Concept of a Distributed Multi-Nodal ATFM Network
Outline

1. Introduction
2. Stakeholder Engagement in Concept Development
3. Concept of Operations
4. Benefits Analysis – Singapore Case Study
Introduction
Purpose of R&D Project

- Develop a Concept of Operations (ConOps) for Regional ATFM/CDM for Singapore and the Asia Pacific Region
- Study existing ATFM/CDM concepts for potential implementation in Asia Pacific
- Validate ConOps using proven Concept Engineering process
- Conduct analysis for the benefits of ConOps in Singapore
Use of Existing ATFM/CDM Methods

- ATFM Implementations Studied:
  - USA, Europe, Australia, and South Africa

- Current ATFM implementations achieve demand and capacity balance when applied to flights regulated by a single authority.

- Asia Pacific has a number of international hub airports with limited domestic traffic to apply existing ATFM principles:
  - E.g. Hong Kong and Singapore are 100% international
  - Concept applicable to ANSPs with significant domestic traffic

- Concept must be developed to regulate flights to an airport with a demand and capacity imbalance departing from ANSPs under a different control authority.
Regional ATFM Concept – Overview

• Enable demand-capacity balancing by implementing Traffic Management Initiatives (TMI)
  ➢ Accurate demand and capacity predictions
  ➢ TMI initiated when demand exceeds capacity
    ✓ Assign flights to arrival slot times at the constrained resource

• Flights are expected to absorb delay assigned by the TMI

• High TMI participation is important for successful implementation
  ➢ Means to increase participation
    ✓ Include international flights
    ✓ Provide aircraft operators flexibility to specify delay absorption intent
    ✓ Include airborne flights

• Collaborative Decision Making (CDM)
  ➢ Key aspect of successful ATFM
Regional ATFM Concept – Specifying Delay Intent

• Aircraft Operators are responsible for specifying delay absorption intent
  ➢ Gate Delay
  ➢ Airport Surface Delay
  ➢ Airborne Delay

• Allowing absorption of TMI delay in the air is a new ATFM concept
  ➢ Flights can efficiently increase their EETs by a few minutes per hour of flight time by reducing cruise speed

• Flights measured for compliance based on delay intent
  ➢ A compliance window is provided to increase flexibility and account for variability
Regional ATFM – Data Communication To Regional ATFM System

- Inputs from FMP and FOC via ATFM software interface
- Flight progress via manual input or data feed
Regional ATFM – Data Communication From Regional ATFM System

- Demand-capacity predictions are viewed via software interface
- Slot assignments can be viewed via software interface and notifications
Regional ATFM – Data Communication Between Stakeholders

- Arrival Tower Supervisor
- Approach ATC
- En Route ATC
- Departure Towers
- Flight Operations Center
- Pilot
- Military
- Airport Operators
- Cruise speed and altitude, RTA
- Gate delay intent
- Gate usage requirements

• Existing stakeholders use current communication methods
Stakeholder Engagement in Concept Development
Stakeholder Involvement

• Stakeholder Groups
  ➢ ANSP (ATC)
  ➢ Airlines
  ➢ Airports

• Sessions 1-5
  ➢ Singapore Stakeholders

• Session 6 and 7
  ➢ Tripartite ANSPs
  ➢ AOT (Session 6 only)
  ➢ DCA Malaysia
  ➢ IATA
  ➢ AATIP
  ➢ FAA (Session 6 only)
Human In The Loop (HITL) Session

Purpose

• Validate Regional ATFM/CDM Concept
  ➢ Demonstrate importance of high participation
  ➢ Will operations improve with a Regional ATFM/CDM concept?
  ➢ Where can benefits be expected?

• Further refine Regional ATFM/CDM Concept
  ➢ Each simulation exercise aims to answer specific ConOps questions

• Continue to build basis for joint understanding, acceptance and compliance to the jointly developed Concept
HITL Simulation Environment

Simulation Engine (Jupiter)

Regional ATFM Software (Harmony)

Flow Manager Workstations

Aircraft Operator Workstations

Airport Operator Workstations
HITL Simulations

1. Regional ATFM Concept Overview
2. Participation
3. Short Lead Time
4. Non-Compliant Flights
5. Measuring Compliance
6. Special Case Flights
7. TMI Revisions
Concept Refinement Discussion

- Use flight plans to update delay intent whenever possible

- Flights given little lead time prior to the start of a TMI may not be able to hold on the ground

- In general, meeting compliance will be airlines’ responsibility

- Short range flights could be measured for compliance at takeoff time

- Other flights measured for compliance at a point prior to TMA
Lessons Learned from HITL

• City-pair Traffic Management Initiatives (TMI) alone do not provide sufficient participation for effective ATFM

• Communication between ATC and weather services is important

• Stakeholders understand that successful implementation requires agreement to follow the business rules associated with the Regional ATFM concept
Concept of Operations
Concept of Operations Overview

• Motivation for ATFM/CDM
  - Increasing capacity can be costly and time consuming
  - Capacity reducing events can cause demand and capacity imbalances

• Foundation of Concept
  - ICAO ATFM Manual [Doc 9971]
    - Guidance on implementing an ATFM system
  - Existing ATFM systems in USA, Europe, Australia, and South Africa
Regional ATFM/CDM

- Concept adopted by ANSPs within region
  - Common concept across implementations
  - Each ANSP implements their own ATFM System and is responsible for managing flights to their resources
  - Data shared between ANSPs
Universal Concept Elements
Consistent Across Implementations
Concept Overview – Participation

- Participation key for equitability and effectiveness

- Delay absorption intent
  - Aircraft Operators to identify flight phase where allocated delay will be absorbed
  - Increases participation by:
    - Increasing flexibility for Aircraft Operators
    - Airborne flights are included in programs
Delay Absorption Intent

• Gate Delay Intent:
  ➢ Parked at the gate
  ➢ Default for pre-departure flights

• Airport Surface Delay Intent:
  ➢ Between pushback and takeoff
  ➢ Not part of any current, operational ATFM/CDM system

• Airborne Delay Intent:
  ➢ During the cruise portion of flight
  ➢ Default for flights airborne when Flow Program is run
  ➢ Not part of any current, operational ATFM/CDM system
Submitting Delay Intent

JST692 (SOBT 0310)

25 minutes of ground delay

5 minutes of airborne delay

Major: JST
TMI Start Time: 2013-06-09 0500 UTC

25 minutes of ground delay

5 minutes of airborne delay
Specifying Demand and Capacity

• Many airports in APAC are IATA level 3 Slot Controlled Airports
  ➢ Strategic demand and capacity balancing
• Demand and capacity predictions change based on forecasted weather and events
Initiating a Flow Program

Statistics Associated with Modeled Program

Parameters of Flow Program

Demand Capacity Imbalance
Maximum Delay

• Max Gate Hold
  - Maximum delay that can be absorbed at gate
  - Specified by Airport Operator
  - Could be specified per airport/terminal and per time period

• Max Surface Hold
  - Maximum delay that can be absorbed between gate and takeoff
  - Specified by ATC

• Max Airborne Adjustment
  - ATFM/CDM estimation of practical range of efficient flight times
  - May be dependent on aircraft performance, filed cruise speed and altitude, and distance between origin/current location and destination
Collaborative Decision Making (CDM)

- Common situational awareness
- Substitution capability
- Participate in CDM conferences

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Compliance

- High compliance is critical to successful implementation
- Non-exempt flights measured for compliance

Critical for short range flights

Critical for mid and long range flights
Post Operations Analysis

- **Flow Program Parameters**
  - Start and stop time
  - Lead time
  - Number of flights

- **Delay Metrics**
  - Average delay
  - Total delay

- **CDM Action Metrics**
  - Number of substitutions
  - Number of delay intent modifications
Stakeholder Roles – Flow Management Position

• Monitor demand and capacity at resources in their jurisdiction taking following factors into consideration:
  ➢ Weather
  ➢ Special usage of airspace
  ➢ Resource outages/maintenance etc.
• Model and issue Flow Programs with appropriate parameters
• Monitor and revise programs as necessary
• Conduct post-operations analysis
• Chair teleconferences
• Ensure common situational awareness
• Coordinate with Aircraft Operators for special case flights
Stakeholder Roles – Aircraft Operators

• Provide initial and updated demand inputs to ATFM/CDM System

• Substitute and redistribute delay intent as needed

• Manage flight data

• FOC communicates delay intent to pilots

• Pilots comply with intent within ATC constraints

• Participate in CDM processes
Stakeholder Roles – Airport Operators

• Departure Airports
  ➢ Consider impact of Flow Programs on gate conflicts
  ➢ Coordinate potential gate conflicts with Aircraft Operators
  ➢ Submit Maximum Gate Hold values as needed
  ➢ Assist airlines with compliance
  ➢ Advise FMP of forecasted capacity constraints

• Arrival Airports
  ➢ Consider impact of Flow Programs on turn-around times
  ➢ Advise FMP of forecasted capacity constraints
  ➢ Participate in teleconferences
Stakeholder Roles – ATC Tower

• Departure Tower
  - Assist flights to meet intended departure times
  - Coordinate ground holds based on flight delay intent
  - Submit Maximum Surface Hold as needed
  - Participate in the CDM process

• Arrival Tower
  - Advise FMP of forecasted capacity constraints
  - Participate in teleconferences
  - Monitor Airport Acceptance Rate
Technology and Policy Changes

• New Technology Capabilities
  - Flow Program modeling capability
  - Automated ATFM slot assignment and delivery to appropriate stakeholders
  - Common situational awareness for demand, capacity, and flight updates
  - CDM platform to perform substitutions
  - Ability to perform post operations analysis

• Policy Changes
  - Measuring compliance to allocated ATFM slots
  - Data sharing
  - Teleconferences
Implementation Considerations

Flexibility for Customization Across Implementations
Implementation Considerations

Flexibility in implementation to meet needs of specific ANSP

• Compliance Handling
  - Role of departure towers
  - Penalties for non-compliance

• Performance Metrics and Post Operational Analysis

• Maximum Delay implementation
  - Shared
  - Demand predictions
  - Slot assignment
Concept Summary

• Concept derived from:
  - Experience from existing ATFM/CDM systems
  - Stakeholder participation
  - HITL simulation

• Unique Aspects
  - International flights included in slot allocation and delay absorption
  - Airborne flights included in slot allocation and delay absorption
  - Each ANSP responsible for managing TMIIs within own FIR
  - Aircraft Operators specify delay absorption intent

• ConOps specifies areas that should be consistent across implementations and areas where ANSPs have flexibility
Benefits Analysis
Singapore Case Study
Benefits of ATFM

• Qualitative
  ➢ Optimized Staffing Levels
    ✓ De-peaking of traffic has resulted in reduction in supply of resources prior to ATFM/CDM implementation
    ✓ Effective staff training planning
  ➢ Potential Increased Capacity
    ✓ Smoother and more predictable flow of traffic
Benefits of ATFM

• Qualitative
  ➢ Situational Awareness and Improved Predictability
  ➢ Special Use of Airspace Facilitation
  ➢ Reduced Sector Times
  ➢ Enhanced Safety
    ✓ Consistent orderly flow of traffic

• Quantitative
  ➢ Fuel burn and emissions reduction
Quantitative Analysis – Determining Economic and Environmental Benefits

- Annual Airborne Holding is about 137,000 minutes
  - Annual potential fuel savings: 13.6 mil SGD
- Estimate of airborne holding savings
  - Estimate based on:
    - Sample size, fleet mix, and modeling fidelity
    - ATFM will not eliminate all airborne holding

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<th>Fuel Savings (millions SGD)</th>
<th>Emissions Reduction (Metric Tonnes CO₂)</th>
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Future Benefits Projections

- Airbus market forecasts project ~6% annual traffic growth for Asia Pacific Region
- As demand increases, delays increase at a faster rate, as do ATFM benefits
Airborne Holding with Projected Traffic Growth

- Fast Time simulation analysis shows that for Changi:
  - 6% traffic growth → 75% increase in airborne holding
  - 12% traffic growth → 175% increase in airborne holding
Projected Benefits in 2015 Assuming 6% Growth

- Annual Airborne Holding is about 240,000 minutes
  - Annual potential fuel savings: 24 mil SGD

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Airborne holding projections further into the future are expected to grow more slowly than the simulation projected due to capacity enhancements and curbing of demand growth.
Thank You