INTERNATIONAL CIVIL AVIATION ORGANIZATION
A UN SPECIALIZED AGENCY
Trajectory Based Operations (TBO) — Flight and Flow Information for a Collaborative Environment (FF-ICE) — FF-ICE Operational Requirements (OR) Small Working Group (SWG)
Topics

01 Background

02 Introduction to TBO and FF-ICE

03 Phased Approach to Implementation Strategy

04 Sharing on Implementation Strategy / Plans
**Background**

**Decision ATM/SG/10-3: Establish FF-ICE Operational Requirements Small Working Group**

**What:**
That, ATM/SG establishes the FF-ICE Operational Requirements Small Working Group, that will:

a) study ICAO global TBO and FF-ICE provisions and the outcomes of relevant ICAO technical panels and regional technical groups;

b) to prepare a set of draft harmonised regional operational requirements of FF-ICE/R1, and related operational processes and procedures;

c) present related information to the FF-ICE seminar to be organised by ATMAS TF in 2023;

d) recommend an appropriate approach to devise a FF-ICE implementation strategy for the APAC region; and

e) recommend priority ASBU elements and develop draft regional performance objectives for consideration for inclusion in the Asia/Pacific Seamless ANS Plan version 4.0.
Who are here?

- Engineers
- Planners
- Airspace Users / Airlines
- Air Traffic Controllers

Trajectory Based Operations
Introduction to TBO

Video by IATA (available on youtube)

https://www.youtube.com/watch?v=A0rGw2Ebojw
Basics of TBO

TBO is about predicting where a flight will be and at what time
  • This forms the basis for a ‘strategic plan’

A trajectory is used as a reference for the flight and shared between systems and stakeholders

A trajectory is defined in four dimensions
  • Latitude, Longitude, Altitude, and Time

The trajectory is updated as operations evolve over time and new information becomes available

TBO is a NOT an individual system

TBO is a collection of systems, capabilities, processes, and people working together to achieve operational objectives

Although COTS solution exists to implement elements of TBO, there are currently no COTS solutions to implement TBO as a whole
Agreed Trajectory

The Agreed Trajectory is shared, maintained and used by all stakeholders

*Adapted from ICAO*
Agreed Trajectory

- On departure and remaining portion of flight, negotiations are carried out using FF-ICE/R2 mechanisms and changes to Agreed Trajectory can be made.
- Changes will be shared timely via air-ground and ground-ground systems

*Adapted from ICAO*
Management of ATM Ops in a TBO environment

*Extracted from Global TBO Concept
Getting to TBO

Requires Partnership Among ANSPs and Operators
Key TBO Building Blocks

Based on ASBU Threads

<table>
<thead>
<tr>
<th>Technology (ASUR and COMS)</th>
<th>Operations (NOPS)</th>
<th>Information (FICE and SWIM)</th>
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<tbody>
<tr>
<td>ADS-B</td>
<td>ATFM</td>
<td>FF-ICE</td>
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<tr>
<td>Monitoring via aircraft state</td>
<td>Improved trajectory forecast and enhanced DCB</td>
<td>Information environment supporting standards-based coordination, and trajectory planning &amp; negotiation</td>
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<tr>
<td>ADS-C</td>
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<td>SWIM</td>
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<tr>
<td>Aircraft-derived trajectory downlink for synchronisation</td>
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<td>Technical infrastructure for collaborative environment</td>
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<td>CPDLC</td>
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<tr>
<td>Delivery of closed, end-to-end clearance</td>
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<td>PBC, PBS, PBN</td>
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<tr>
<td>Provide assurance on CNS performance characteristics</td>
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Flight Deck Capabilities / Connected Aircraft

- FMS
  - Clearance execution (closed, end-to-end, RNP)
  - Aircraft-derived trajectory
- EFB / Mobile Device
  - Enables further air-ground connectivity
  - Provides applications for analysis & display
Benefits of Improved Trajectory Prediction Accuracy

- **CM** – Improved separation tools:
  - Fewer unnecessary interventions
  - Earlier, more efficient interventions

- **AO** – Improved arrival forecasts:
  - Improved surface resource planning

- **DCB** – Improved demand prediction:
  - Less lost capacity
  - Fewer tactical interventions

- **AOM** – Higher-capacity procedures

- **AU** – More efficient & predictable flights

- **TS** – Improved time-synchronization:
  - Earlier, more efficient control
  - Reduced buffers
  - Improved throughput

*Extracted from Global TBO Concept*
02

Introduction to FF-ICE

What is FF-ICE?

- Flight and Flow Information for a Collaborative Environment (FF-ICE) facilitates sharing of 4D flight trajectory information among all stakeholders to collaboratively establish a preferred flight trajectory between all parties.

- FF-ICE will modernise the present day ICAO flight plan (FPL 2012) and flight planning process to enable the realisation of the ICAO Global ATM Operational Concept (GATMOC) vision and an essential enabler to support Trajectory Based Operations (TBO).

Vision Statement

To achieve an interoperable global air traffic management system, for all users during all phases of flight, that meets agreed levels of safety, provides for optimum economic operations, is environmentally sustainable and meets national security requirements.
FF-ICE to support TBO

Agreed Trajectory obtained via FF-ICE/R1

Negotiations between eAU and eASPs

Pre-Departure
- Collaboratively develop an Agreed Trajectory
- Takes into account airspace users’ preferences and ASPs’ limitations and restrictions

On departure and onwards
- Updates and revisions to Agreed Trajectory can be made
- Negotiations continue to take place, taking into account changing environmental factors and tactical events
- Any change is shared timely and consistently with all stakeholders (ground-ground and air-ground systems)
### Difference Between FPL 2012 and FF-ICE

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<thead>
<tr>
<th></th>
<th>FPL 2012</th>
<th>FF-ICE Flight Plan</th>
<th>Near Term Benefits</th>
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</thead>
<tbody>
<tr>
<td><strong>Data Fields</strong></td>
<td>• Limited data fields</td>
<td>• Expansion of data fields providing more details possible</td>
<td>• Changes made with lower cost as FF-ICE flight plans are scalable</td>
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<td></td>
<td>• Fixed flight plan form</td>
<td>• XML schema</td>
<td>• Higher predictability on routes and flight trajectory that will be given to flight</td>
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<tr>
<td><strong>Collaboration</strong></td>
<td>• No acknowledgement upon receipt of flight plans</td>
<td>• Status feedback from eASPs for all submissions from eAUs</td>
<td>• eAUs can plan ahead and optimise flight trajectories</td>
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<td></td>
<td>• aAUs unable to trial alternative routings</td>
<td>• eAUs allowed to trial alternative routings</td>
<td>• ANSPs have more accurate demand information for planning of airspace utilisation/other resources. Filed flight plans are also more likely to be unaltered significantly</td>
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<tr>
<td></td>
<td>• aAUs unable to negotiate on trajectories</td>
<td>• eAUs allowed to negotiate on preferred trajectories</td>
<td>• Alleviates workload of human operator and minimise human error for both eAU and ANSPs</td>
</tr>
<tr>
<td><strong>Automation</strong></td>
<td>• Manual processing and corrections required</td>
<td>• Extensive use of automation to conduct checks and compliances to restrictions</td>
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<td></td>
<td>• Lacks linkage to database of restrictions</td>
<td>• Automated responses to eAUs</td>
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<td></td>
<td></td>
<td>• SWIM enables subscription of required data from other systems</td>
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<tr>
<td><strong>Main Usage</strong></td>
<td>Inform aASPs of flight intent; Individual aASP uses limited and static flight plan information for their own planning</td>
<td>A live flight plan with detailed trajectory, that is constantly updated as plans change, and consistently shared and used by all stakeholders</td>
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**eFPL:** FF-ICE flightplan  
**eASP:** FF-ICE capable ATM Service Provider  
**aASP:** non-FF-ICE capable ATM Service Provider  
**eAU:** FF-ICE capable Airspace User  
**aAU:** non-FF-ICE capable Airspace User
Sample FPL2012 and eFPL

**18 Fixed Data Fields**, including:
- Originator of Flight Plan
- Aircraft Identification
- Type of Aircraft
- Wake Turbulence Category
- Equipment
- Departure Aerodrome
- Departure Time
- Cruising Speed, Level and Route
- Destination Aerodrome etc.

Flight plan form that airlines use

What ANSPs see when FPL2012 is printed out, based on 18 fixed data fields

- One possibility of how an airline’s flight planning tool might look like.
- Visually able to view restrictions and to plan trajectory around it
- There is currently no COTS

Expandable format (pages long)
- Addition of elements when necessary
- Meant to be read by machine

What ANSPs see when eFPL is printed out
Intro to 6 FF-ICE Services

**Serves existing functions**
- File flight plan (FPL)
- Update FPL

**Improved features**
- eASP to provide digital filing status to all FPLs (states whether flight plan is accepted)
  - Digital exchange of constraints information
  - Operator and eASP able to collaboratively reach an agreed trajectory
- Re-evaluation service – eASP updates filing status if there are new constraints

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**Serves existing function**
- Replace current request for FPL

**Improved features**
- Request for status of the flight (whether flight plan is accepted)

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**Serves existing function**
- Replace current Arrival and Departure notification thru’ AFTN
Intro to 6 FF-ICE Services

**New function – Planning Service**
(for planning purpose)
- Allows operator to file a prelim flight plan (PFP) to indicate intention of flight in advance
  - eASPs obtain early flight intent information and provide constraints to operator
  - eAUs able to plan for a preferred trajectory taking into consideration known constraints
  - eASPs and eAUs can negotiate to reach an agreed trajectory that optimise their operations
- Re-evaluation service – updates planning status if there are new constraints

**New function – Trial Service**
(after PFP or FPL is filed, non-committal)
- Allows operator to submit “what if” type of request to ascertain acceptability of flight, without committing to it
  - Ensures stability and relevance of information in main ATM system
  - Improves quality of information submitted to planning or filing service
- After receiving feedback, eAU then decides whether to update PFP or FPL

**New function – Publication Service**
- Subscribers may obtain information about flights relevant to their operations
Long Term Benefits FF-ICE?

Enhanced flight planning and ATM with FF-ICE

Increased predictability and accuracy of flight trajectories and pilot’s intent. This will allow ATC to manage flights in advance to better utilise airspace and airport resources.

Enables collaboration between ATM service providers and airspace users (through negotiations) to adjust and agree on final flight trajectory throughout entire phase of flight to better cater to ATM needs and user’s preference. Harmonised way of issuance of time and/or altitude crossing restrictions to standardise air traffic flow management measures (demand/capacity balancing function).

Fundamental building block for future ATM

Future releases of FF-ICE will enable trajectory negotiation between ground and air nodes (while in flight) for more refined ATM – beyond DCB, FF-ICE can support even conflict management (CM) and traffic synchronisation (TS) to enhance safety and optimise airspace and airport capacity.

Implementing FF-ICE/R1 is first step to developing enhanced flight planning processes focused on pre-flight phase. It is also a fundamental building block for longer term vision of TBO. These are not solely FF-ICE benefits but could also be shared benefits of the other TBO building blocks.
End 2024: FF-ICE/R1 provisions, concept documents and implementation guidance finalised and made applicable

2025 onwards: States begin implementation of FF-ICE/R1 including workshops, table-top exercises, demos and/or trials

End 2032: Regional sunset of FPL 2012

2034: Global sunset of FPL 2012
Phased Approach to Implementation Strategy

• Learning from FPL 2012 implementation, transition to FF-ICE flight plan will be a phased approach
• Provisions for FF-ICE/R1 is expected to be made applicable by 2024
• Mixed mode operations will likely be prolong till sunsetting of FPL2012 in year 2032-34
• ASP or AU may use translators to implement FF-ICE/R1 however full benefit may not be realised
• Incremental implementation of translators and/or Minimum FF-ICE/R1
### Phased-Approach to FF-ICE(R1) Implementation

<table>
<thead>
<tr>
<th>Non FF-ICE Capable</th>
<th>Use of Translators</th>
<th>Min FF-ICE/R1 Svc</th>
<th>Varying Ivs of FF-ICE Implementation</th>
<th>Full FF-ICE/R1 Service</th>
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<tbody>
<tr>
<td>• Accepted</td>
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<tr>
<td>FF-ICE Flight Plan</td>
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<td>FF-ICE Flight Plan</td>
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<tr>
<td>• Not Accepted</td>
<td>• Accepted but limited utility</td>
<td>• Accepted</td>
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<tr>
<td>FF-ICE/R1 Svc</td>
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<td>• Flt Data Req Svc</td>
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Implementing filing service & flight data request service would allow global sunset of FPL2012
Strategy to FF-ICE Phased Implementation

Global Strategy

- ICAO to spearhead with workshops, briefings and technical symposiums
- No more amendments to ICAO FPL 2012 unless due to aviation safety
- Promote minimal FF-ICE/R1 capability by system design

Regional Strategy

- Regional harmonised implementation approach to maximise benefits
- Establishing incremental steps for States’ planned transition to FF-ICE/R1.
- Set transition dates for the regional

Pioneer Group (Proposed)

- Proposed formation of pioneer group for Asia/Pacific region as early implementors of minimum FF-ICE/R1 system capability

From Doc 9965 Vol II (draft)
Sharing by ATMB, Airways NZ, AEROTHAI, FAA and CAAS
Thank You!