



## Inner Thames Estuary Feasibility Study

*Response to Airports Commission Call for Evidence*

# **The Mayor of London's Submission: Supporting technical documents**

**23 May 2014**

Title: **Planning for Transition to a New Hub Airport**

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Purpose of paper: To identify a number of ways in which a new hub airport could be successfully constructed and opened, successfully minimising disruption to the London airport system. To identify a number of relevant international examples.

### **Key messages:**

- Transferring airport operations to a new site will bring a number of challenges. However, several other countries have successfully opened new airports to replace old ones. There is every reason to believe that the UK could do so successfully too.
- Short-term teething troubles in any major transport infrastructure project can be expected. However, with competent planning and testing, a new hub airport can be expected to work better and more efficiently than Heathrow today.
- There are a number of workable options for the transition. Each has advantages and disadvantages. A comprehensive ORAT plan will provide the certainty required.

# Mayor's Aviation Works Programme - New Hub Airport

## Technical Note – Planning for transition to a new hub airport

Transport for London

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## Summary

- Transferring airport operations to a new site will bring a number of challenges. However, several other countries have successfully opened new airports and there is every reason to believe that this could be achieved in the UK.
- Short-term teething troubles with specific activities such as baggage handling should be expected. However, with effective planning and thorough testing, these could be minimised.
- There are two main options to manage the transition, each having advantages and disadvantages. A 'big-bang' overnight transfer or a phased introduction of different activities could both work with sufficient preparation and strong leadership.
- Successful transition will require detailed logistics planning, high level commitment from all organisations concerned and protection of the Operational Readiness and Airport Transfer (ORAT) phase.

# 1. Introduction

Modern hub airports are complex businesses involving a large number of organisations that must, individually and collectively, deliver products and services that blend into an effective and efficient whole. Growth in air passenger traffic and aircraft movements has been facilitated not only by the increasing physical scale of airport infrastructure but by the sophistication of technological and process innovations that underpin them. These have enabled airports to meet the many significant challenges posed by major changes in security, legislative and environmental requirements, as well as ever-increasing levels of passenger and stakeholder expectation in lower cost environments. However, as airports outgrow their ageing facilities, new airport facilities and terminals are required to accommodate growing demands.

The challenges associated with getting a new airport up and running are large, requiring thorough planning and the execution of an extremely detailed plan. The management of these issues has led to the recognition of the need for a specific Operational Readiness and Airport Transfer (ORAT) programme that will test operational preparedness of every aspect prior to formally commencing operations at a new facility. Any new airport facility will inevitably involve the integration of new systems, processes, procedures and equipment with legacy issues, all of which need testing, integrating, proving and, critically, user training. A systemic approach is therefore essential to co-ordinating and testing the myriad of interfacing systems, processes, procedures and people.

The sections below cite recent examples of large airports which have required the transfer of operations to a new site, summarising key lessons learnt and suggest some of the conditions required to facilitate a successful transfer. This document focuses primarily with ORAT issues linked to the logistics and operations of an airport: and this note helps to summarise, at a high level, the requirements and logistical challenges associated with the opening of a new airport and the transition from, and closing of, an existing airport facility. The first section, however, is a brief overview of one of the macro-level issues for the transition to a new airport: the issue of slots and the transfer of access rights to the new airport. This issue is raised purely as one of the issues that needs to be addressed, but which does not directly impact an ORAT plan for the logistical matters associated with a major airport switch.

## 2. Slots and the transfer of access rights

The process of transferring flight schedules, and therefore slots, from one airport to another is not new. However, neither the International Air Transport Association's (IATA) guidelines, nor European and UK legislation on airport slot coordination, set down how existing slots held by airlines (sometimes described as 'grandfather rights') should be handled when moving to a new airport. Regardless, there have been multiple occurrences where a fully coordinated (IATA Level 3 coordinated airport) have transitioned between facilities and the same core principles have been followed, namely that;

- Any airline that has to move or whose current operation cannot be sustained after the opening of a new facility (terminal or airport) will be offered the identical slot timings at the new facility. This is on the assumption that the new facility has equivalent or greater capacity, which would be the case with a new hub.
- Any airline that wants to take the opportunity, at a new airport with spare capacity, to re-schedule timings must request new slots in accordance with the relevant guidelines and regulations.
- Where a phased approach to the transition is adopted the Coordinator protects capacity at the new facility for services that are moving in any later stages of the relocation, thus ensuring a carrier's grandfather rights are maintained.

The above approach is transparent, fair and equitable and has been already adopted at airports such as Munich, Athens, Heathrow Terminal 5 and is being used for Heathrow Terminal 2. Any new runway capacity within the South East will have an impact on the monetary value of slots and airlines will have sufficient notification to make the necessary adjustments. The availability of additional capacity provides the benefit of growth and the corporate value that can be earned from it.

### 3. A plan for transition

ORAT is a recognised concept that aims to manage the complex series of interfaces to ensure the successful transfer of operations to a new airport facility. The application of a detailed ORAT programme in preparation of the opening of the new airport in Munich demonstrated the effectiveness and value of such a thorough process facilitating the closure of Munich Reim on 16th May 1992 and the highly successful overnight transfer of all operations to the city’s new Franz Josef Strauss airport.

The primary purpose of ORAT is to provide assurance that people, processes, infrastructure and operational systems are all aligned and prepared for the commencement of normal operations at a new airport facility. This approach has been applied to the launch of every major airport facility in the last decade, with considerable success.

ORAT activities are distinct to both construction and operation phases and are designed to provide assurance and enable a successful transition between the old and new facilities. A typical process map for major airport infrastructure development is illustrated in Figure 2–1. This shows the handover of fully tested and commissioned facilities prior to the start of operations.

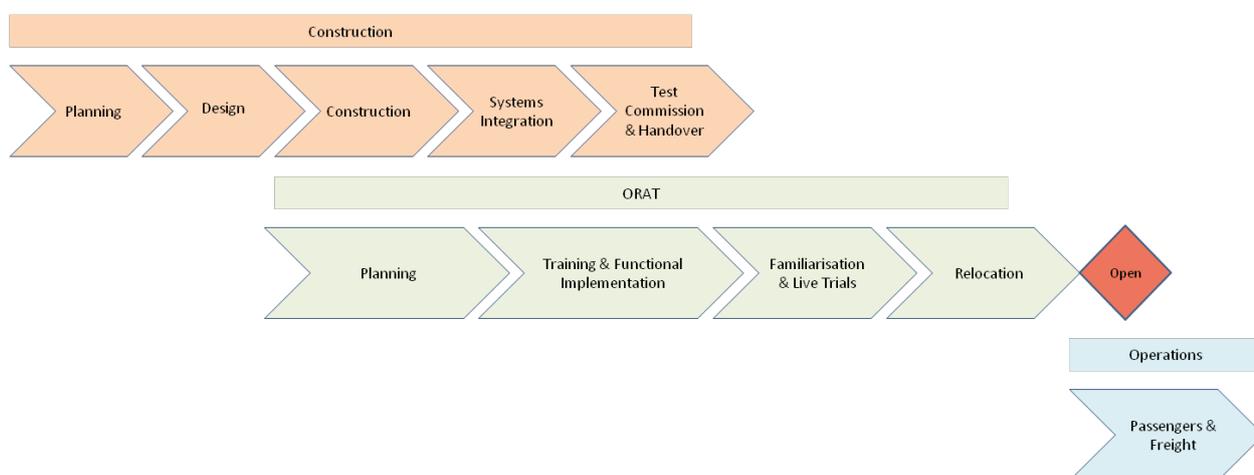


Figure 2–1 High level view of ORAT activity

Key activities that typically form part of the ORAT programme include;

#### Management

- Design of governance procedures – determining who is in charge of what, and when, as well as designing the structure of the decision making process
- ORAT governance roles underpinned by high level commitment from key organisations and escalation procedures
- ORAT strategy and planning

#### Process assurance

- Review of Standard Operating Procedures (SOPs) covering all functions and core processes, including;
  - systems management and integration
  - passenger and crew handling
  - aircraft handling
  - aircraft control
  - airport security
  - administration and management
  - landside access
  - commercial operations & customer services

- environmental integration
- baggage handling
- cargo and mail handling
- facilities management
- Testing of SOPs
- Contingency planning

#### **People readiness**

- Training and familiarisation
- Recruitment programme

#### **Facilities readiness**

- Build certification i.e. fire, evacuation and wayfinding
- Options for 'soft launch'

#### **Proving trials**

Proving trials are commonly conducted for new airport terminals, sports stadia and new public transport services. They should be conducted only after all systems and facility testing has been completed and the facility has been commissioned for use. Proving trials involve the following activities;

- Scope and design
- Organisation of trials organisation / volunteer recruitment and management
- Conducting trials
- Review outcomes

#### **Transition planning and phasing**

- Key activities that will need to be carefully planned include those with heavy infrastructure. Examples in the UK of this can be seen in the closure and reopening of facilities overnight, e.g. the transfer of the London Air Traffic Control Centre operations from West Drayton near Heathrow to Swanwick in 1991, the overnight transfer of operations from the old to the new Control Tower at Heathrow and the transfer of Eurostar services from Waterloo to St. Pancras, both in 2007.
- Management of relocation. Successful transition programmes involving the relocation from one airport to another have relied on strong and independent leadership and high level political support facilitating logistical arrangements using various form of transport.

# 4. Ensuring a successful transfer

## 4.1. Previous relevant examples

A number of major airports and individual passenger terminal buildings have opened in recent years. The vast majority experienced “teething problems” to their planned opening day operation, however, most quickly resolved these issues and delivered successful and efficient operations. It is anticipated that the transfer of activities to a new hub airport for London would be circa 90 Million Passengers Per Annum (mppa), approximately double the scale of any previous transfer to date. Thorough ORAT planning, to address the logistics challenges and personnel issues, will therefore be the key to achieving a successful transition.

Appendix 1 provides a summary of key statistics and issues encountered with the transfer of airport operations to new facilities in Hong Kong, Munich, Bangkok, Denver, Kuala Lumpur, Seoul, Milan and Doha, as well as the opening of new terminals at Heathrow Terminal 5 and Beijing Terminal 3.

## 4.2. Issues to be considered

Based on previous examples of airport moves the following can be applied when planning to open a new hub airport for London;

### Strategies for opening

There are generally two approaches to launching major new airport facilities, namely;

- ‘big bang’, or,
- phased transition

The advantages and disadvantages of each approach are summarised in Table 3-2.

Transfer option	Examples	Advantages	Disadvantages
<b>‘Big-bang’ – all at once and usually overnight</b>	<ul style="list-style-type: none"> <li>• Hong Kong</li> <li>• Munich</li> <li>• Denver</li> <li>• Kuala Lumpur</li> <li>• Seoul</li> <li>• Milan</li> </ul>	<ul style="list-style-type: none"> <li>• Can plan for minimal disruption to operators</li> <li>• Messaging can be very clear and structured around a single date that simplifies the workload</li> <li>• Reduces complexity of logistics planning required</li> <li>• Single transition of traffic reduces complexity of airspace design</li> </ul>	<ul style="list-style-type: none"> <li>• Greater risk of troublesome first few months</li> <li>• Unable to recover quickly from issues, with airport systems already operating at high utilisation</li> <li>• Initial overloading of unfamiliar systems and staff</li> <li>• Issues arising from the complete transfer of all operational equipment and repositioning of aircraft overnight</li> </ul>
<b>Phased transition – ideally over a period of months, in suitably ‘packaged’ blocks of traffic</b>	<ul style="list-style-type: none"> <li>• Bangkok</li> <li>• Heathrow T5</li> <li>• Beijing T3</li> <li>• Doha</li> </ul>	<ul style="list-style-type: none"> <li>• Additional time to get used to systems / address faults</li> <li>• Sufficient capacity and resilience allowing systems to bed in</li> <li>• Reduced risk of failure and greater capacity for recovery</li> <li>• Ability to co-ordinate transfer equipment over several phases</li> <li>• Fewer new personnel at any one time</li> </ul>	<ul style="list-style-type: none"> <li>• Complexity in communicating details of transfer</li> <li>• Cost of developing a transitional airspace design and putting into effect</li> <li>• Increased cost to operators and suppliers of split operations</li> <li>• Logistical issues resulting from running split operations</li> <li>• Impact on transfer passengers, baggage and cargo</li> <li>• Increased number of service vehicles needed</li> <li>• Each phase of transition requires airlines to re-write their schedules, further adding complexity to their operation</li> </ul>

**Table 3-2 Advantages and disadvantages of different opening strategies**

Although a 'big-bang' opening involves the transfer of all traffic in one move, it does not necessarily need to happen over a single night. Complexity of the logistics operation involving the transfer of equipment, staff and the relocation of aircraft could be reduced by closing down the old facility a number of days before opening the new airport. The loss of revenue to airlines during this closure period would need to be weighed up against potential losses incurred by an opening that happens over a single night and is fraught with opening day teething problems. Allowing a few days for the transition would allow additional time to transfer all operations as well as time to check the systems, finalise staff preparations and make sure everything is ready for the 'big-bang' opening when the airport opens with all of its traffic on day one.

Although a phased opening is somewhat more complicated it has a lower associated risk, as the new airport is not operated at capacity and therefore has greater operational flexibility to rectify any issues. However, either strategy could be supported.

Additional considerations that will influence the ultimate strategy include the following;

### **Scale**

The opening of Bangkok Suvarnabhumi airport in 2006 was the busiest complete airport relocation to date, with 41.9 million passengers processed within its first year. It is also one of a few examples of a phased approach to the opening of a large hub airport, where the transition of flights was carefully planned to take place over a number of weeks. The relatively short transition period revealed serious problems with the Baggage Handling System (BHS), Flight Information Displays (FIDS) and Check-in, forcing the retention and operation of the old airport. This raised questions about the quality of construction and extent of build completion and systems integration rather than the logistics associated with the transition to the new site.

The opening of Terminal 3 in Beijing, although only a single terminal, perhaps provides the most successful phased opening of a major airport facility. Comparable to Bangkok, with 39 mppa using the terminal in its first year of operation (2008), it initially opened with six airlines operating from the terminal before moving the remaining fourteen airlines across a month later.

### **Airline transfer product**

Hub airports rely on a strong route network and frequency of services to a wide variety of destinations. Travellers are able to utilise the network of destinations by transferring through hub airports. The proportion of transfer passengers at Heathrow is 37 per cent and is key to the profitability of airlines operating out of the airport.

Transfer passengers, however, bring with them inherent levels of complexity when compared to Originating and Destinating (O&D) passengers travelling through the airport. Baggage handling including Hold Baggage Screening (HBS) and Early Bag Storage (EBS) becomes more complex. The need to accept, process and deliver baggage over large distances within declared Minimum Connect Times (MCTs) is key. Equally important are the facilities required to security screen and transport passengers themselves between aircraft.

Encouraging the airlines to reduce the number of interline transfer ticket sales during the transition period and / or increasing MCTs for this duration could help to reduce pressure on the system. In addition, the requirement for foreign nationals who require visas would further reduce ticket sales during the period of transition, should passengers require transferring between the old and new airport.

### **Airspace considerations**

A key consideration for the transfer of services to a new airport would be the airspace design, particularly the control of inbound and outbound aircraft if both airports are operating concurrently.

#### 'Big bang'

A single 'big bang' switch such as that conducted at Munich may be preferable in terms of airspace management, but would require the repositioning of a large number of flights overnight as well as dealing with other risks referred to elsewhere in this section.

#### Phased opening

During a phased transition period it would be possible to develop airspace designs that could operate concurrently at the old and new site during this time. The only constraint being that the number of aircraft movements may be capped to that of the existing airport's capacity levels until the end of the transition period.

Amendments to airspace require high levels of coordination for the re-programming of aircraft and air traffic systems worldwide. Therefore the industry-wide transfer of information between IT, communication and navigation systems usually takes place on specific days, usually once a month.

### Transfer of equipment

As well as the quantum of equipment there are a large number of specialist vehicles that are not permitted on the public highway. Evidence from previous airports indicates that the transfer of equipment between sites can be achieved, so long as comprehensive logistics plans are in place well in advance of the move (as shown in Table 3-3). Bangkok for example was able to phase the moving of equipment over a 15 week period with non-essential / operational equipment moved well in advance of the main transfer. At Munich and Hong Kong all essential equipment was transferred overnight using the various modes of transport available. No examples exist of where the opening of a new airport has been impacted due to issues resulting from the physical relocation of equipment.

The physical transfer of equipment between sites is not the critical issue; rather it is achieving the move in a short space of time. Detailed planning is therefore required during the proposed transition period to avoid anticipated peaks in airline traffic, identifying capacity on road and rail networks and organising the appropriate transport required. An important consideration is the implication on the road and rail networks and identifying potential bottle necks along the route used by vehicles during the transition.

There is the potential for a significant amount equipment to be transferred as freight overnight on the rail network, thus minimising disruption to other road users.

Opportunities exist to review asset management strategies and to extend the life of existing assets at the existing site. For example, the purchase of new equipment at the new site can be brought forward so that it can be used for training and trials. This helps maintain existing operations at the old facility, whilst reducing the amount of equipment that needs to be transported as part of the transfer.

Airport	Transition	Logistics of transition
Hong Kong	Overnight transition	<ul style="list-style-type: none"> <li>• Containers were stacked on top of barges and shipped to the new site</li> <li>• Major road closures were required to transport all the ramp equipment including 77 cargo loaders</li> <li>• All movements were given a "time slot" for their departure from Kai Tak and arrival at Chek Lap Kok</li> </ul>
Munich	Overnight transition	<ul style="list-style-type: none"> <li>• 1,600 trucks were used to transport the airports complete "inventory" to the new location</li> <li>• Motorways and roads were closed throughout the night</li> <li>• Traffic dispatchers directed drivers from 80 freight companies to 130 drop-off locations at the new site</li> <li>• Some 5,000 movers worked through the night</li> </ul>
Bangkok	Phased	<ul style="list-style-type: none"> <li>• A military style logistics exercise was centrally coordinated by an operations centre</li> <li>• Over 2,928 trips were made by large trucks</li> <li>• The entire operation was phased over 15 weeks, with non operational equipment moving across 13 weeks before opening</li> </ul>

**Table 3-1 Examples of logistics planning for the relocation of airport equipment**

### Maintenance

As well as aircraft servicing vehicles, transition would require the relocation of vehicle and aircraft maintenance facilities. With the exception of retaining casualty maintenance functions, the transition of most functions and stocks could commence in advance of the main move.

### **Links to external systems**

All airports are given a designated IATA and ICAO airport code for identification within global navigation, air traffic and airline booking systems. When new airports open or transfer operations to a new location they will be allocated a new airport designation code, should the facility that they replace remain active with the existing designator. As a result, all global interrelated IT systems will need to be updated to reflect this change. This is however standard protocol and would not be unique for the opening of a new hub airport for London.

## **4.3. Key enablers for a smooth transition**

The success of the transition period will depend on a number of issues, not least of which are;

### **Clear definition of scope and responsibilities**

Operational and maintenance management structures should be in place to witness the testing and commissioning phase of the project prior to accepting handover of infrastructure and systems. Engagement is required with all organisations, including third party suppliers, to identify and assign responsibility for individual processes. Critically, analysis of these processes would identify those issues requiring stakeholder attention and scope requirement for training or live trials.

### **High level commitment and cooperation**

Businesses at airports operate in a highly competitive environment and are naturally cautious about control of information. Experience suggests that the clear flow of information with the body coordinating the ORAT phase is essential, with risks sometimes unknowingly being introduced when communication is reduced. High level commitment from all relevant organisations and an escalation procedure is therefore required as part of the governance processes to deliver a successful launch.

### **Staff training**

A particular challenge for most organisations is the logistics and cost of ensuring that all staff receive effective training and familiarisation at the new facility. Nevertheless this has proved a recurring complaint at several airport launches and should be proactively managed by;

- Commencing the ORAT planning early on in the project
- Early identification of construction delays
- Should delays occur, working in parallel with the design and construction teams to influence priorities, in order to protect the period set aside for staff training and live trials.

### **Programme**

Numerous examples exist, including Hong Kong, Denver, Bangkok and Terminal 5 of where construction delays have resulted in reduced time for systems testing, staff familiarisation and training within the new facility. This has arguably led to some of the teething problems experienced at these airports, which further reinforces the need to protect the planned ORAT activities. Planned opening dates should therefore not be driven by political / commercial pressures, so that any delay in construction and commissioning must result in an equal delay to opening.

### **Familiarisation and proving trials**

Learning from previous projects reinforces the principle that the ORAT phase should be distinct from construction, with operational proving trials and familiarisation commencing only after handover to the operations team of the relevant facility and systems being tested.

Heathrow's Terminal 2 is currently undergoing live trials before its opening in June 2014. It has held nearly 180 trials with over 14,000 volunteers over a 6 month period. Running live trials is a critical part of the staff familiarisation and the training process whilst also testing how the entire operation will function upon opening.

### **Setting expectation levels**

It is important to set public expectations prior to the transition, as the opening of a facility as vast as a new hub airport comes with a potential for teething troubles during the first few days of operation, in spite of best efforts of testing, familiarisation and logistics planning.

When comparing the number of passengers processed within a first year of opening, Bangkok is the busiest complete airport relocation to date (42 mppa in 2007). Within its first year it still only handled roughly half the

number anticipated for the planned capacity of a new hub airport for London (90 mppa 2029). This further supports the need to manage expectations for the opening. It should be noted, however, that, the following mega hub airports will also all have opened prior to the proposed 2029 opening and they will provide further learning for the successful launch of a new hub airport for London;

- Dubai World Central with 200 mppa in 2017
- Beijing Daxing International Airport with 130 mppa in 2017
- New Istanbul International Airport with 150 mppa in 2020

The anticipated design life of a new hub airport is 60 years plus and it is therefore important to place such teething problems in perspective, predict and plan for them. On the whole, the issues that have occurred have been eclipsed by the step change in performance of the new facilities and the business, social and environmental benefits they have delivered.

Hong Kong for example had huge public expectation that the opening day operation was expected to be a complete success. Although the airport opening was marred by significant failures, which led to acrimonious debate, it is regarded today as one of the world's best hub airports in terms of operation, design and passenger experience. Heathrow Terminal 5, remembered for a chaotic opening, was operating normally within weeks and has been voted by passengers as the best airport terminal in the world on four separate occasions (Skytrax 2014).

No airport relocation will have ever been attempted on this scale before. With an initial capability of 90 mppa, the opening of a new hub airport would be more than double the size of any other airport relocation to date and represent a logistical challenge. It is therefore important that the media and travelling public are made aware of the scale of the logistics operation required and that effective preparation is carried out.

## 4.4. Lessons learnt and key criteria essential for a successful opening

The issues encountered during the launch of new airports / terminals often exhibit the following common causes of failure;

### **Construction delays**

Delayed completion of construction work, commissioning and handover all have a knock-on impact of reducing the originally planned testing phase of the new facility, as was the case with the opening of Heathrow T5, Denver, and Bangkok.

### **Baggage Handling Systems failure**

Problems associated with introducing new BHS and the inherent complexities associated with increased levels of automation. Examples include the widely publicised problems at Denver, Heathrow T5, Bangkok, Seoul, Hong Kong and Kuala Lumpur. The opening of Denver in 1995 was delayed by 16 months due to problems with its fully automated BHS, eventually resulting in the airport abandoning the system in 2005.

### **Systems failures**

A common theme has been software and interface failures affecting key systems. Heathrow Terminal 5, Milan Malpensa and Kuala Lumpur all opened with failures affecting systems such as airport wide information management systems and FIDS. These provide vital information for essential airport terminal operations including passenger and baggage handling, safety related systems including fire detection, Close Circuit Television (CCTV), communications links and security systems such as Access Control Systems (ACS) or HBS. A failure of the entire cargo terminal computer system in Hong Kong resulted in a complete shutdown of cargo operations at the airport with normal operations only resuming six weeks after opening.

### **Poor staff preparedness**

This has been cited at a number of airport openings and attributed to late recruitment, industrial relations issues, insufficient or poor quality of training and inability to release staff from normal operations to visit the new site.

### **Insufficient number and quality of tests**

Conducted during the building trials that were not representative of opening day scenarios and busy hour rates. These trials must also be designed to ensure that they actually "stress test" the new facility.

The risks associated with transferring to a new airport can be mitigated by adopting these key criteria to ensure a successful opening;

- Operating IT systems with live data during testing
- Transfer operations with lower risk / levels of interface in advance of commercial services
- Transfer low risk / low interface operations prior to formal opening, such as;
  - Transfer back office staff
  - Transfer cargo flights
  - Low cost airlines / airlines with high O&D traffic
  - New entrants
- Manage the airline transfer product by deliberately cutting passenger transfers / increasing MCTs for the duration of the transition period
- Group airlines by alliance
- Develop a comprehensive communications plan for all stakeholders
- Schedule transition to times of the year with lower demand
- Resource plan to ensure there are sufficient personnel to cover training and the transition period. Examples may include acceleration of recruitment plans / deferment of retirement plans / moratorium on annual leave
- Allow sufficient time for staff training and familiarisation within the new airport
- Recruiting and training volunteers to assist with wayfinding to allow front line staff to concentrate on managing the operation such as the “Games Helpers” used during London 2012
- Asset management and vehicle fleet planning; accelerate purchase of new / replacement equipment
- Increase maintenance to delay disposal of older equipment until after the transition
- Transfer all non essential operational equipment well in advance of opening
- Reflect any delays in construction and commissioning with equal delays to the opening
- All new systems installed within the airport are proven and are fully integrated prior to the commencement of ORAT

## 5. Conclusion

Many of the world’s leading hub airports have relocated to new locations or have transferred significant amounts of their traffic to open new terminals. Transferring airport operations to a new site will bring a number of challenges. However, with detailed planning, appropriate staff training and familiarisation as well as efficient communication through proper application of ORAT there is every reason to believe that transition to a new hub airport would be successful.

Despite experiencing initial teething problems after opening, many of these new airport facilities that have opened are now regarded as world leading, offering the very best airport infrastructure. This is supported by the 2014 Skytrax<sup>1</sup> awards which highlight the success of these new facilities today;

### Ranking of the world’s best airports

- Seoul: No.2
- Munich: No. 3
- Hong Kong: No.4

### Ranking of the world’s best airports by size category

- Kuala Lumpur: best airport serving 40-50 mppa - No.2
- Denver: best airport serving 50+ mppa - No.9

### Ranking of the world’s best airport terminals

- Heathrow T5: No.1
- Beijing T3: No.8

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<sup>1</sup> Skytrax is a respected airline and airport global rating system for product and service, safety ratings and the industry benchmark for quality excellence voted for by the travelling public

Although the opening of a new hub airport for London is considerably larger than any attempted to date, the following mega hub airports will all have opened prior to the proposed 2029 opening of a new hub airport for London;

- Dubai World Central with 200 mppa in 2017
- Beijing Daxing International Airport with 130 mppa in 2017
- New Istanbul International Airport with 150 mppa in 2020

As well as indicating the growing importance of hub airports, the opening of these facilities will provide further learning for the successful launch of a new hub airport for London.



# Appendix A. Examples of worldwide airports that have relocated

City	Airport name	Opened	Closed	Annual Pax & Cargo (Year prior to opening)	Annual Pax & Cargo (Year after opening)	Annual Pax & Cargo (Current)	Distance between airports	Relocation information / statistics of the move	Opening day Issues	Current operation
	Transition									
Hong Kong	Chek Lap Kok (HKG)	6th July 1998	Current	N/A	30.4 mppa (1999) 1.97 M tonnes (1999)					
	Kai Tak (HKG)	1925	5th July 1998	28.3 mppa (1998) 1.56 M tonnes (1998)	N/A	59.9 mppa (2013) 4.12 M tonnes (2013)	29 km	<ul style="list-style-type: none"> <li>Aircraft were relocated overnight</li> <li>ULD baggage containers were stacked on top of barges and shipped to the new site</li> <li>Major road closures were required to transport all the ramp equipment which included the transportation of 77 cargo loaders</li> <li>55 food delivery trucks and 42 vans were driven across to the new site</li> <li>All movements were given a "time slot" to dictate their departure from Kai Tak and arrival at Chek Lap Kok</li> </ul>	<ul style="list-style-type: none"> <li>The Hong Kong cargo terminals computer crashed, which led to the complete collapse of functionality cargo systems within the terminal</li> <li>Normal Cargo handling services resumed on 24th August</li> <li>Failure of Flight Information Display System (FIDS) led to system failures within the apron control centre and the airport operations control centre as well as creating problems within the baggage handling system. This resulted in long delays and slow dissemination of flight information leading to delays in gate and stand allocation</li> <li>Problems with the FIDS led to 80% of boarding gates either unable to display the correct flight information or displayed nothing at all</li> <li>There were operational issues with 38 of the 66 airbridges</li> <li>There was a reported breakdown of the cooling system, water and electrical systems</li> </ul>	<ul style="list-style-type: none"> <li>Following the problems on opening day, Chek Lap Kok successfully processed over 100,000 passengers a day by the end of 1998</li> <li>It is widely accepted as one of the most successful airports in the world</li> <li>Hong Kong has been ranked as the busiest airport for international air cargo since 1996</li> <li>Skytrax rating: 4-star</li> <li>Skytrax 2014 ranking for world's best airport: No. 4</li> </ul>
	<b>Overnight transition:</b> Kai Tak ceased operations at midnight on 6th July and at 6 am the following morning aircraft took off from Chek Lap Kok.									
Munich	Franz-Josef Strauss (MUC)	17th May 1992	Current	N/A	12.7 mppa (1993) 0.07 M tonnes (1993)					
	Munich-Riem (MUC)	1939	16th May 1992	10.8 mppa (1991) 0.06 M tonnes (1991)	N/A	38.7 mppa (2013) 0.28 M tonnes (2013)	25 km	<ul style="list-style-type: none"> <li>Involved the relocation of the entire airport operation overnight</li> <li>1,600 trucks were used to transport Riem airports complete "inventory" to the new location</li> <li>Motorways and roads were closed throughout the night to facilitate the transfer</li> <li>Traffic dispatchers directed drivers from 80 freight companies to 130 pre-defined drop off locations at the new site</li> <li>Operations at the new site opened a day early with passengers processed in maintenance hangers that acted as a temporary passenger holding area, whilst passengers were ferried between the two airports on busses.</li> <li>Some 5,000 movers worked through the night, to put hoists, baggage carts, airport tugs, passenger stairs and other heavy ramp equipment into position at the new site</li> </ul>	<ul style="list-style-type: none"> <li>Widely regarded as one of the most successful airport transfer operations</li> <li>The detailed logistics planning led to a smooth and punctual start to operations on the morning of the 17th May</li> </ul>	<ul style="list-style-type: none"> <li>In 1996, the airport overtook Düsseldorf as Germany's second busiest airport</li> <li>Since opening in 1992, Munich's annual passenger numbers have more than tripled with the new airport, allowing Munich to become an established hub ranked 6th in terms of annual passengers for EU airports</li> <li>Skytrax rating: 4-star</li> <li>Skytrax 2014 ranking for world's best airport serving 30-40 mppa: No.1</li> </ul>
	<b>Overnight transition:</b> Munich Reim ceased operations on 16th May and commenced at the new airport at 6 am the following morning									
Bangkok	Suvarnabhumi (BKK)	15th Sept 2006	Current	N/A	41.9 mppa (2007) 1.23 M tonnes (2007)	50.9 mppa (2013) 1.3 M tonnes (2013)				
	Don Mueang (DMK)	1924	Current	38.9 mppa (2005) 1.2 M tonnes (2005)	3.2 mppa (2007)	15.6 mppa (2013) 17,149 M tonnes (2013)	29 km	<ul style="list-style-type: none"> <li>Operational trials included airport wide tests conducted on 3rd and 29th July 2006 with multiple wide body departures and arrivals set to test the airports long haul handling capability</li> <li>A critical element to the move was determining the best day of the week to move. This involved undertaking detailed analysis of aircraft schedules, the road traffic network and identification of specific routes to be used during the relocation</li> <li>A military style logistical exercise that began with an inventory and analysis of the total volume of equipment, a plan for where equipment should be loaded and off-loaded as well as transport routes and bottle necks were all considered</li> <li>The operations centre co-ordinated 8 "packaging" units and were responsible for overseeing the 2,928 trips made by large 10 wheel trucks</li> <li>27 aircraft were transferred on the night of 27th September</li> </ul>	<ul style="list-style-type: none"> <li>The new airport was originally due to open in late 2005, however, a series of budget overruns, construction problems and political issues delayed the opening until 2006</li> <li>Prime Minister Thaksin publicly declared that the airport must be operational by September 2006, with all efforts for completion accelerated to deliver this expectation</li> <li>On the opening day, major problems were reported with the Baggage Handling System (BHS) with passengers reportedly waiting for hours for their baggage. Faults were blamed on excessive overloading of the system and failure of the system to read international bag tags</li> <li>Many flights were delayed due to failures with the check-in system</li> <li>Problems with the FIDS resulted in departure boards showing erroneous information</li> <li>Months after the opening, issues of congestion, construction quality and poor signage plagued the new airport</li> <li>Over the months that followed, serious concerns over the quality of taxiways and runways arose. It was reported that there were over 100 cracks in the taxiways which led to serious drainage issues</li> </ul>	<ul style="list-style-type: none"> <li>In order to alleviate immediate congestion and allow for remedial works on the taxiways and runway the prime minister decided to re-open Don Mueang on 16th February 2007 for domestic flights only.</li> <li>71 weekly flights moved back across to Don Mueang and it still currently handles mainly domestic services operated by Nok Air, Thai Air Asia and Orient Thai Airlines</li> <li>Thai Airways has subsequently moved all of its domestic services back to Suvarnabhumi</li> <li>In 2013 Suvarnabhumi was ranked the world's 17th busiest airport</li> <li>Skytrax rating: 3-star</li> </ul>
	<b>Phased opening:</b> Phased over 15 weeks, commencing with limited domestic traffic on 15th September and a series of Asian carriers on 21th, 25th and 26th, followed by all remaining commercial traffic on 28th September									
Denver	Denver International Airport (DEN)	28th February 1995	Current	N/A	34.96 mppa (1997) 0.44 M tonnes (1997)					
	Stapleton (DEN)	1929	27th February 1995	Unknown	N/A	52.6 mppa (2013) 0.23 M tonnes (2013)	20 km	-	<ul style="list-style-type: none"> <li>At the time the project involved installation of the world's largest automated baggage system. However, the baggage system was an after thought to the construction of the airport with the system having to fit around the constraints of the existing structure</li> <li>System complexity and lack of robust testing resulted in failure of the baggage system and delayed the opening by 16 months. Throughout the delay this cost the City of Denver \$1.1M per day, with the overall facility costing \$4.8 billion. Overall it was nearly \$2 billion over budget</li> <li>The BAE President (baggage system designer) explained "we simply ran out of time". BAE maintain that the opening timetable was never realistic which pushed back and reduced system testing</li> <li>Problems included: concrete mechanical, electrical and software flaws</li> <li>Upon opening day, the baggage system was a shadow of its original plan. Rather than automating all 3 concourses into one integrated system, the system was used in a single concourse and by a single airline (United) but for outbound flights only</li> <li>In 2005 United announced that they would abandon the system completely reverting to simple conveyer belts plus a manual tug and dolly system. Decommissioning the baggage system saved an estimated \$1 million per month in maintenance costs</li> </ul>	<ul style="list-style-type: none"> <li>In 2013 Denver was the 5th busiest airport by passenger traffic in the USA and 15th busiest in the world</li> <li>Skytrax 2014 ranking for world's best airport serving 50+ mppa: No.9</li> </ul>
	<b>Overnight transition:</b> Stapleton closed on the 27th and the new Denver International Airport opened on 28th February 1995									

City	Airport name	Opened	Closed	Annual Pax & Cargo (Year prior to opening)	Annual Pax & Cargo (Year after opening)	Annual Pax & Cargo (Current)	Distance between airports	Relocation information / statistics of the move	Opening day Issues	Current operation
	Transition									
Kuala Lumpur	Kuala Lumpur International Airport (KUL)	30th June 1998	Current	N/A	13.2 mppa (1999) 0.42 M tonnes (1999)	47.5 mppa (2013) 0.68 M tonnes (2013)	45 km	-	<ul style="list-style-type: none"> <li>The inauguration of the airport was marked with problems. Aircraft stand allocation systems broke down and there were failures with airbridges. Aircraft were reportedly kept in holding patterns for up to an hour before being allowed to land.</li> <li>The new airport pioneered the use of a state-of-the-art technology in airport management, known as "Total Airport Management Systems" (TAMS). TAMS is responsible for the following airport interface functions; air traffic management, baggage handling, passenger check-in and flight information displays</li> <li>Software glitches and failure of TAMS was reportedly blamed for causing flight delays, baggage being lost or misplaced and passengers missing flights through failure of flight information displays</li> <li>Upon opening there were an insufficient number of adequately trained staff that were familiar with the new TAMS</li> <li>Operations tests of TAMS were reportedly only done within a controlled environment and failed to replicate anticipated full operations</li> </ul>	<ul style="list-style-type: none"> <li>In 2013 Kuala Lumpur was the 11th busiest airport by passenger traffic in the world</li> <li>Skytrax rating: 4-star</li> <li>Skytrax 2014 ranking for world's best airport serving 40-50 mppa: No.2</li> </ul>
	Sultan Abdul Aziz Shah Airport (SZB)	1965	Current (limited operation)	15.8 mppa (1997)	N/A	1.4 mppa (2012)				
	<b>Overnight transition</b>									
Seoul	Incheon International Airport (ICN)	29th March 2001	Current	N/A	20.9 mppa (2002) 1.7 M tonnes (2002)	41.5 mppa (2013) 2.5 M tonnes (2013)	32 km	<ul style="list-style-type: none"> <li>Korean officials were reportedly proud of how they handled the overnight transition to the new spacious \$5.4 billion airport</li> <li>Overall the operational transition ran relatively smoothly and on the first day 50 airlines flew in and out without incident and mostly to schedule</li> </ul>	<ul style="list-style-type: none"> <li>Upon opening, the baggage system was found to have flaws with its automatic operation and the facility had to be operated in semi-automatic mode</li> <li>The airport reportedly opened as scheduled despite known issues with the baggage system with formal tests conducted a few weeks before opening, as opposed to months in advance</li> <li>Kang Dong-suk, Incheon airport Chairman acknowledged that the training of airline staff and ground service workers at the airport had not reached the level needed for smooth operations on opening</li> <li>Despite these opening day glitches, the system flaws were quickly rectified and the airport began to operate normally within a month of opening</li> </ul>	<ul style="list-style-type: none"> <li>Incheon's baggage system was designed to process 31,000 pieces per hour whilst only having a 0.0009% baggage mishandling rate. This makes it the most accurate baggage system in the world</li> <li>In 2013 Incheon was the 9th busiest airport by passenger traffic in the world</li> <li>Skytrax 2014 ranking for world's best airport: No. 2</li> </ul>
	Gimpo International Airport (GMP)	1958	Current	36.6 mppa (2000) 2.1 M tonnes (2000)	17.9 mppa (2002) 0.3 M tonnes (2002)	19.9 mppa (2013) 0.3 M tonnes (2013)				
	<b>Overnight transition</b>									
Milan	Malpensa (MXP)	Re-developed for 25th 1998 October opening	Current	N/A	16.97 mppa (1999)	18.54 mppa (2012)	47 km	<ul style="list-style-type: none"> <li>During the night of October 24/25 1998 Alitalia moved the majority of its fleet from Rome-Fiumicino to Malpensa</li> <li>Malpensa started a new lease of life as the Italian flag carriers main hub</li> <li>Alitalia's move to the terminal added 488 movements and 42,000 passengers a day</li> </ul>	<ul style="list-style-type: none"> <li>Following the immediate years of opening, Milan was firmly established as Italy's leading airport until Alitalia announced in 2007 to move a significant proportion of their traffic back to Rome-Fiumicino</li> <li>Since Alitalia's departure, traffic has significantly reduced at Malpensa from 23.9 mppa in 2007 to 18.54 mppa in 2012</li> </ul>	
	Linate (LIN)	1930	Current	7-9 mppa	N/A	9.2 mppa (2012)				
	<b>Overnight transition</b>									
Doha	Hamad International Airport (HIA)	30th April 2014 (soft) 27th May 2014	Current	N/A	Not available- Transition currently in progress	Not available- Transition currently in progress	4 km	<ul style="list-style-type: none"> <li>The opening of the first of three phases of the new \$15.5 billion gateway had been repeatedly pushed back (originally planned for 2008) to such an extent that it forced the existing airport to be expanded with new first-class and arrivals terminals.</li> <li>Building delays resulted in the airport further postponing their projected 12th December 2012 opening, to April 2013 and then further to 30 April 2014</li> <li>The reasons for the delays have included incomplete lounges and failed safety inspections</li> </ul>	<ul style="list-style-type: none"> <li>No major reported issues of the phased transition of traffic to date</li> </ul>	<ul style="list-style-type: none"> <li>Doha is currently the world's newest international hub airport. It is located four kilometres from the existing facility, built on a 5,400-acre site of which 60% was reclaimed from the sea</li> <li>The airport initially opened with three concourses, capable of handling 30 mppa, with a further two set to open at a later date taking the total operating capacity to 50 mppa</li> </ul>
	Doha International Airport (DOH)	1978	26th May 2014	21.2 mppa (2012) 0.8 M tonnes (2012)	N/A	23.3 mppa (2013) 0.9 M tonnes (2013)				
	<b>Phased opening:</b> Cargo operations commenced on 1st December 2013. The soft opening for commercial operations was on 27th April which saw 10 airlines operating from Concourse B. All remaining traffic, including the entire Qatar Airways fleet moved across on 28th May.									
London	Heathrow (LHR) Terminal 5	27th March 2008	Current	N/A	Airport wide: 65.9 mppa (2010) 23.42 mppa (2010)	Airport wide: 70 mppa (2012) 29.8 mppa (2012)	N/A	<ul style="list-style-type: none"> <li>Two main switches of BA's traffic were planned to facilitate the move of the airlines fleet, staff and routes into the new terminal. On 27th March the majority of flights from T1 were moved (excepting 6 routes)</li> <li>The first switch comprised 70% of BA's traffic</li> <li>A second switch was planned for 30th April to move all flights from T4 (except SIN, BKK and SYD).</li> <li>The second switch was postponed to June to allow T5 time to recover from the opening day issues that were experienced</li> <li>Postponing the switch of BA's long haul fleet from T4 had a knock-on effect for those airlines (Air France, KLM, Delta and Continental) that were due to move into T4</li> </ul>	<ul style="list-style-type: none"> <li>Publicised problems included; glitches with the baggage system, failure of airbridges, delays in security staff screening and a general lack of staff familiarisation on opening day</li> <li>Almost 250 flights in and out of T5 were cancelled during its first four days with checked baggage suspended on the first day of operation</li> <li>23,205 bags were misconnected in the first few days of operation</li> <li>The T5 enquiry into the opening found that most of the problems were caused by: insufficient communication between the owner and operator, lack of thorough staff training and familiarisation as well as insufficient time for system testing</li> <li>BA accepted that training had not been sufficiently thorough and that with hindsight that they should not have absorbed the continued building delays by compromising the time needed to complete the full testing and familiarisation process as planned</li> <li>BA was not able to operate its full schedule from T5 until 8th April 2008</li> <li>The financial impact for the first 5 days of operation in T5 cost BA £16m</li> </ul>	<ul style="list-style-type: none"> <li>Since the opening issues experienced within T5, travellers have consistently commented on its grand architecture, ambience, spacious terminal layout as well as its ability to offer a high level of passenger experience that meets customer demands</li> <li>In 2014 T5 won the Skytrax award for the world's best terminal. This is the fourth time that the terminal has been awarded this prize.</li> <li>Skytrax 2014 ranking for world's best airport: Heathrow - No.10</li> </ul>
	<b>Phased opening</b>									
Beijing	Beijing Capital Int Airport (PEK) - Terminal 3	29th February 2008	Current	N/A	Airport wide: 65.4 mppa (2009) Terminal 3: 39 mppa (2009)	Airport wide: 83.7 mppa (2013) Terminal 3: 50.2 mppa (2013)	N/A	<ul style="list-style-type: none"> <li>There were no major reported issues on the opening day</li> <li>The biggest problem on opening day was the 1,100 passengers that proceeded to the wrong terminal.</li> </ul>	<ul style="list-style-type: none"> <li>No major reported issues on the opening day</li> </ul>	<ul style="list-style-type: none"> <li>Terminal 3 is the largest airport terminal building complex ever built in a single phase with 986,000 sq. meters of total floor area.</li> <li>Skytrax 2014 ranking for world's best airport terminal: No.8</li> </ul>
	<b>Phased opening:</b> The terminal opened in two phases. Phase one involved 6 airlines, followed by phase two with the remaining 14 airlines on 26th March									

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