Air Traffic Management Sub-Group (ATM/SG/11) of APANPIRG

Multi-regional TBO Demo from Boeing Perspective

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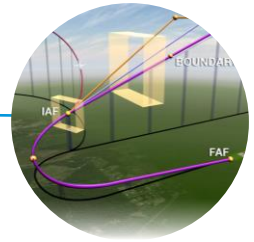
BOEING

Boeing’s 30 years of contribution for ATM Modernization

1993
Boeing and CAAC initiate multi-decade partnership to improve China’s ATM system

1996
Invention of FANS to enable reduced oceanic separation

2003
SWIM Prototype in partnership with FAA

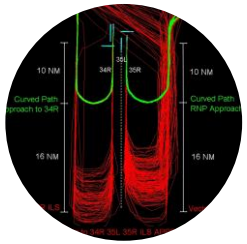


2006
Tailored arrival procedures enabled at Schiphol Airport

2010
Launched Direct Routes & Wind Updates for reduced enroute fuel consumption

2010
Boeing begins its multi-year support for SESAR in Europe

2018
ecoDemonstrator conducts Formation Flight and achieves 5% reduction in fuel use



2018
Developed Established on RNP technologies and regulatory criteria

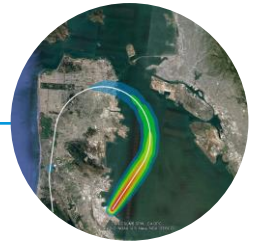
2023
MR-TBO project in partnership with FAA and multiple ANSPs from Asia

1995 2000 2005 2010 2015 2020 2025

2008
Seattle Greener Skies in partnership with airlines and FAA NextGen

2012
737 ecoDemonstrator showcases Flight Trajectory Optimization

2015
New GLS procedure to reduce noise and emissions at San Francisco Airport



2019
Boeing initiates CNS-ATM Modernization Roadmap to Airports Authority of India

2021
FliteDeck Advisor launches on Etihad’s 787 fleet

2022
Ryanair deploys SWIM functions to improve fleet management

Boeing’s Net Zero Commitment

- **Commitment:** Net zero carbon emissions by 2050
- **Operational efficiency**: One of four Boeing strategies for decarbonizing aviation
- **System-of Systems Approach:** Aviation operations ecosystem
- **Trajectory Based Operations (TBO):** Big rock for operational efficiency, decarbonizing aviation industry today
- **Technical Approach**
  - Continue inspiring/investing new technology development
  - Continue collaborating with ANSPs and others stakeholders for benefits of ecosystem today

Operational Efficiency encompasses how aircraft operate in the air traffic system and aims to optimize the fuel efficiency throughout all stages of flight operations

Aviation Operations Ecosystem

Multi-Regional Trajectory Based Operations (MR TBO) Demo

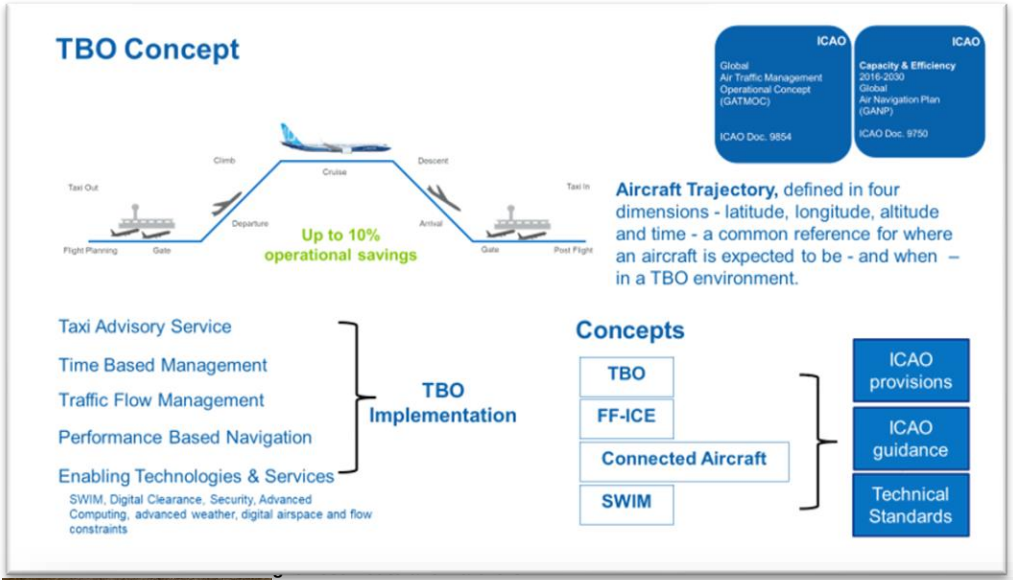
- **What it is:**
  - **TBO** - ATM operational concept to enhance predictability, efficiency and safety.
  - **MR TBO Demo –** ANSPs of Japan, Singapore, Thailand and USA conducted the live flight demonstration, the culmination of a three-year collaboration.

- **How we did:**
  - Acted as the One MR TBO team.
  - Enabled by SWIM, FF-ICE, Connected Aircraft, Digital Clearance.
  - Flown by Boeing ecoDemonstrator Explorer 787-10 on 23 use cases.
  - Events at Daytona Beach, Tokyo, Singapore, and Bangkok.

- **What is demonstrated** (from airspace user perspective)**:**

The use of ground systems infrastructure and modern aircraft with existing equipage, IP connectivity and portable EFB to share, negotiate, manage and use trajectories with multiple ANSPs could achieve an optimal flight path across multiple regions, factoring in conditions such as weather, air traffic and airspace closures.

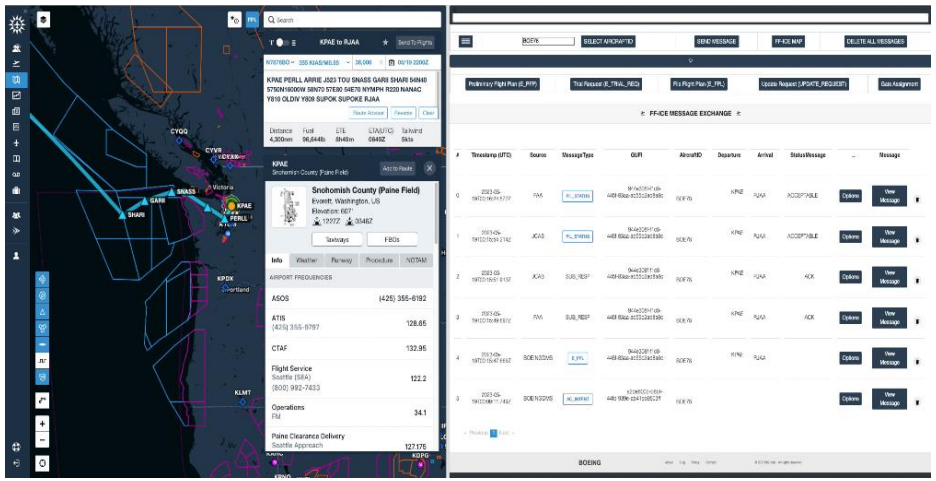
  - SWIM, FF-ICE and CPDLC services are preferred, but legacy can be integrated
  - Connected Aircraft – EFB for enhanced situational awareness and trajectory management at Flight Deck



Airspace User Tools

Dispatch

Flight Operations Center (FOC)

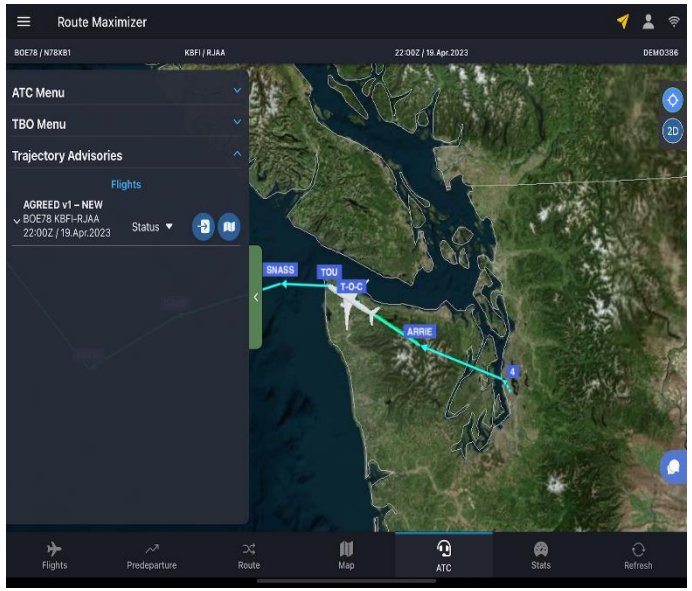


Flight Crew

Electronic Flight Bag (EFB)

AID ←

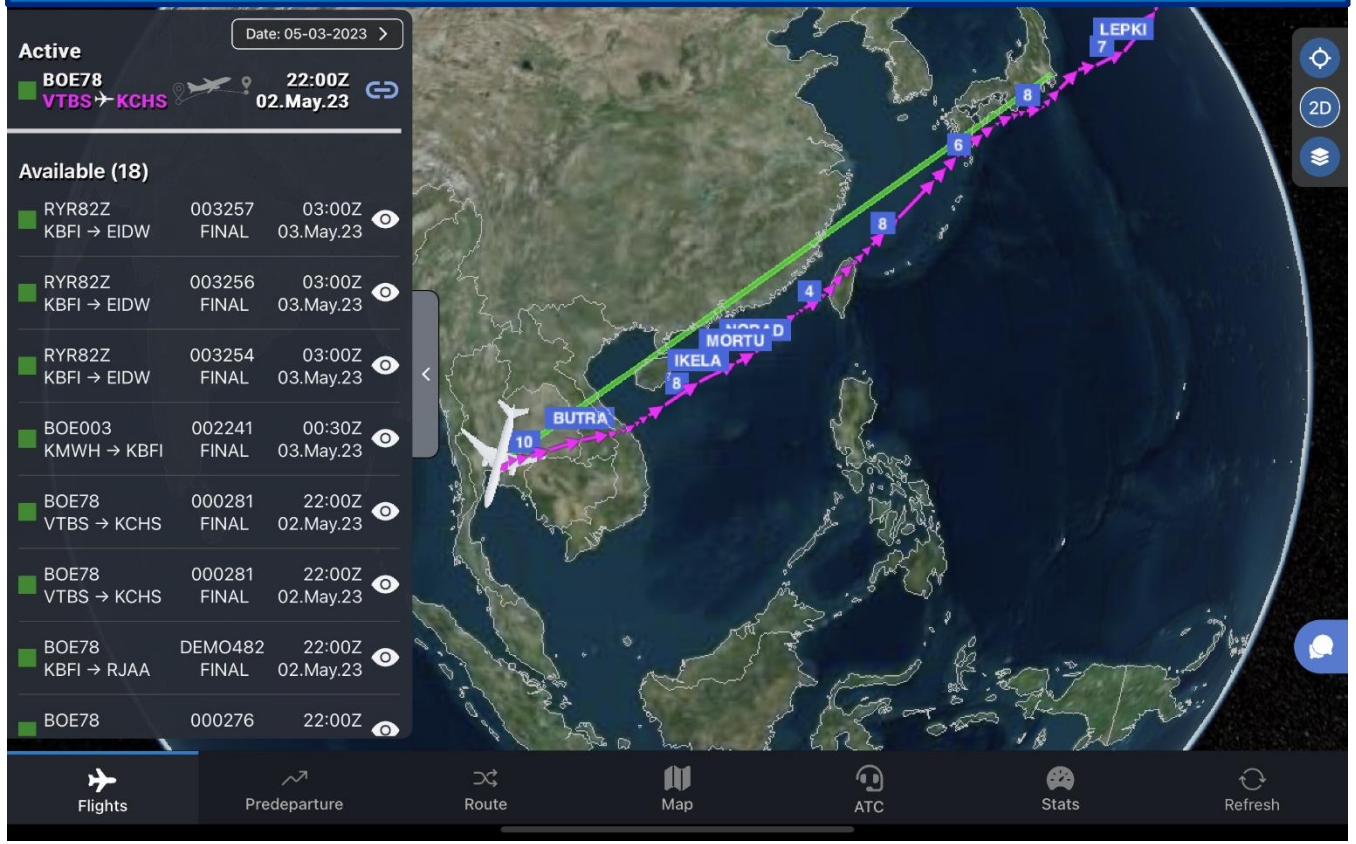
Flight Management System (FMS)



EFB

- Aircraft Intent
- Chat with Dispatch
- Dispatch Release
- FF-ICE Messages
- Flight Data Synchronization
- Flight Plan Mod
- FPL 2012
- NOTAM
- Navigation Chart Display
- Ownship and Surrounding Traffic
- Real-time Flight Advisory Message
- Flight Comparison
- Route(s) Display
- Trajectory Negotiation/Management
- Taxi Advisory Message
- Wind and Weather Display

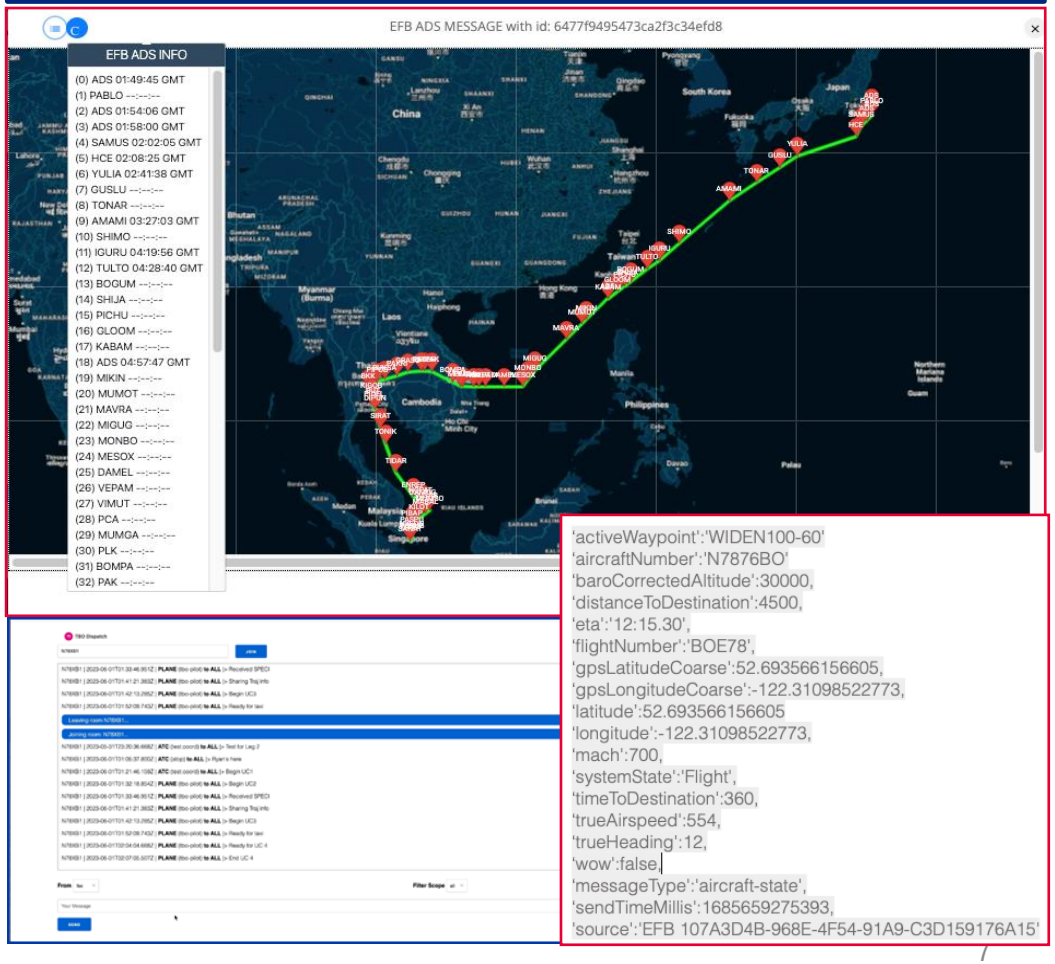
Testimony from Boeing Testing Pilot:
“So often there’s stress because of the vacuum of information within the flight deck. The use of EFB in MR TBO offers a construct for much greater awareness of the vast amount of information available outside the aircraft.”



FOC : Current Operations vs Operations in MRTBO

Current Operations
▪ File and forget pre departure flight planning FPL2012
▪ Very limited performance information sharing
▪ Low situation awareness especially after filing
▪ Limited operational use of aircraft connectivity
Operations in MRTBO
▪ Trajectory negotiation in all phases of flight
▪ Trajectory information sharing, negotiation, and management
▪ Real time situation awareness enables FOC to handle disruptions (by rerouting, delay departure, etc.)
▪ Connected aircraft (EFB) enables FOC to chat with flight deck, receive aircraft real-time and intent information, and negotiate and manage trajectories

Testimony from Boeing Testing Dispatch: FOC can initiate rerouting trajectory negotiation on disruption at any phase of flight with the trial services



Key Take-aways

- TBO enhances operational efficiency as well as safety
- TBO improves predictability - helping optimized use of constrained resources (e.g., corner post, runway, gate, etc.)
- SWIM, FF-ICE and existing communications are key building blocks
- Successful execution with existing equipage and portable EFB
  - Cert not required for non safety critical apps on EFB
  - EFB reduces cost and time to operation than a certified box
- TBO global concept can be implemented in a harmonized way while allowing each region to customize it

Boeing continues to work with airlines, ANSPs, airports and other stakeholders for efficiency improvements today

Thank you !