Flight Planning in the Digital Age

Whitepaper

Introduction

With the introduction of digital applications and enhanced automation in the flight deck and in ATM system, changes in flight planning and Operation management in the Flight Operations Center (FOC) are expected and needed in the next decades. The increase of enhanced data sharing mechanisms among flight planning stakeholders will facilitate data-driven decision-making processes, enabling dispatchers to make informed decisions that optimize flight routes, enhance safety and efficiency, and minimize operational disruptions. Rapid advancements in artificial intelligence (AI), machine learning, and automation technologies enable dispatchers and FOC to leverage/ conduct predictive analytics, optimize flight operations, and streamline operational workflows and resources.

The evolution of Air Traffic Management (ATM) towards Trajectory-Based Operations (TBO), supported by new concepts such as System Wide Information Management (SWIM), Flight & Flow Information for a Collaborative Environment (FF-ICE), and Airport Collaborative Decision Making (A-CDM), promises to enhance operational efficiency, optimize airspace utilization, and streamline collaborative decision-making processes across the aviation stakeholders. These ATM and technology advancements will transform the role of dispatch and flight crew. Enhanced communication tools and the integration between Airline FOC and flight deck operations foster real-time collaboration, facilitate seamless information exchange, and equip flight crews with the situational awareness necessary to respond effectively to evolving operational conditions.

Working towards NetZero, dispatchers and FOC will play a major role in handling environmental impacts of CO_2 and non-CO_2 and their trade-offs. The imperative to reduce emissions and mitigate the environmental impact of aviation necessitates a holistic approach to flight planning and trajectory adjustment, where dispatchers must navigate the trade-offs between CO_2 emission reduction strategies and minimizing non-CO_2 environmental impacts.

In an era of increasing cyber threats, ensuring the cyber resiliency of flight dispatch operations is paramount, with robust security measures safeguarding critical infrastructure and data integrity against evolving risks.

As the industry navigates towards a future characterized by collaboration, innovation, and adaptability, the role of airline flight dispatchers and FOC will continue to evolve, shaping the future of aviation operations with confidence, efficiency, and resilience.

This white paper outlines future requirements and enablers for dispatch and FOC operations, including required skills and flight planning system capabilities.

Characteristics of the Future Operational Environment

The TBO concept is designed to support an ATM environment where a flown flight path is as close as possible to the optimal user-preferred trajectory, while efficiently reducing potential conflicts and resolving demand/capacity imbalances. Trajectory information exchanged and managed through automation will allow the provision of more accurate, consistent and operationally relevant information. This information feeding improved methods and techniques better supports the human actors in decision-making and performing their roles and responsibilities. The provision of service will be adaptive to dynamic conditions (e.g., weather) and performance-based (independent of aircraft type - unmanned, manned etc.).

Pre-Tactical

Using the principles of TBO, decisions about trajectory adjustments are made more strategically, improving single-flight and system efficiency and predictability. In this context, the strategic decisions during the flight planning phase reduce tactical interventions, and tactical interventions in-flight follow as far as practicable a strategic plan. However, for such an approach to be operationally practical, enough flexibility is required in-flight to enable in-flight - trajectory adjustment and prioritization.

TBO focuses on trajectory-based coordination and performance optimization across all phases of a flight. Starting with the flight planning phase, the following steps can be considered within the development of a flight plan.

1. Airline develops trajectory preferences while understanding known constraints through:

    a. identification of meteorological factors affecting trajectories (e.g., winds, turbulence, hazardous weather, low visibility conditions, warming impact of contrails);
    b. identification of constraints that may affect decisions across all phases of flight (e.g., airspace capacity, airspace closure);
    c. development of alternative trajectories and understanding associated constraints;
    d. comparison of trade-offs (costs, environmental impacts, fuel on-board, etc.).

2. Airline shares flight plan information, including trajectory, with the ATM Service Provider (eASP) using the Flight & Flow Information for a Collaborative Environment (FF-ICE) services. Additionally, eASP provides any additional constraints that may only be known by the eASP.

3. Collaborative Decision Making (CDM) processes are applied to manage trajectory negotiation between the airline and the eASP t. Several operational factors need to be considered to generate and rank alternate trajectories where relevant. The agreed trajectory will be used as a basis for managing and monitoring the flight trajectory.

Using such an approach will provide a clear visibility of the planned 4D trajectory and/or constraints that define it. . Once accepted by the flight crew and ATC the agreed trajectory is executed subject to ATC clearances. .

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Changing / up-grading a flight planning system for an airline operator is a big endeavour but with other requirements on the horizon such as FF-ICE and the sunsetting of Flight Plan 2012 (FPL2012), future flight planning system changes would ideally enable most challenging future requirements including contrail avoidance.

Tactical

Flight-execution and trajectory negotiation post-departure allow the airline and ANSP to react to changing constraints or conditions, e.g., change in weather or airspace. In-flight trajectory may be affected when;

1. Deviations from original predictions change the predicted downstream positions or times of the aircraft.

2. New constraints make part of the current trajectory infeasible.

3. Changing conditions provide an opportunity for a better path, possibly identifiable only by the operator due to their combination of operational objectives.

A trajectory negotiation post-departure may result in one of the following outcomes:

1. No Change: the request of trajectory change is rejected resulting in the agreed or planned trajectory remaining the same.

2. A revision: following a positive trajectory negotiation a revised trajectory is agreed and a clearance should be issued so this new trajectory can be flown.

While the agreed or planned trajectory provides a common intent to be achieved, the process by which this trajectory is delivered is through the provision of clearances by Air Traffic Control (ATC), which are then accepted and executed by the flight crew. A flight execution is based on the agreed trajectory and flight plan, but this does not mean that the flight must be precisely flown to all dimensions of the trajectory. A request for a trajectory adjustment can come from ATC, the flight crew or the FOC. In case the adjustment request comes from ATC or the flight crew, and it is not for tactical operational requirements such as conflict avoidance, the Dispatch/FOC will play a key role. The request can also originate from automation, and after approval by the dispatcher and/or flight crew, it will typically be communicated through ground-ground infrastructure.

SWIM and Data Exchange

System Wide Information Management is designed to be the new global mechanism for making available and exchanging information. SWIM allows stakeholders to share and consume AIM, MET, flight, and flow information using defined exchange models.

SWIM comes with standardized data formats are used to facilitate the distribution, accessibility and consumption of information by automation including airlines flight planning systems Distributing, querying and retrieving information becomes easier as the flight planning system can automatically subscribe to updates to the information it needs to create or update fight plans. SWIM is also expected to be used for CDM and ATFM information exchanges soon.

New Entrants

New entrants, of all types and sizes emerge into our skies with challenges that the aviation industry actors need to address and find appropriate solutions.

To overcome these challenges, it requires implementation of new aviation concepts in terms of airspace structure, enhanced digitalization and automation, and air services provision.

The ATM community has to ensure that new entrants' operations are safely and efficiently conducted initially within a segregated airspace while maintaining the level of standards of the legacy ATM system.

The high level of automation carried by the new entrants also leads to a dramatic change in the roles and responsibilities of the different actors where human intervention will be limited to managing the unusual situations.

Future Role of Dispatch

With increasing levels of automation and the implementation of concepts such as TBO and FF-ICE, the role of dispatch will evolve. Automation will enable computation and prediction, but a day in any dispatcher's life is uncertain, to say the least. What may seem like common occurrences in the day-to-day life of a dispatcher are difficult measurements to predict. Therefore, automation will play a big role in providing better information and tools for dispatchers to make more precise decisions, but the function of an aircraft dispatcher is not expected to disappear. In fact, it is expected to grow in scope and evolve.

Not only will there be an increase in involvement in decision-making at the tactical level, for trajectory management and revalidation as the flight crew will not be in a position to make use of all the information, but there will also be an evolution to a shared responsibility for trajectory selection and ranking for flight execution. Therefore, the term "dispatcher" will most probably evolve into a flight manager, as the role now involves orchestrating the different systems for a positive output. Filing of flight plans is envisioned to be automatic and in sync with an airline's schedule. The dispatcher functionality is expected to migrate from a planner to a collaborative decision maker acting as a single point of truth between internal airline operational teams and external stakeholders, specifically ATC.

With the expanded use cases for eVTOLs, UAS, and higher airspace vehicles, the flight dispatch functionality will need higher levels of automation to enable real-time up-dates to be available regarding airspace capacity changes, so that flight dispatch and air crew can work together on the best flight trajectory. Additionally, because of growing geopolitical tensions and conflict zones, the dispatchers will have to use all planning tools available to decide a safe flight path. Combined with the need to ensure optimized trajectory and assessment of CO_2 vs. non-CO_2 emissions, the role of strategic planning of trajectory and trajectory adjustment en-route will be more critical for safety and efficiency.

Today, there are some variations amongst the regions when it comes to the scope of dispatch as it interfaces with flight crew. These variations and the boundaries of dispatch and FOC functionality will most probably continue to exist, but with added emphasis on the role of flight dispatch and FOC. In the following are different scenarios illustrating how the future role may differ / vary based on the regulatory environment or the nature of the trajectory adjustment.

- Scenario 1: Dispatch / FOC as the Primary Decision Maker
- Scenario 2: Dispatch / FOC as a support function

Electronic Flight Bag (EFB)

The emergence and proliferation of portable devices (uninstalled) have significantly enhanced the landscape of on-board aircraft computing. When pairing EFB's with onboard aircraft connectivity, portable uninstalled devices can provide quick enhanced access to operational data and information to the flight crew. However, challenges remain such as: Cost per/unit of the devices and provision of onboard Wi-Fi connectivity (specifically older generation aircraft). Additionally, certain countries have rules against Wi-Fi coverage over their territories which thereby poses further challenges for the sharing of critical information such as trajectory changes with the flight crew.

Operators must equip their crews with the knowledge of how to interact with the EFB, regardless of the device in questions, that being "installed" or "uninstalled". Training is critical and therefore must be provided to ensure crews are utilizing the tools correctly and effectively. The function and role of the EFB (installed or uninstalled) must be clearly communicated to them for a smooth mind set shift when adopting the new technology. Therefore, training should be part of the aircraft rating for the pilot. As such, separate licensing is not required.

Future Flight Planning Systems

Future flight planning systems must become a proactive tool which integrates flight planning with flight following and continuously provides advise to the system users. There are three main drivers for enhanced and more automated flight planning systems / tools;

1. Optimization of fuel burn which leads to cost savings.
2. Reduction of CO_2 and where applicable non-CO_2 emissions.
3. Enhanced on-time performance.

Enhanced weather tools

Statistically, weather plays the most significant role in operational disruptions and is one of the key factors that both flight dispatch and air crew focus on when planning a trajectory. Additionally, more accurate weather prediction models and real-time up-dates will enable dispatch, flight crew, and ATC to more effectively adjust flight trajectory at strategic and tactical levels. This is not only critical for adverse weather operations but also for optimizing trajectories to reduce either CO_2 or non-CO_2 emissions. Without having better weather prediction tools embedded in flight planning systems, trajectory adjustment and negotiation may not be fully realized.

Airspace Capacity Changes

With the expected growth of varying types of traffic, there will be a need for more sophisticated ATC systems to manage the increasing number of aircraft, including the integration of cargo flights and UAS/eVTOLs. Access to real-time up-dates on route restrictions from ATC and regulatory constraints will be required for more effective strategic flight planning. The increasing capabilities to aggregate different data sources blended with machine learning are expected to provide dispatch and flight crew with accurate advance and real-time changes in airspace capacity, congestion, airspace unavailability, and other factors that may impact flight operation. This will enable airlines to optimize routes and minimize delays.

Trade-offs

The development and execution of a flight plan involves dynamic route optimization, accurate flight planning, and dynamic airborne replanning and trajectory adjustment. With the increasing pressure on aviation to reduce emissions, automation will be required to develop multiple scenarios and support dispatch and air crew in trajectory adjustment decision, especially at the tactical level. Without automated tools supporting decision making, especially post departure, effective and quick decision will not be possible. This will also require future flight planning systems to have reliability in providing different trajectory scenarios post departure.

Overall System Modernization

ATC system modernization

The increasing demand for access to airspace forces ATC to become more automated. Air traffic controllers are limited in how much traffic they can handle without the support of automation. To increase capacity, new tools are needed like planning tools, conflict detection and resolution or flow management. ATFM will become increasingly important as the mechanism set up to organize in the most efficient way and in collaboration with the airspace users the different traffic flows. Those tools to be efficient need access to digital information made available by the right source. Information flows need to be organized between ATC/ATFM, aerodrome and airspace users so that the best decisions can be taken at the right time.

Cyber resilience

The future of communications in aviation relies on the use of communication technologies that are not specific to aviation anymore. This allows to use COTS products, but it comes with a price which is a higher vulnerability to cyber-attacks. It is therefore critical that cyber resilience be embedded in all developments meant to adapt those COTS for aviation.

Connected Aircraft

The connected aircraft concept builds upon the availability of higher capacity communication infrastructure to provide the aircraft with more information while at the same time facilitating the provision of aircraft data to different ground stakeholders. The concept of connected aircraft offers tremendous potential through commercial communications, but further work will be needed to ensure safety and reliability.

SWIM

SWIM is the enabling set of principles and technologies supporting the exchange of information between ATM stakeholders. It relies on open standards and a service-oriented approach allowing to de-couple the provision of information from its elaboration or consumption. This is a key enabler for FF-ICE and TBO.

Conclusion

The challenge of future systems & technology can be met by establishing flight dispatch / FOC as the Primary Decision Maker. This encourages and develops consistent industry software performance and ultimately global safety within the role of flight dispatch. This is supported and recommended by ICAO, especially within the on-going work on up-dating Annex 1 & Annex 6 documents. The challenges of FF ICE, TBO & subsequent software enhancements will require a more prominent role of flight dispatch. However, that will require training and change in mindset at the airline and ANSP levels.