Trajectory-Based Operations (TBO)

SWIM Needs

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Global TBO Concept

- ATMCP wrote the Global ATM Operational Concept (GATMOC, ICAO Doc. 9854)
- Significant changes were expected in use & exchange of Flight Information → FF-ICE Concept (Doc. 9965)
- Described need for SWIM and some notions of Global SWIM → ATMRPP developed SWIM Concept (Doc. 10039) → Further development through IMP
- Identified a need for aircraft connectivity to SWIM → A/G SWIM Concept being developed

- GATMOC, FF-ICE described trajectory operations through the use and exchange of trajectories → ICAO/ATMRPP developing TBO Concept
Global Air Navigation Plan

Technology Roadmaps

Aviation System Block Upgrades (ASBU)

These layout the timeline of standards & guidance development activities
## Key ASBUs

<table>
<thead>
<tr>
<th>Thread</th>
<th>Block 0</th>
<th>Block 1</th>
<th>Block 2</th>
<th>Flight Information</th>
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<tbody>
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<td>Increased Interoperability, Efficiency and Capacity through Ground-Ground Integration</td>
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**Timeline**

- **2013**
- **2018**
- **2023**
- **2028**

**Aeronautical Data / Constraints**

**Core Information Services**

**Operations**
Key Characteristics of TBO
ATM Delivered via Collaboration

- **Interdependence**
  - Manage Airspace
  - Plan Workforce
- **Manage interactions through coordination between participants**
  - Manage Flows
    - Congestion, Weather, Outages
  - Synchronize Flights
  - Separation
  - Operate Flight
  - Re-optimization

Aircraft Operator
Scheduling
Flight Planning
Operate Flight
Re-optimization
Air Traffic Management
Manage Flows
Congestion, Weather, Outages
Synchronize Flights
Separation
Trajectory Interactions

- **Flight Planning**
- **Scheduling**
- **Air Traffic Management**
- **Aircraft Operator**
- **Operate Flight**
- **Re-optimization**
- **Manage Flows**
- **Congestion, Weather, Outages**
- **Synchronize Flights**
- **Separation**
- **Trajectory Interactions**

**Interdependence**

**Manage interactions through coordination between participants**

**ATM**

**ATHEC**

**Aviation Information World - Forecasting the Future**

**Flight Crew**

**FOC**

**TM ATCSCC**

**TMU**

**ATC**
Coordination Today

Disparate Plans in Automation

FD Automation

ATFM Automation

FOC Automation

ATC Automation

Multiple Participants Control a Flight
All Affect the Trajectory

Transform to Trajectory-Based:
Decision-Making, Control and Coordination
TBO Transformations

Transform Control Methods
- FD Automation
- Improved Control Precision
- Closed Trajectory
- FOC Automation

Transform Control Tasks
- Transform Coordination
- Shared plans, consistent trajectories
- Trajectory Constraints
- Trajectory Informed
- ATC Automation

Transform Coordination
- Negotiated Trajectory
- ATFM Automation

 Improved Control Precision
- Accurate Execution
- Automation Informed
TBO - Three important attributes

- **Sharing** trajectory information
- **Managing** that information
- Using it as **reference for the flight**
The Role of SWIM - Sharing

- **SWIM-enabled application used to request information**
- **Uses Information exchange service to request**
- **Uses exchange model for content and format**
- **SWIM core services provide security, messaging, addressing**
- **Encoded and transmitted over global IP network**

- **Data Standards:** AIXM, WXXM, FIXM
- **Service Standards:** FICE, DATM, AMET
- **A/G SWIM Support**

Image: ICAO SWIM Concept
SWIM & Managing the Trajectory

Rules for Trajectory Management

- Permissions
- Criteria & responsibility for update & revision
- Timing / Frequency
- Prioritization
- Services & transactional behavior
  Not static, vary as flight operates

Standards

Agreed Trajectory includes tolerances laterally, vertically and temporally

Update

Revision
Managing the Trajectory - Example

Operate Flight

Operate Flight

SYD-LAX-PVG-NRT-ATL-JNB-ATL-JN
B-ATL-NRT-ATL-JNB-ATL-DXB

Operates through >25 ANSPs

Ten days, One Airframe

Images: Google Earth, ICAO

Flight 1
Scheduling
Flight Planning
Re-optimization
Operate Flight

Flight 2
Scheduling
Flight Planning
Re-optimization

Keeps going…

Aviation Information World - Forecasting the future
Managing the Trajectory (2)

- Consider planning & re-planning w/ Automation-to-automation coordination

Rules for Trajectory Management
- Permissions
- Criteria & responsibility for update & revision
- Timing / Frequency
- Prioritization
- Services & transactional behavior
Using the Trajectory

- Fit-for-purpose Information Services support operational use
Transition & Mixed-Mode

• Important SWIM role for transition

Voice Comm.
Non-TBO Area
Airspace supports TBO

Trajectory Information exchange via Air-Ground SWIM

Limited Automation
No SWIM

ATC
FD

ASP
ATFM
ATC
AO
# Looking Forward

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