Multi-Regional TBO Demonstration

Agenda

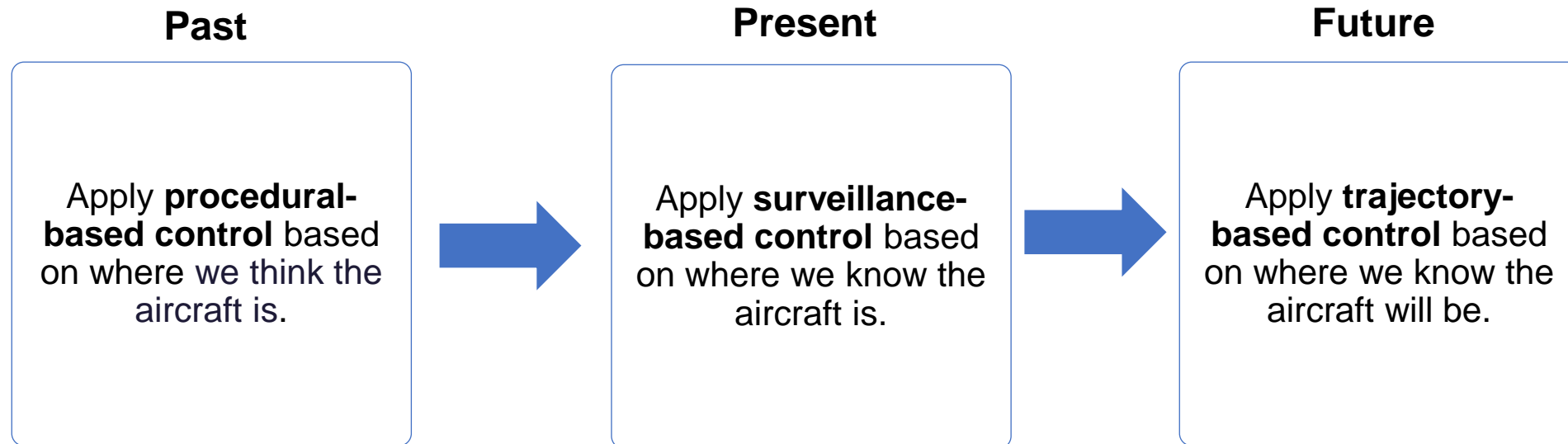| #	Topic	Presenters
1	MR TBO Video	-
2	TBO: Current vs Future • Paradigm shift in ATM operations • TBO vs non-TBO environment • TBO Enablers (FF-ICE, SWIM, Connected Aircraft)	CAAS
3	MR TBO Project Overview • Project phases and partners • Demonstration objectives • Operational scenarios and TBO Operational Values	FAA
4	Lessons learnt • Operational and technical capabilities, for eAUs and eASPs • Key takeaways (operational and technical) & recommendations	AEROTHAI

# MR TBO Video

TBO: Current vs Future

ATM/SG/11

3 October 2023

TBO: Paradigm shift in ATM operations

Past

Apply **procedural-based control** based on where we think the aircraft is.

Present

Apply **surveillance-based control** based on where we know the aircraft is.

Future

Apply **trajectory-based control** based on where we know the aircraft will be.

TBO is a new paradigm in which flight trajectories are optimized on a <u>transboundary basis</u>, where <u>ANSPs collaborate each other and with Airspace Users</u> to make better decisions at various stages of a flight

Transition to Future Info-Centric ATM
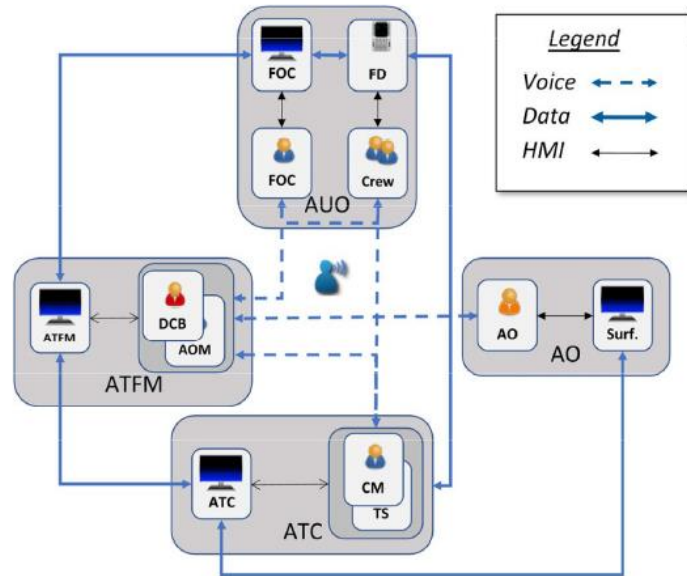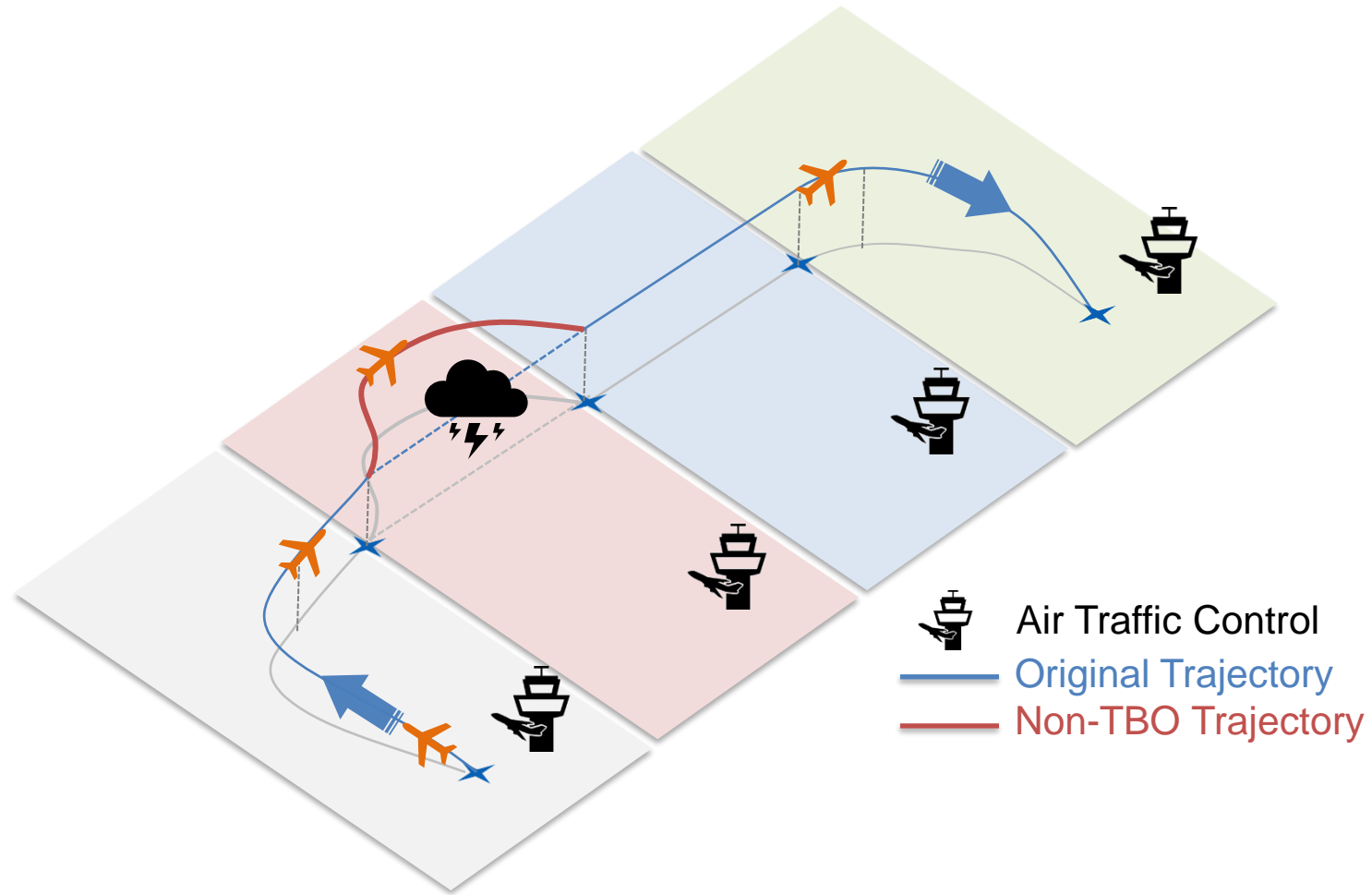

Current Operations

- Reliance on one-to-one voice communications between human participants
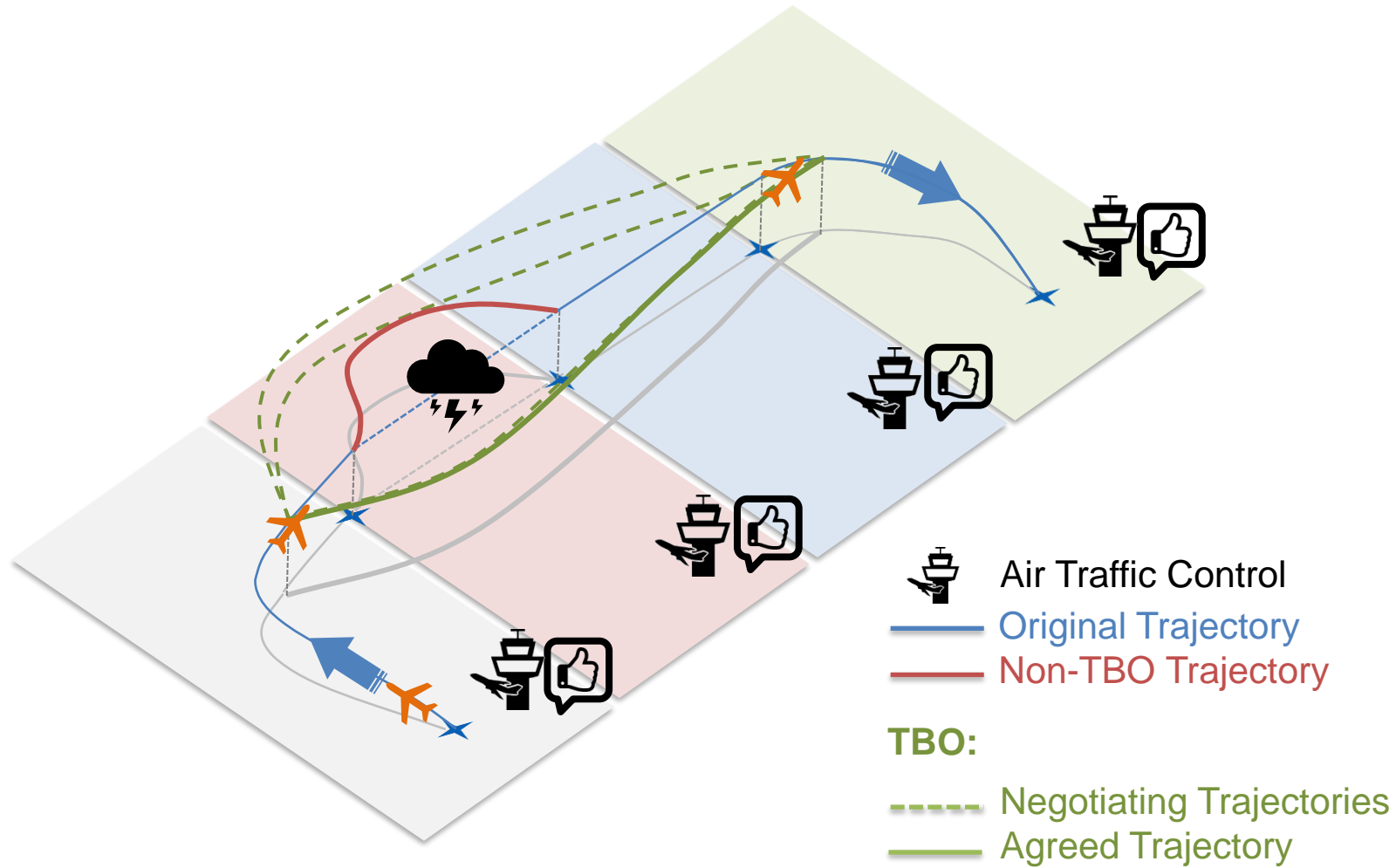- Limited data exchange between supporting automation systems
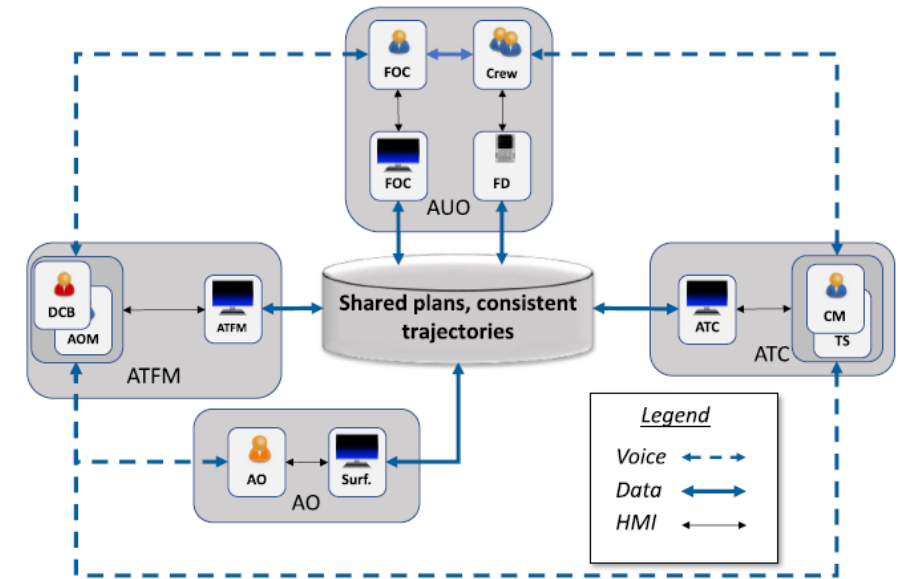
Future Operations

- Every participant / system is operating to a same plan, shared trajectory and constraints
- Automation of information flow

CAAS

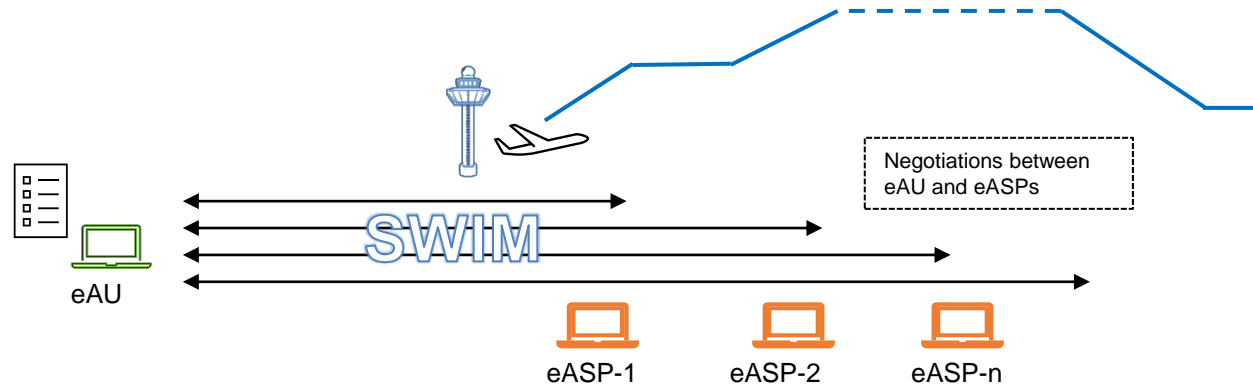# Today's non-TBO environment

Air Traffic Control
Original Trajectory
Non-TBO Trajectory

Future: TBO environment

Air Traffic Control
Original Trajectory
Non-TBO Trajectory

TBO:

----- Negotiating Trajectories
Agreed Trajectory

TBO Enablers

FF-ICE & SWIM to support TBO

FF-ICE

Negotiations between eAU and eASPs

eAU

SWIM

eASP-1   eASP-2   eASP-n

FF-ICE / R1

FF-ICE / R2

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 and shared in a timely & consistent manner, with all stakeholders

- Negotiations continue to take place, taking into account changing environmental factors and tactical events

SWIM
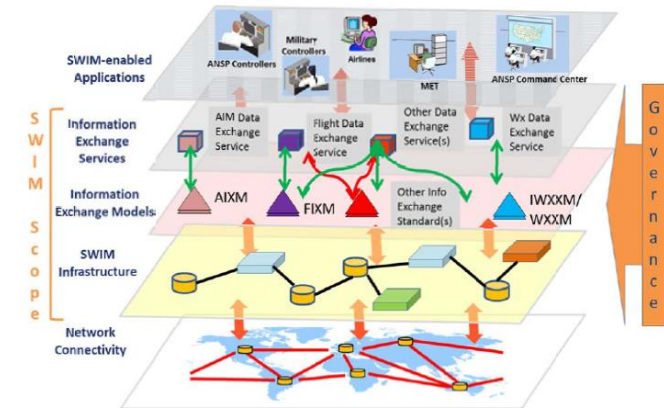
SWIM Global Interoperability Framework; ICAO Doc 10039

- SWIM will provide the messaging infrastructure, standards and governance to facilitate interoperable exchange of ATM-related information

- Utilisation of standard information models e.g., FF-ICE information will be exchanged via the FIXM format, NOTAMS will be via AIXM and weather information via IWXXM

Connected Aircraft to support TBO

To support TBO, the CA concept enables the A/G exchange of:

- 4DT trajectory information

- complex requests, clearances & negotiation messages

Range of capabilities and applications possible with CA

- Data sharing and crowdsourcing of weather information – creating a composite weather view / forecast using data collected by various aircraft

- Arrival information made available to airports where the airline does not manage the gate

- More efficient communications between Flight crew, Flight Operations Center (FOC) and Airline Administrative Control (AAC) – which may include flight plans, manifests, electronic logbooks, and other data exchange related to operations
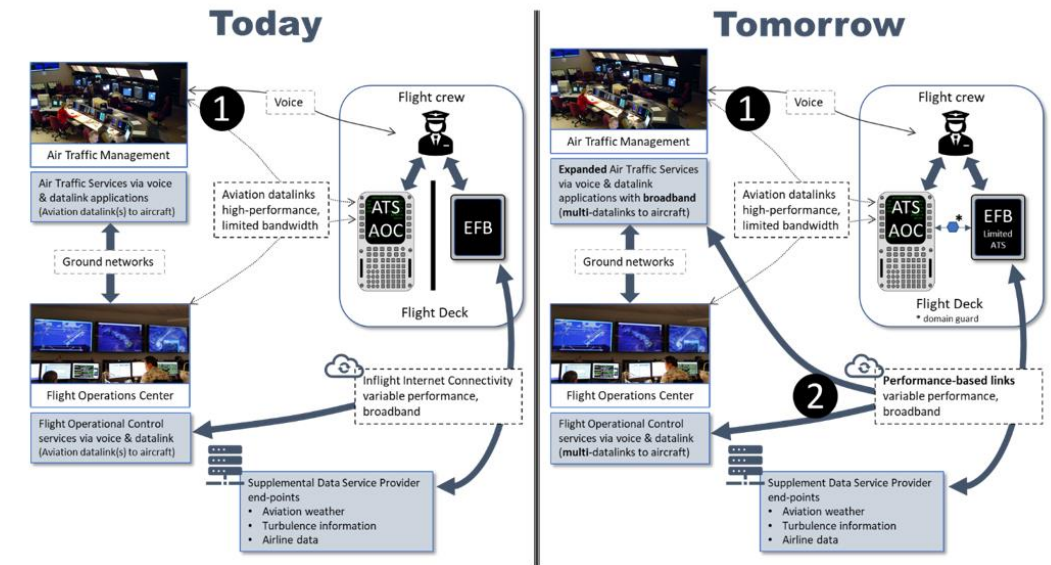
A/G Information Exchange Paths

Thank you!

Multi Regional TBO Overview

- ## MR TBO Objective:
  - Information Exchange – Leverage global exchange models, negotiation between ground and aircraft and improve performance of trajectory prediction

  - Communications - Demonstrate the use of various communication services and providers consistent with the Connected Aircraft Concept

  - Multiple eASP Exchange – Demonstrate procedures for cross FIRs exchange of information to share, manage and execution of trajectory

MR TBO Phases

- **Phase 1: Guided Discussions and Tabletops (February 2021)**
  - Guided Discussion/Table Tops – lexicon, operational values, FF-ICE and ATFM services

- **Phase 2A: Laboratories Demonstration of scenarios (April 2022)**
  - Lab Demonstration – systems connectivity and exercise global exchange standards

- **Phase 2B: Live Flight (June 2023)**
  - Demonstrated the use of modern aircraft with existing equipage (FANS 1/A, PBN, etc.), IP connectivity, and flexible auxiliary devices (i.e., EFB approval AC120-76D) to share, negotiate, manage and use the trajectory with multiple eASPs/ASPs to achieve the optimum flight-fleet-flow operation efficiency.

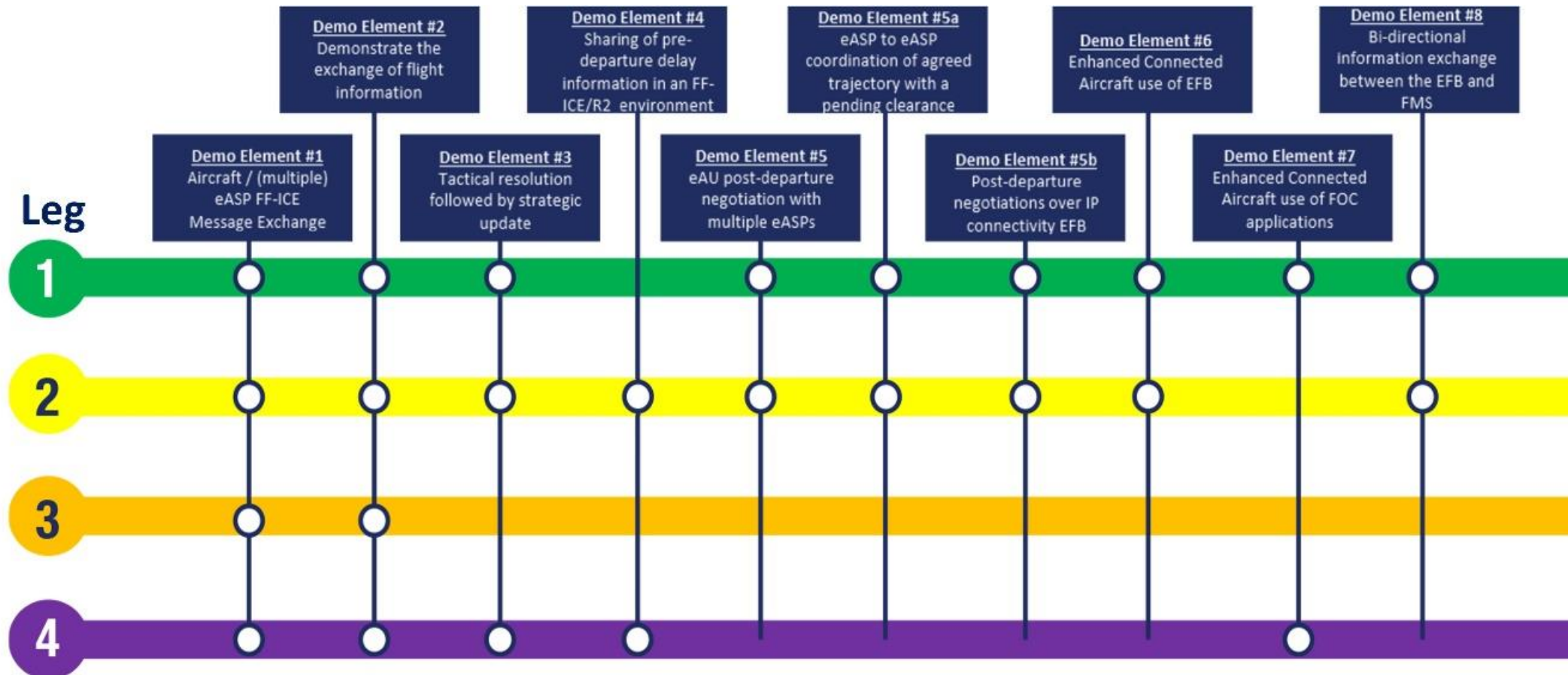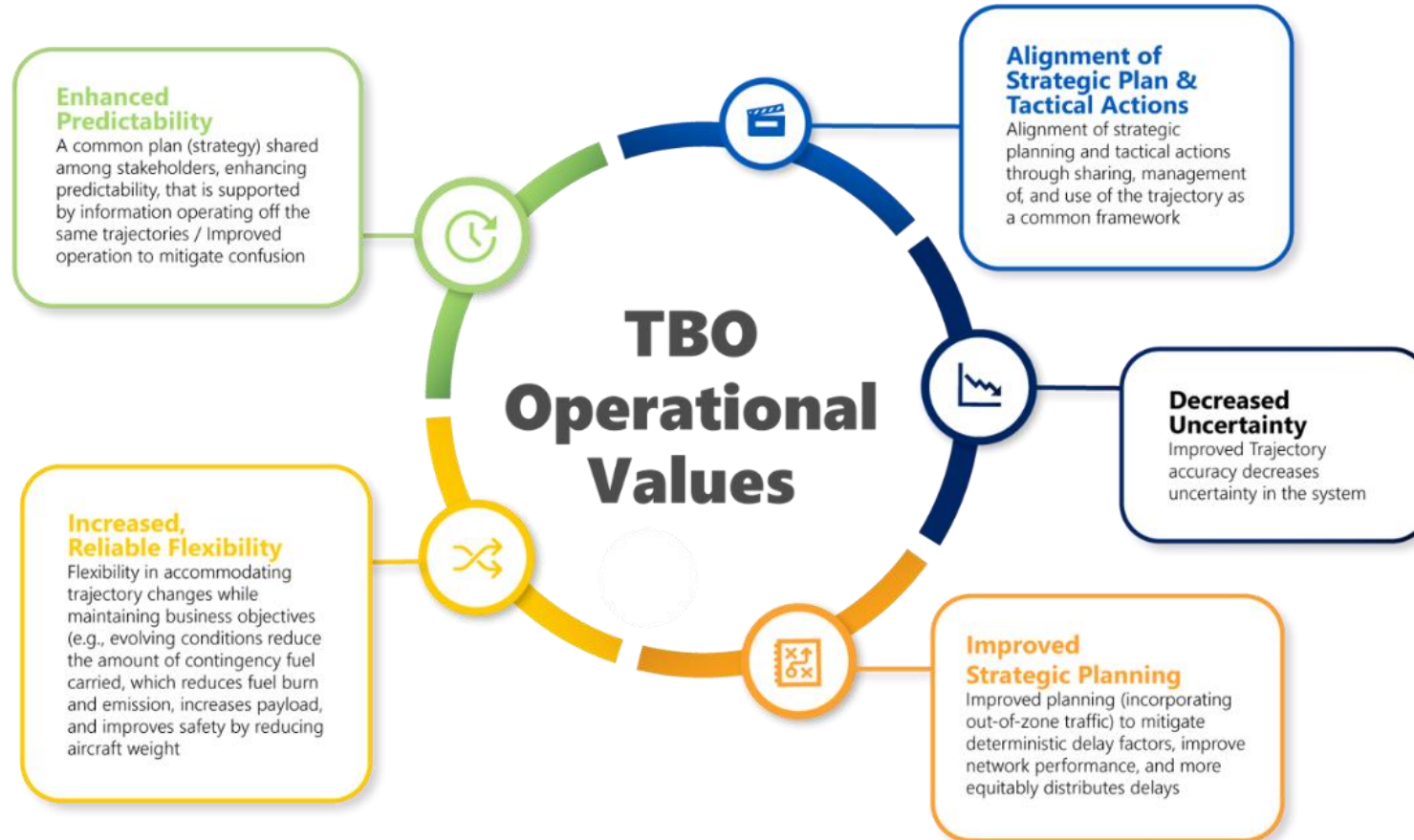INFO-CENTRIC
NATIONAL AIRSPACE SYSTEM

MR TBO Partners

- Aeronautical Radio of Thailand (AEROTHAI)
- Civil Aviation Authority of Singapore (CAAS)
- Federal Aviation Administration (FAA)
- Japan Civil Aviation Bureau (JCAB)
- Nav Canada
- The Boeing Company

MR TBO Scenarios

MR TBO Operational Values

Enhanced Predictability
A common plan (strategy) shared among stakeholders, enhancing predictability, that is supported by information operating off the same trajectories / Improved operation to mitigate confusion

Alignment of Strategic Plan & Tactical Actions
Alignment of strategic planning and tactical actions through sharing, management of, and use of the trajectory as a common framework

TBO Operational Values

Decreased Uncertainty
Improved Trajectory accuracy decreases uncertainty in the system

Increased, Reliable Flexibility
Flexibility in accommodating trajectory changes while maintaining business objectives (e.g., evolving conditions reduce the amount of contingency fuel carried, which reduces fuel burn and emission, increases payload, and improves safety by reducing aircraft weight

Improved Strategic Planning
Improved planning (incorporating out-of-zone traffic) to mitigate deterministic delay factors, improve network performance, and more equitably distributes delays

Thank You!

Operational Capability

Pre-departure trajectory planning, negotiation, and filing

Sharing of constraint information e.g. ATFM measure, MET, airspace usage

TBO clearance

Post-departure trajectory negotiation and revision

Trajectory parameter exchange Sharing of a/c-derived trajectory

eASP-eASP coordination

SEATTLE

TOKYO

BANGKOK

SINGAPORE

MULTI-REGIONAL
TBO

Technical Capability

SWIM technical infrastructure

Standardized data formats (FIXM [+Ext], AIXM, IWXXM, FLXM)

SWIM information services

SWIM

FF-ICE/R1 services

(Initial) FF-ICE/R2 services

Connected Aircraft

CPDLC

FMS

Cybersecurity

(Demonstrated) TBO Enablers

TBO Capability	CPDLC	FMS	CA	FF-ICE	SWIM
Pre-departure trajectory planning, negotiation, and filing			↑	✓	✓
TBO clearance	✓	✓			
Trajectory parameter exchange			✓	✓	✓
Sharing of a/c-derived trajectory		✓	✓	✓	✓
Sharing of constraint information			✓		✓
Post-departure trajectory negotiation and revision			✓	✓	✓
eASP-eASP coordination				✓	✓

Key Lessons Learned

TBO: Sharing, Maintaining, and Using Trajectory as a Common Reference across Stakeholders

- Further development and refinement are still required, e.g.
  - > Strategic/tactical integration
  - > Processing of agreed trajectory (airborne) by downstream eASPs
  - > Negotiation horizon
- The globally standardized information exchange models are foundational to the success of TBO
- The continued evolution of the Connected Aircraft is required

Key Lessons Learned

✈ FIXM usage

> Clear definitions of data attributes

> Careful consideration on data attributes to be included in Extension

> FIXM v4.2 schema

✈ FLXM usage

✈ Required parameters to support different trajectory modeling used

SWIM and FF-ICE: Essential Building Blocks for TBO

Recommendation

Establish APAC Regional SWIM

Conclusion APANPIRG/33/9 (CNS SG/26/06 (SWIM TF/06/02, SWIM TF/06/04)):
The Asia-Pacific SWIM Implementation Timeframe and inclusion of the Asia/Pacific SWIM Implementation in the Asia/Pacific Seamless ANS Plan

What:	Expected impact:
1. To set the timeframe for the implementation of SWIM in the Asia-Pacific region to be between 2024 and 2030, with 2030 being the target timeline for implementation completion. 2. To include SWIM implementation in the next edition of the Asia/Pacific Seamless ANS Plan.	☐ Political / Global ☐ Inter-regional ☒ Economic ☐ Environmental ☒ Ops/Technical
Why: This is to set the concrete target implementation of the Asia-Pacific regional SWIM to assist States in harmonizing their implementation plans in order to achieve the seamless information exchange across the region in time for future operations, e.g. FF-ICE. Additionally, to ensure that SWIM, a key building block to achieve the vision outlined in ICAO Doc 9854 Global ATM Operational Concept (GATMOC), is captured in the Asia/Pacific Seamless ANS Plan, providing an overall framework for Asia/Pacific States to plan their implementations to meet the future performance requirements.	Follow-up: ☒ Required from States

When:	24-Nov-22	Status:	Adopted by PIRG
Who: TF	☒Sub groups ☒APAC States ☒ICAO APAC RO ☐ICAO HQ ☒Other: SWIM		

APANPIRG/33/9 Conclusion

> Asia/Pacific SWIM Implementation Timeframe

Timeframe: 2024 – 2030

Completion target: 2030

> Inclusion of SWIM in Asia/Pacific Seamless ANS Plan

SWIM/TF/07/03 Decision

> Formation of the SWIM Implementation Pioneer Ad-hoc Group

Initial target: June 2024

Decision SWIM/TF/07/03 – Formation of the SWIM Implementation Pioneer Ad-hoc Group

What: To establish a SWIM Implementation Pioneer Ad-hoc Group to develop an initial version (prototype) of the Asia/Pacific regional SWIM with ToR provided in **Appendix D**.	Expected impact: ☐ Political / Global ☐ Inter-regional ☐ Economic ☐ Environmental ☒ Ops/Technical
Why: To kick-start the SWIM implementation for the Asia/Pacific region in accordance with Conclusion APANPIRG/33/9 The Asia/Pacific SWIM Implementation Timeframe.	Follow-up: ☐Required from States

When:	12-May-23	Status:	Adopted by SWIM TF
Who:	☐Sub groups ☒APAC States ☒ICAO APAC RO ☐ICAO HQ ☒Other: SWIM TF		

Draft Decision ATM/SG/11-X: <ESTABLISH FF-ICE TASK FORCE>.

That, ATM/SG establishes the FF-ICE Task Force, to:

a) study the successful development of FF-ICE in other regions and States, and draw useful lessons; and raise the understanding of FF-ICE by sharing use case scenarios and business cases;

b) develop the Asia Pacific regional FF-ICE operational requirements and related operational processes and procedures;

c) provide guidance on capabilities required for mixed mode environment where both FF-ICE capable and non-FF-ICE capable airspace users and ATM service providers operate;

d) develop a FF-ICE implementation strategy for the Asia Pacific region including timeframes and roadmap;

e) coordinate and collaborate with APAC SWIM TF, review the development of FIXM revisions and if needed, propose FIXM extension amendments for regional adoption;

f) recommend more ASBU elements for inclusion into the Asia Pacific Seamless ANS Plan, as they mature;

g) submit inputs and recommendations to the ICAO ATM Requirements and Performance Panel (ATMRPP) when deemed necessary; and

h) undertake any other tasks related to FF-ICE implementation that may arise in the future.

Expected impact:
☐ Political / Global
☐ Inter-regional
☐ Economic
☐ Environmental
☒ Ops/Technical

Why: Regions, including Asia and Pacific, are expected to transition from FPL2012 to FF-ICE, therefore there is a need to develop a regional harmonised implementation approach to maximise benefits. FF-ICE will transform the current flight planning format and processes completely. This task requires the strong support of ICAO APAC regional office to help Asia Pacific region to transit towards this new flight planning paradigm hence establishment of a Task Force to ensure a harmonious and effective transition.

Follow-up:
☐Required from States

When: 06 Oct 2023

Status: Draft to be adopted by Subgroup

Who: ☒Sub groups ☐APAC States ☐ICAO APAC RO ☐ICAO HQ ☐Other:

ATM/SG/11 WP/20
Proposal for Establishment of FF-ICE Task Force

> APAC regional FF-ICE operational requirements, related operational processes, and procedures

  Mixed-mode environment

> APAC regional FF-ICE implementation strategy

TOKYO

SINGAPORE

Thank You