness and trustworthiness) all the while accounting for industry compliance to standards.

2. Proper training for officers and data originators vis-a-vie the quality maintenance of data/information.

3. Standardized format/template of information to avoid diverging descriptions hindering a defined automated process.

4. Process aeronautical information and distribute to the end user in a timely manner in order to capture dynamic situational changes.

5. SWIM capabilities should be introduced as soon as practicable following the availability of the ICAO provisions on SWIM using criteria (based on principles of delivering the right information to the right place/person at the right time to facilitate coordination, cooperation and informed decision making by interested and invested participants:

    a) Common authorized access

    b) Core services for information

    c) Directory and registry

    d) Interface to multiple protocols

    e) Message brokering/ secure messaging with other agencies

    f) Cyber security

    g) Data dictionary

    h) Pathway to consolidated data processing

Without the above noted improvements, accurate information cannot be extended to the end users (dispatcher, performance/operations engineers and flight crews) in timely manner. Incorrect data will require a manual intervention in an automated process which will exponentially increase the workload of the airline back office. Delayed information will create inappropriate trajectory (flight plan) calculation and impact to the accuracy of the overall trajectory negotiation including demand and capacity balancing. Lack of these basic qualities will prevent the expected outcome from the AIM defined benefits.

IATA position:

Supports the effective implementation of ICAO defined Aeronautical Information Management with the following minimum main requirements:

- **Implementation of an effective certified quality management system for aeronautical information managers and service providers ensuring continuous review and improvement.**
- **Implementation of robust aeronautical information management regulation that supports and enables aeronautical information originators, managers and users in the origination, production, supply, and access to data.**
- **Implementation of effective aeronautical information management processes across the aeronautical information data chain ensuring timely and equitable access to aeronautical information that conforms to defined data quality attributes and user requirements.**
- **Implementation of globally harmonised standardised templates/formats for aeronautical information products and services.**
- **Implementation of electronic data management and exchange based on the defined Aeronautical Information Exchange Model (AIXM).**
- **Advocates for the implementation of globally agreed governance principles and communication infrastructure (see URATS Vol 2 CNS).**
- **Implementation of a transition AIS/AIM process characterised by the increasing application of the SWIM interoperable services.**
- **Full cost recovery for Aeronautical Information should be facilitated through Air Navigation Charges and AU should not carry any additional separate costs associated to accessing required aeronautical information.**

3.8.2 System Wide Information Management (SWIM)

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

SWIM was developed to overcome the deficiencies of the ICAO ATS messaging defined 40 years ago. Its goal is to provide the right information, to the right people at the right time, in an interoperable manner. In contrast, the current messaging system suffered from message-size limitations, a non-scalable approach to information exchange and many interfaces designed to support point-to-point exchanges thus reducing the flexibility to accommodate new users, additional systems, and new content or format changes. In addition, automation systems more and more require accurate digital data transmitted with high integrity from the originator to the end user. SWIM will complement human-to-human with machine-to-machine communication and improve data distribution and accessibility.

Information Exchange Protocols (Concepts and tools)

SWIM is intended to replace the existing data exchange infrastructure (i.e., AFTN and AMHS) by an IP-based infrastructure and will initially support all information exchange relating to AIS, MET and ATM. The data will be exchanged using standardized data format like AIXM, FIXM, and IWXXM relying on XML, UML, or other languages, that will bring flexibility to the information delivery. SWIM can be supported by a cloud environment connecting each stakeholder like ATM, AIS, MET, Operator, Airport, etc. SWIM, by itself, is just an enabler and as such does not by itself provide operational benefits.

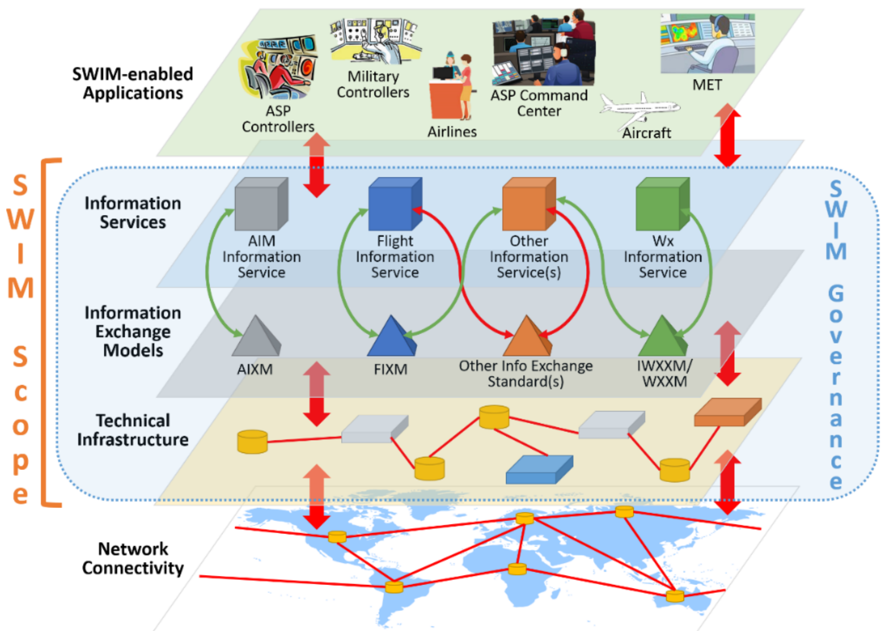

Figure 2 – SWIM structure, scope and governance

SWIM depends on IP technology, which in and of itself, opens the system to cyber threats. ICAO has acknowledged that there are concerns regarding Cyber security and has established expert groups to develop requirements that should be applied to this technology. Cybersecurity will require the implementation of technical enablers in most communication layers, including IPV6, a dedicated domain name and identity management. In addition, an information security framework commensurate with the safety/security level of the information to be exchanged will need to be applied. Implementing such a security framework might be very costly for AU that would not already have some security measures in place.

However, given that ATM concepts such as FF-ICE (§ 3.7.2) and TBO (§ 0) will rely on SWIM to support these applications, all stakeholders should be aware that absent a solution for protecting against Cyber threats, the implementation of SWIM will not come to fruition.

Potential SWIM benefits for the operator and other ATM stakeholders include:

a) There will be more information available over SWIM than the current information available over the existing network infrastructure. This information will be more system friendly allowing integrating of the information into decision making tools like automation of flight planning;

b) The data available over SWIM can be accessible in a more timely and user-friendly way (when appropriate interface is used for visualization), and

c) SWIM can accommodate not only IWXXM/AIXM/FIXM data, but also various information can be shared between ANSPs, airport and operators for AFTM/CDM using SWIM as a data exchange platform.

However, SWIM is an information exchange tool, it will not improve the information elaboration process. If data providers do not implement Quality Management Systems to guarantee the quality of the data/information they provide, the benefit from the data exchange over SWIM may not be achieved. As the end goal is for all data supporting the operation to be exchanged over SWIM, failure of SWIM will impact the entire operation.

The operator needs to consider the following points to implement SWIM:

a) A need to update their systems to handle IWXXM (MET), AIXM (AIS-AIP/NOTAM), FIXM (ATM-Flight plan), and develop interconnectivity between internal systems including EFBs for efficient use of information over SWIM;

b) IP based connectivity is available in an airline system environment, thus bringing SWIM connectivity to airline systems has a relatively low impact but the capability of those systems to use the additional information that SWIM makes available will have a higher impact on airline systems; and

c) Mixed SWIM environment between States will reduce the value and benefit of the operator supporting flights across countries and regions.

IATA Position on SWIM:

Support: IATA supports SWIM as the future communication infrastructure with the following considerations:

- **To maximize its benefit, appropriate implementation planning and deployment management over major traffic flow (inter and intra-regional) is required;**
- **Cost and Benefit should be proven from applications like Meteorological, AIS and ATM;**
- **Redundancy and resiliency of system is required as infrastructure, with a backup plan and contingency procedures;**
- **Access to SWIM services should be harmonized across regions;**
- **The number of SWIM registries should be limited to one per region;**
- **Information services should provide added value and not just replace the current messages;**
- **Cybersecurity features should be included from the beginning to limit the security risks;**

- **SWIM should be linked to an airline AOC with their flight plan and flight operation support system for common situational awareness; and**

- **The end goal is for all data supporting the operation to be exchanged over SWIM, and thus any delay in implementing SWIM will have an impact on operation improvements. From now on every new information exchange should be implemented over SWIM.**

4. New Entrants

The COVID-19 pandemic may have fast-tracked certain future operational concepts. New consumer trends and behaviours are motivating new models for e-commerce from customer needs to get their purchases faster to last mile delivery, micro-mobility and new suppliers. At the same time, there is a growing demand for remote inspection and surveillance of critical infrastructure. With remote technology and remote working, there is an emphasized need for different services that are expected by the flying public. At the same time, aviation's environmental targets are becoming drivers for airline decision-making when it comes to new aircraft technology. Airlines are announcing plans to acquire new aircraft such as eVTOL.

Technologies such as big data, artificial intelligence, robotics and internet of things are slowly making their way in aviation to improve the efficacy and system optimization. At the same time, commercial aircraft today can provide enormous amounts of data. Access to timely, consistent, secure and accurate information can enhance decision making across the aviation supply chain.

4.1. New Airspace Users and Future Airspace

With the anticipated increase in the number and diversity of AU, ATCOs may not be able to efficiently manage and support such a large scale of diverse traffic using current methodologies without resorting to restrictions or requiring additional resources, both of which are not sustainable solutions in the long term. Segregation of different types of AU may be feasible in the short term, but as traffic numbers increase, integration will be needed if efficiency is to be maintained/achieved.

Future aircraft capabilities will enable sharing of information such as intent, location of surrounding traffic and constraints so that operations can be planned safely. Digital and cloud-based applications and implementation of standardized communication protocols will enable sharing of safety and flight critical information amongst all AU. This digital situational awareness will enable operators with the required capabilities and performance to self-manage their operations and their interactions with other AU. A more coordinated approach towards traffic deconfliction will be possible through which automated decisions can be taken throughout all flight phases. This will trigger a shift in the role of ATC to supervising the system, monitoring its performance, and intervening only when necessary, to ensure the desired system outcome. With this paradigm shift, ATC will focus on solving and diagnosing complex problems, leaving situations that require rapid response and alertness to automation. Strategic de-confliction and dynamic airspace allocation will allow operations to take place without the need for regular ATC intervention as is the case today.

At the same time, a high percentage of new and emerging operators are expected to have the capability to strategically manage their operation through interactive planning and orchestration of intent information. Future automation is expected to enable alerts about exceptions that cannot be handled automatically and present the operator with the necessary information to investigate off-nominals and take necessary actions. Access to airspace constraints and weather reporting and forecast should enable strategic de-confliction for multiple aircraft. Therefore, the notion of one remote pilot per remotely piloted aircraft will be replaced by a remote pilot or operator managing a fleet of remotely piloted aircraft or supervising the system managing this fleet.

The bulk of ICAO's work on provisions related to new entrants has been focusing on non-passenger carrying RPA operating in an IFR environment. This does not reflect the long-term vision of various types of new entrants operating across borders. However, there is an intention to integrate UAS in the ASBU framework under the Global Air Navigation Plan (GANP). In parallel, regulators across different regions have started working on local requirements for new entrants. In the absence of global provisions for operations of new entrants, there is a risk of fragmentation which will affect manufacturers and operators. Therefore, it is important to target integration of new entrants into airspace, supported by global regulations that ensure safety, efficiency and cost effectiveness.

It is envisioned 4D TBO will support future airspace requirements from capacity and environmental perspectives. Current legacy methods of traffic separation based on calculated time of departure (CTOT) in the strategic phase, and the use of procedural or radar based human intervention in the tactical phase will inevitably fail to meet future airspace requirements due to traffic flow complexity. AU in the future should be able to fly pre-negotiated trajectories while ensuring safe separation from traffic, obstacles and weather. The key paradigm shift will lie in the degree of authority over the trajectory and responsibility for safe separation a remote pilot or operator or service provider will have, given the wide differences in the type of operations and performance capabilities of the aircraft.

Airspace is a finite resource and in order to ensure safety and equitable access for all AU, new entrants should be integrated in a safe manner and without negatively impacting aviation. This may result in a need to re-visit some of the underlying assumptions governing how traffic is managed and assessment of the requirements for access to segregated airspace. To avoid varying regional requirements, the integration of new entrants should be addressed at a global level and under the auspices of ICAO. New working mechanisms are needed to ensure that the standard development process is aligned with the pace of innovation.

Future ATM concepts intend, among other benefits, to increase capacity and, in combination with future traffic mix, including remotely piloted vehicles (RPV)/UAS, may result in complexity that exceeds the capability of the provision of the ATC services in certain portions of the airspace. Effectively, the flight crew may be delegated to self-separate from other traffic to prevent conflicts or proximity events.

IATA Position New Entrants:

Support the safe and efficient integration of new entrants into airspace without creating financial or operational burden to airline operators.

Several aspects need to be considered when integrating new entrants into airspace:

1. **Future airspace construct should consider the conditions for integrated operations of unmanned and manned aircraft as well as their specificities when defining the services available and the requirements to be applied.**

2. **Incremental implementation, and parallel operations will be needed until a state of convergence between legacy ATM and Unmanned Traffic Management (UTM) and Space Traffic Management (STM) can be achieved.**

3. **Upskilling and reskilling of operational staff, especially within ANSPs, may be required.**

4. **The critical path towards the end state of higher automation will be the regulatory framework; how will such future traffic management system be certificated and how will safety management and safety oversight be exercised; and**

5. **Future operations should be demand & performance based with a performance baseline agreed for new entrants to assure safety and efficiency are maintained.**

5. Workforce

The combination of human intelligence and of artificial intelligence, supplied by a highly automated system, will lead to a stronger and more efficient system overall. The aviation workforce of the future should be prepared to deal with many different types of AU as well as exponential traffic growth. At the same time, COVID-19 has had a huge impact on the aviation workforce. The industry faced issues attracting young professionals prior to the outbreak of the pandemic, a problem which is now amplified after a huge skills bleed in the industry. Therefore, attracting the right skills to support current and future operations will have its challenges. Above all, we will need to prioritize more diverse, creative, future-focused skills coming into the industry.

IATA has initiated an Aviation Skills Working Group to identify the operational skills and capabilities that are critical to the industry's growth. Through collaboration with different aviation stakeholders, external experts such as universities, and relevant authorities, an assessment will be carried out and recommendations will be formulated. At the same time, there is a trend towards making training more digital and remote to enable more individuals to connect and become aviation experts. The challenge that the industry will face there is in ensuring that the quality of training is maintained, when digitized.

At the same time, a framework for cross-domain training and in-field exchange programs will be needed between airlines, ANSPs and airports to ensure better mutual understanding of operational challenges. It will also include enabling people to upskill so they can be more easily re-allocated according to needs, and more mobile in their careers. Mentorship programs will support both upskilling and knowledge transfer.

Outreach campaigns will enable engaging a new generation and interest them in a career in aviation, reaching them through a multitude of touchpoints, including social media, and directly in universities and high schools through campaigns and talks from experts.

The industry should work together with universities to define programs to better recruit and train young people in all aspects of the industry. These will include scholarship funds and student internships. There is value in an industry-wide recruitment platform that can enable skilled professionals to be aware of job and training opportunities across all disciplines. Such an industry-wide recruitment platform can facilitate the redistribution of talent regionally and globally. It will enable stakeholders to seek newly trained people and senior talent alike by posting vacancies accessible to all.

As ICAO defines the minimum standard requirements for future roles, these will be published on the site, enabling people already employed to identify any new skills they need. Training development guides will accompany these requirements, to help industry schools and institutions update their programs, and the relevant programs can then also be publicized to help candidates easily identify them. The industry would therefore have one central reference source to ensure its skilled professionals are of the same level worldwide, and to enable a fully mobile workforce.

References

[1] ICAO, **Doc 10088 – Manual on Civil-Military Cooperation in Air Traffic Management**, First Edition, 2021.

[2] ICAO, **Doc 9993 – Continuous Climb Operations (CCO) Manual**, First Edition, AN/495, ICAO 2013.

[3] ICAO, **Doc 9931 – Continuous Descent Operations (CDO) Manual**, First Edition, AN/476, ICAO 2010.

[4] ICAO, **Doc 4444 – Procedures for Air Navigation Services, Air Traffic Management**, PANS-ATM, 16th Edition, 2016.

[5] ICAO, **Doc 9854 – Global Air Traffic Management Operational Concept**, First Edition, AN/458, 2005.

[6] ICAO, **Annex 11 – Air Traffic Services. Air Traffic Control Service, Flight Information Service, Alerting Service**. 3. Related operating procedures, 3.2 Collision Avoidance. Fifteenth Edition, July 2018

[7] ICAO, **Doc 9830 – Advanced Surface Movement Guidance and Control System (A-SMGCS) Manual**, First Edition, AN/452, 2004.

[8] ICAO, **Global TBO Concept** (Draft Version 0.11), by the ICAO Air Traffic Management Requirements and Performance Panel (ATMRPP).