

# Introduction to Aviation Systems and Air Traffic Regulation (AAE2004)

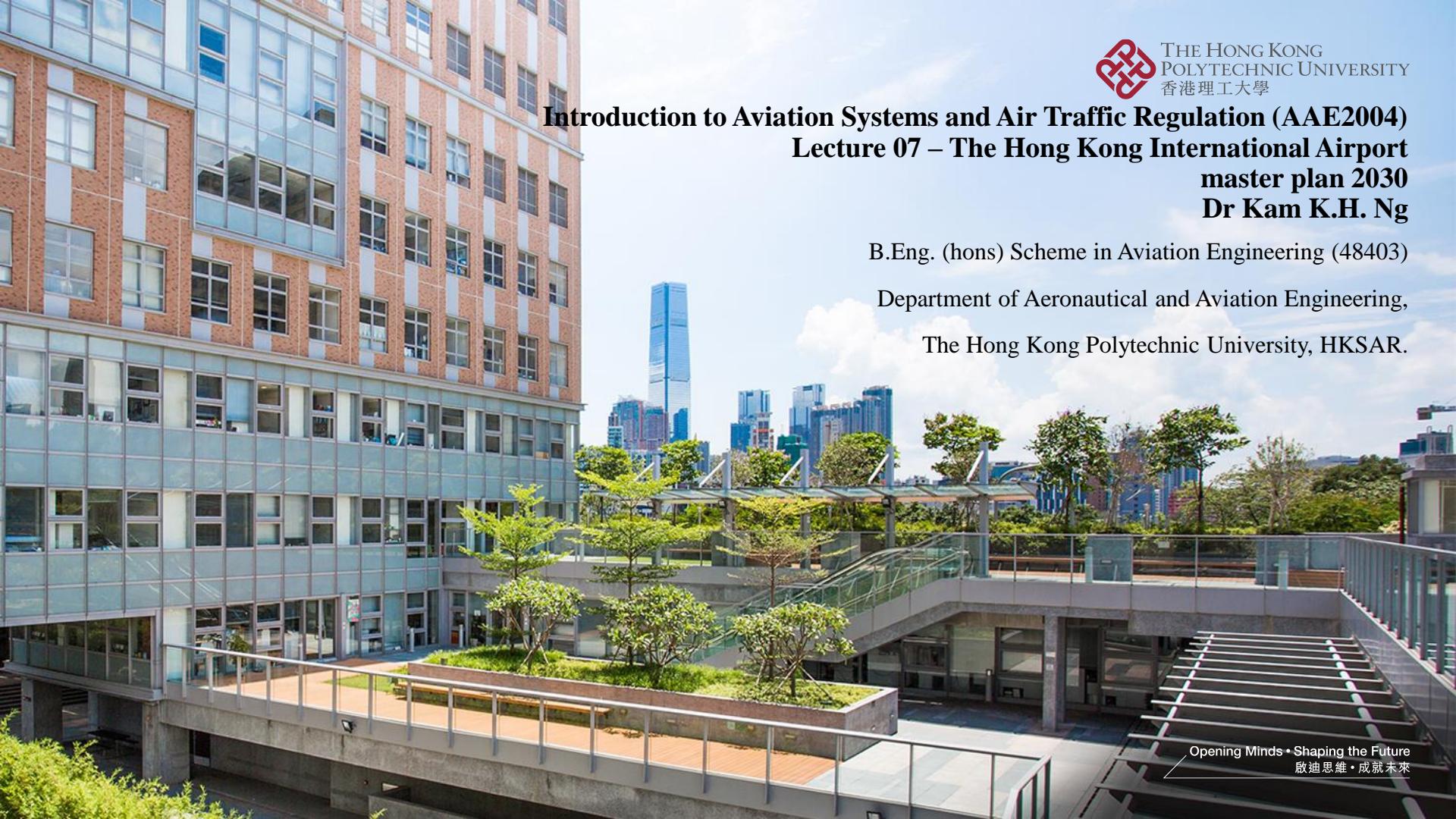
## Lecture 07 – The Hong Kong International Airport master plan 2030

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## Agenda

- Airport master planning process
- Air traffic demand forecast
- HKIA : operations and capacity
- Latest infrastructure and facility developments
- Airfield configuration evaluation
- Optimising runway capacity with a third runway



# Airport master planning process

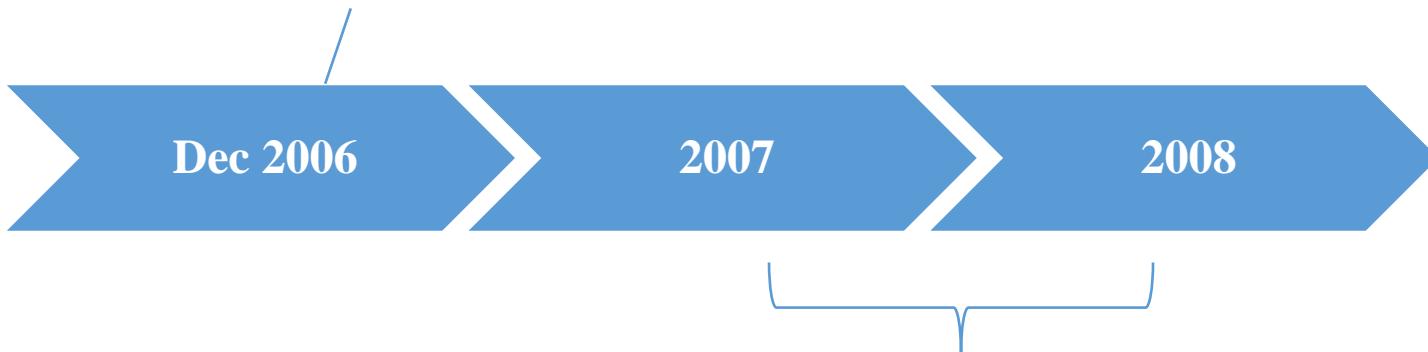
# Continuation of master plan 2025



Fig 1. HKIA Master Plan 2025 – Potential Land Use Plan

# Continuation of master plan 2025 (cont'd)

HKIA MP2025 recommended that a thorough examination of the airspace and runway capacity should be undertaken to arrive at a definitive practical maximum air traffic movement level for the airport.



As the prelude to the HKIA master plan 2030 (MP2030), Airport Authority Hong Kong (AAHK) appointed the United Kingdom's National Air Traffic Services (NATS) to examine the practical maximum capacity of HKIA's existing two-runway system.

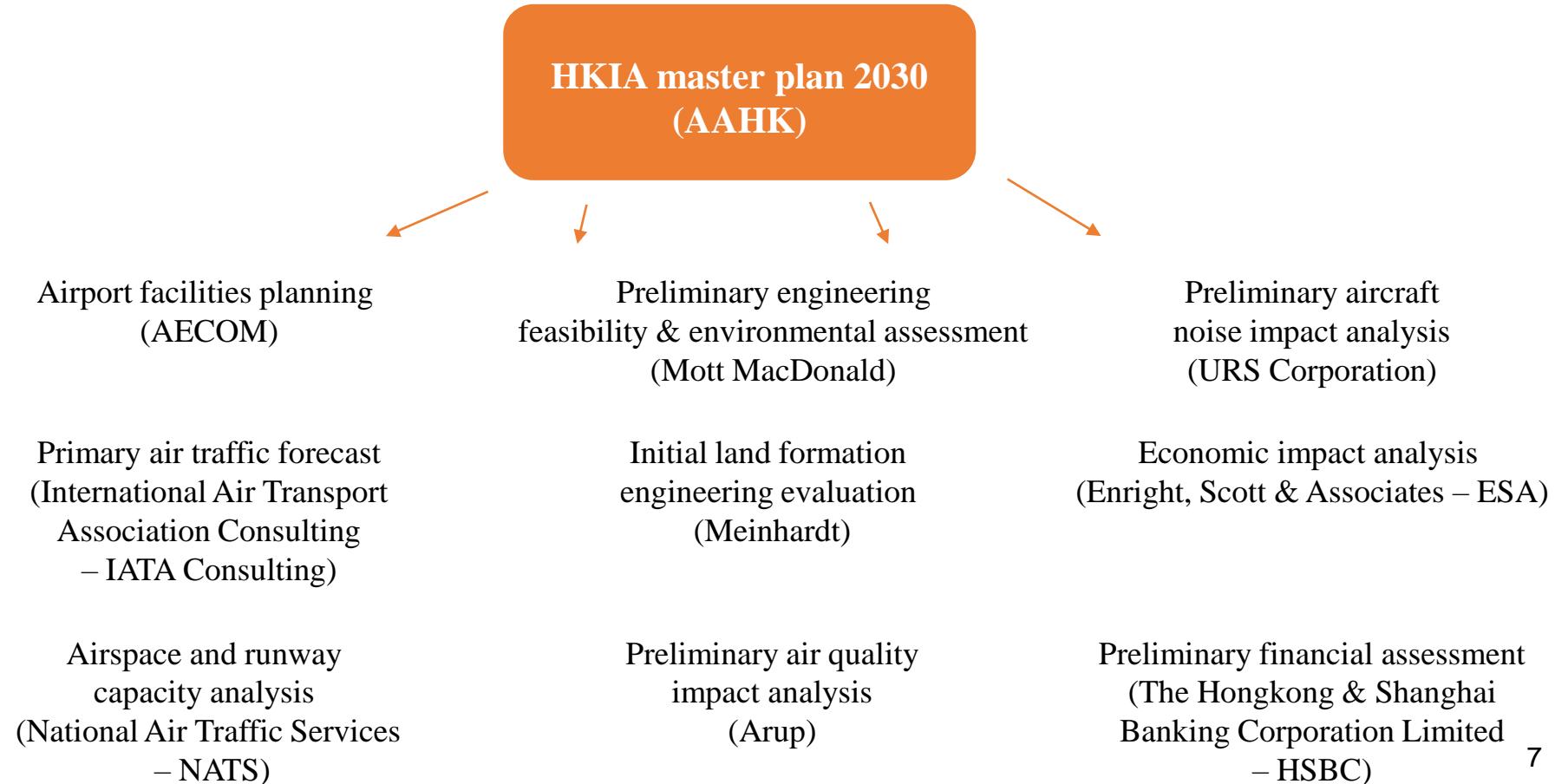


# Development of master plan 2030

After the completion of  
NATS' review

- AAHK's professional and management experts have commissioned 9 independent consultants to research into different strategic aspects of airport development to ensure a transparent and objective planning process.

# Development of master plan 2030 (cont'd)





# Airport facilities planning

## Consultant: AECOM

- AECOM (formerly known as Maunsell) is a global provider of professional, technical and management support services to a broad range of sectors: transportation (including airports), facilities, environmental, energy, water and government.
- With approximately 45,000 employees around the world, AECOM offers a blend of global reach, local knowledge, innovation, and technical excellence in delivering solutions that enhance and sustain the world's built, natural, and social environments.
- Involved in HKIA's previous master plan studies dating back to the New Airport Master Plan carried out in the early 1990s.





# Airport facilities planning (cont'd)

## Work scope of AECOM:

- Undertook a comprehensive assessment of the existing airport's operational requirements and constraints.
  - To achieve an optimal balance between airport operations, aviation support and airport-related development in the planning of facilities capable of meeting future air traffic growth at HKIA.
- Reviewed and recommended optimal airport layout and land use development plans incorporating the possibility of building a third runway along with its associated supporting facilities and infrastructure.

# Primary air traffic forecast

## Consultant: IATA Consulting

- IATA is the trade association of the world's international airline industry. IATA Consulting is part of the commercial division of IATA.
- Serve the entire aviation industry and deliver tailor-made business solutions to airlines, airports, cargo and civil aviation authorities, and air navigation providers.





# Primary air traffic forecast (cont'd)

## Work scope of IATA Consulting:

- Prepared air traffic forecasts for HKIA for passengers, cargo and ATMs up to 2030 in order to facilitate the preparation of the HKIA MP2030.
- The IATA Consulting air traffic forecasts covered three scenarios (High, Base and Low Cases) and took into consideration the financial and economic downturn at the end of 2008.
- Looked at the following key air traffic drivers and their impact on HKIA:
  - Economy
  - Air Services Agreements
  - Trade agreements
  - Travel policy
  - Tourism
  - Modal competition
  - Cross boundary infrastructure development
  - Airport strategies
  - Airline strategies



# Airspace and runway capacity analysis



**Consultant: NATS**

- A leading and experienced provider of air traffic management services in the UK.
- Provide air traffic control services to aircraft flying in UK airspace, and over the eastern part of the North Atlantic. In 2009, NATS handled 2.2 million flights carrying around 200 million passengers.
- The services provided by NATS:
  - Operate and maintain a nationwide communications, surveillance and navigation network
  - Provide engineering support to all operational units
  - Carry out advanced research and development
  - Develop ground-breaking software for current and new systems
  - Provide world-class training for air traffic controllers and engineers
- Involved in the airspace and air traffic management of London's Heathrow Airport.
- Assisted the British Airports Authority (BAA) in the planning for a third runway and is currently looking at ways to add capacity based on the existing two-runway system at Heathrow Airport.



# Airspace and runway capacity analysis (cont'd)

## Work scope of NATS:

NATS' involvement came in two phases:

- 1<sup>st</sup> phase involved the review of the existing airspace and runway system at HKIA.
  - Primary objective: identify a set of technical solutions and recommendations to maximise the capacity of the existing two runways to meet air traffic demand growth.
- 2<sup>nd</sup> phase concerned exploring the option of a third runway and the associated gain in capacity from the perspectives of technical feasibility, airspace and air traffic control procedure.
- Possible alignments of the proposed third runway at HKIA were evaluated for taking forward in the HKIA MP2030 development, taking into consideration various factors such as:
  - Runway capacity
  - Meteorological conditions
  - Terrain constraints
  - Operational issues such as compliance with International Civil Aviation Organisation (ICAO)'s Manual on Simultaneous Operations on Parallel Runways (SOIR), Instrument Landing System issues, runway mode of operations, air traffic crossover, wider Pearl River Delta (PRD) airspace issues, etc.



# Preliminary engineering feasibility & environmental assessment

## Consultant: Mott MacDonald

- Mott MacDonald Hong Kong Limited (formerly known as Mott Connell Limited) is a multidisciplinary engineering and environmental consultancy firm providing engineering design services.
- Involved in the following engineering design projects at HKIA:
  - Passenger Processing Terminal 1 (T1) (opened in July 1998)
  - North Satellite Concourse (opened in January 2010)
  - SkyPier (opened in January 2010)
  - Hong Kong Business Aviation Centre Hangar No.2 (opened in September 2007)

M

MOTT  
MACDONALD

# Preliminary engineering feasibility & environmental assessment (cont'd)

## Work scope of Mott MacDonald:

- Provided engineering, environmental impact evaluations, cost and programming input of the various airport expansion options and preferred airport layout plan.
- Preliminary engineering design was carried out for various facilities of the optimal airport layout plan provided by AECOM, including:
  - Preliminary specifications of the third runway and its taxiways, aircraft apron, airfield navigational aids and lighting, passenger processing terminal and concourse, landside transportation access system, etc.
  - Other infrastructure requirements e.g. the supply of aviation fuel, gas and electricity, the treatment of storm water, sewage, and waste generated on site were also identified.
- The environmental work stream identified the scope and scale of the potential environmental impact associated with HKIA expansion.
  - Allowed further preliminary consideration of key “differentiating” environmental issues & possible mitigation and compensatory measures.
  - Facilitated a qualitative comparison of the available three runway alignment options.
- Key environmental considerations were: aircraft noise, air quality, water quality/hydrodynamics & marine ecology (in particular the potential impact on Chinese White Dolphins).



# Initial land formation engineering evaluation

## Consultant: Meinhardt

- Meinhardt (Hong Kong) Limited is a multi-disciplinary engineering and environmental consultancy firm providing engineering design services.
- Involved in the following projects at HKIA:
  - Hong Kong Aircraft Engineering Company Limited Hangar No.2 and No.3A (opened in December 2006 and September 2009 respectively)
  - T1 East Hall extension (opened in March 2004 & mid 2013)
  - T1 enhancement work (from February 2006 to 4th quarter of 2010)



# Initial land formation engineering evaluation (cont'd)

## Work scope of Meinhardt:

- An initial land formation engineering evaluation was conducted to examine the feasibility of various construction options for land formation over the contaminated mud pits North of the airport island.
  - Facilitated the work relating to preliminary engineering feasibility.
- Carried out a preliminary assessment of the environmental impact, programme impact and costs associated with the proposed land reclamation options.



# Preliminary air quality impact analysis

## Consultant: Arup

- A leading international business, planning and design consultancy providing building design, economics and planning, infrastructure design, management consulting, and specialist technical services such as air emission modelling.
- Involved in aviation development work for more than 50 years.
- Worked on a wide range of projects at more than 100 airports throughout the world.

ARUP

# Preliminary air quality impact analysis (cont'd)

## Work scope of Arup:

- Prepared a preliminary air quality review
  - Evaluated the cumulative impact on representative Air Sensitive Receivers (ASRs) along North Lantau and at HKIA from projected future growth in airport operations along with the emission projections considered in the Environmental Impact Assessment (EIA) reports from future operations of the nearby projects – including:
    - The Hong Kong Boundary Crossing Facilities (HKBCF)
    - The Hong Kong Link Road (HKLR) of Hong Kong – Zhuhai – Macao Bridge (HZMB)
    - Tuen Mun – Chek Lap Kok Link (TMCLKL)
- The analysis was based on a hypothetical scaling up of HKIA's two-runway operations to the same level as that of the three runway option.
- Compared the cumulative air quality impact for a future year under maximum operating conditions with the current Air Quality Objectives (AQOs) for Hong Kong.



# Preliminary aircraft noise impact analysis

## Consultant: URS Corporation (URS)

- An architectural and engineering design firm, with over 300 offices worldwide.
- Its airport consulting services group has six key practice areas:
  - Planning, Environmental, Civil Design, Architectural Design, Systems Design & Program/Construction Management.
- Implemented projects at more than 500 airports worldwide & a wide variety of assignments performed directly for airlines, the US Federal Aviation Administration (FAA) and state aviation departments.
- URS' airport and aviation noise practice is considered an industry leader in assessing and addressing the impact of aircraft and airport operations on communities in the airport environs.
- Performed numerous studies at airports of all sizes across the US and abroad involving:
  - Airport noise modelling and analysis, land use compatibility planning, and operational and land use noise mitigation measures.
- Undertook the aircraft noise study for the previous EIA update of HKIA (published in 1998).





# Preliminary aircraft noise impact analysis (cont'd)

Other representative airports where URS has performed environmental or noise studies include:

- Dallas Fort Worth International Airport
- Phoenix Sky Harbour International Airport
- San Francisco International Airport
- Denver International Airport
- Washington-Dulles International Airport
- Lambert-St. Louis International Airport
- Memphis International Airport
- Austin-Bergstrom International Airport
- Palm Beach International Airport
- Orlando International Airport
- Aeroporto di Venezia Marco Polo

# Preliminary aircraft noise impact analysis (cont'd)

## Work scope of URS:

- Provided a projection of the HKIA Noise Exposure Forecast (NEF) contours for the third runway development (based on NATS' airspace and runway capacity evaluation and recommendations).
- The FAA Integrated Aircraft Noise Modelling software was used in the projection to generate a forecast of NEF contours for HKIA at design capacity under a three-runway option.
  - With the projected flight track designs, aircraft operational forecasts, runway utilisation and practical assumptions of evening noise mitigation measures.



# Economic impact analysis

## Consultant: ESA

- A research and strategy consulting firm based in Hong Kong.
- Assist corporate, government, and multinational organisations to understand and benefit from changes by combining thought leadership based on rigorous research with hands-on knowledge of the corporate world to provide advice on the forces that influence business and economic development.



# Economic impact analysis (cont'd)

## Work scope of ESA:

- An economic impact analysis was undertaken to address the economic impact of expanding HKIA on Hong Kong as a whole.
- The objectives of the analysis were to:
  - Assess the economic impact of the proposed airport expansion from a Hong Kong perspective.
  - Provide a thorough analysis of the capital costs and economic benefits of expanding HKIA under the two-runway and three-runway options.
- The analysis also focused on the following key questions:
  - What is the current economic contribution of HKIA to the Hong Kong economy?
  - What will the economic contribution of HKIA to the Hong Kong economy be in 2030 based on two runways?
  - What will the economic contribution of HKIA to the Hong Kong economy be in 2030 with a third runway?



# Preliminary financial assessment

## **Consultant: The Hongkong and Shanghai Banking Corporation Limited (HSBC)**

- Established in Hong Kong and Shanghai in 1865, HSBC is the founding member of the HSBC Group – one of the world's largest banking and financial services organisations – and its flagship in the Asia- Pacific region.
- The largest bank incorporated in the Hong Kong Special Administrative Region (HKSAR) and one of the HKSAR's three note-issuing banks.
- HSBC is a wholly owned subsidiary of HSBC Holdings plc, the holding company of the HSBC Group, which has around 8,000 offices in 87 countries and territories and assets of approximately US\$2,418 billion.
- HSBC's infrastructure practice has been consistently ranked as the leading project finance advisor for the Asia Pacific region, and leading bank for capital raising.
- Has a strong track record of delivering client solutions in Hong Kong, across the region and globally. These include:
  - Advised on the new Hong Kong airport financial consultancy before the opening of the Hong Kong International Airport, AsiaWorld Expo, Sky City Hotel, Ocean Park, the securitisation of government-owned toll tunnels and bridge in Hong Kong & acquisition financing for BAA Airports in the United Kingdom.





# Preliminary financial assessment (cont'd)

## Work scope of HSBC:

- Commissioned to assess AAHK's financial capability to undertake two development options: the two-runway option and the three-runway option.
- The work involved:
  - Evaluated the financial model and the assumptions in MP2030 to ensure the validity of the projections.
  - Assessed the financial feasibility of MP2030 by performing analytical tests and sensitivity analyses.
  - Quantified the amount of funding required to undertake the implementation of MP2030.
  - Advised AAHK on whether it has the financial resources to complete MP2030 implementation.
  - Considered and analysed the feasibility of different financing options for MP2030 implementation.



# Air traffic demand forecast



# Air traffic demand forecast

- The first step of the master planning process is forecasting air traffic demand over a 20-year period.
- AAHK commissioned IATA Consulting to undertake this process, which involves:
  - Evaluating the best model to apply for the forecast.
  - Compiling the gross domestic product (GDP) forecast.
  - Producing preliminary traffic forecasts based on GDP.
  - Adjusting traffic forecasts to accommodate the latest market changes.
  - Conducting reality checks with aviation-related industries.
  - Making primary projections for passenger and cargo traffic and air traffic movements (ATMs, also known as flight movements).
  - Conducting sensitivity analysis to produce a range of estimates for high, low and base cases.

# Air traffic demand forecast (cont'd)

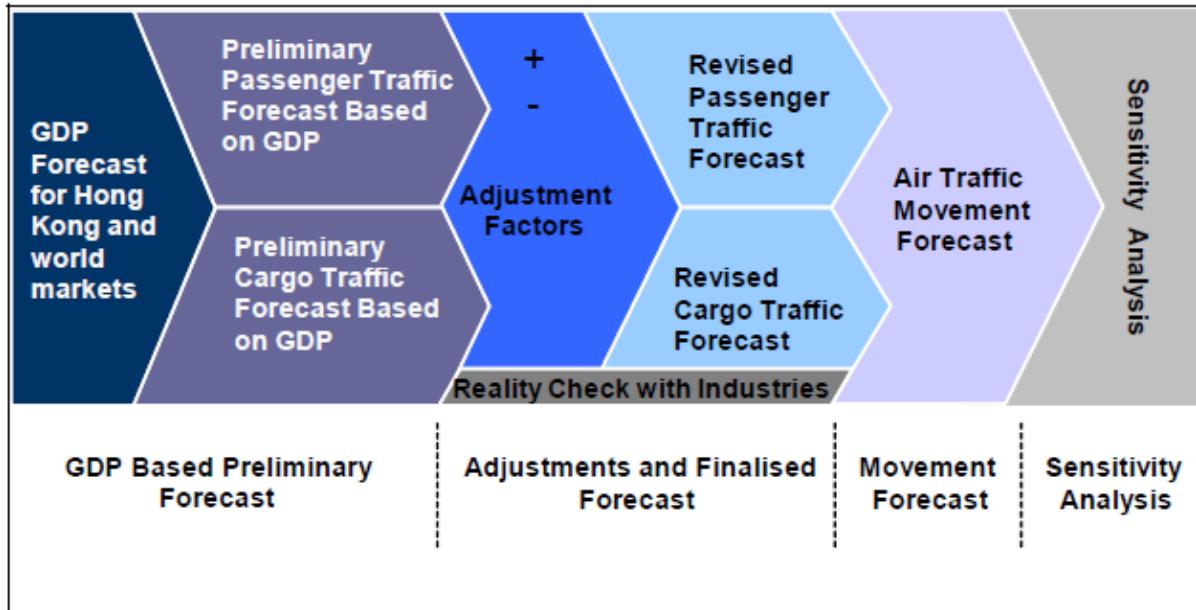


Fig 2. A structured air traffic demand forecast process

# Air traffic demand forecast (cont'd)

- Several forecasting models were evaluated to identify the one most suitable for HKIA.
    - E.g. simple linear regression, multiple linear regression, log regression and linear regression based on growth rate.
  - While evaluating the models, IATA Consulting examined key factors.
    - E.g. fit with expected evolution of the market, sufficiency of historical data, link between causal variables and traffic & the accuracy of data and causal variables.
  - Statistical tests were also conducted.
    - E.g. the coefficient of determination, Student's T-test and F-test.
- ✓ Simple and multiple linear regression models gave the best results, after examining the drivers for traffic and applying statistical tests.
- ✓ GDP was found to be the best variable to explain historical traffic evolution (other causal variables were tested and discounted).

# GDP forecast

- The GDP forecast is critical as it is the foundation for the entire traffic demand forecast.
- Historically, air traffic growth has had a strong correlation to global GDP growth.

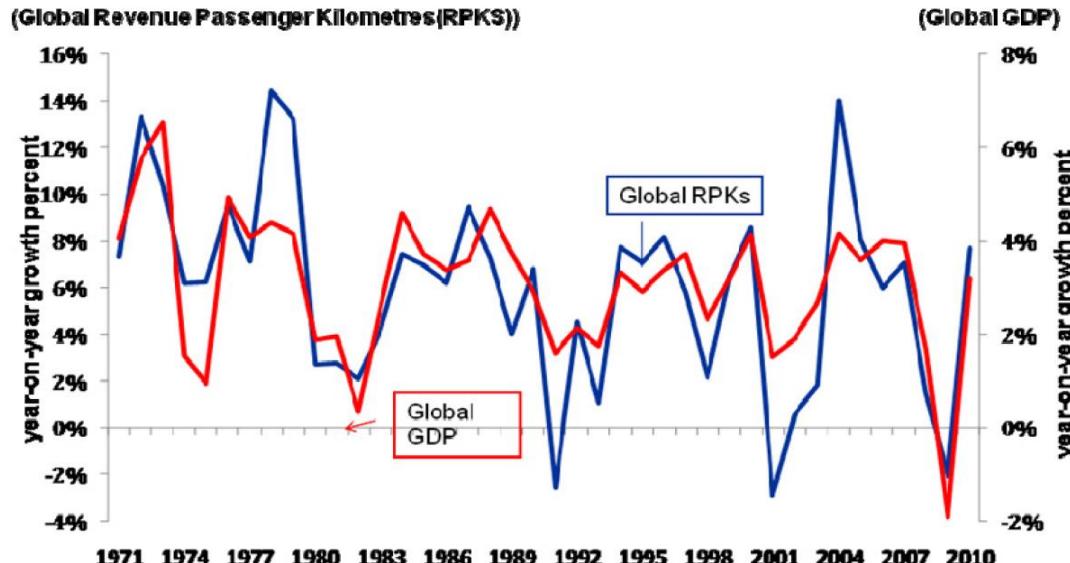


Fig 3. Global air traffic versus economic growth

# The Pearl River Delta (PRD) economy

- Increasing competition between the Mainland's manufacturing regions has led to PRD seeking new sources of economic growth.
- Developing better connectivity between the Guangdong cities and Hong Kong will enable both partner regions to leverage their combined vast and dynamic resources to attract more investment.
- Political and economic agreements such as the Hong Kong-Guangdong Co-operation Agreement of April 2010 will further facilitate this.



# Potential factors impacting HKIA's future growth

- During the forecasting process, IATA Consulting considered various factors that may impact the airport environment.

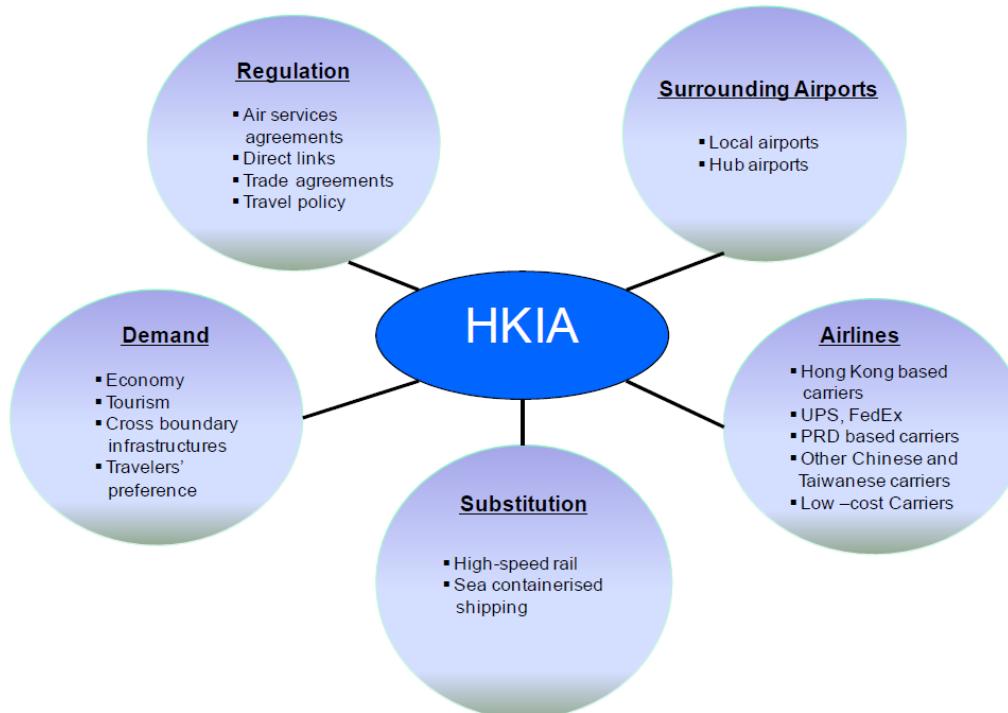


Fig 4. Market dynamics surrounding HKIA



# Regulation: Air Services Agreements

- Air Services Agreements (ASAs) provide the regulatory umbrella under which the aviation industry operates and develops.
- Recent years have witnessed a continuous liberalisation of traffic rights, not only between HKSAR and its counterparts but also between the Mainland and other major world economies.
- Further deregulation is expected to take place in the short, medium and long term enabling existing markets to grow and new markets to emerge.
- Direct links between the Mainland and other major world economies constitute an unprecedented factor that will need to be assessed separately from the regression traffic model.

# Demand consideration: cross-boundary infrastructure development

- A number of infrastructure improvement projects around the Greater Pearl River Delta (GPRD) have been either approved or are under study.
- Several of these projects will improve the accessibility of GPRD airports, which is expected to strengthen their role.
- These infrastructure developments represent unprecedented factors whose specific impact on traffic was assessed by IATA Consulting.
- The most sizeable projects:
  - Hong Kong-Zhuhai-Macao Bridge (HZMB)
  - Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL)
  - Tuen Mun-Chek Lap Kok Link (TMCLKL) and Tuen Mun Western Bypass (TMWB)

# Demand consideration: cross-boundary infrastructure development (cont'd)

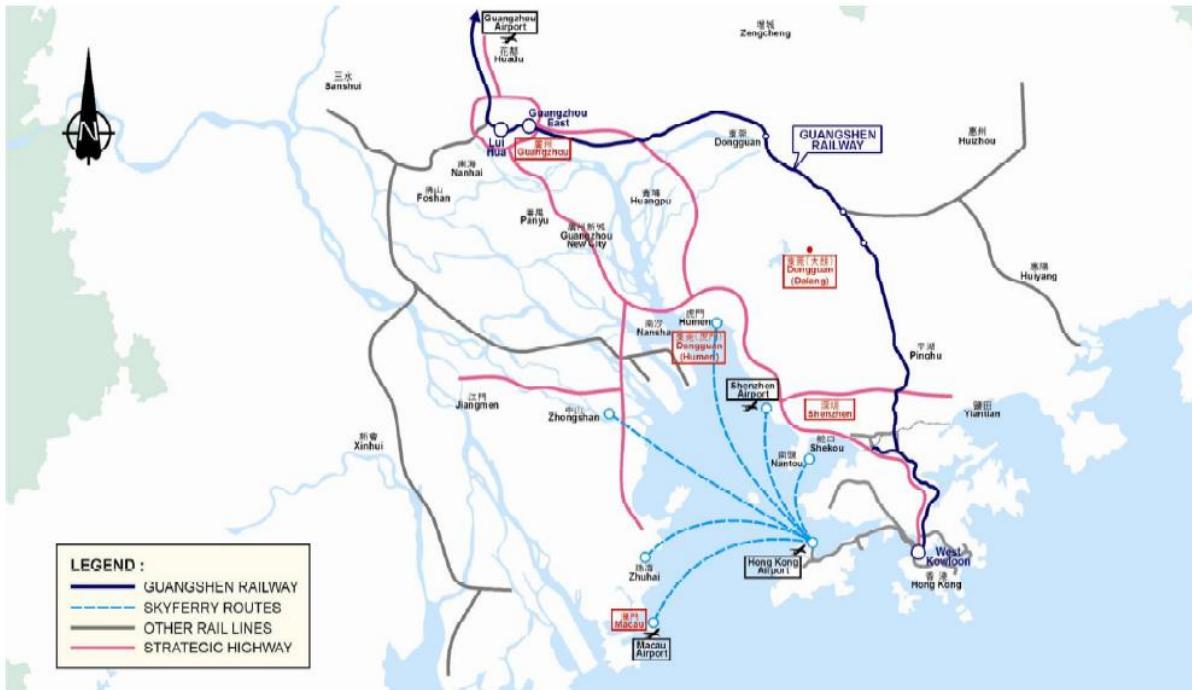


Fig 5. Current surface transport in the GPRD

# Demand consideration: cross-boundary infrastructure development (cont'd)

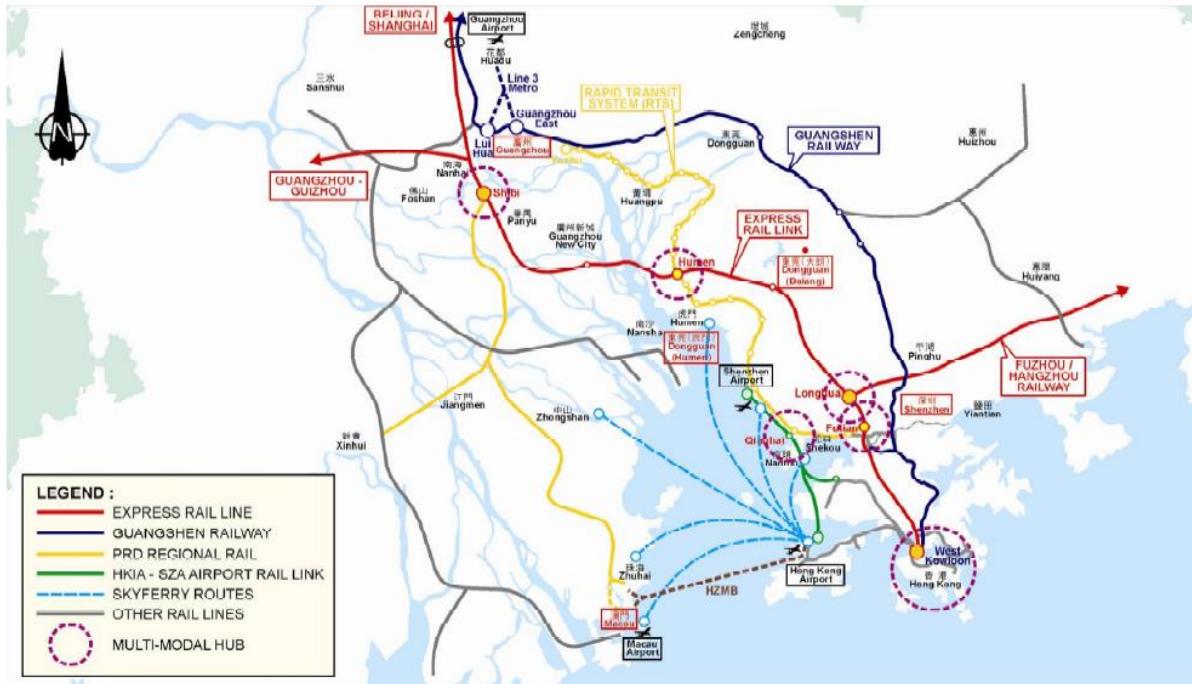


Fig 6. Potential future surface transport in the GPRD

# Substitution factor: high-speed rail development

- The Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL), a 26-kilometre railway, connects Guangzhou, Shenzhen and Hong Kong and interconnect with the Mainland's high speed train (HST) network.
- The XRL will dramatically improve rail service quality and is expected to raise train transportation to a competitive level to air, although travel times will remain more advantageous for air.

# Substitution factor: high-speed rail development (cont'd)

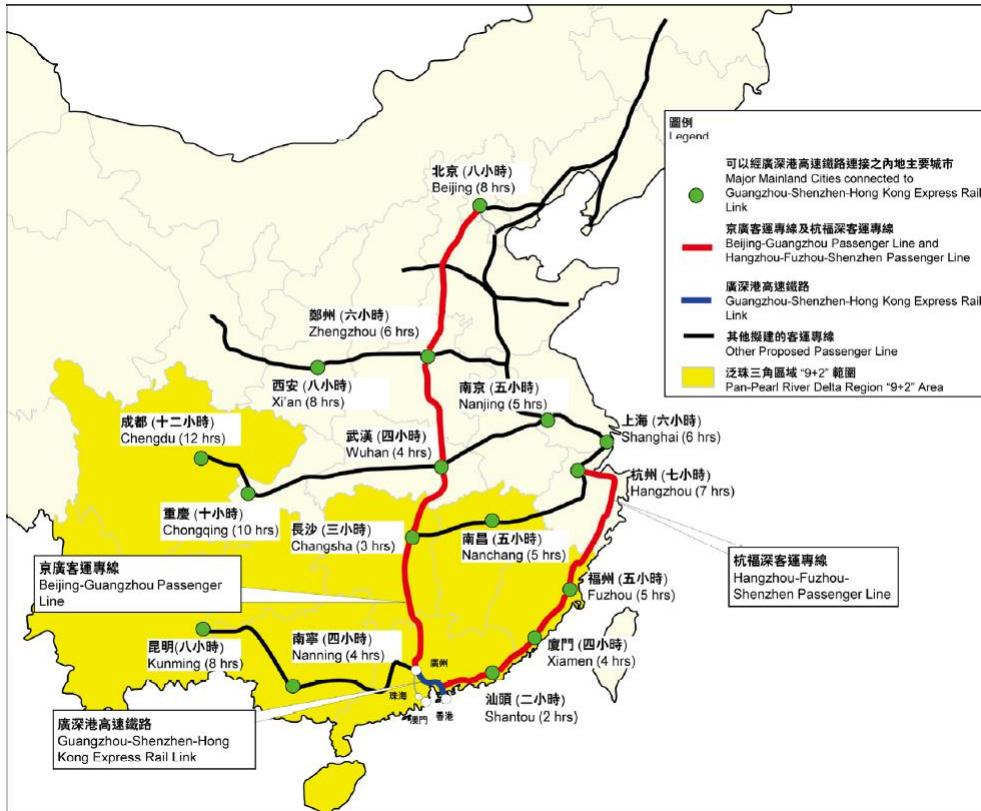


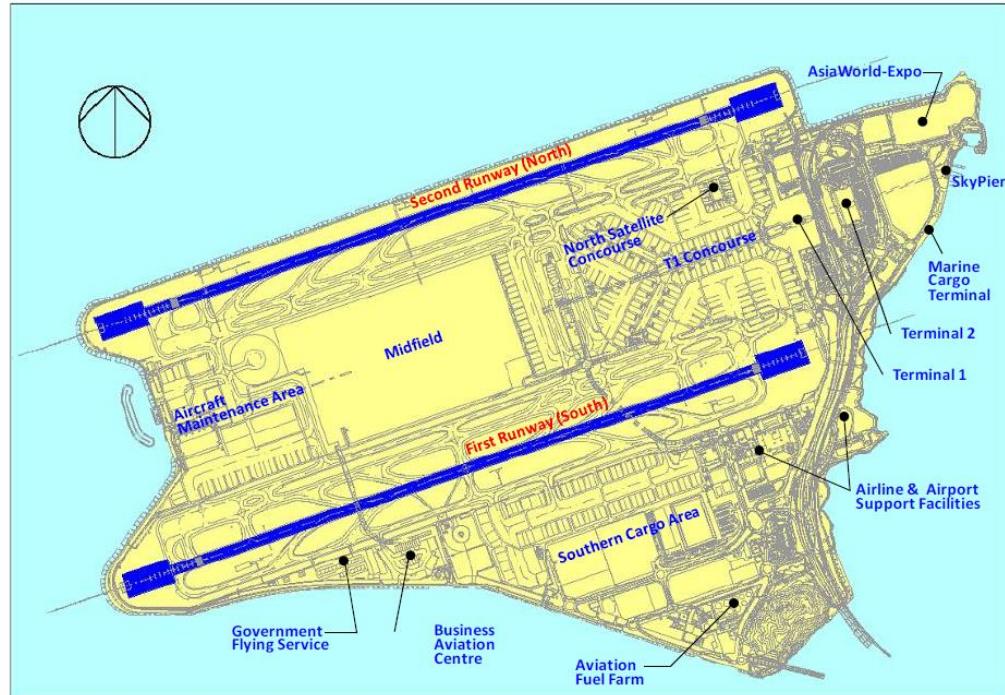
Fig 7. The railway infrastructure development map of the Mainland



# HKIA : operations and capacity

# Existing HKIA layout

- The existing airport layout consists of two runways, which are supported by two passenger processing terminals, two passenger concourses with 97 passenger aircraft parking stands, three cargo terminals, a cargo apron with 34 cargo parking stands, and other supporting facilities.

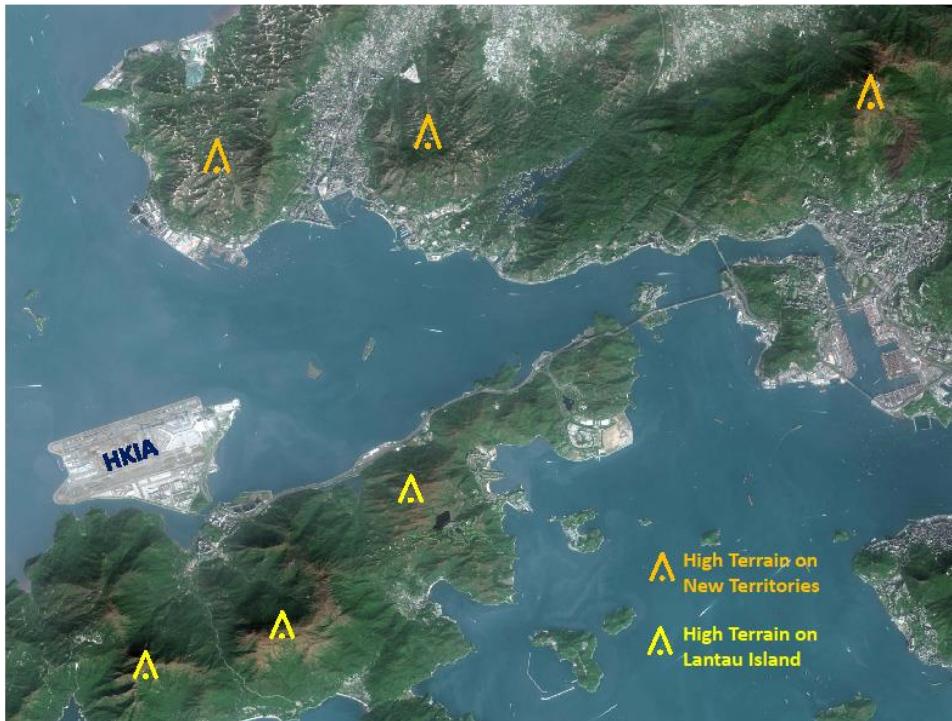


# Practical maximum capacity of the two-runway system

- Since 1998, HKIA has been meeting air traffic demand growth through progressively upgrading, maximising usage and increasing the efficiency of its facilities on the airport island.
- AAHK has always aimed to get the most out of HKIA's current capacity before considering expansion measures, as was the case with the one-runway Kai Tak Airport in the '80s and '90s.

# Hourly ATM capacity

- The operating environment of HKIA is unique because of high terrain and a complicated and restrictive airspace surrounding the airport.



# Hourly ATM capacity (cont'd)

- AAHK has commissioned the British aviation experts - NATS to assess how the capacity of the existing two runways of HKIA can be maximised.
- NATS' recommendations include:
  - Reforming the existing Air Traffic Control (ATC) philosophy
  - Improving flight procedures and operations
  - Increasing ATC-related manpower levels
  - Enhancing airfield infrastructure
- The practical maximum capacity that can be achieved with two runways will be 68 movements per hour using the existing independent segregated mode of operations.
  - E.g. one runway exclusively for departures and the other exclusively for arrivals.



# Hourly ATM capacity (cont'd)

- Under independent segregated operations, each runway is limited only by its maximum arrival or departure rate.
- The levels that NATS has validated using fast time simulation modelling:

Runway	ICAO Minimum Separation	Potential Runway Capacity
North Runway (Arrivals Only)	3 NM *  	33 per hour
South Runway (Departures Only)	90 seconds **  	35 per hour

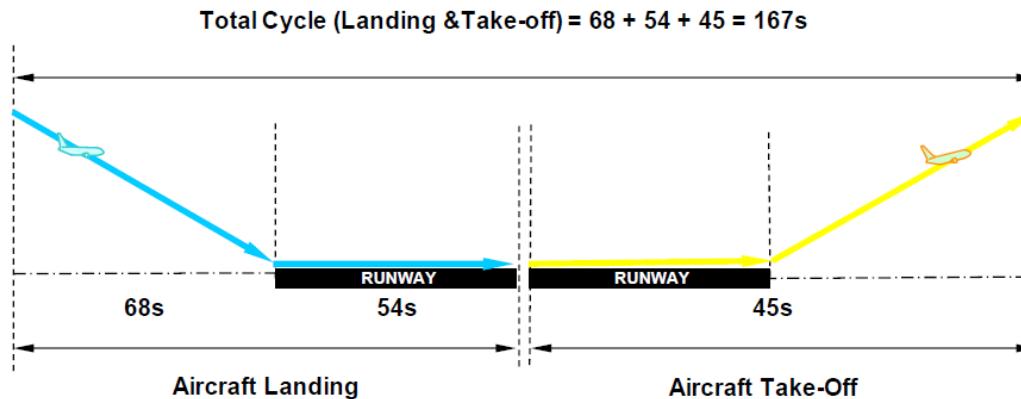
*Note:* \* NM = Nautical Mile

\*\* 90 seconds between all departures except 2 minutes vortex separation as appropriate

- These levels have already factored in International Civil Aviation Organisation (ICAO) recommended practices as well as other relevant factors (terrain, airspace, traffic mix, weather, etc.)

# Hourly ATM capacity (cont'd)

- NATS has determined that there will be no capacity gain by changing the dual runway operations from segregated mode to mixed mode (e.g. both departures and approaches can take place on each of the two runways).
- Mixed mode operation can theoretically maximise the capacity of a single runway to 44 movements per hour.
- Based on a typical 6 Nautical Mile (NM) spacing between approaches which can be translated into a typical time interval of 167 seconds for each landing and take-off cycle ( $3,600$  seconds (s) per hour/ $167$  seconds per cycle  $\times 2 = 44$  movements as shown in below figure):



*Note:* The landing aircraft must be at least 3NM from the runway end when the departure begins and may not touchdown before the departing aircraft has left the runway.

Fig 8. Single-runway arrival/departure timeline in mixed mode

# Hourly ATM capacity (cont'd)

NATS has concluded that only “dependent” mixed mode operations can be supported by the existing runways at HKIA, due to the following reasons:

- a) Due to the terrain on Lantau Island, the missed approach and departures procedures from the South Runway have to share the same track.
  - The minimum spacing between approaches has to be increased from 6NM to 8NM to adhere to the recommendation of the Manual of Air Traffic Control.
  - Limit the hourly capacity to 34 movements under mixed mode operation.
- In contrast, there is no terrain constraint on the North Runway.
  - Enable its missed approach and departure procedures to be separated under mixed mode operation & allow the use of 6NM minimum spacing between approaches and 44 movements per hour in isolation.



# Hourly ATM capacity (cont'd)

- b) The existing two runways cannot support independent parallel approaches.
- For independent parallel approaches to take place on both runways, a long final approach procedure needs to be adopted to avoid the terrain to the east (Tai Mo Shan) and interaction with Macao airport traffic to the West of HKIA (the final approach is extended out to 18NM from touchdown, compared to the standard 10NM recommended in ICAO's Manual).

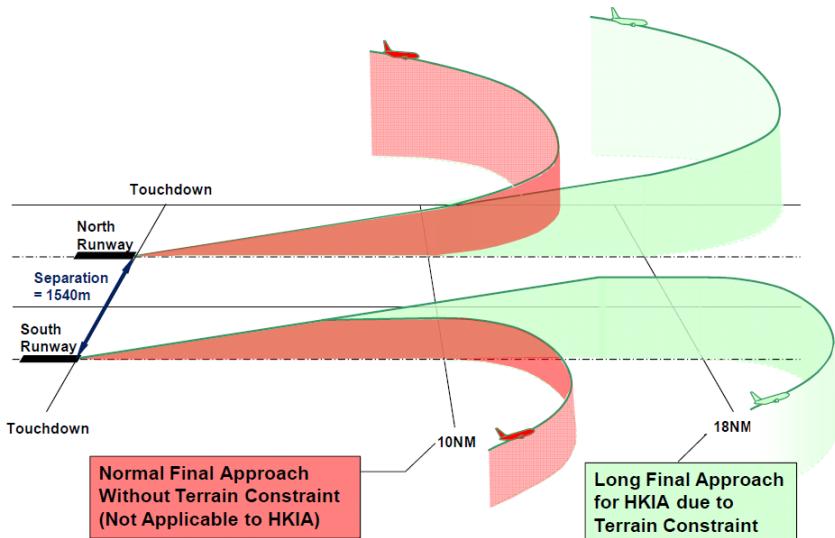
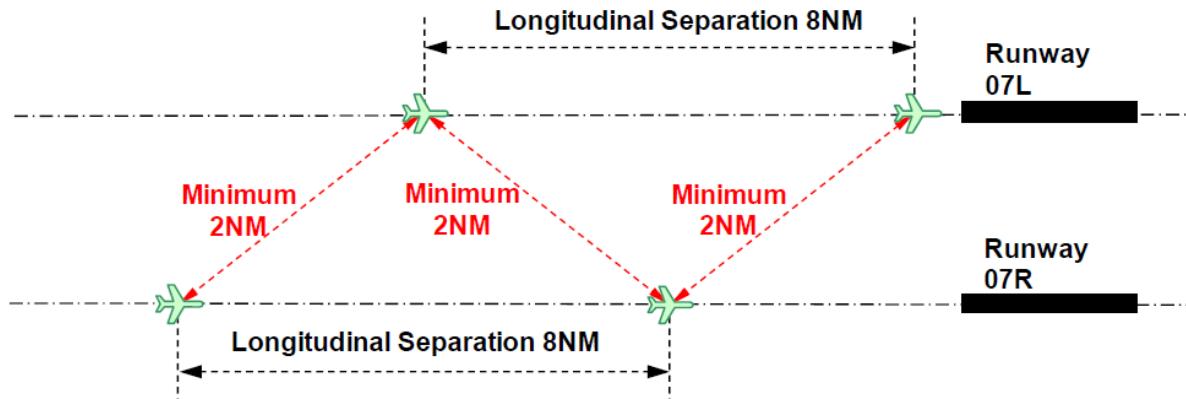


Fig 9. Independent parallel approaches requirement for HKIA (long final approach)

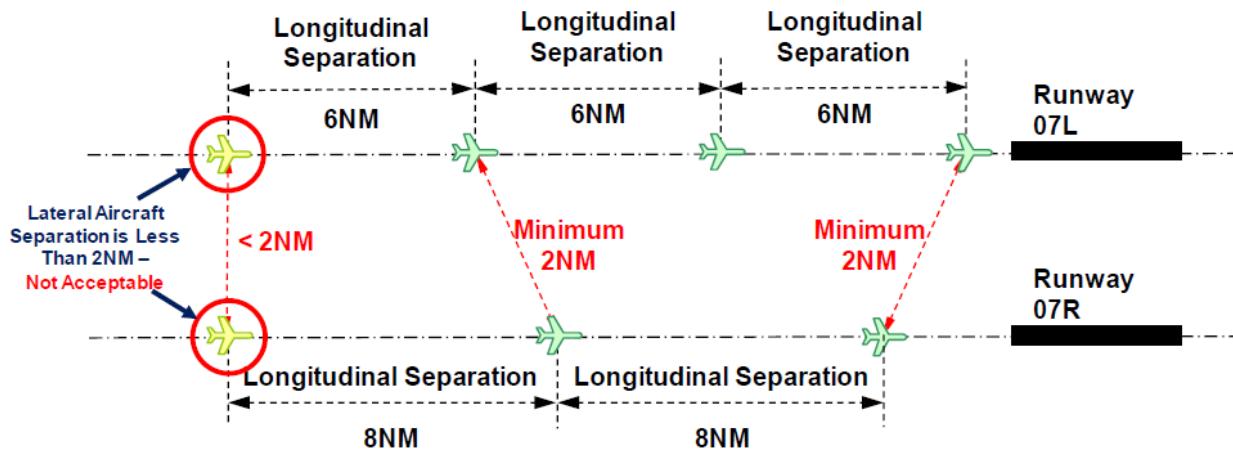
# Hourly ATM capacity (cont'd)

- With a long final approach procedure needed for carrying out independent parallel approaches, a wider separation between runways than that currently available is needed to meet ICAO criteria for Instrument Landing System (ILS) performance.
- The current two-runway configuration is thus incapable of accepting independent parallel approaches and requires at least a 2NM stagger to be kept between respective approaches on the adjacent runways as per ICAO's mandates.
- Even under “mixed mode” operation, the North Runway has to be dependent upon the South Runway.



# Hourly ATM capacity (cont'd)

- c) While the North Runway can accept unconstrained mixed mode operations, which requires a 6NM spacing between landing aircraft, the South Runway can accept only constrained mixed mode operations, which requires an 8NM spacing between landing aircraft.
- It is considered impractical for landing aircraft on the two runways to comply with these different approach spacing requirements.



# Hourly ATM capacity (cont'd)

- A consistent approach spacing of 8 NM would have to be applied to both runways if they were to be operated in mixed mode.
  - An hourly capacity of 34 movements for each runway, or a total 68 hourly movements for both.
-  Changing the operations of the two runways from the current segregated mode to mixed mode will not increase overall capacity.

# Hourly ATM capacity (cont'd)

- NATS reckons there is only a nominal potential to stretch the maximum capacity of the two runways beyond 68 movements per hour, even if there are future advances in air traffic control technology that reduce landing aircraft's arrival spacing.
- NATS recommended the evaluation of possible locations for a third runway and the associated potential for capacity expansion, considering operational challenges, ATC procedure design and PRD airspace considerations.
  - Further increase runway capacity.



# Latest infrastructure and facility developments



# Capacity enhancement projects

- In 2006, AAHK committed HK\$4.5 billion to capacity enhancement works to the passenger terminal building and airfield (involve the upgrading of existing facilities and provision of new facilities).
  - Enhance airport operational efficiency, meet updated safety and security standards, and improve the ambience of the concourse for passengers' comfort.
- These works include:
  - Enhancements to the airfield
    - North Satellite Concourse
    - 10 additional cargo stands
    - Resurfacing of the two runways and the taxiways
    - Enhancements to facilitate A380 operations
  - Enhancements to terminal 1
    - Increasing the capacity of the Baggage Handling System
    - Upgrading X-ray baggage screening machines
    - More transfer desks, security channels and immigration counters
    - Central Concourse extension

# Midfield development

- AAHK has committed an additional HK\$9.3 billion to the first phase of the midfield development to ensure that there would be sufficient aircraft parking stands to serve the forecast passenger, cargo and ATM demand by 2015.
- These works include:
  - Construction of 11 airbridge-served aircraft parking stands and nine remote parking stands, as well as an “I-shaped” passenger concourse at Midfield (costing HK\$7.8 billion).
  - Extension of the existing automated people mover (APM) system to the passenger concourse at Midfield from Passenger Processing Terminal 1 (T1) (costing HK\$1.3 billion).
  - Minor enhancements to the baggage handling system (costing HK\$0.2 billion).



# Long-term development

- The Master Plan has reviewed two options for the development of HKIA in the longer term, beyond 2015 and up to the year 2030:
  1. Two-runway system: The development plan is to serve the constrained demand forecast for passengers and cargo under the airport's existing two-runway system.
  2. Three-runway system: The development plan is to serve the unconstrained demand forecast for passengers and cargo under a three-runway system.



# Airfield configuration evaluation

# Third runway alignment options

- The third runway needs to be located on Chek Lap Kok, the existing airport island.
- Locating it elsewhere would lead to a split of flight operations into two “de-facto” airports resulting in very inconvenient and time-consuming landside flight connections between the two airports.
- Completely negate HKIA’s long standing competitive edge as an efficient transfer hub with a minimum connection time as low as 50 minutes.
- NATS has considered the following factors while assessing the feasibility of the third runway:
  - Limitations due to terrain, wind direction and other meteorological factors.
  - Identification of safe and viable modes of operation (arrivals only, departures only or mixed mode) for the three-runway system.
  - Modification of air traffic procedures for the immediate airspace surrounding the airport.
  - Modification of air traffic procedures for the wider PRD airspace, in particular independence of operations from those of the surrounding airports.

# Third runway alignment options (cont'd)

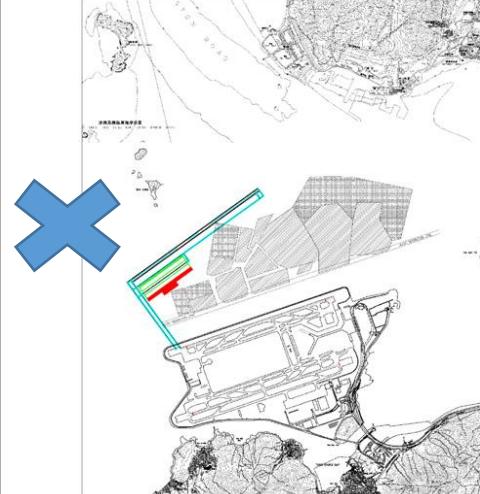
- Considering the geographical constraints on the potential expansion of HKIA, viz. the terrain to the South of HKIA on Lantau and to the North-east of HKIA in North West New Territories:
  - 15 possible runway alignment options was generated, including parallel, angled or crossed runways for comparative evaluation.

Option A	Hong Kong International Airport Third Runway Study Other Options	Runway Separation: N/A – Proposed Runway Aligned North/South
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**General Description**

A near perpendicular runway with a self-contained set of airside, passenger terminal and landside facilitates located adjacent to its southern end. Intended to avoid mud pits.

Option B	Hong Kong International Airport Third Runway Study Other Options	Runway Separation: N/A – Proposed Runway Aligned NE/SW
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**General Description**

Acutely angled runway with a self-contained set of airside, passenger terminal and landside facilitates located adjacent to its southern end. Intended to avoid mud pits. Sketch shows single full length parallel taxiway, but twin parallel taxiways possible if runway moved north.

Option C	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: Approx 2800m
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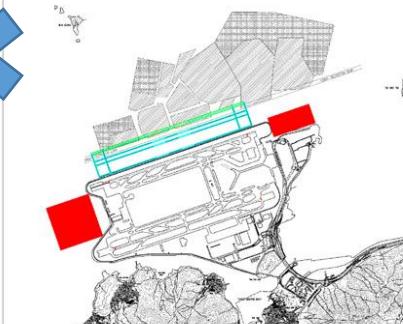
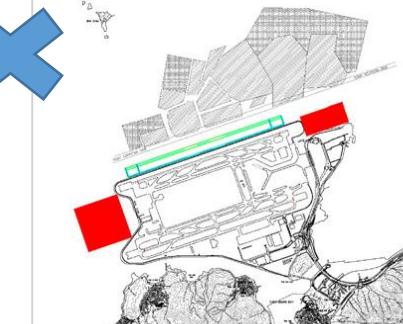
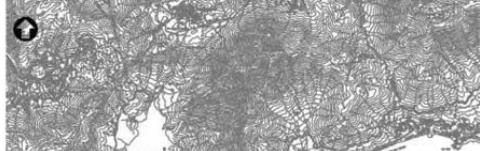
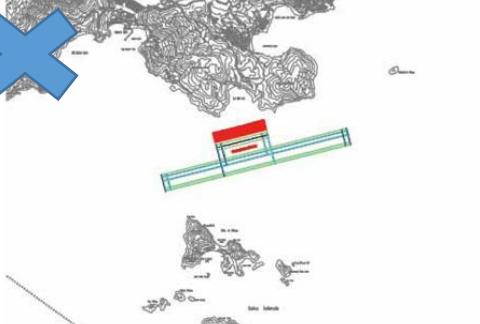

**General Description**

A parallel runway, with sufficiently separation to ensure the runways, aprons and terminal facilities are not located over the mud pits (although apron and terminal area limited for that reason). New taxiways must cross mud pits.

# Third runway alignment options (cont'd)

Option D	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: Approx 1525m
Option E	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: 1035-1524m
Option F	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: 915-1034m

# Third runway alignment options (cont'd)

Option G	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: 760-914m
		
		
<b>General Description</b>	A parallel runway with a separation of at least 760m to achieve independent IFR departures and segregated Arrival/Departure operations. Aprons and terminal facilities are located in either the east or west end zones shown. The new runway would be developed over the mud pits.	
Option H	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: 380-759m
		
		
<b>General Description</b>	A parallel runway with a separation of at least 380m to facilitate dependent operations. Aprons and terminal facilities are located in either the east or west end zones shown. With a 380m separation, the new runway would be developed clear of the mud pits.	
Option J	Hong Kong International Airport Third Runway Study Other Options	Runway Separation: N/A – Proposed Runway South of Lantau
		
		
<b>General Description</b>	A new runway with all supporting airside and landside infrastructure.	

# Third runway alignment options (cont'd)

<b>Option K</b>	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: $>1035\text{m}$

**General Description** A parallel runway to the South east of the existing 25L/07R with nearly a 5000m stagger to the east.

<b>Option M</b>	Hong Kong International Airport Third Runway Study Other Options	Runway Separation: N/A – Proposed Runway North of HKIA

**General Description** A new runway with all supporting airside and landside infrastructure.

<b>Option N</b>	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: $\geq 380\text{m}$

**General Description** A parallel runway with a separation of at least 380m plus a stagger of approximately 3000m to enable the aprons and terminal to be located adjacent to the runway.

# Third runway alignment options (cont'd)

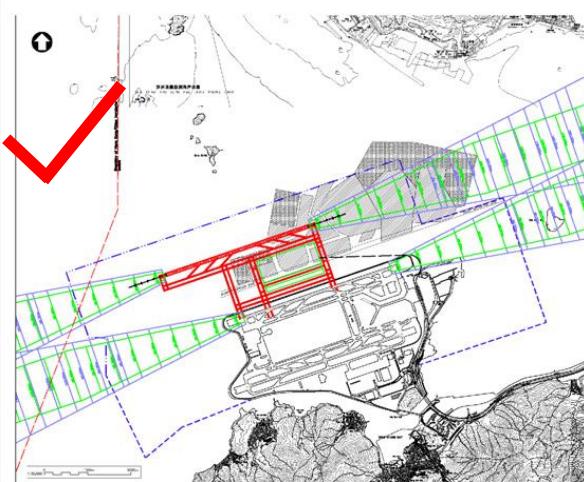
Option P	Hong Kong International Airport Third Runway Study Detailed Options	Parallel Runway Runway Separation: 2240m
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## General Description

A parallel runway, with a westerly stagger of 2000m to enable the terminal and aprons to be provided outside the mud pits. The runway has been shortened to ensure that the approach lights do not enter Chinese Territorial Waters.

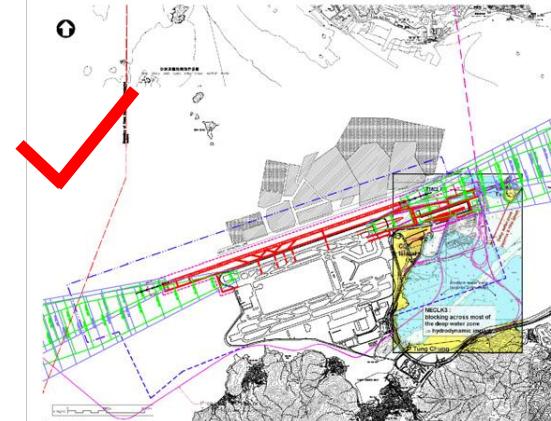
Option R	Hong Kong International Airport Third Runway Study Detailed Options	Parallel Runway Runway Separation: 1525m
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## General Description

A parallel runway positioned with a western stagger of approximately 1430m. The terminal and apron facilities can be provided in mid field zone.

Option S Ext Variant D	Hong Kong International Airport Third Runway Study Detailed Options	Parallel Runway Runway Separation: 380m
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## General Description

A very long parallel runway with a separation of 380m. The 1889m stagger in the westerly direction provides close to SOIR compliance between the 07C SID and the 07L missed approach in respect of the runway offset. In the Runway 25 direction, the additional 1000m offset over Variants A,B and C provides some additional separation between the 25C SID and 25R missed approach while not fully SOIR compliant.

# Third runway alignment options (cont'd)

- The 15 alignment options can indeed be categorised into 3 main families of alignment options for evaluation in terms of:
  - Operational safety, obstacle clearance, PRD airspace constraint issues, air traffic control procedures, and optimum mode of operations including runway usability and capacity.

Alignment  
option A

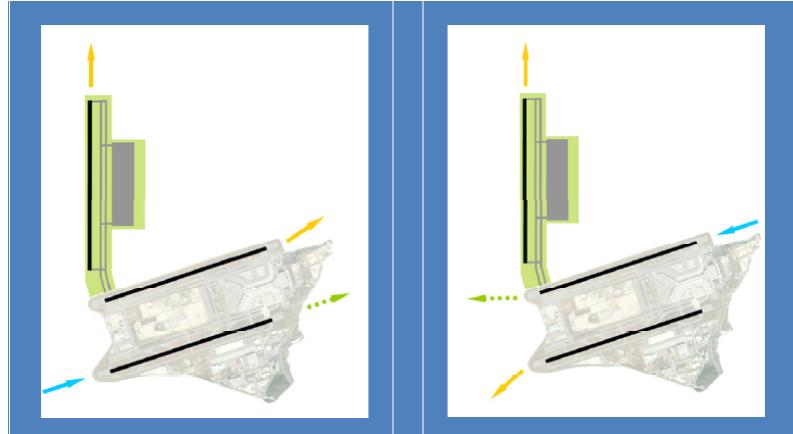
Alignment  
option B

Alignment  
option C

# Third runway alignment options (cont'd)

## Alignment option A

- Construct a near-perpendicular runway to the existing runways.
- The third runway can be used for departures to the North only.
  - A huge imbalance in departure and arrival capacity.
- In the Runway 25 direction, the third runway can be used in certain wind conditions only.
- This category appears infeasible for capacity expansion.



Alignment Option A – Runway 07 Direction			Alignment Option A – Runway 25 Direction		
Runway	Use	Capacity	Runway	Use	Capacity
Third	Departures	35	Third	(Departures)	(35)
07L	Departures	35	25R	Arrivals	35
07R	Arrivals	33	25L	Departures	33
Total		103	Total		68(103)
Increase		35	Increase		0 (35)

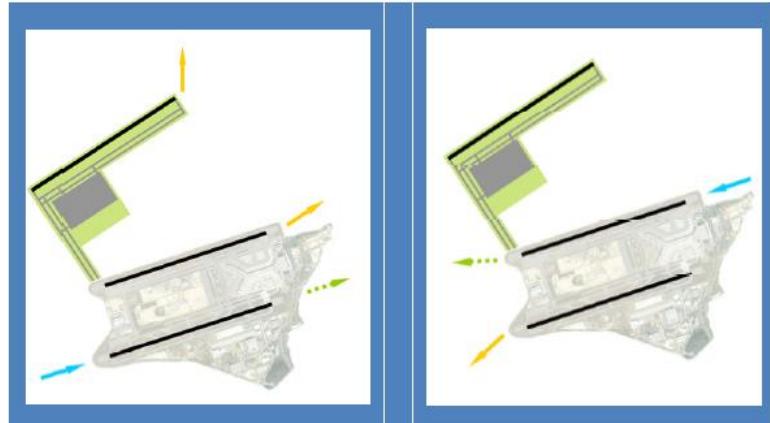
**Key**

- Departure ➔
- Arrival ➔
- Missed Approach ➔➔➔

# Third runway alignment options (cont'd)

## Alignment option B

- Construct a third runway aligned at an angle to the existing runways.
- Conflict with air traffic procedures between the third runway and the existing runways in the Runway 25 direction.
- Dependent operations create little or no additional capacity increase.
- The lack of usability of the third runway in Runway 25 direction makes this option impractical.



Alignment Option B – Runway 07 Direction			Alignment Option B – Runway 25 Direction		
Runway	Use	Capacity	Runway	Use	Capacity
Third	Departures	35	Third		0
07L	Departures	35	25R	Arrivals	35
07R	Arrivals	33	25L	Departures	33
Total		103	Total		68
Increase		35	Increase		0

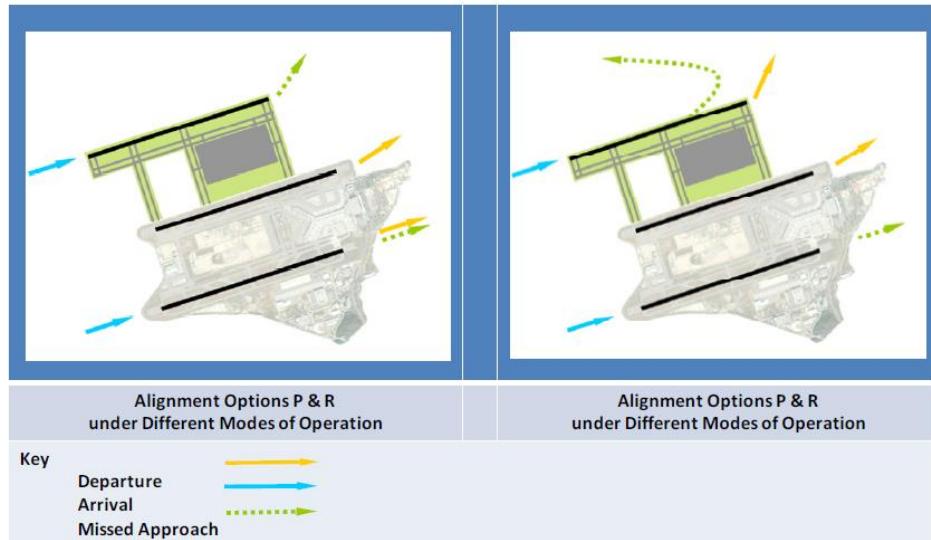
**Key**

- Departure
- Arrival
- Missed Approach

# Third runway alignment options (cont'd)

## Alignment option C

- The most effective alignment should allow fully independent parallel operations of all three runways.
- Achievable only through a parallel alignment of the third runway, provided that the runway separation is adequate for independent operation.
- As per ICAO guidelines, a runway separation of at least 1,525m will allow independent parallel approaches in variable meteorological conditions.





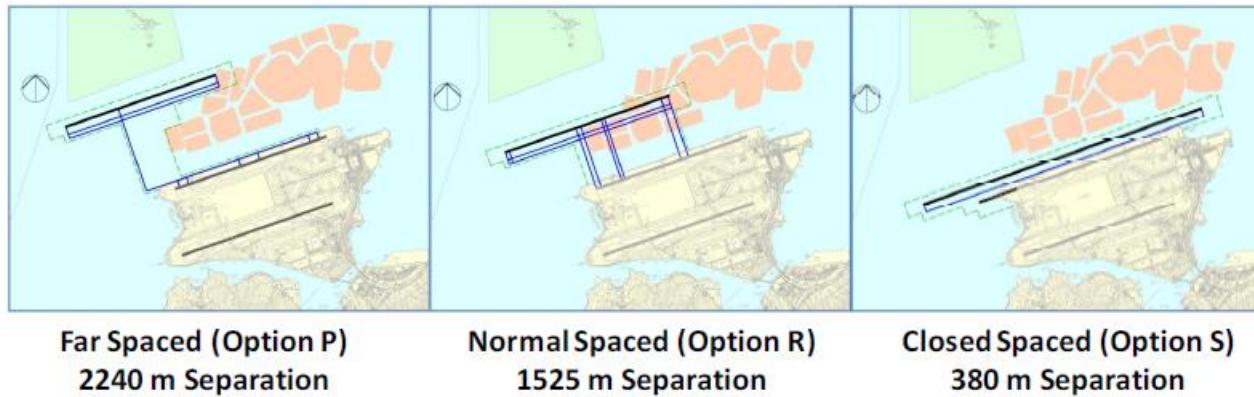
# Third runway alignment options (cont'd)

Non-parallel new runway options were eliminated due to the following:

- Terrain constraints on Lantau Island South of the airport restrict the use of the non-parallel runway aircraft either departing to or arriving from the North.
- Conflicts with air traffic procedures for the existing runways.
- Clashes with traffic flying into and out of Macau and Shenzhen Airports.
- The difficulty of landing safely on a non-parallel runway without imposing very restrictive operating dependencies on the existing runways.
- The negligible gains in capacity offered by a non-parallel alignment.

# Third runway alignment options (cont'd)

- Given the geographical constraints of the airport, viz. Tung Chung township and Lantau Island to the south, the Hong Kong Boundary Crossing Facilities (HKBCF) and Tuen Mun- Chek Lap Kok Link (TMCLKL) to the east, and the territorial boundary of HKSAR waters to the west, only three runway alignment options have been shortlisted from NATS' recommendations.
- Different separation distances from the existing North Runway require different extent of overlap with the existing contaminated mud pits (situated to the North of the airport island).



# Need to stagger the third parallel runway

- The east-west position of the third parallel runway depends on the terrain surrounding the airfield such as Tai Mo Shan and Castle Peak.
- Preliminary procedure design work by NATS indicates that a fully parallel alignment of the third runway with respect to the existing two runways' positions would provide for better integration of airport operations but would have an unacceptable climb gradient for missed approach and departure in the Runway 07 direction.
- Some staggering of the runway to the west by around 1,000 - 1,500m with respect to the existing North Runway's threshold position will be required.
- The subsequent airport layout evaluation steps have recommended a western stagger by around 1,140m for the third runway (subject to further ATC procedural design studies during the detailed design stage).





# Optimising runway capacity with a third runway



# Mode of operations and hourly capacity of the three-runway system

- Runways can be operated in one of the three modes:
  - Departures only
  - Arrivals only
  - Mixed mode
- Each of which sets a different limit on its maximum capacity.

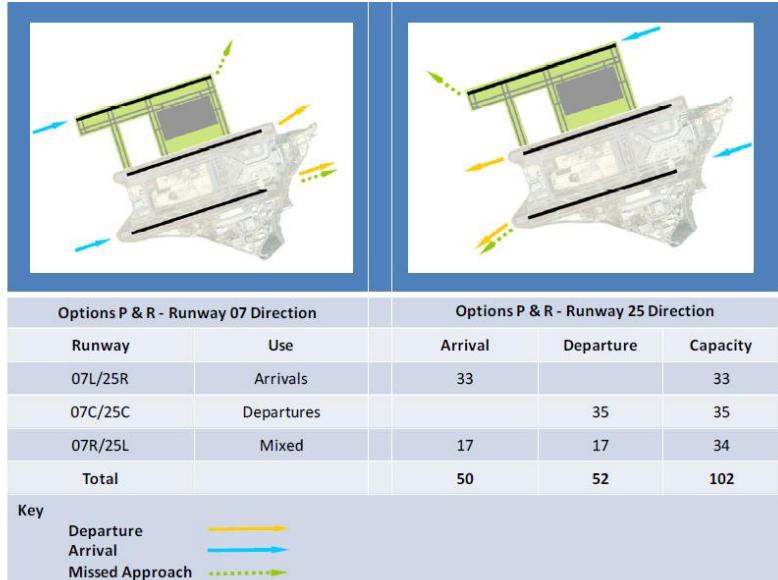
Runway Mode of Operation	ICAO Guidelines on Minimum Separation	Maximum Runway Capacity (Hourly Movements)
Arrivals Only	3NM *	33
Departures Only **	90 seconds	35
Constrained Mixed Mode	8NM arrival spacing	34
Unconstrained Mixed Mode	6NM	44

Note: \* 'NM' means nautical miles

\*\* 90 seconds between all departures except two minutes vortex separation as appropriate

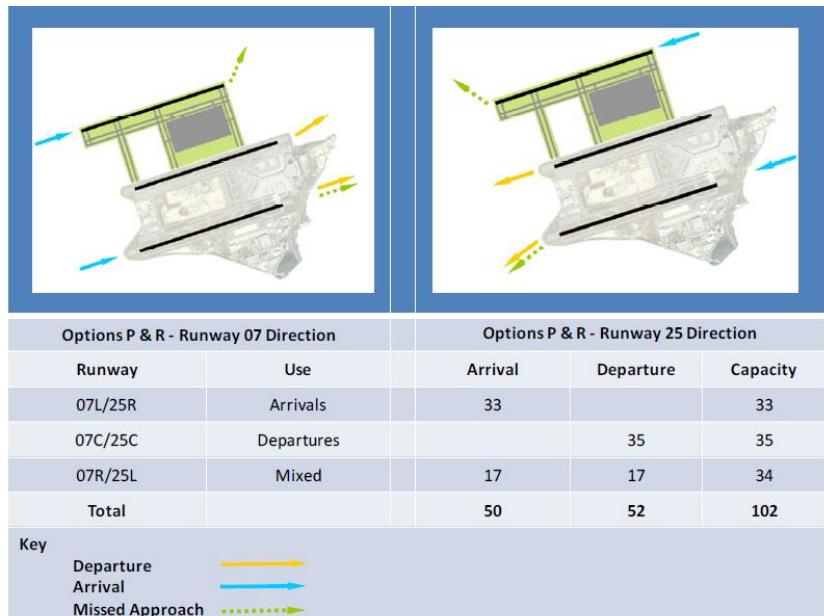
# Mode of operations and hourly capacity of the three-runway system (cont'd)

- NATS recommends the primary mode of operation for the three-runway system to be “Arrivals only, Departures only, Mixed” (ADM) for the new Third, Second (current North) and First (current South) Runways respectively.
- This mode was derived to maximise runway capacity, while considering factors like terrain, flight track separation, wake vortex, operability and capacity. The recommendation is based on the following:
  - The third runway can only be used for arrival operations in order to avoid conflict with the Shenzhen airport arrival circuit in the Runway 07 direction (e.g. take off to the north east). Departure traffic using the third runway for take-off would pass abeam the Shenzhen arrival circuit at roughly the same altitude (3,000 feet to 4,000 feet) and is therefore not possible.
  - Independent mixed mode operations cannot occur on both the first and second runways.



# Mode of operations and hourly capacity of the three-runway system (cont'd)

- c) As independent parallel approaches are not permitted for the first and second runways, the second runway is restricted to departures, while the first runway operates in mixed mode to balance the overall take-off and landing slot availability in each hour.
- d) The proposed alignment would also permit independent parallel approaches to the first and third runways which are the widest apart.
- The ADM mode of operation for a three-runway configuration provides a maximum total capacity of 102 movements per hour.
- With the development of future aircraft navigation technology and improvements in airspace and air traffic management, runway capacity could potentially be stretched even further.



# Practical maximum capacity of the three-runway system

- NATS estimates the practical maximum ATM capacity to be 1,650 to 1,800 movements a day for the three-runway system as opposed to the 1,100 to 1,200 movements a day for the two-runway system.
- Using the historical design day/annual ATM ratio of 0.0029
  - An annual ATM capacity ranging from 570,934 to 622,837 for the three-runway system.

# Airport layout options evaluation

- Based on the three Third Runway alignment options, AECOM has developed 18 airport layout options to cover all possible permutations of apron, passenger terminal and concourse expansion locations.
  - Evaluated comprehensively across key operational and functional parameters.

**A, B, C & D** show the possible location of Passenger Processing Terminal (where passengers are processed for check-in, Customs/Immigration/Quarantine and security screening)

**X, Y & Z** show the possible location of Aircraft Apron and Passenger Concourse Area (where aircraft gates are located)

**P, R & S** denote spacing between the third and existing North runways (e.g. far-spaced, normal-spaced and close-spaced) respectively

## Option 1 (P)

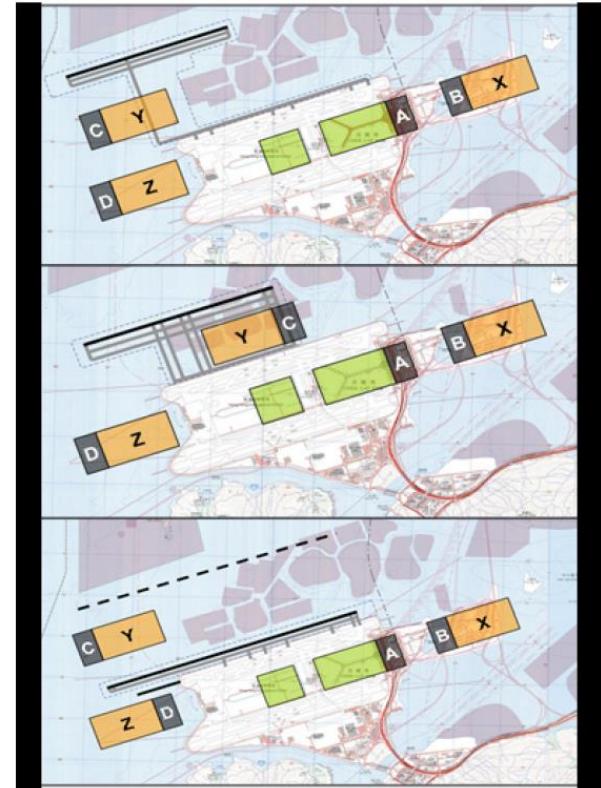
- A + X
- A + Y
- A + Z
- B + X
- C + Y
- D + Z

## Option 2 (R)

- A + X
- A + Y
- A + Z
- B + X
- C + Y
- D + Z

## Option 3 (S)

- A + X
- A + Y
- A + Z
- B + X
- C + Y
- D + Z



# Airport layout options evaluation (cont'd)

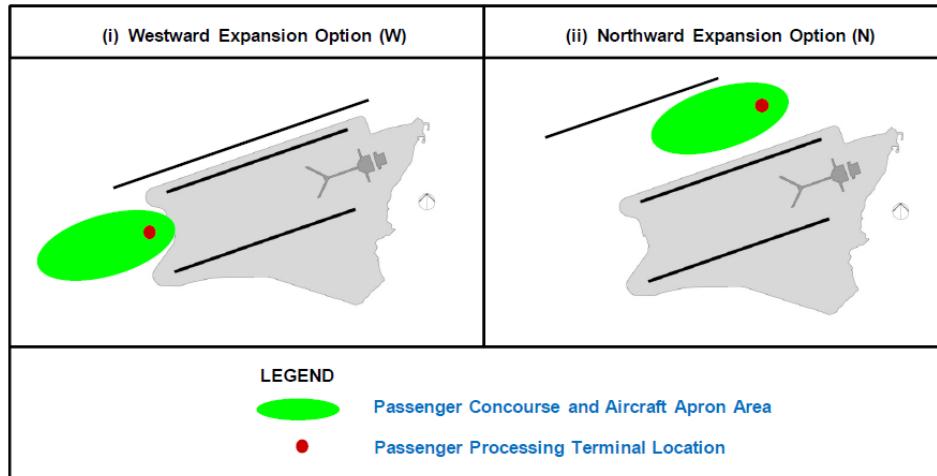
- For the purpose of high level master planning, the 18 airport layout options have been streamlined into two families for further in-depth assessment:
  - Westward expansion
  - Northward expansion

High level evaluation criteria:

<b>1. AIRFIELD</b>	<ul style="list-style-type: none"> <li>Taxing Time/Distance</li> <li>Runway Crossings</li> <li>Additional Control Tower</li> <li>Balance East/West</li> <li>Cargo Connectivity</li> </ul>	Relative compared to each option Relative compared to each option If needed for operations or for blocked lines of sight — Proximity of stands/access to cargo
<b>2. TERMINAL</b>	<ul style="list-style-type: none"> <li>Passenger Connectivity</li> <li>Baggage Connectivity</li> <li>Duplication of Facilities</li> <li>Synergy with Airport Related Development (ARD)</li> </ul>	Minimum transfer time, APM complexity and capacity Connection time/complexity Terminal processor, Retail, Surface Access Interchange, APM, etc Proximity
<b>3. SURFACE ACCESS</b>	<ul style="list-style-type: none"> <li>Road Access &amp; Capacity</li> <li>Airport Express Line (AEL)</li> <li>Cross Boundary Transport Facilities</li> </ul>	Extension of existing roads and capacity of new road Ability to extend existing line, or the need to create a secondary bifurcation Ability to serve cross boundary air/surface transit passengers via Coach, SkyPier and potentially WEL
<b>4. LONG-TERM CAPACITY/FLEXIBILITY</b>	<ul style="list-style-type: none"> <li>Strategic Consideration</li> </ul>	Ability to meet demand growth beyond 2030
<b>5. CONSTRUCTIBILITY/COST</b>	<ul style="list-style-type: none"> <li>Runway/Taxiways</li> <li>Construct Over Mud Pits</li> <li>Terminal Processor</li> <li>Surface Access – Road/Rail</li> <li>Total Land Reclamation Area</li> <li>Operational Impact</li> </ul>	Runway/Taxiway Length or area Cost (and possible lead time) Expansion/Extension of Terminal 1 (T1)/Terminal 2 (T2), or reclamation for a new terminal Short extension of existing versus major line extensions/bifurcation Land take-up —

# Airport layout options evaluation (cont'd)

- Westward expansion: The third runway adopts a close-spaced runway separation, at around 380m from the existing North Runway.
- Northward expansion: The third runway adopts a similar runway separation as that between the existing two runways. the third runway is around 1,645m from the existing North Runway, while the existing two runways are 1,540m apart.





# Airport layout options evaluation (cont'd)

- The northward expansion option was recommended as the basis for developing the preferred airport layout after analysis of both families of options from the airport planning, engineering and environmental perspectives.
- The comparative performance between the two expansion options:

Criteria	Westward Expansion	Northward Expansion
Airfield Efficiency	✗	✓
Passenger Convenience	✗	✓
Surface Access	✗	✓
Cargo Operations Efficiency	✗	✓
Degree of Environmental Impact	✗	✓

*Thank  
you!*

