Envisaged Benefits of SWIM for Air Navigation Services

SWIM TF/8

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Civil Aviation Authority of Singapore

Objective

- To share the envisaged benefits of System Wide Information Management (SWIM) and how it can help to overcome current challenges in the aviation industry

Scope

- Challenges of Today
- Overcoming challenges with Flight and Flow Information – In a Collaborative Environment (FF-ICE)
- What is System Wide Information Management (SWIM) and what can it achieve
- Benefits for Air Navigation Services through SWIM
- Conclusion

Challenges of Today - Need for Digitalization

- The increase in air traffic volume worldwide has highlighted the need to enhance flight efficiency for global sustainability
  - ➢ Today, the aviation industry accounts for approximately 2% of global CO2 emissions
  - ➢ Through digitalization, closer collaboration can be fostered and allows better management of air traffic in an info-rich environment

- Current constraints of FPL2012 and the conventional usage of the Aeronautical Fixed Telecommunication Network (AFTN) limit the potential for a more effective Collaborative Decision Making (CDM) and higher resolution of information exchange, which are essential for improving flight efficiency

The evolution of FPL2012 and its Limitations

Conventional FPL includes:

- Item 7: Aircraft identification
- Item 8: Flight rules and type of flight
- Item 9: Number and type of aircraft and wake turbulence category
- Item 10: Equipment
- Item 13: Departure aerodrome and time
- Item 15: Cruising speed, altitude/level and route
- Item 16: Destination aerodrome, total estimated elapsed time and alternate aerodrome
- Item 18: Other information
- Item 19: Supplementary information

FPL 2012

- Major changes made to include flight plan details such as modern navigation, communication and surveillance equipment
- Item 10: Capabilities and equipage of ADS-B, ADS-C, Mode S
- Item 18: Level of performance – RNAV, RNP

Limitations of FPL2012

- More information needed as aviation technology evolves → FPL2012 is unable to support
- Limitations:
  - ➢ Fixed format in terms of capacity and the level of details it can contain
  - ➢ Truncation of Field 18 due to system character size
  - ➢ Insufficient FPL information on aircraft equipage to support sharing of additional flight info
  - ➢ AFTN – limit to maximum message size and the ability to add info to current messages

Moving forward, FPL2012 is **no longer sustainable**

Overcoming Limitations of FPL2012 with Flight and Flow – Information in a Collaborative Environment (FF-ICE)

What is FF-ICE?

A system designed to improve the efficiency and safety of ATM by enabling real-time flight and flow information exchange between stakeholders

How can FF-ICE address limitations of FPL2012?

- Enables systematic exchange of detailed flight and flow information, reducing human error through automation
- Designed to be “future proof” – can handle increasing requirements from operators and ATM
- Allows for continuous updates and sharing of flight plans, facilitating negotiation and optimal route determination
- Enhances predictability and ability to plan for airspace users’ requirements and preferences
- Transmit beyond AFTN, provides more efficient and effective means of information exchange

Benefits of FF-ICE

- Increases collaborative ATM planning and real-time information exchange
- Maximizes operational and system benefits with advanced equipment
- Increases flexibility for optimum management of different ATM system in the same “language”
- Enables dynamic trajectory management

The vehicle for FF-ICE?

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System Wide Information Management (SWIM)

as conventional AFTN is not able to support information exchange of FF-ICE

System Wide Information Management (SWIM) – Enhancing seamless information exchange

What is SWIM?

- SWIM is the digital data-sharing backbone of ATM for Airspace Users (AU) and ANSPs to access information to support decision making from flight planning, to traffic flow management to situational awareness.

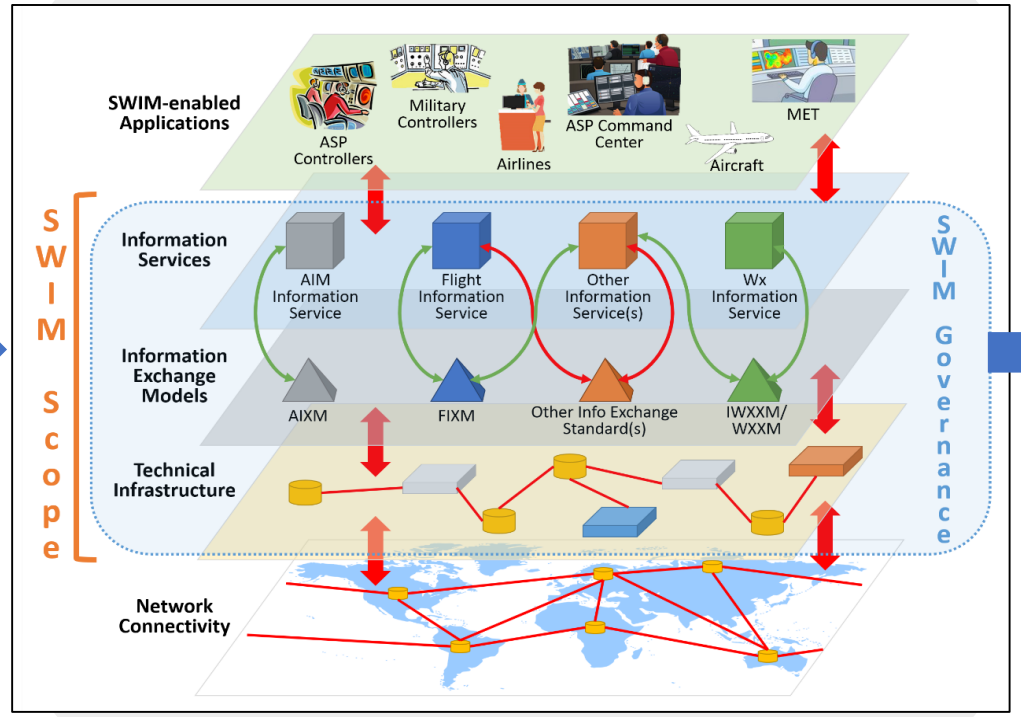
- SWIM consists of information standards, infrastructure and governance enabling the management of ATM related information and its exchange between qualified parties via interoperable services

- Shift ATM information architecture paradigm from point-to-point data exchanges to system-wide interoperability

What can SWIM strives to achieve?

Current limitations

- Most ATM information now are managed in partial isolation leading to duplication and inconsistency
- Message-size limitations with present infrastructure and costly for one stakeholder to access timely information originated by another stakeholder
- Current systems are not designed and implemented to be globally interoperable
- Current interfaces have limited flexibility to accommodate changes, especially to data format



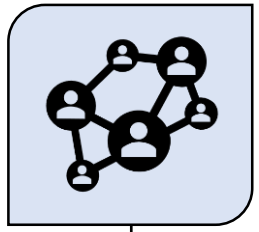
Potential achievements

- Improved decision-making by all stakeholders
  - ➢ Shared situational awareness
  - ➢ Availability of quality data and information
- Complement human-to-human with machine-to-machine communication, improve data distribution, accuracy, timeliness and accessibility of data
- More flexible and cost-effective communications using common standards for information exchange
- Foundation on which future concepts can be realized (ATFM, TBO, FF-ICE)

Technical benefits of SWIM

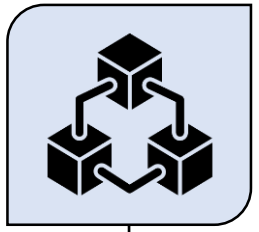
Global Unique Flight Identifier (GUFI)

GUFI is intended to provide a globally unique reference for each and every flight. Its purpose is to assist in associating any flight related message to the correct flight and help in distinguishing between similar flights.



Standardization of ICAO/IATA callsign

SWIM ensures all stakeholders use the same format and structure for identifying aircraft and airlines. This is critical for safe and efficient air traffic management (ATM), as it helps to avoid confusion and errors in communication.



Standardization of messages for safety

SWIM ensures all stakeholders use the same format and structure when exchanging information. SWIM defines a set of standard message formats and protocols for different types of information exchange.

ATM Information Reference Model

AIRM provides a common understanding of the information exchanged between different systems and stakeholders in the aviation industry. It ensures all stakeholders have a consistent view of the information

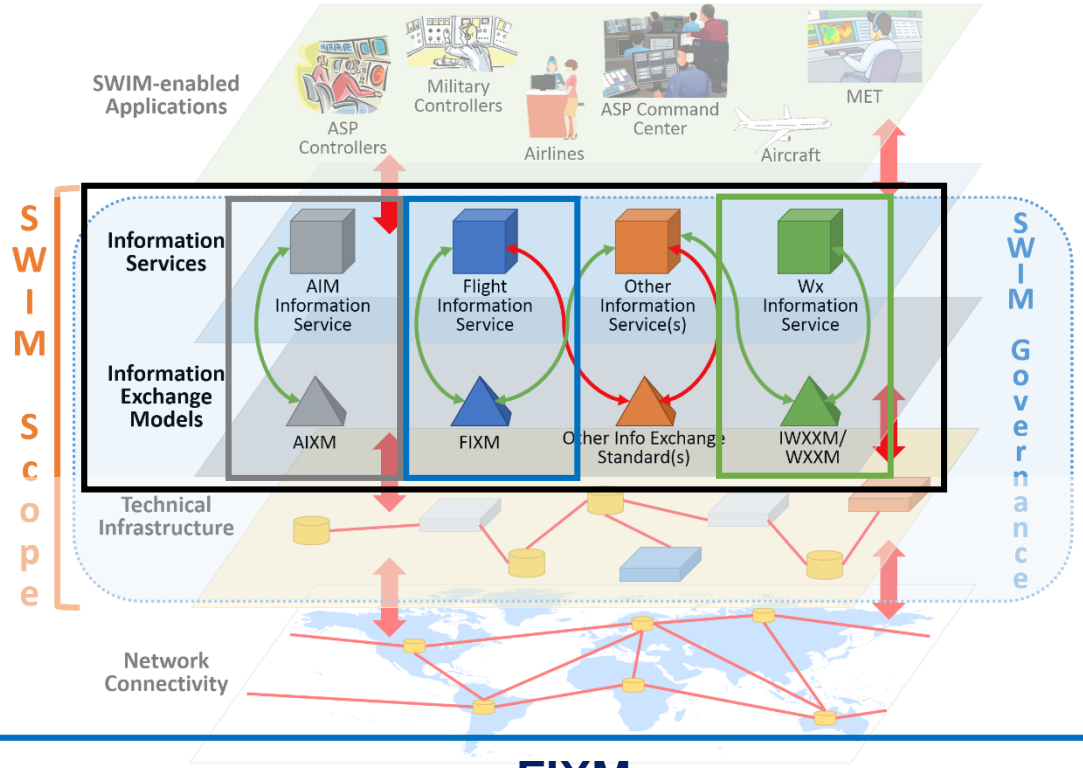
Extensible Markup Language (XML)

SWIM uses XML as the standard format for data exchange. XML is a flexible and widely-used format that enables efficient and accurate information exchange between different systems and organizations.

Information Exchange Models available on SWIM

AIXM

- Standard for representing and exchanging aeronautical information
- Used for airspace structures, navigation aids, airport facilities, and flight procedures
- Transition for current AIM messages e.g. NOTAM etc.



IWXXM

- Standard for representing and exchanging weather information
- Designed to support aviation meteorology
- Used for weather observations, forecasts, and warnings
- Enables real-time information between aviation stakeholders
- Transition for current weather messages e.g. TAF, SIGMET etc.

FIXM

- Standard for representing and exchanging flight-related information (e.g. CTOT, TTOT, CTO)
- Designed to support flight planning and execution
- Used for flight plans, trajectories and performance data
- Enables real-time information exchange between aviation stakeholders
- Transition for current flight messages e.g. FPL, DEP etc.

Benefits for AIS using AIXM through SWIM

Functions	Possible improvements	Potential benefits
Digitalization of aeronautical information	Automate processing of Notice to Airmen (NOTAM) information	• Automate plotting of coordinates on ASD and trigger alerts/notifications from digital NOTAMs to enhance safety and efficiency.
	Improve training scenarios and simulations	• Use AIXM data to create realistic training scenarios for pilots and ATC, improving their preparedness through simulated environments that reflect real-world conditions.
Close interaction between Unmanned Aircraft Systems (UAS) and ANS Service Providers	Real-time communication of airspace constraint statuses for beyond visual line-of-sight (BVLOS) UAS operations	• Automated sharing of real-time airspace constraints to UAS operators to manage operations safely without receiving positive air traffic control
Exchange of Digital Datasets, Integrated Briefing and Exchange of aeronautical information through electronic charts	Standardized aeronautical data format, optimized cross-system data exchange, real-time data sharing and efficient integration of data into electronic charts from diverse sources.	• Enhance aviation safety and efficiency by streamlining data exchange and providing up-to-date aeronautical information to pilots and airline operators. Ensure accurate and timely presentation of aeronautical data through streamlined chart data integration.

Benefits for Aeronautical Met using IWXMM through SWIM

Data elements	Areas of improvements
Terminal Aerodrome Forecast (TAF)	• Operational contingencies – airlines use TAF for contingency planning. If a significant weather event is forecasted, airlines can prepare for potential diversions, alternate routes or additional fuel reserves • Optimal altitude selection – TAF includes data on expected cloud heights and turbulence levels, helping flight crews select the optimal cruising altitude for a smoother and more fuel-efficient flight
Significant Meteorological Information (SIGMET)	• Integration with cockpit systems – aircraft equipped with advanced avionics systems can receive and display SIGMET information directly in the cockpit, allowing pilots to make real-time decisions based on latest weather data • Precise geographic information – SIGMETs include precise geographical coordinates and altitudes where hazardous conditions are occurring → allows pilots and ATC to pinpoint affected areas accurately

Benefits for ATM using FIXM through SWIM

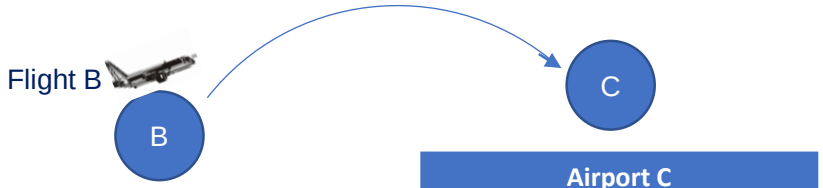
Data elements	Areas of improvements
Calculated Take-Off Time (CTOT)	• Optimise CTOT sharing within a SWIM environment to enhance business continuity, resource management for airport operations, airspace users, passengers and ATC operations, resulting in improved compliance and ATFM outcomes.
Calculated Time Over (CTO)	• CTO enables route flexibility and reduces holding patterns, resulting in fewer delays, lower fuel burn, greenhouse gas emissions, and operating costs. In a SWIM environment, seamless sharing of CTOT ensures greater compliance and better ATFM outcomes.
Target Off-Block Time (TOBT)	• Accurate TOBT predictions enhance the passenger experience and reduce taxiway congestion → predictable and less stressful travel, fewer delays, and minimized risk of aircraft delays due to taxiing.
Target Take-Off Time (TTOT)	• Use TTOT in a SWIM environment for precise departure sequencing, reduced runway congestion and fuel consumption, and improved compliance and ATFM outcomes. Share TTOT seamlessly to extend tactical planning for short-haul flights, further improving compliance and ATFM outcomes
GUFI vs Callsign	• ICAO alphanumeric callsign could easily be used by ANSP and airport operator uses IATA callsign all while referencing to a common GUFI • This improves safety in the air by reducing similar sounding callsign without manually referencing flights from ICAO alphanumeric callsign to IATA callsign

Benefits for ATFM through SWIM

1) Better ATFM outcomes

- Compliance to Calculated Take-off Time (CTOT) is a key component for the success of ATFM measures
- With awareness of Target Take-off Time (TTOT), potential improvements on compliance to CTOT as both the initiating and facilitating ATFMUs can determine the likelihood of non-compliance (e.g. sufficient lead time) and carry out necessary actions (e.g. slot swop)

Without TTOT sharing
(between B and C)

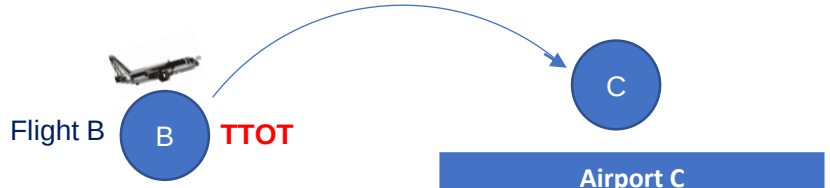


Airport B		
Callsign	**TTOT**	**CTOT**
Flight B	1130	1100

Airport C		
Callsign	**CTOT**	**TTOT**
Flight B	1100	????

The initiating ATFMU (Airport C) is **unaware** that Flight B is **not able to comply** with the CTOT

With TTOT sharing
(between B and C)



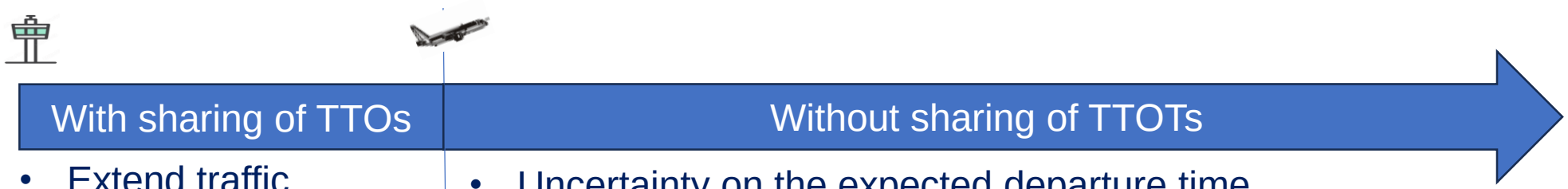
Airport B		
Callsign	**TTOT**	**CTOT**
Flight B	1130	1100

Airport C		
Callsign	**CTOT**	**TTOT**
Flight B	1100	1130

The initiating ATFMU (Airport C) is **aware** that Flight B is **not able to comply** with the CTOT

Benefits for ATS operations through SWIM

2) Improving the tactical planning by ATC for short haul flights (between airports which have approximately less than 60mins of flight time)



- Extend traffic planning horizon of AMAN (prior to departure of these flights)
- Better prediction on the expected departure time as derived from TTOTs

- Uncertainty on the expected departure time
- Arrival Manager (AMAN) can only curate a stable arrival sequence after these flights have departed
- Need to adjust the sequence in AMAN after these flights have departed

Conclusion

- To enhance information sharing in an increasingly data-rich environment, there must be improvements to the conventional system of sharing information:
  - FPL2012 → FF-ICE
  - AFTN, email exchanges → FIXM, AIXM and IWXXM through SWIM

- Collectively, to enhance accuracy of data sharing amongst aviation stakeholders towards enabling the vision of Trajectory-based Operations (TBO) and gate-to-gate optimization

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Thank you