



#### Agenda

- Flexible use of airspace
- Briefing on next generation surveillance technology (ADS-B)
- ADS-B coverage in Hong Kong
- Signal interference in surveillance data
- ADS-B implementation in Hong Kong



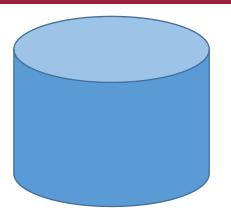


# Flexible use of airspace

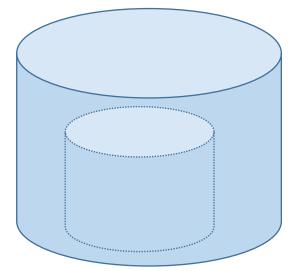
#### What is FUA



• Flexible use of airspace (FUA) is an airspace management concept based on the principle that airspace should not be designated as purely civil or military, but rather as a continuum in which all user requirements are accommodated to the greatest possible extent.







Military only

Civil/Military Coordination

Civil only

## Environment in context

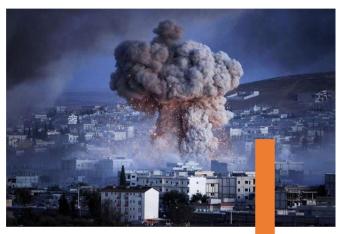




Global air traffic doubles every 15 years



Increase in UAS operations for military activity



A world in conflict



Increased military operations globally



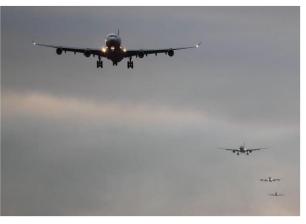


Increase in aviation operations for national security

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# Environment in context (cont'd)









**Civil Aviation** 

Airspace

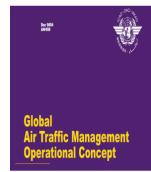
Military/National Security

# Background on FUA

- The Convention on International Civil Aviation was signed in Chicago in 1944
- Article 3, excludes State aircraft used in military, customs and police services from ICAO's regulations
- Resolution A37-15, Appendix O, "Coordination and cooperation of civil and military air traffic" was further articulated
- GPI-1, "Flexible Use of Airspace"
- ASBU PIA 3 Optimum Capacity and Flexible Flights
- ASBU PIA 4 Efficient Flight Paths



2013-2028 Global Air Novigation Capacity & Efficiency Plan



Doc 9554-AN/932

Chicago –7 December 1944









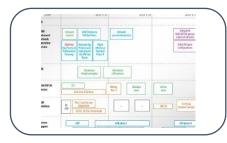


#### Process to establish FUA





National, high-level civil/military coordination body



National airspace planning process



Letters of agreement



Process for publication



Review and update process



System that allows predictive and timely access to restricted or reserved airspace

# ICAO's guidelines on airspace management (ASM)



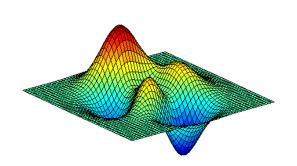
- All available airspace should be managed in a flexible manner, whenever feasible;
- Airspace management processes should incorporate dynamic flight paths and provide optimal operational solutions;
- When conditions require segregation, based on different types of operations and/or aircraft, the size, shape and time zones of said airspace should be determined to minimise impact on operations;
- The use of airspace should be coordinated and monitored in order to accommodate the conflicting requirements of all users and minimise any constrains on operations;
- Airspace reservation should be planned in advance with changes made dynamically whenever possible;
- The system also need to accommodate short-notice unplanned requirements;
- The complexity of operations may limit the degree of flexibility.

# ICAO's guidelines on ASM

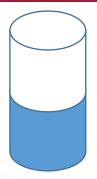




Flexible airspace management



Dynamic flight paths



Minimise impact of airspace reservations on operations



Coordination



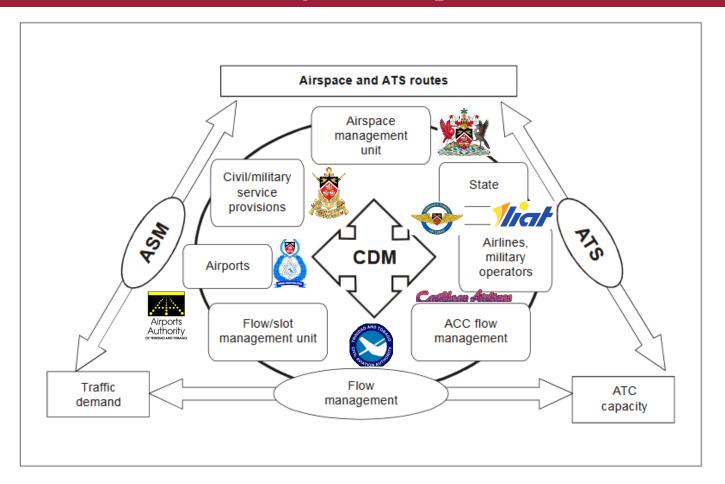
Plan and schedule



Be aware that complexity may affect flexibility

# Collaborative decision making (CDM) process

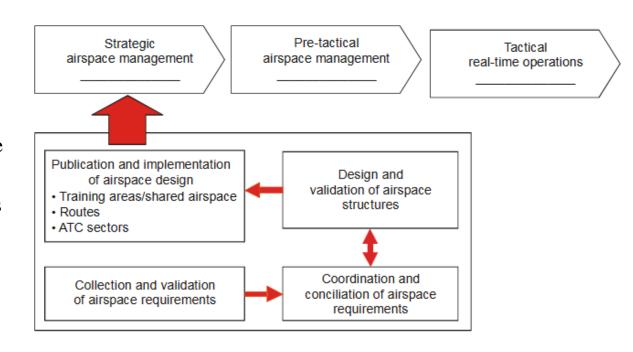




# Principles of FUA

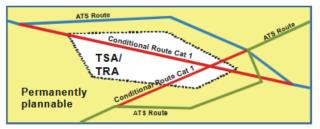


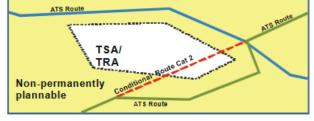
- Coordination between civil and military authorities should be carried out at the strategic, pretactical and tactical levels;
- Airspace reservations should be of a temporary nature;
- Applied across national borders and/or the boundaries of flight information regions (FIRs).

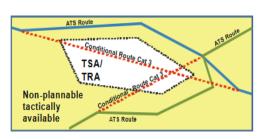


# Flexible and adaptable airspace structures and procedures



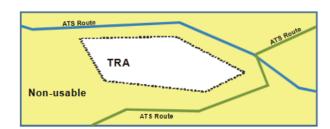






- Permanently plannable during times published in AIP;
- Expected to be available for most of the time;
- Plannable in the same way as all plannable ATS routes;
- ATC tactically reroutes if TSA becomes active on short notice.

Daily allocated based on ATC capacity imbalance.



Unusable

- Usable on ATC instruction only;
- Used for short notice routing.

# Considerations when designing special use airspace (SUA)



- Many current prohibited areas may be more correctly described as restricted areas;
- Restricted areas may not be designated over the high seas or in airspace of undetermined sovereignty;
- Restricted areas should be designed to be as small as possible;
- Danger areas may be considered in lieu of restricted areas;
- SUA should only be activated when required.







#### How does it work?



#### Without FUA

- Increase in track miles or operating at flight levels that are not optimum cause
  - Increase fuel burn;
  - Increase carbon emissions.
- Reduction in airspace capacity cause
  - Increase in ATC workload;
  - Increase in cockpit workload.

Permanent Restricted/ Prohibited Airspace

Permanent Restricted/ Prohibited Airspace

## How does it work? (cont'd)



#### **Utilising FUA Concept**

#### **Benefits:**

- Reduce fuel burn;
- Reduce carbon emissions;
- Increase in Airspace Capacity;
- Reduction of complexity for ATCOs and Pilots.

TRA/TSA coordinated with ATS to allow flight at certain times

TRA/TSA coordinated with ATS to allow flight at certain times

# Performance based navigation (PBN) concept



Regular method of

descending: Engine

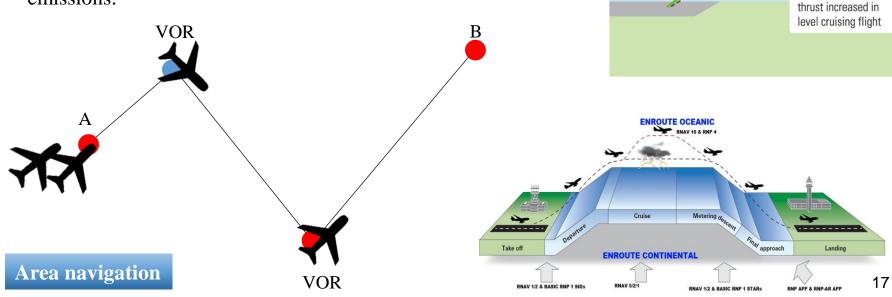
**Energy-efficient** 

Active runway

method of descending: Continuous descent with

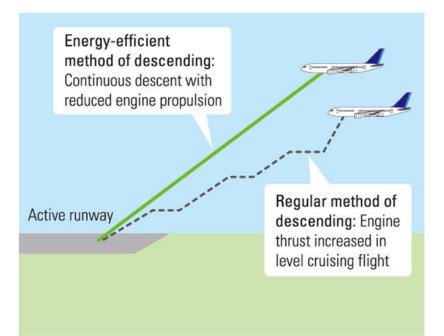
reduced engine propulsion

- More accurate;
- Allow for shorter more direct routes;
- Safer & more efficient take-offs and landings;
- Reduce fuel burn, airport and airspace congestion, aircraft emissions.



#### CCOs and CDOs



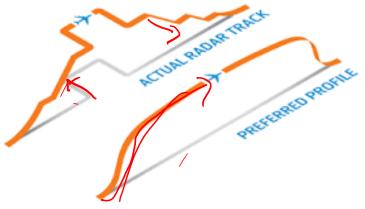


PBN is essential to the implementation of ICAO's Aviation System Block Upgrade (ASBU) performance improvement areas. For example it provides critical support to the imporvement of airport operations through ASBU modules:

**B0-APTA** – Optimization of Approach procedures including vertical guidance **B1-APTA** – Optimized Airport Accessibility.

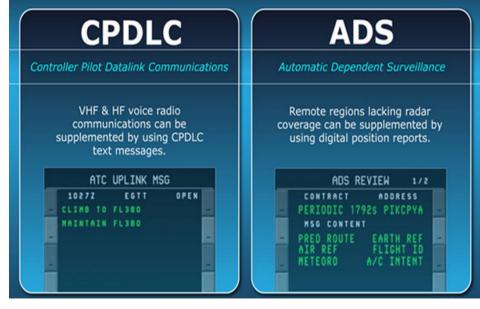
And is also a major enabler of the Efficient Flight Path concept through Trajectory-based Operations (TBO). In this capacity, PBN further supports the application of modules which contribute to significant efficiency, capacity and environmental benefits, namely:

**B0-CD0 and B1-CD0 –** Continuous Descent Operations (CD0s: see diagram, below) **B0-CC0 –** Continuous Climb Operations (CC0s)



### ADS-C & CPDLC





- Provide situational awareness and data link communication in remote or oceanic areas
- → Increase safety



#### Considerations for ASM team



- Performance Based Navigation (PBN) concept allows for greater flexibility for aircraft operations;
- FANS 1/A (ADS-C/CPDLC) allows for more efficient operations;
- Some military ACFT may not have the appropriate equipage on board;
- Result in lack of interoperability between Civil ANSPs and Military Operations.



# Constraints on military operations

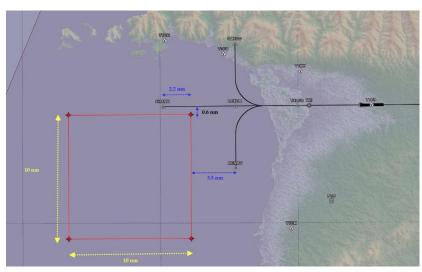


- Lengthy military procurement cycles;
- Public budget constraints;
- Lack of space in the cockpit for extra avionics;
- Absence of supporting military requirements;
- Lack of recognised certification processes;
- Security and institutional aspects;
- Difficulty monitoring civil CNS/ATM developments.

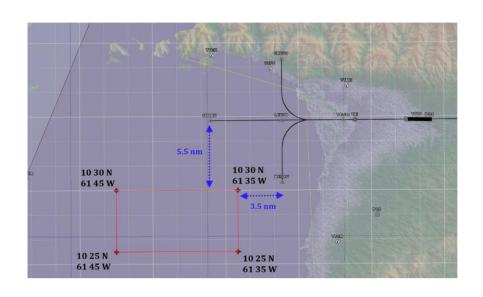


# Example of CDM between TTCAA and TTDF





Requested restricted airspace



Restricted airspace agreed to

# Example of the CDM process in Trinidad and Tobago





Modified Airspace
Boundary

Current
Airspace

Cu

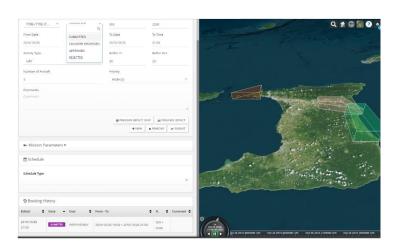
- Request received to increase restricted airspace
- Request infringed on helicopter operations

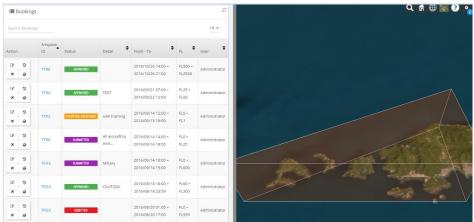


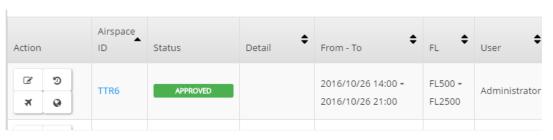
Procedure designers designed a modified restricted airspace which was agreeable to both parties

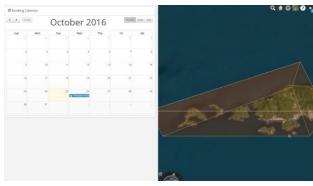
#### Trinidad and Tobago's ATFM system has capability to provide platform for FUA











#### Flex route trials with KLM Airlines

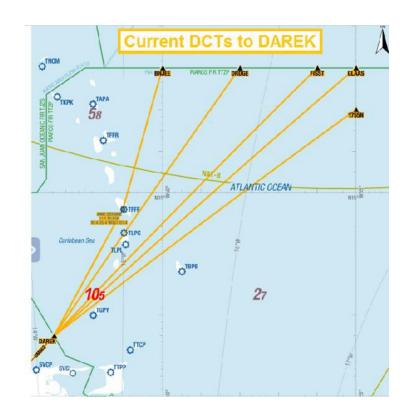


#### **Total reductions from Mar – May**

- Mileage 1238 NM
- Time 162 minutes
- Fuel burn 24760 kgs
- CO2 emissions 78242 kgs

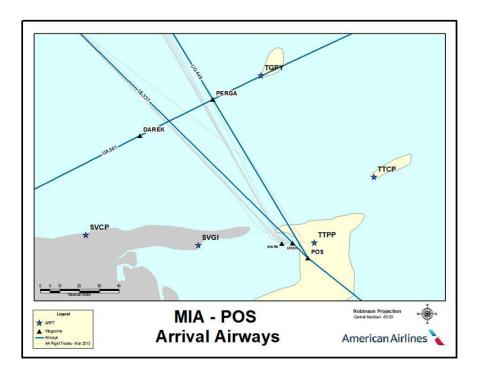
#### **Total reductions from Jun – Aug**

- Mileage 1809 NM
- Time 241 minutes
- Fuel burn 35891 kgs
- CO2 emissions 113416 kgs



# CDM with American Airlines for CDO





777-300ER				
	Time (min)	Fuel (lbs)	Dis (NM)	
CDO Descent	17.2	1188	96.7	
Step at FL190 for 1 min	20.9	1967	102.0	
A319 w/ Sharklets				
A31	9 w/ Sharkl	ets		
A31	9 w/ Sharkl	ets Fuel (lbs)	Dis (NM)	
CDO Descent			Dis (NM)	
	Time (min)	Fuel (lbs)		

### Benefits of FUA

















Briefing on next generation surveillance technology (ADS-B)

Opening Minds • Shaping the Future, 啟迪思維 • 成就未來

# Briefing on ADS-B



Automatic Dependent Surveillance – Broadcast		
Automatic	No interrogation is needed	
Dependent	Depend on data from aircraft's navigation system	
Surveillance	Transmission of surveillance data	
Broadcast	Broadcast to everyone in range	

# Basic Principle of ADS-B



- Use the Global Navigation Satellite System (GNSS) receiver in the aircraft to determine aircraft position
  - No direct measurement of aircraft position by ground equipment.

- Broadcast automatically from aircraft (Twice per second)
  - No interrogation is required to trigger the transmission
  - Data includes:
    - Aircraft Position;
    - Pressure Altitude:
    - Identity;
    - Other aircraft status (speed, heading, etc.)





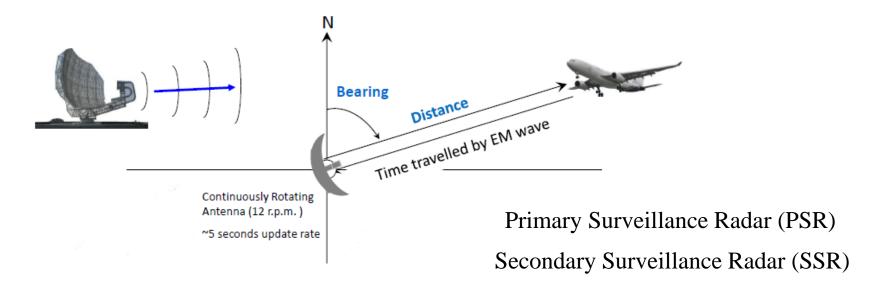
# Comparison between ADS-B and Radar

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# Basic Principle of RAdio Detection And Ranging (Radar)



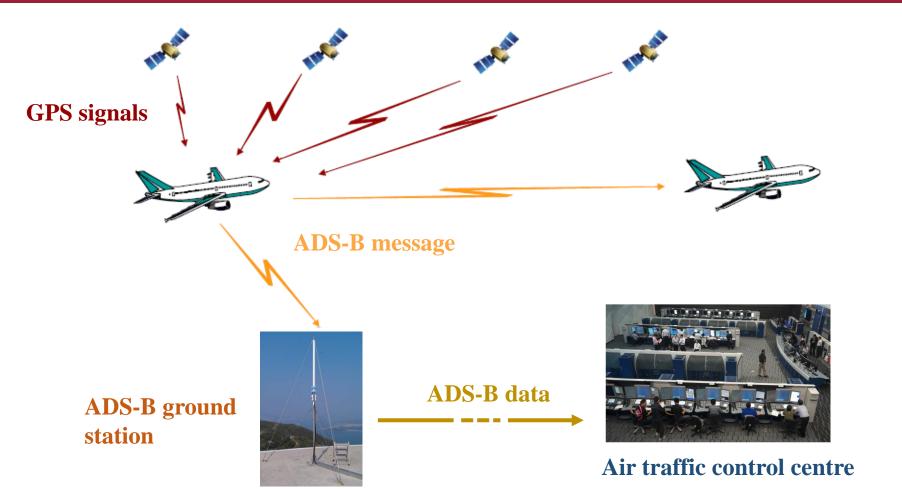
• Use electromagnetic (EM) waves to identify the range and bearing of objects being detected



Distance = (Speed of electromagnetic wave X time)  $\div$  2

# ADS-B operating principle





# Scale of ground equipment





Omni-directional ADS-B Antenna

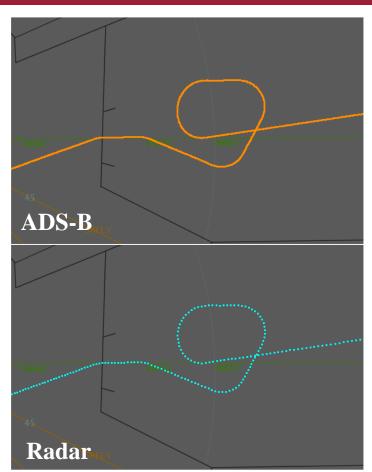
Tai Mo Shan Radar Radome

# Advantages of ADS-B over Radar



- Accurate position information
  - From GNSS (GPS) signals
- Easy to maintain
  - No mechanical movement
  - No transmitter
- Cost effective
  - Less expensive to setup/maintain
- Fast update rate
  - Typically every 1 second
- Able to provide low-level surveillance coverage

High update rate is particularly useful to ATC in handling air traffic in complex and busy airspace







# ADS-B coverage in Hong Kong

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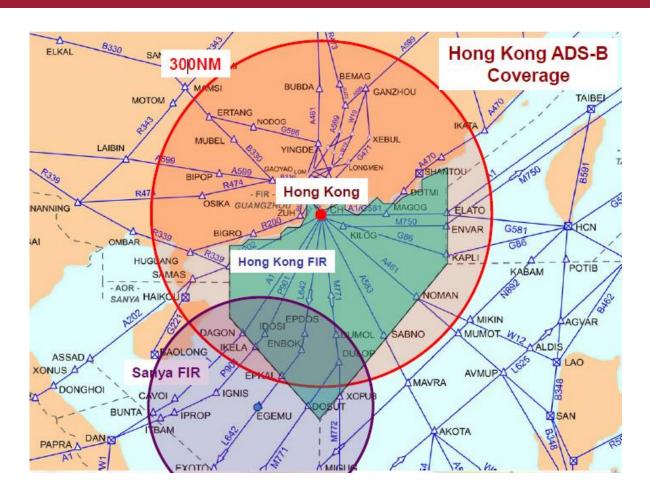
# ADS-B ground station sites in HK





#### Combined ADS-B coverage of Hong Kong flight information region (FIR)

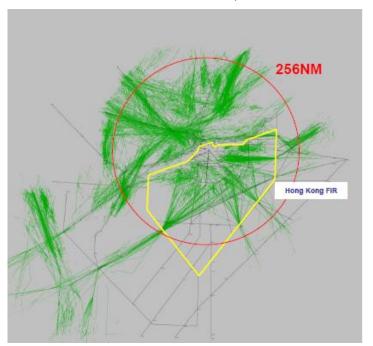




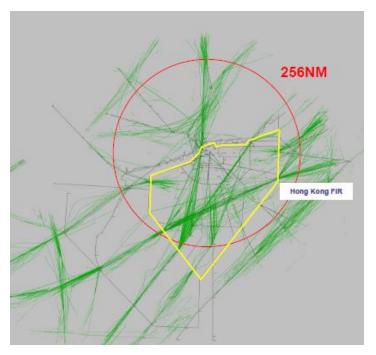
# Combined ADS-B coverage of Hong Kong FIR



Combined ADS-B at FL290 (can reach 280NM)



Combined ADS-B at FL400



Supplement radar to provide reliable surveillance coverage to ATC for maintaining aircraft separation





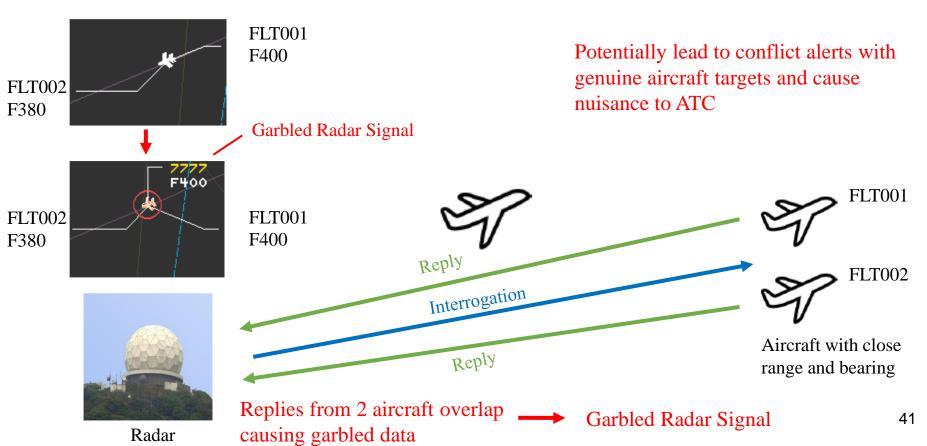
# Signal interference in surveillance data

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# Limitation in radar technology (signal garbling)



#### Caused by overlapping replies from close aircraft



# Handling of signal interference in ADS-B



# ADS-B information broadcast in an omnidirectional manner randomly from aircraft without the need of interrogation

• Lower chance of overlapping signals from aircraft at close range.

#### Data verification done at ADS-B ground station

Ensure data integrity of received ADS-B information.

Minimise the possibility of causing nuisance to ATC due to signal interference on the surveillance data





# ADS-B implementation in Hong Kong

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# ADS-B implementation in Hong Kong

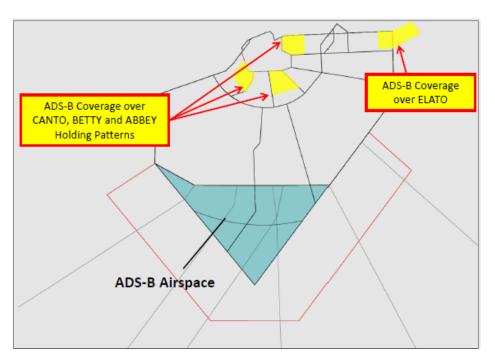


- ADS-B mandate for aircraft flying FL290+ within HKFIR effective on 8 December 2016
- ADS-B Equipage
  - More than 96% of aircraft are ADS-B equipped with accurate position report transmission.
- Adopted phased implementation approach in accordance with the ICAO's Safety
  Management System (SMS) to manage changes/risks and ensure safe and smooth ADS-B
  implementation.

# ADS-B implementation in Hong Kong (cont'd)



- ADS-B coverage over holding patterns and ELATO area
  - Aircraft usually fly at close distance but separated vertically;
  - Effectively reduce nuisance to ATC due to radar signal garbling.



# ADS-B implementation in Hong Kong (cont'd)



- Future Plan
  - Gradually expand ADS-B operation to fully integrate with the new Air Traffic Management System in late 2017 after all safety assessment are satisfactorily completed.





Thank you!