Concept of a Distributed Multi-Nodal ATFM Network

Civil Aviation Authority of Singapore

Outline

1. Introduction
2. Stakeholder Engagement in Concept Development
3. Concept of Operations
4. Benefits Analysis – Singapore Case Study

Introduction

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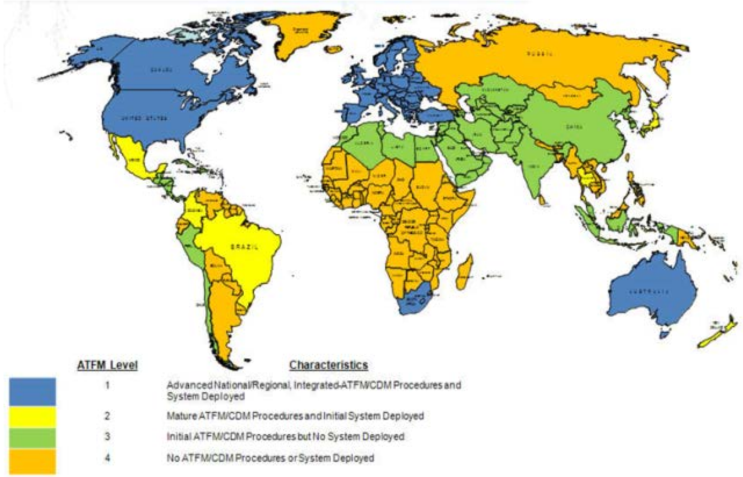
Purpose of R&D Project

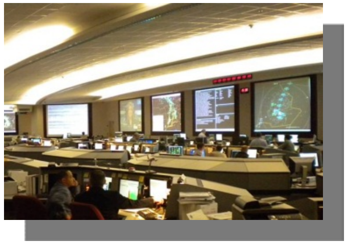
- Develop a Concept of Operations (ConOps) for Regional ATFM/CDM for Singapore and the Asia Pacific Region
- Study existing ATFM/CDM concepts for potential implementation in Asia Pacific

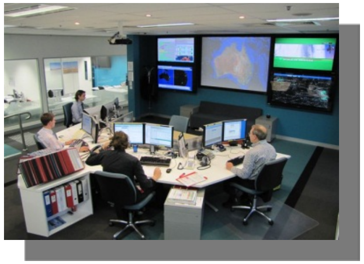


- Validate ConOps using proven Concept Engineering process
- Conduct analysis for the benefits of ConOps in Singapore

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 (TMIs)
  - ➢ Accurate demand and capacity predictions
  - ➢ TMIs 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

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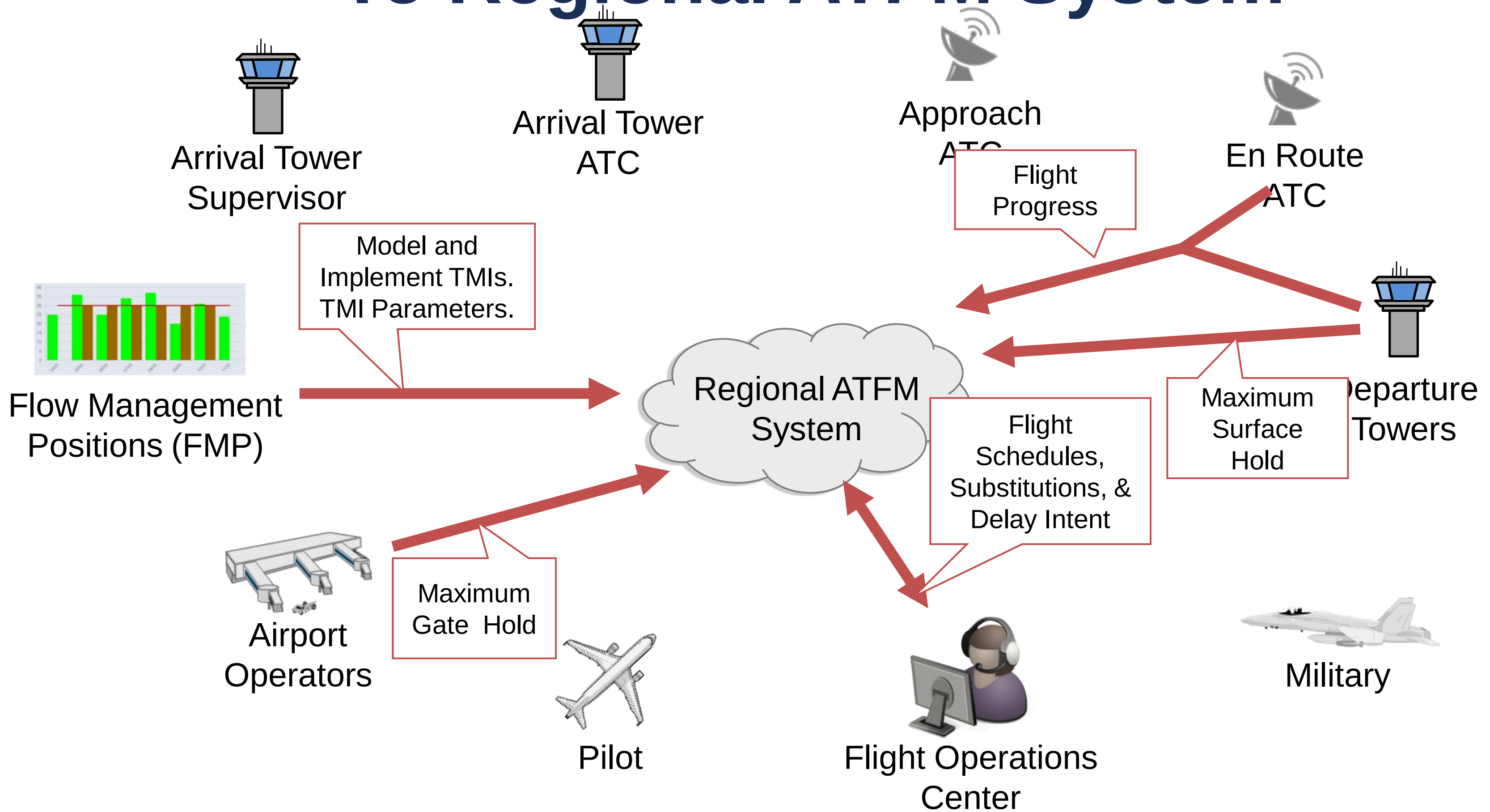
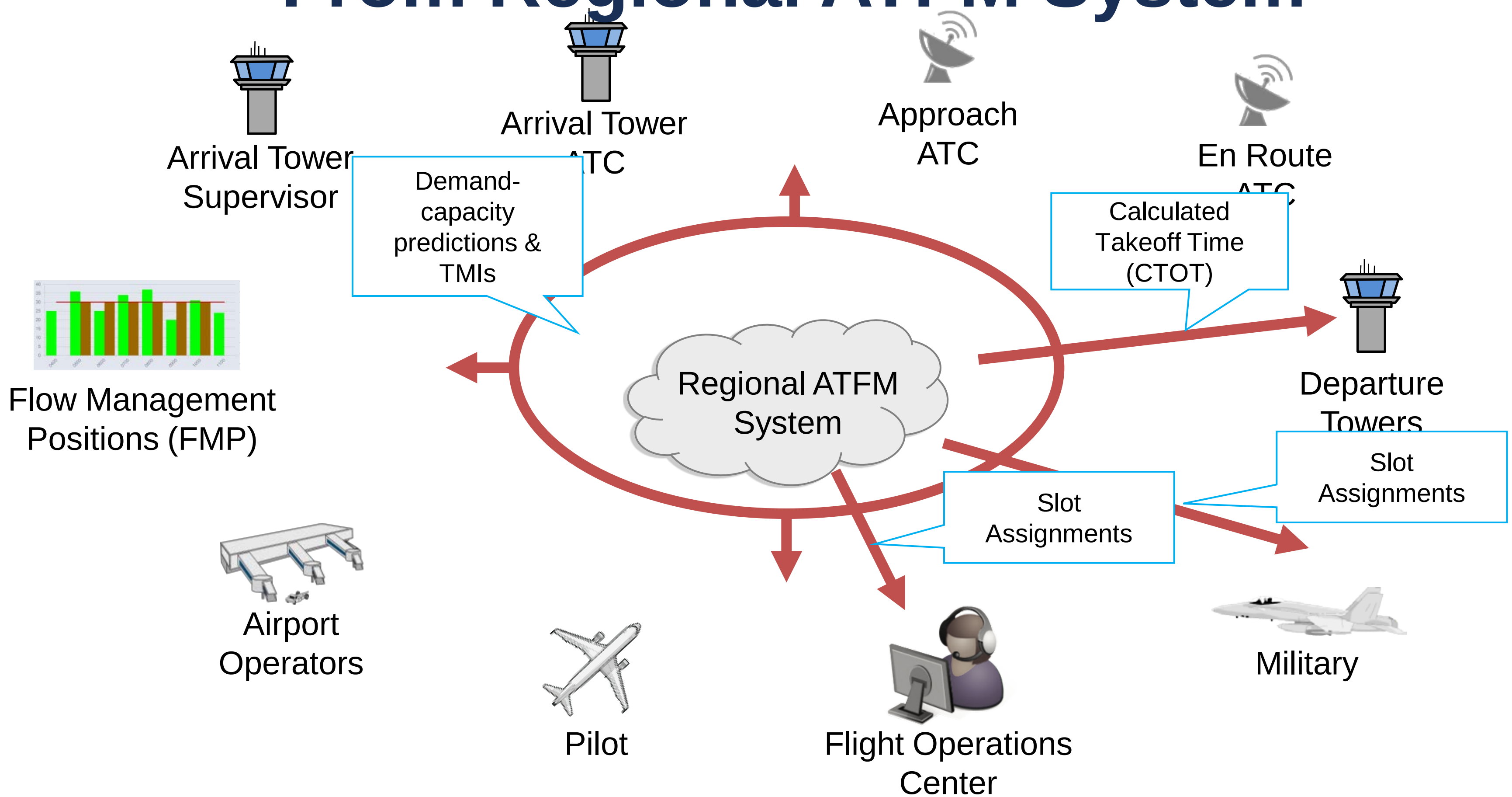
Regional ATFM – Data Communication To Regional ATFM System



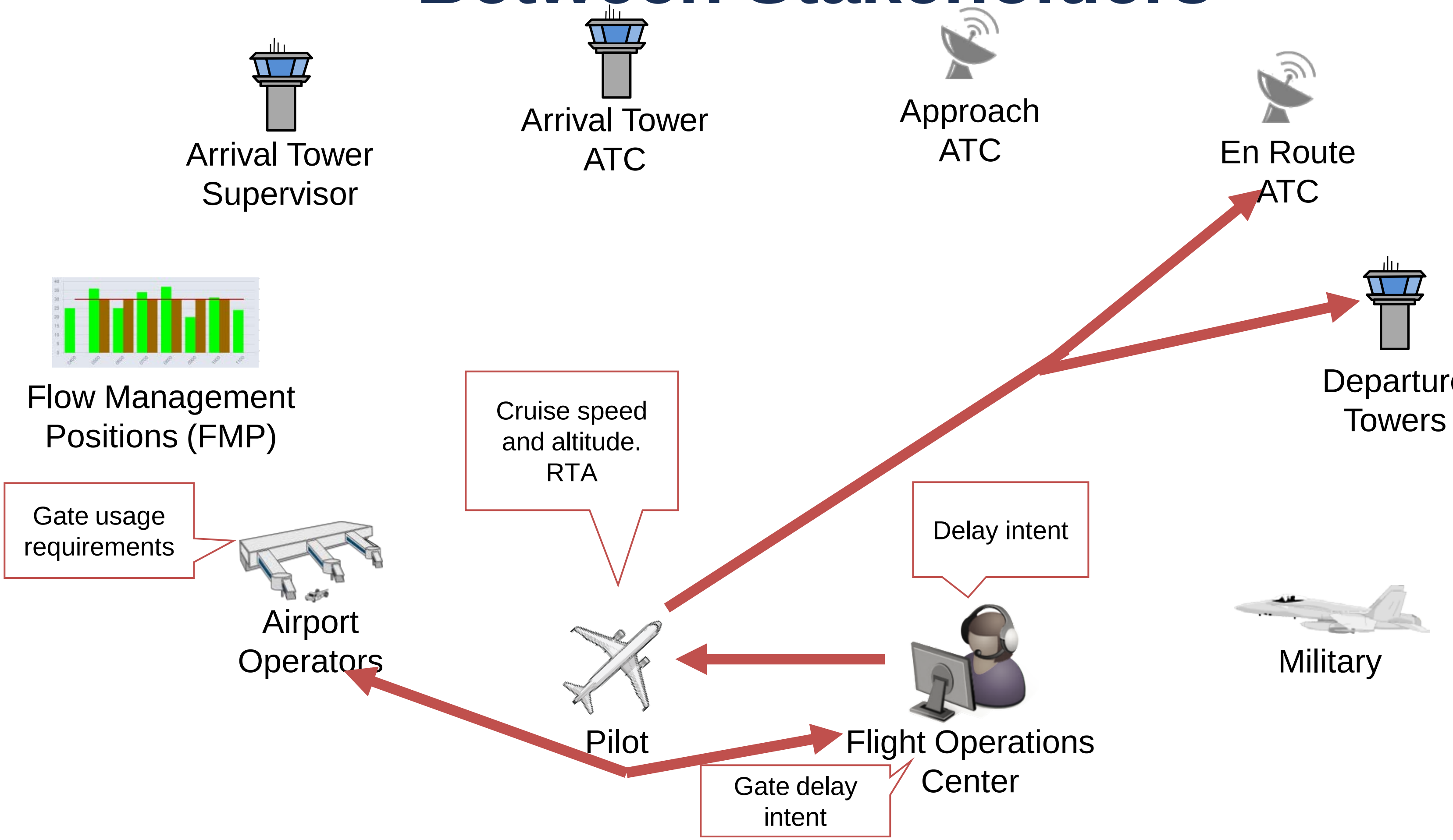
- Inputs from FMP and FOC via ATFM software interface
- Flight progress via manual input or data feed

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



- Existing stakeholders use current communication methods

Stakeholder Engagement in Concept Development

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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)

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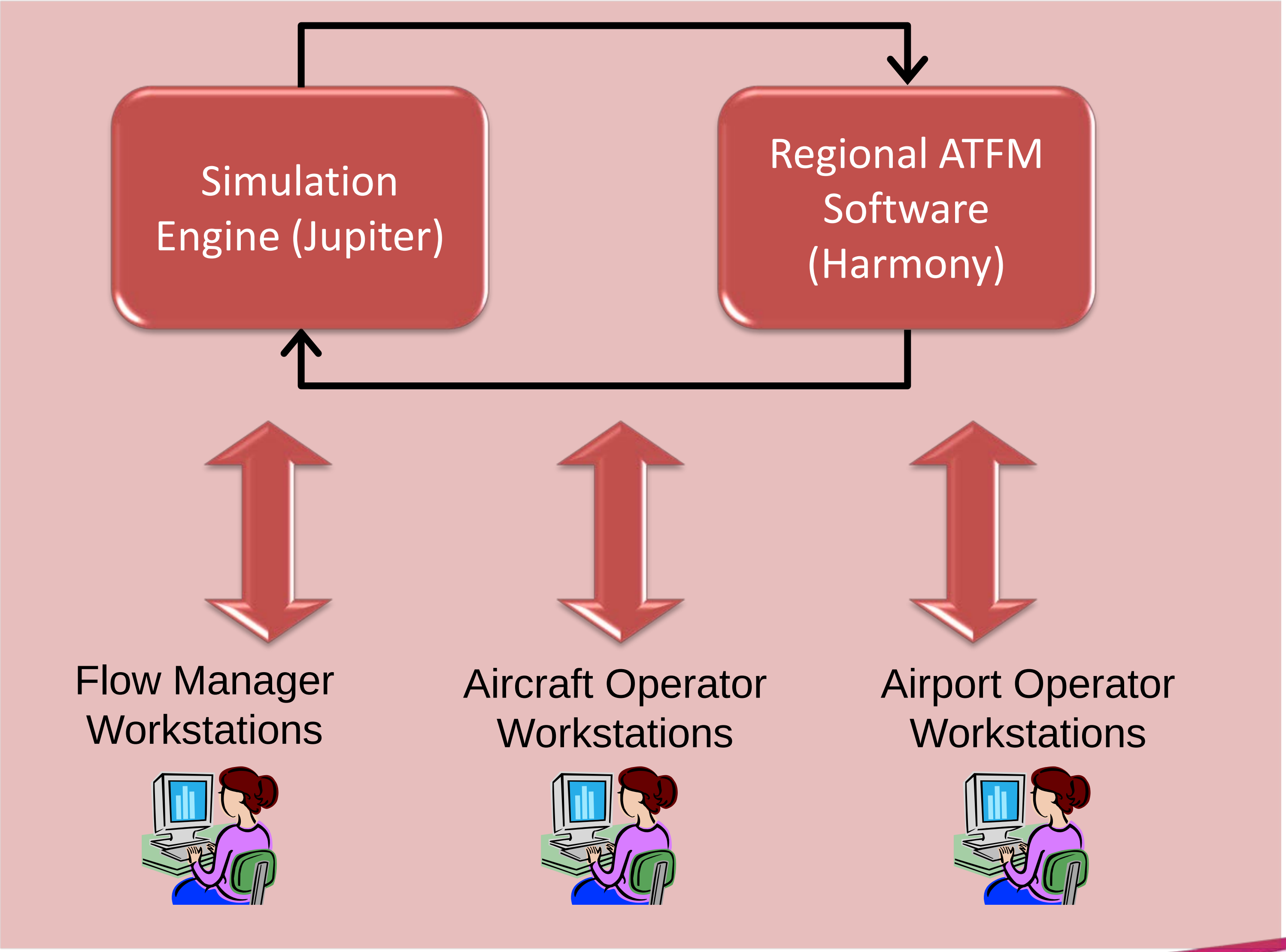
Human In The Loop (HITL) Session Purpose

- 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



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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

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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

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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

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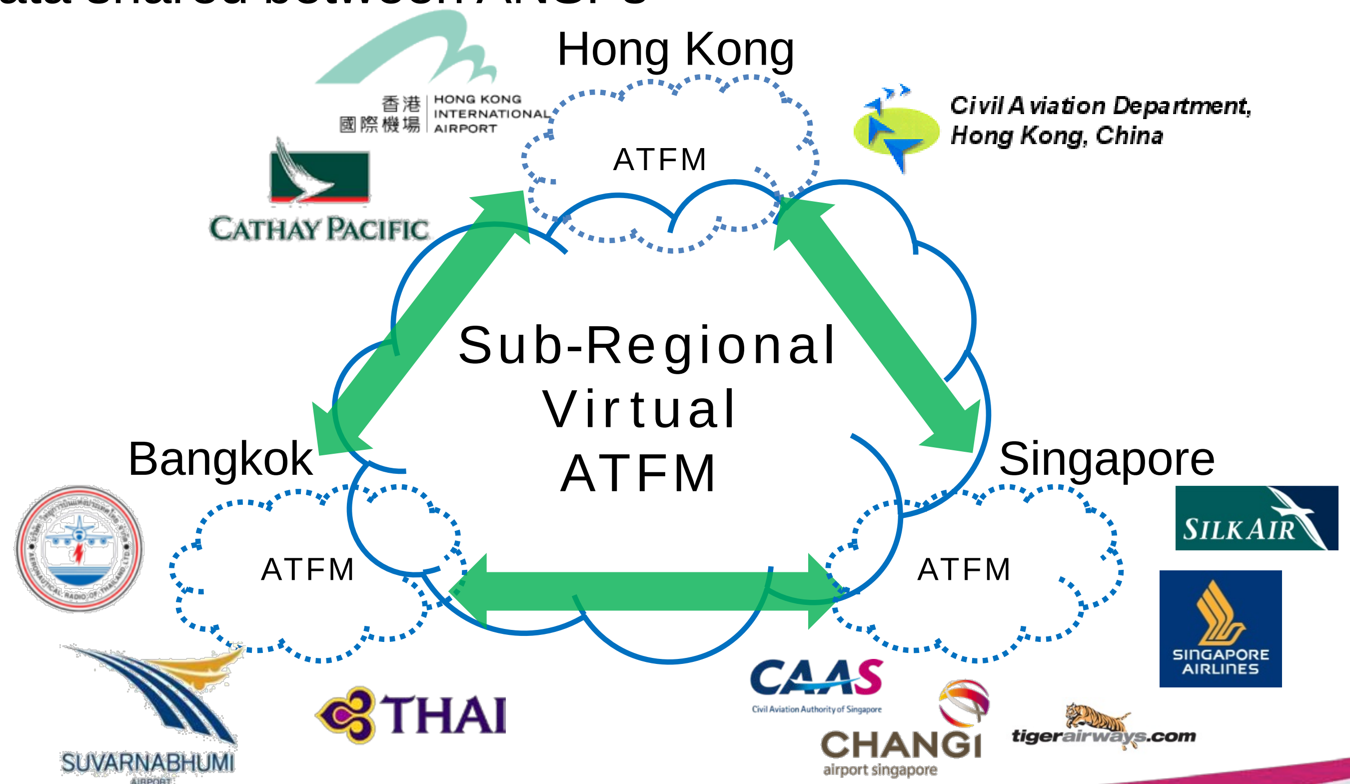
Concept of Operations Overview

- 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

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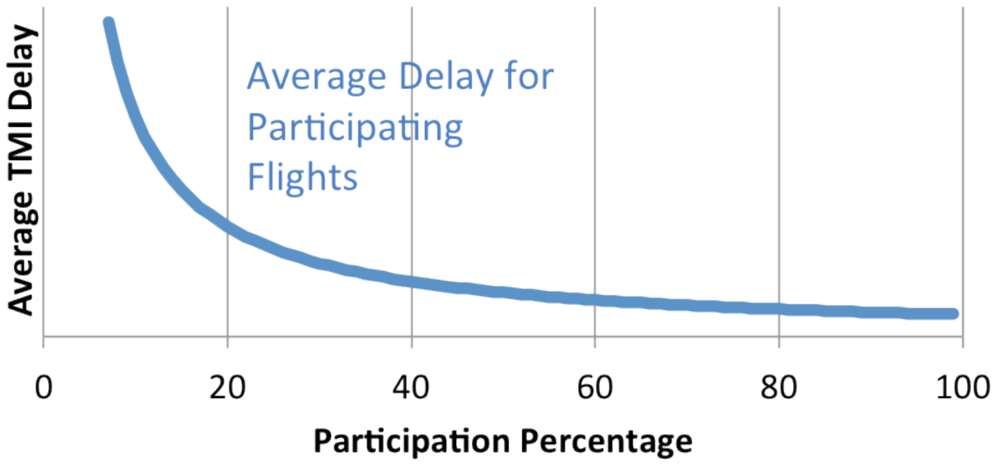
Concept Overview – Participation

- Participation key for equitability and effectiveness



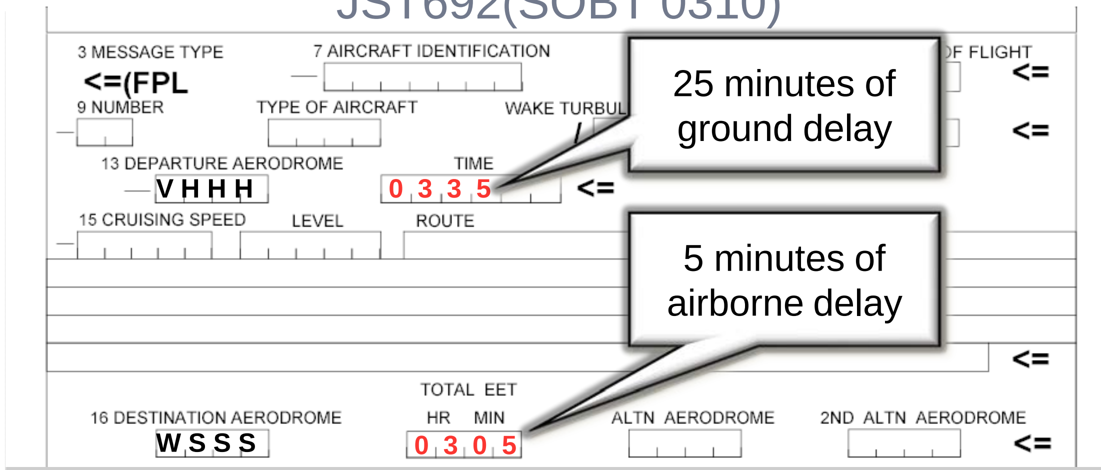
- Delay absorption intent
  - ➢ Aircraft Operators to identify flight phase where allocated delay will be absorbed
  - ➢ Increases participation by:
    - ✓ Increasing flexibility for Aircraft Operators
    - ✓ Airborne flights are included in programs

Delay Absorption Intent

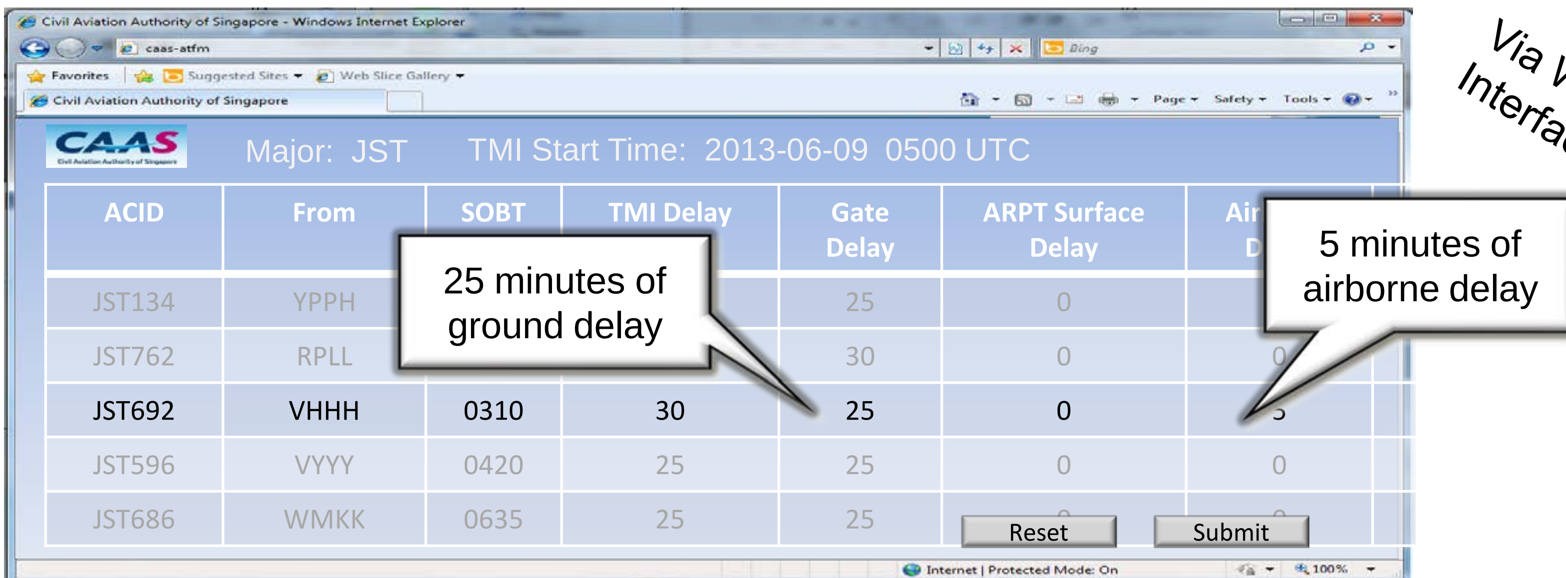
- Gate Delay Intent:
  - Parked at the gate
  - Default for pre-departure flights
- Airport Surface Delay Intent:
  - Between pushback and takeoff
  - Not part of any current, operational ATFM/CDM system
- Airborne Delay Intent:
  - During the cruise portion of flight
  - Default for flights airborne when Flow Program is run
  - Not part of any current, operational ATFM/CDM system

Submitting Delay Intent

JST692(SOBT 0310)



Via Flight Plan

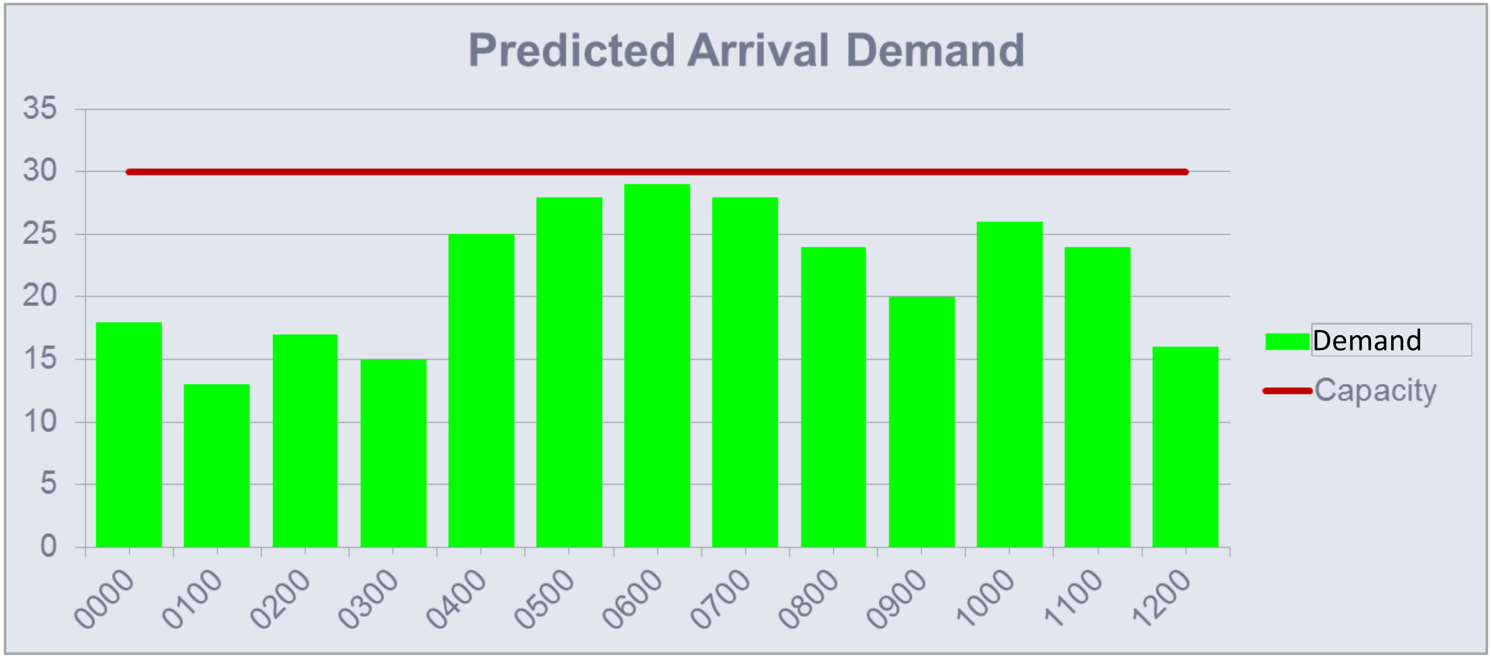


ACID	From	SOBT	TMI Delay	Gate Delay	ARPT Surface Delay	Air D
JST134	YPPH			25	0	
JST762	RPLL			30	0	0
JST692	VHHH	0310	30	25	0	5
JST596	VYYY	0420	25	25	0	0
JST686	WMKK	0635	25	25		

Via Web Interface

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



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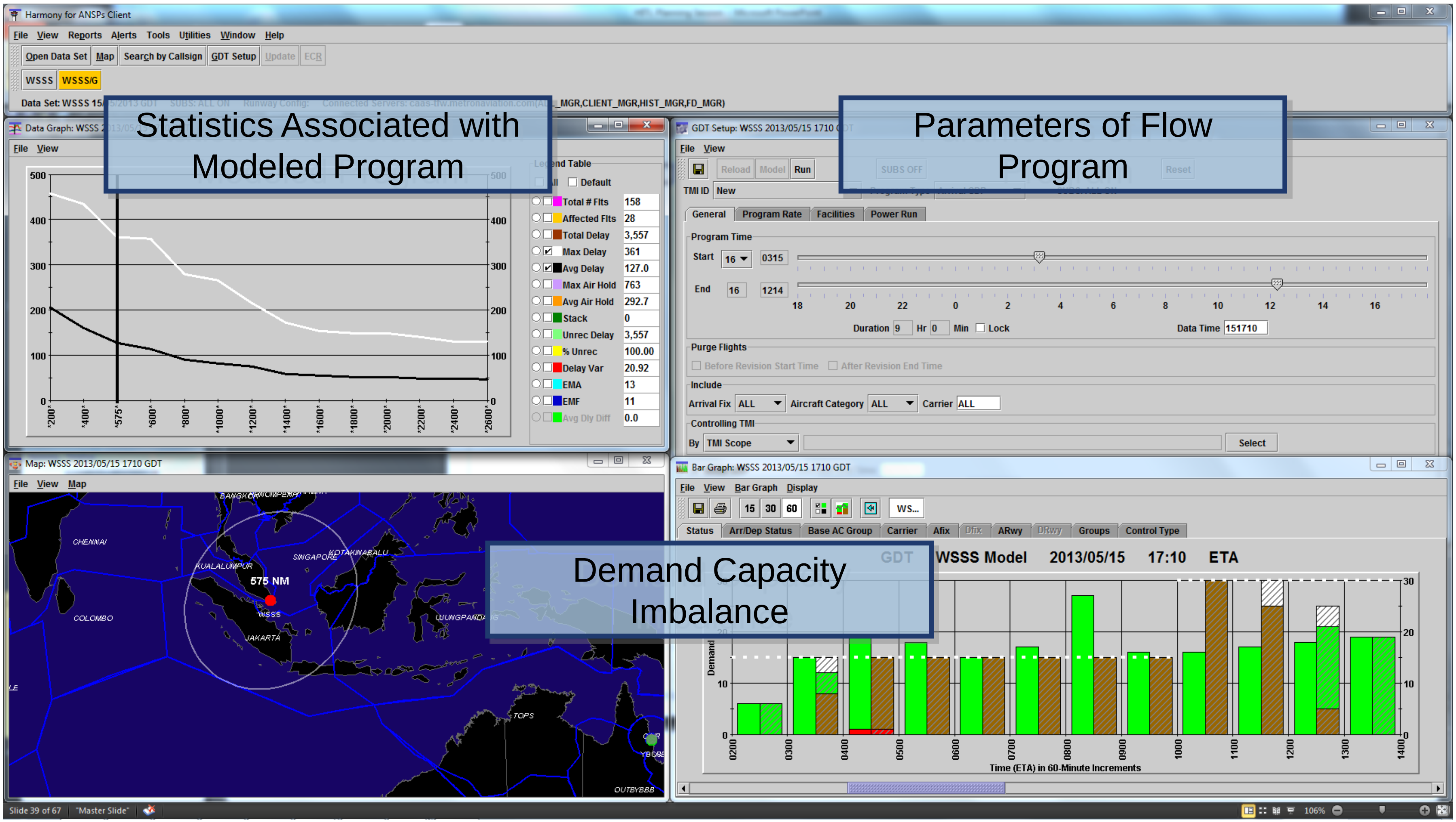
Initiating a Flow Program



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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

Pre-Substitution

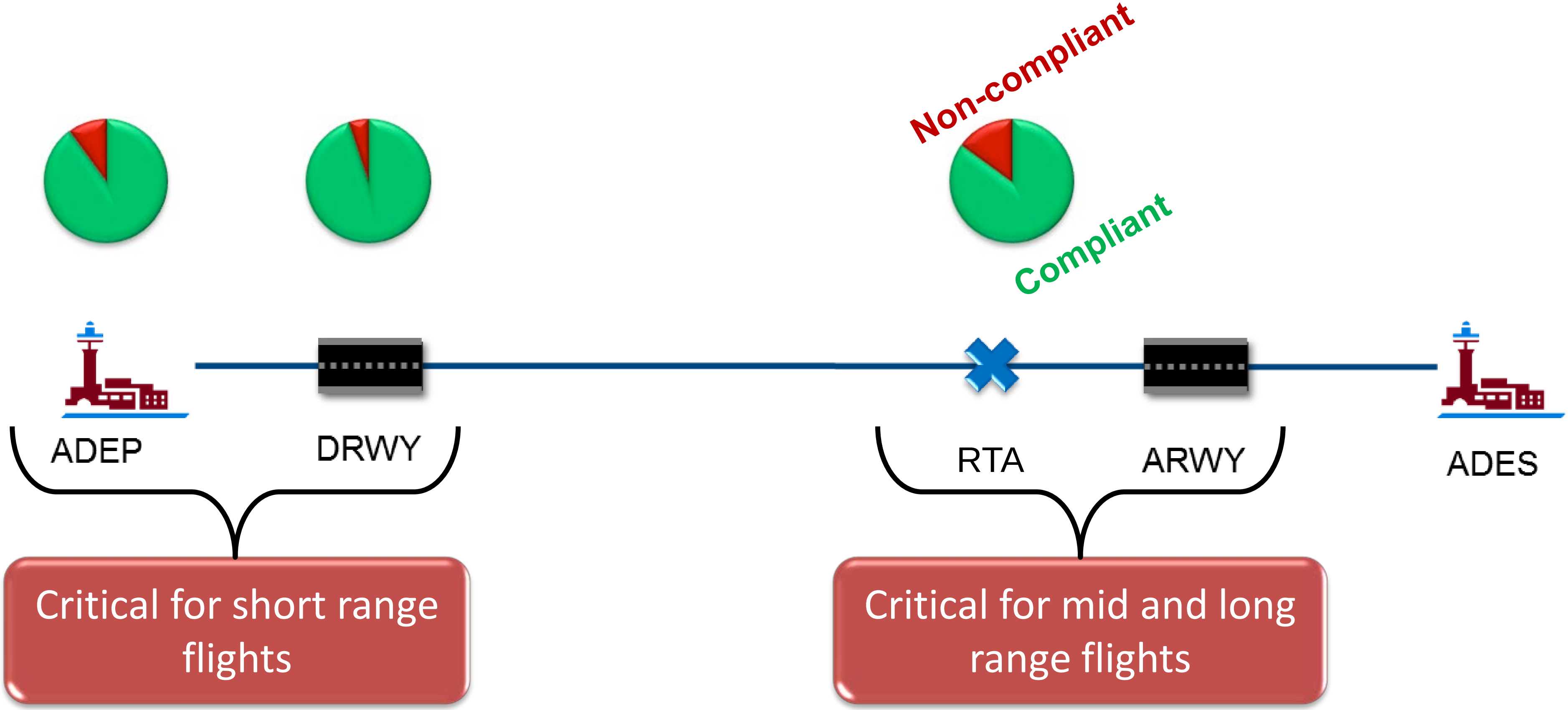
ACID	ADEP	CTOT	ATOT	SLDT	CLDT	TMI Delay
CPA739	VHHH	0345	----	0705	0710	5
CPA713	VTBS	0455	----	0710	0720	10

Post-Substitution

ACID	ADEP	CTOT	ATOT	SLDT	CLDT	TMI Delay
CPA739	VHHH	**0355**	----	0705	**0720**	**15 (+10)**
CPA713	VTBS	**0445**	----	0710	**0710**	**0 (-10)**

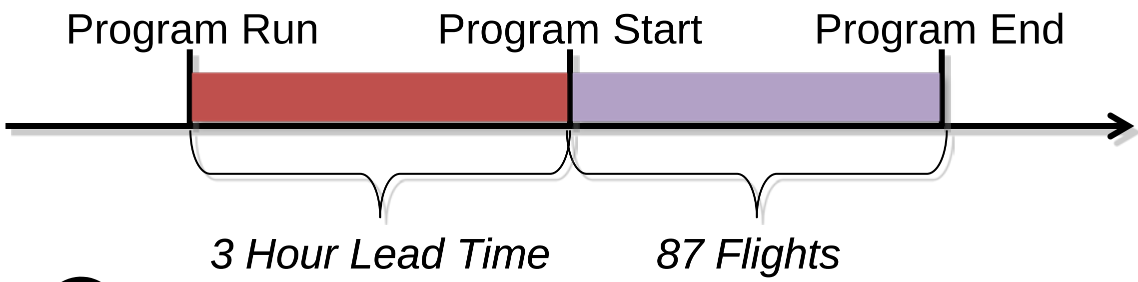
Compliance

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



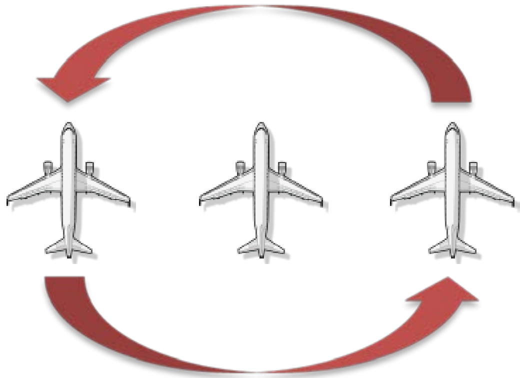
Post Operations Analysis

- 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

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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

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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

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Implementation Considerations

Flexibility for Customization Across Implementations

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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 TMIs 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

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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

Percentage of Airborne Holding Saved by ATFM	Fuel Savings (millions SGD)	Emissions Reduction (Metric Tonnes CO_2)
3/4 (75%)	$10	24,000
2/3 (66%)	$9.0	22,000
1/2 (50%)	$6.8	16,000
1/3 (33%)	$4.5	11,000

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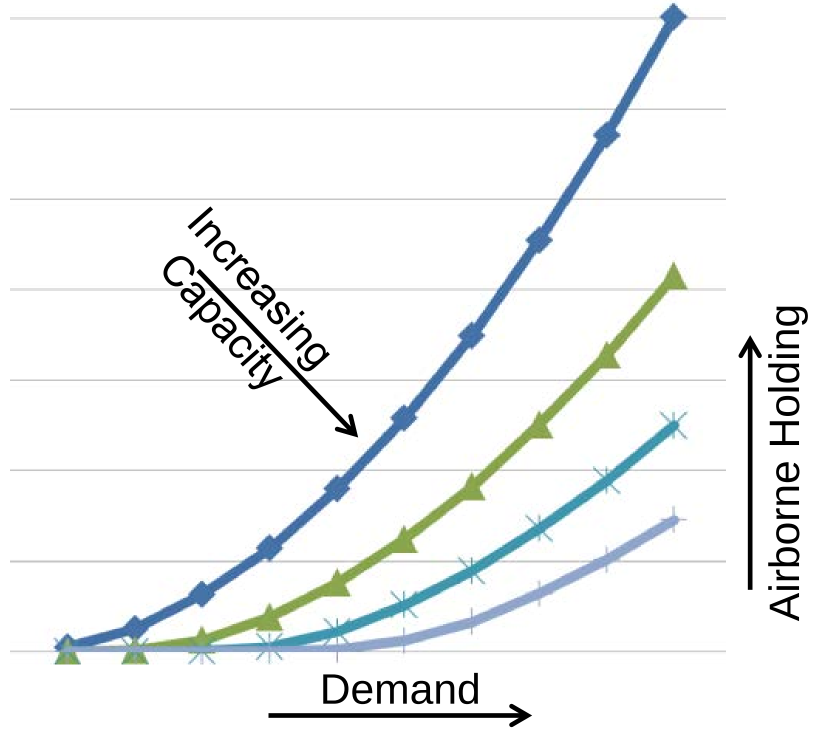
Future Benefits Projections

- 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



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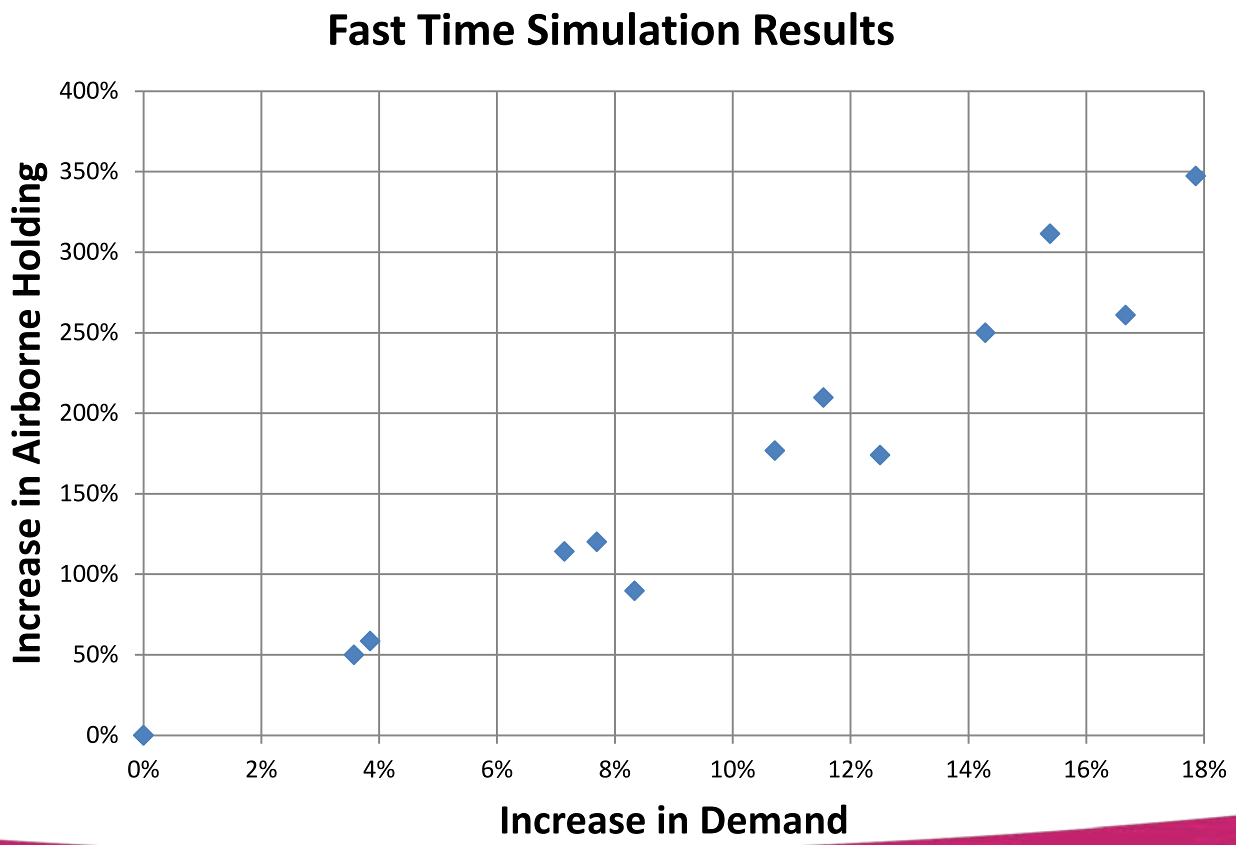
Airborne Holding with Projected Traffic Growth

- 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

Percentage of Airborne Holding Saved by ATFM	Fuel Savings (millions SGD)	Emissions Reduction (Metric Tonnes CO_2)
3/4 (75%)	$18	43,000
2/3 (66%)	$16	39,000
1/2 (50%)	$12	28,000
1/3 (33%)	$7.9	19,000

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

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