EFB Innovations from Mission Support to Trajectory Based Operations

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The global Air Traffic Management (ATM) community is united on a shared vision for safe, secure, sustainable, and affordable Trajectory Based Operations (TBO). The transition to TBO requires exponentially more information sharing between air and ground automations. Huge investments needed for infrastructure and airplane capabilities pose the biggest challenge for the TBO implementation. Traditionally, new functions and capabilities required for aircraft to enhance ATM safety and efficiency have been added to certified avionics components. The 1st Electronic Flight Bag (EFB) innovation, started in 1990s, has replaced the paper manuals and provided crew's mission support. The ICAO Connected Aircraft concept has brought the 2nd innovation of EFB to live in enabling trajectory update from air to ground and direct involvement in trajectory negotiations on the flight deck. This paper provides insights from Boeing's researches in using EFB-based solutions to support initial TBO operations such as digital taxi coordination, control time of arrival, etc. With widespread aircraft equipage in various forms and wide adoption of the key airline operational efficiency tools in EFB, the EFB-based solutions in ATM have provided a timely and cost-effective way for modern aircraft to be TBO capable.

Key Words: TBO, Connected Aircraft, EFB, Digital Taxi Coordination, Trajectory Negotiations, Trajectory Update

1. Introduction

Airlines, air navigation service providers (ANSPs), airports, regulators and other aviation stakeholders are united on a shared vision of the ICAO trajectory-based operations (TBO) concept for future ATM. TBO is not one-size-fits-all. Stakeholders in different regions have different operational priorities. The TBO implementation requires significant investments ($$$) in ground infrastructure and airplane capabilities. It also requires regulatory approval for ATM safety and procedures. Finding the right mix of infrastructure, equipage, and procedures is key to ensuring a value-driven transition to TBO.

This paper discusses two EFB innovations – the first on airline mission support; and the second on emerging ATM support for time-critical needs.

2. 1st EFB innovation

Prior to the regulatory approval of using EFB applications to replace paper manuals in 2011, pilots were required to carry over 35 lbs. of paper documentation such as navigation charts, operations manuals, and aircraft checklists. The laptop computers used by FedEx pilots to calculate the flight departure performance in 1990s were among the first EFBs that assisted flight crews during preflight. In 2009, KLM accepted the 1st EFB with applications produced by Jeppesen to display digital navigation charts and operations manuals on B777.

Since 2011, EFBs have become a vital technology platform on the flight deck of modern aircraft for mission support. They are equipped with various applications that help flight crews perform tasks from preflight, to inflight, and to postflight.

3. 2nd EFB Innovation

TBO is about sharing, using, and managing the trajectory to support airspace stakeholders' predictability as they make their decisions to optimize airspace usage. With more airlines seeking new ways to enhance flight operations, key operational efficiency applications on EFB have been widely adopted. In addition, the ICAO Connected Aircraft (CA) concept has provided a framework for an alternative solution to the legacy approach. In June 2023, Multi-regional TBO (MRTBO) live flight demonstration showcased EFB solutions in pre-departure and inflight use cases that supported 4-dimensional trajectory negotiations, aircraft intent downlinks, real-time System Wide Information Management (SWIM) information such as flight, airspace constraints, and weather on flight deck. The use of EFB for digital taxi instruction coordination is another example of flight deck innovation. This paper further discusses the benefits of EFB in enabling modern aircraft to be TBO capable. Built on the Connected Aircraft concept, EFB applications leverage multiple air-ground datalinks and integrate with AI/ML and cloud computing. They have potential to create speedy, flexible and low-cost transition to TBO.