International Civil Aviation Organization

Europe – Asia Trans-regional Special Coordination Meeting

Beijing, China, 23 – 25 September 2013

Agenda Item 4: ATS route realignment

SILK ROAD INITIATIVE

(Presented by the Secretariat)

SUMMARY

This paper presents information on a possible high density routing initiative for traffic from Southeast Asia or Southern China to Europe via north of the Himalayas, taking advantage of the latest Performance-based Navigation (PBN) navigation specifications.

This paper relates to –

Strategic Objectives:

A: ***Safety*** *– Enhance global civil aviation safety*

C: ***Environmental Protection and Sustainable Development of Air Transport*** *– Foster harmonized and economically viable development of international civil aviation that does not unduly harm the environment*

Global Plan Initiatives:

GPI-6 Air traffic flow management

GPI-7 Dynamic and flexible ATS route management

1. INTRODUCTION

1.1 The Silk Road initiative is a proof-of-concept ATS route study. The Silk Road concept is a pair of ATS routes spaced at least 20NM apart, utilising RNP 2, RNAV 2 or RNAV 5 Performance-based Navigation (PBN) navigation specifications. The initiative was first presented to the Regional ATM Contingency Plan Task Force (RACP/TF) as a possible future contingency system north of the Himalayas for traffic operating on Major Traffic Flow (MTF) AR-4 via South Asian airspace between Europe and Southeast Asia, in case of airspace unavailability in South Asian FIRs.

2. DISCUSSION

QANTAS Bangkok-Europe Route Study

2.1 The thinking behind the Silk Road initiative is not new. As long ago as 1997 the Australian airline QANTAS commissioned a study that routing options that crossed part of the Tibetan plateau for their B747-400 aircraft would provide benefits, and that suitable depressurization escape routes were able to be determined.

2.2 The QANTAS study did not take into account political and ATM matters, but did study terrain, meteorological and aircraft performance aspects. The study is appended at **Attachment A**.

Technology Advances

2.3 Since 1997, there had been considerable advances in aircraft performance and in ground-based support such as the capability of Automatic Dependent Surveillance-Broadcast (ADS-B) systems to provide Air Traffic Services (ATS) surveillance where this was not previously possible.

2.4 The RNP 2 and RNAV 2 navigation specifications have become available in the PBN Manual (Doc 9613), providing the possibility of more accurate navigation than the RNP 4 specification that the QANTAS study was based on. While the procedural separation standards against terrain and other aircraft for these navigation specifications were likely to become available in the 2015 time period, these navigation standards could be used now using ATS surveillance-based separations within surveillance coverage.

2.5 It was important to understand that the new navigation specifications provided benefits not just in terms of lateral navigation accuracy, but also were likely to enable smaller longitudinal separation[1] and thus these routes could support a much higher traffic density than conventional routes. In addition, smaller longitudinal separation standards enabled aircraft a greater opportunity to reach their preferred flight level for fuel and emissions efficiency.

2.6 A key advance in the last decade has been the advent of sophisticated Geographical Information System (GIS) supporting the design of PBN route planning. One of the ICAO-endorsed PBN design companies volunteered to demonstrate the capability of such systems by conceptualize possible Silk Road routes. The RACP/TF Chairperson stated that the planning software used by a leading ICAO-endorsed procedure design organization was a useful tool, as it enabled the effective management of a large amount of data needed for a design. Further information on the conceptual designs is available in the presentation appended at **Attachment B**.

Contingency Plan Task Force

2.7 At RACP/TF/2, IATA stated that the concept passed through airspace that may be difficult to obtain agreement on optimum design, as consideration of high terrain areas was also required. IATA requested that airlines be involved in the earliest planning phases. The Secretariat suggested that this trans-regional concept be discussed between the Asia/Pacific and EUR/NAT ICAO Regional Offices to seek endorsement and support from the States that may be involved; thus the initiative is being presented to the Beijing Special Coordination Meeting.

2.8 The RACP/TF Chairperson stated that alternative contingency route systems could be considered along with the current routing structure, so the Task Force could manage their integration in a step-by-step manner. India positively acknowledged the Silk Road concept, noting the contingency routes could even eventually be used as standard routes, with the capability of improving efficiency while reducing fuel usage and emissions.

ATM Sub-Group

2.9 The Silk Road initiative was presented to the First Meeting of the APANPIRG ATM Sub-Group (ATM /SG/1, Bangkok, Thailand, 20 – 24 May 2013) as a study indicating the possible fuel and emissions savings for aircraft using the Silk Road routes, compared to conventional routing systems north and south of the Himalayas. The ATM/SG/1 Working Paper is appended as **Attachment C**.

[1] Initial calculations from the ICAO Separations and Airspace Safety Panel indicate a value of 15NM is possible using RNP 2 – this is still to be approved by the Air Navigation Commission (ANC).

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper;

b) discuss possible means of researching the Silk Road concept further; and

c) discuss any relevant matters as appropriate.

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PBN Highways

A New Concept for Increasing Efficiency and Capacity of Inter-Regional Air Travel

Vision for the Future

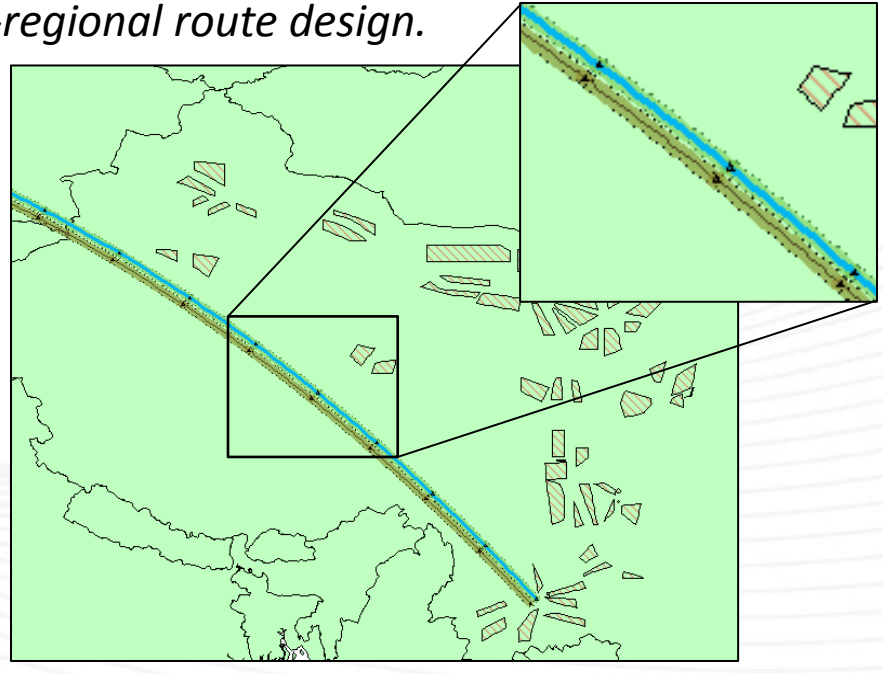
New navigation specifications allow us to look beyond the current methods to a new concept of operations for inter-regional route design.

More Efficient Inter-Regional Flight Paths

Rather than simply 'drawing new lines over old lines,' PBN is best implemented on highly efficient routes designed from **end-to-end,** providing priority by just as any highway would, thereby saving flying time for enhanced aircraft utilization, fuel usage and emissions.

Capacity Increase

Often ignored is the increased capacity gained from reducing longitudinal spacing, providing an opportunity to achieve optimum flight levels.



High-capacity 'highways' connecting major population centres designed to follow the most efficient paths and utilizing the latest PBN standards

A New Norm

Outside of the developed nations, many ANSPs don't use ATS surveillance separation but rely on PBN spacing or other procedural separations, even within ATS surveilled airspace.

Even within the developed nations, PBN spacing is used for SID/STAR allowing for 'ATC hands-off' terminal operations to increase ATC capacity by reducing ATC workload.

Monitored ATC operations are becoming the norm everywhere!

Positive Impact

Network Efficiency

Reduced flying time and fuel usage
Contingency alternatives
Reduced need for en-route civil airspace

Network Capacity

Theoretical capacity increase by a factor of 4 (RNAV10 vs. RNP2)
Traffic simplicity & predictability

Level Optimization

Achievement of optimal flight levels more regularly

Tremendous Economic and Environmental Benefits

Don't forget Safety!

Less complexity and greater predictability
Less congestion on other less capable route systems

Impact on Civil/Military Coordination

EMARSSH Example

EMARSSH was a revolutionary concept of multi-state coordination to design routes regionally more than a decade ago

But,

It was only partially successful because major parts of the route system are not available or are restricted by individual state ANSP and military requirements

Key Difference with PBN Highways

Parallel 'PBN Highways' based on RNP2 only require approximately 40NM of protected space, reducing potential civil/military conflicts.

PBN Highways supported by an inter-regional push by ICAO, IATA, and other stakeholders will put extreme pressure on States to avoid restrictions on the routes

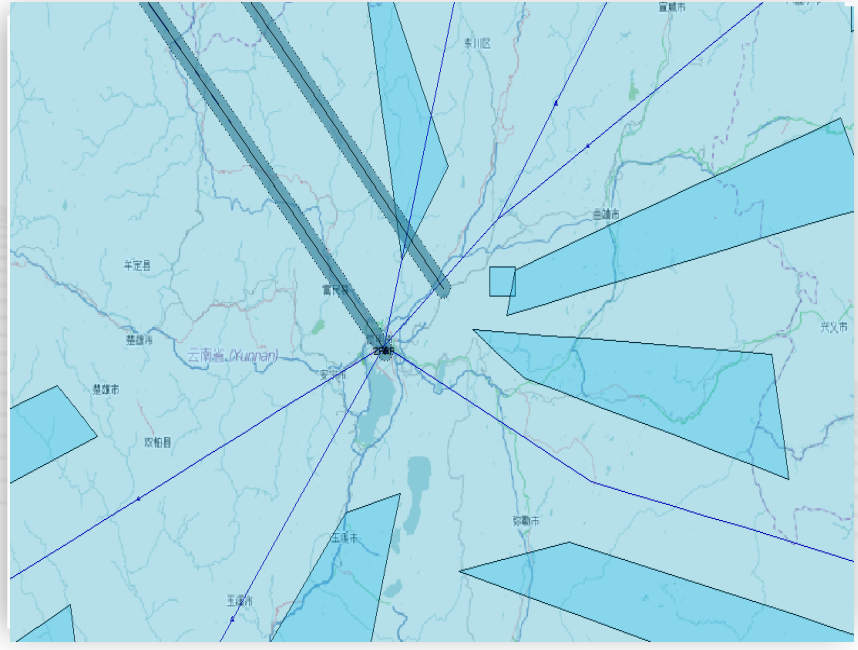
Air navigation services now need to catch up as aircraft capacity and efficiency have advanced at a greater speed than Network capacity and efficiency

PBN Highways

CASE STUDY: SILK ROAD

Silk Road

The Silk Road initiative is a proof-of-concept study that originated from the Bangkok Regional Office, and has been presented to the Asia/Pacific Regional ATM Contingency Plan Task Force.

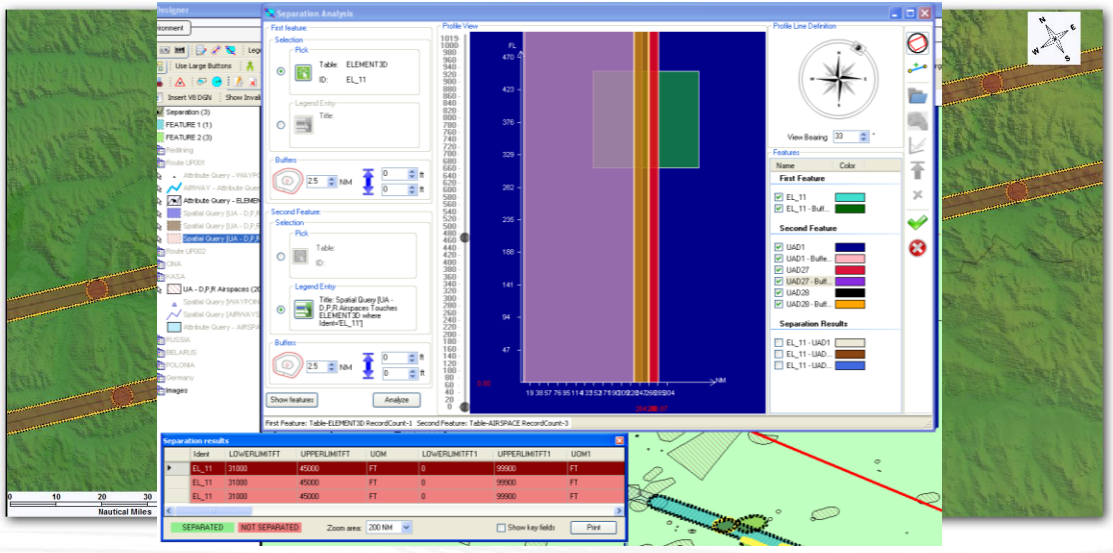


It is a contingency routing system for Southeast Asia /Australasian – Europe traffic in the event that airspace such as Afghanistan/Iran/Pakistan becomes unavailable.

The routes are expected to be designed to provide a north-of-the-Himalayas alternative, with appropriate consideration of the high terrain in terms of emergency descents, Special Use Airspace (SUA), and ATM problem areas.

Two near-parallel RNP2 routes nominally 20NM apart are proposed to allow maximum capacity and alternatives in the event of weather.

Design Methodology



Geodesic Great Circle paths between Kunming and Frankfurt

Parallel paths considering 20 nm separation

New waypoints every 200 nm on both paths with new airway segments in between each waypoint

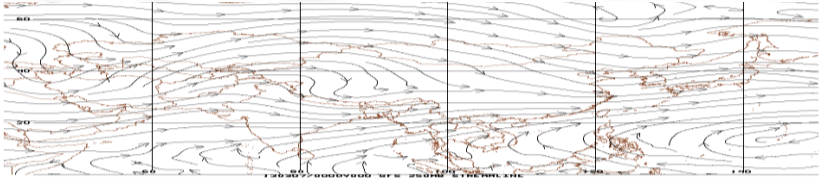
Construction of RNP 2 protection area for each airway segment

Terrain & Obstacles assessment of each protection area to find out each segment's Lower Limit, based on a MOCA (Minimum Obstacle Clearance Altitude) calculated using ICAO standard MOC (Minimum Obstacle Clearance) for the underlying terrain nature.

Lateral and Vertical interaction of Dangerous, Restricted and Prohibited Airspaces with each airway segment including its protection areas (and Lower/Upper Limits).

Other airspace structures assessment to find the MEA/MEL

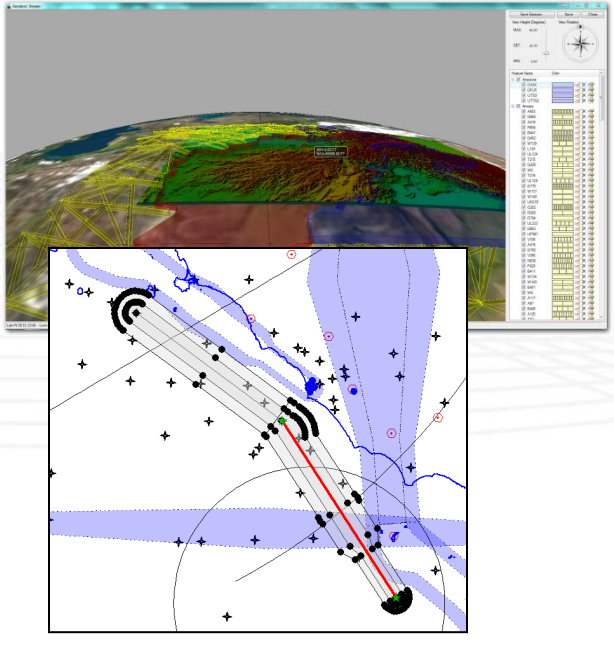
Empirical consideration of eventual Jet Streaming impact on the routes at FL 310



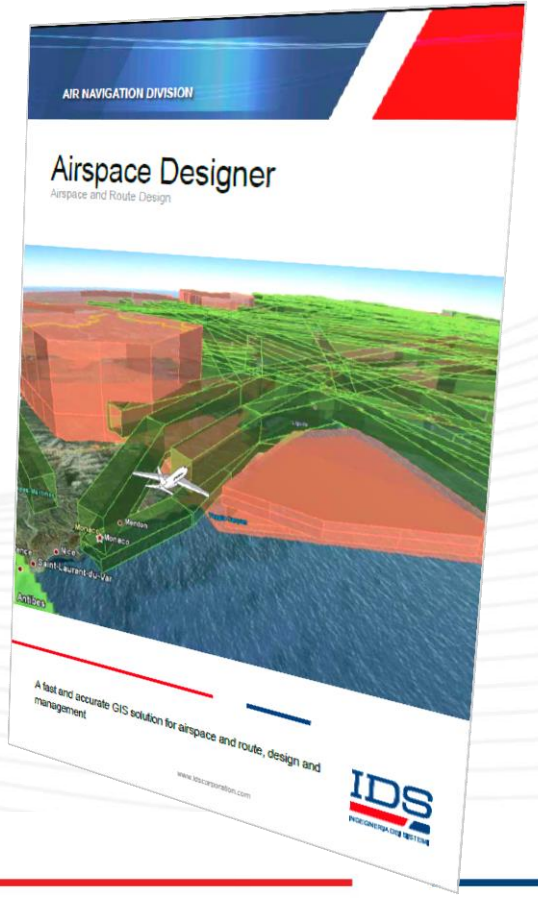
Design Tools

IDS Airspace Designer

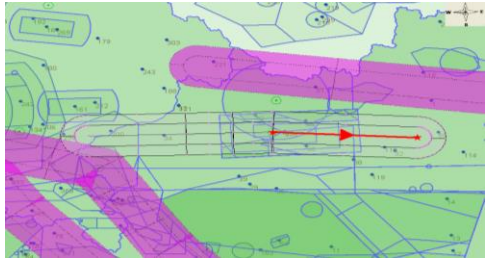
The fast and accurate GIS solution for airspace and route, design, and management



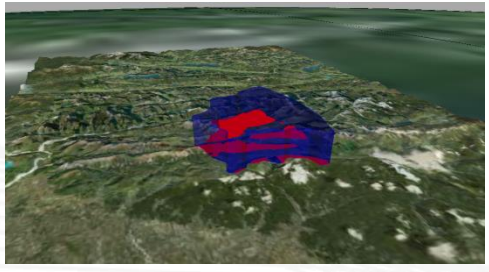
- Design, visualization, and validation of airspace structures:
  - Airways
  - Waypoints
  - Airspaces
- Sectorization
- Civil/Military Coordination
- AIXM v5.1 Compliant
- Compatibility with Fast Time Simulation



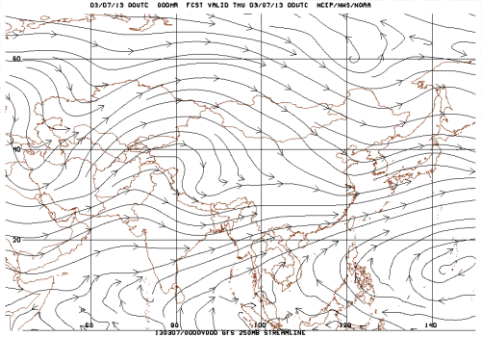
Data Sources



ATS Geography – Aerodromes, Waypoints, NAVAIDS, Routes, Airspaces,
European AIS Database (EAD): AIXM Snap shot dated May 31, 2013
http://www.ead.eurocontrol.int/eadcms/eadsite/index.php.html

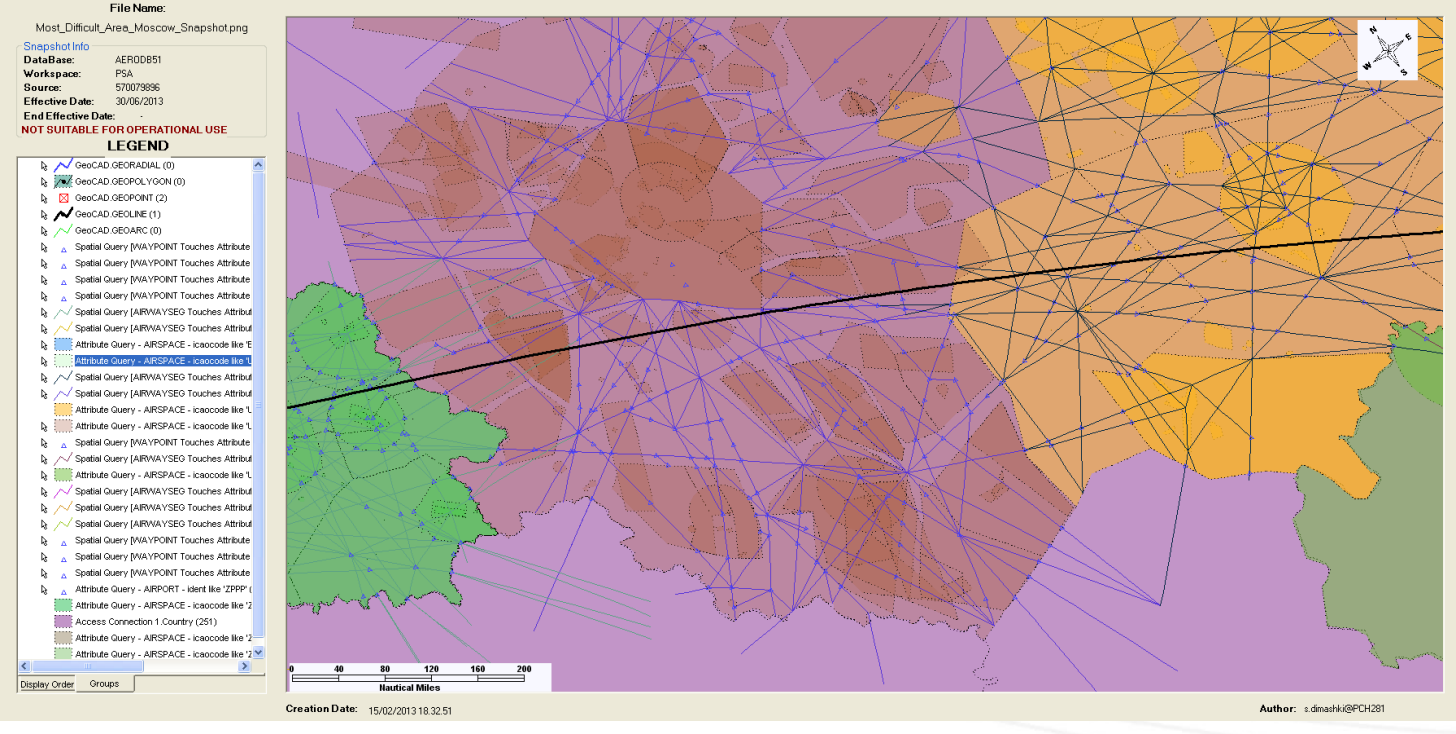


Terrain Data:
NASA/U.S. Geological Survey SRTM (Shuttle Radar Topography Mission) : DEM (Digital Elevation Model) files
http://dds.cr.usgs.gov/srtm/



Climatic Data (to estimate jet stream impacts)
NOAA (National Oceanic and Atmospheric Administration) GFS (Global Forecast System) : 250 Millibar streamlines: that is around FL310
http://mag.ncep.noaa.gov/gfs_area_param.php?model=gfs&cycle=20130304+00+UTC&area=asia

Live Demonstration



Future Design Work

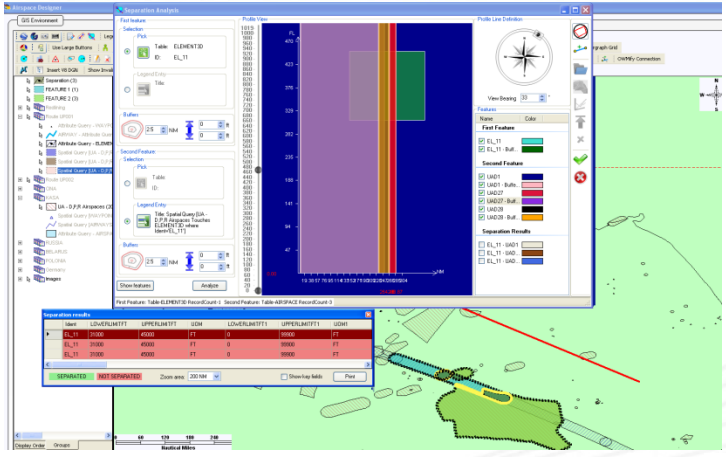
Identifying the optimum Silk Road endpoints i.e. entrances into intra-regional networks

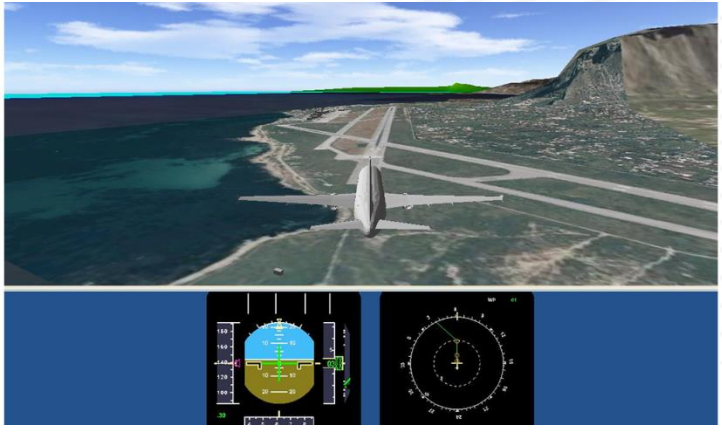
Adjustments as necessary in coordination with state authorities to deconflict the route

Utilizing the appropriate Magnetic Variation models for calculating route segment bearing along the whole path

Route flyability & Ground Validation next to Navigation Requirements.

Enhance the empirical climatic consideration up to analytical process





Considerations

It is recognised that the Silk Road routes may not be as efficient on a daily basis as UPR or DARP, but in higher density airspace or airspace where military or State restrictions do not allow tactical re-routes, the Silk Road initiative may provide the most efficient option.

It is possible that a number of high density highways between any two major population centres could be developed to provide alternative options for airlines that seek to take into account factors such as wind and over flight charges/approvals.

While being initially proposed as a contingency routing system, the concept could be expanded to regular use and other regions

A key will be each State agreeing to provide the same levels of service and priority for aircraft operating on the PBN Highway.

This level of service is an attempt to match the ground and airborne capability/performance , and provide certainty of service to benefit the airlines.

Silk Road Sanity Test

The Basics

Does Silk Road provide improvements over the current routing with respect to total distance and fuel usage?

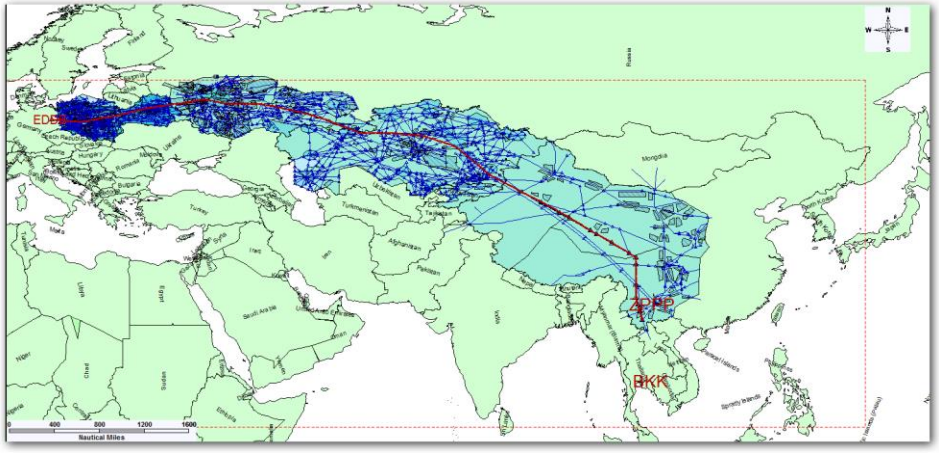
Scenario One

Silk Road as a direct route between Kunming and Frankfurt

Scenario Two

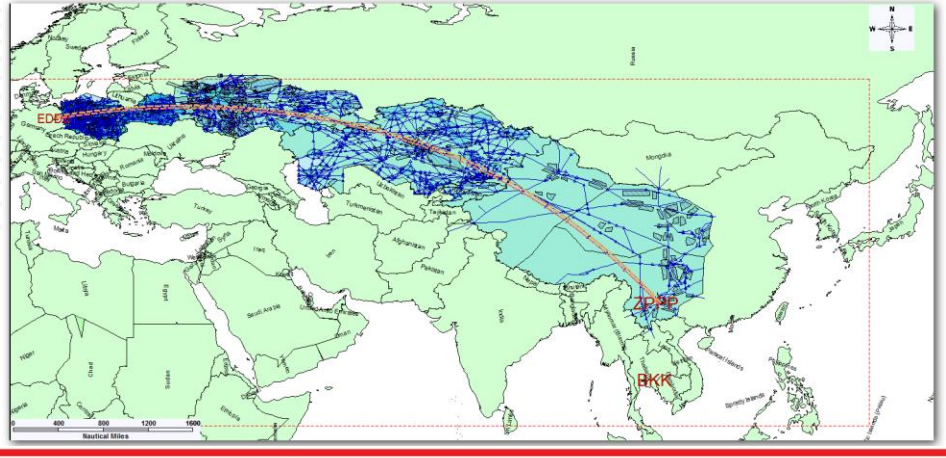
Silk Road as a regional contingency route being utilized for a route between Bangkok and Frankfurt

Kunming to Frankfurt Analysis



KMG – FRA Using Existing Routing

Total Distance: 4455 nm

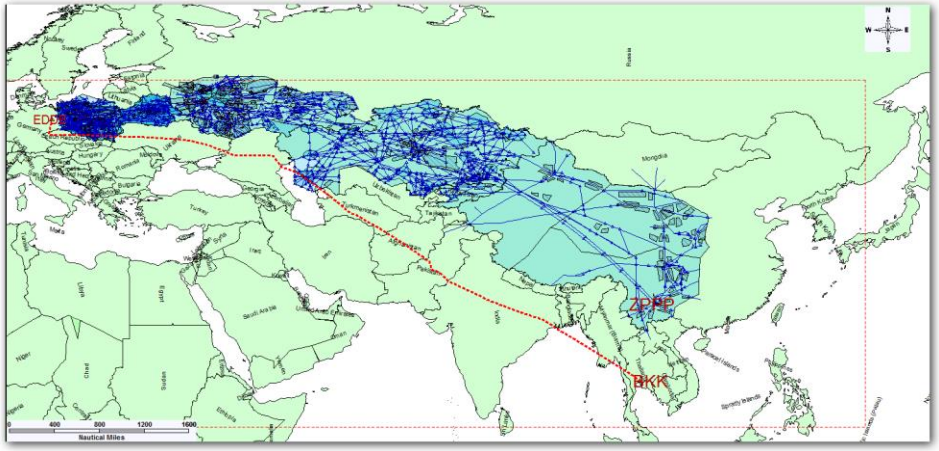


KMG – FRA Using Silk Road

Total Distance: 4210 nm

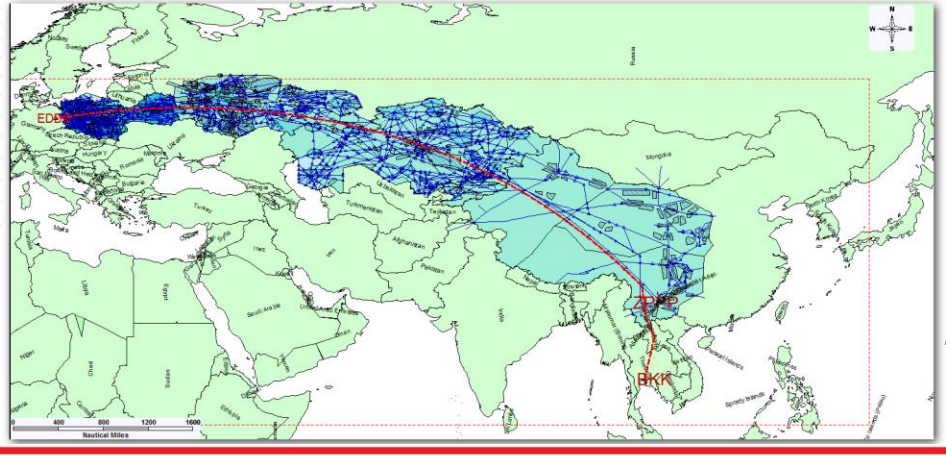
Difference: 245 nm

Bangkok to Frankfurt Analysis



BKK – FRA Using Existing Routing

Total Distance: 4999 nm



BKK – FRA Using Silk Road as Contingency

Total Distance: 4860 nm

Difference: 139 nm

Silk Road is not only a viable contingency, but a potentially superior primary route, thereby supporting the concept of inter-regional PBN highways

Next Steps - Fuel Usage

IFSET

The ICAO Fuel Savings Estimation Tool

The ICAO Fuel Savings Estimation Tool (IFSET) has been developed by the Secretariat with support from States and international organizations to assist the States to estimate fuel savings in a manner consistent with the models approved by CAEP and aligned with the Global Air Navigation Plan.

As a next step, an estimation of the fuel savings should be conducted. The ICAO IFSET tool has been selected to perform this analysis. Will ICAO HQ support IDS in performing this analysis?

Conclusion

Proof of Concept

Silk Road has demonstrated the technical feasibility and the potential economic and environmental benefits of PBN Highways

Transferable Results

PBN Highways is a transferable concept which can be rolled out to all regions to achieve the same results

What can ICAO HQ do to support this initiative?

Provide HQ direction and support to the Regional Offices for inter-regional development of the Silk Road proof-of-concept initiative PBN Highway concept

Expedite the adoption of the RNP2 standards – Doc 8168 & 4444 (and most importantly, approval process for aircraft) so they are available by November 2014, after which it is possible that Silk Road operational trials could begin

International Civil Aviation Organization

The First Meeting of the APANPIRG ATM Sub-Group (ATM /SG/1)

Bangkok, Thailand, 20 – 24 May 2013

Agenda Item 9: Any other business (including Election of Officers)

IFSET EXAMPLE TO DEMONSTRATE POTENTIAL ENVIRONMENTAL BENEFITS

(Presented by the Secretariat)

SUMMARY

This paper presents an example of how using the IFSET tool to provide potential environmental benefits.

This paper relates to –

Strategic Objectives:

C: ***Environmental Protection and Sustainable Development of Air Transport*** – *Foster harmonized and economically viable development of international civil aviation that does not unduly harm the environment*

Global Plan Initiatives:

GPI-21 Navigation systems

1. INTRODUCTION

1.1 ICAO has been stressing the importance of operational measurements to demonstrate the positive work conducted within the aviation sector to reduce its effect in the environment. Aside from the improvement in aircraft technologies and market-based measures, one of the key areas of focus is ATM as an instrument available to States to improve fuel efficiency and reduce CO2 emissions. The ICAO Fuel Savings Estimation Tool (IFSET) has been developed by ICAO with support from States and international organizations to estimate fuel savings in a manner consistent with the Global Air Navigation Plan.

1.2 The IFSET is not intended to replace the use of detailed measurement or modeling of fuel savings, where those capabilities exist. Rather, it is provided to assist those States without such facilities to estimate the benefits from operational improvements in a harmonized way. The tool is available at http://www.icao.int/environmental-protection/Pages/Tools.aspx.

1.3 The Silk Road initiative was a proof-of-concept ATS route study. The initiative had been presented to the Regional ATM Contingency Plan Task Force (RACP/TF) as a possible future contingency system north of the Himalayas for traffic previously operating on Major Traffic Flow (MTF) AR-4 via South Asian airspace between Europe and Southeast Asia. The Silk Road concept is a pair of ATS routes spaced at least 20NM apart, utilising RNP 2, RNAV 2 or RNAV 5 Performance-based Navigation (PBN) navigation specifications.

2. DISCUSSION

2.1 To date, the input by Asia/Pacific States of IFSET data has been poor. Given the increasing traffic of the Asia/Pacific Region towards being the busiest in the world, there is an urgent need for the Asia/Pacific to demonstrate its contribution and commitment to environmental improvements.

2.2 In developing the possibilities and rationale of the Silk Road concept, early consideration was made of the environmental effect of any contingency operation utilising a Silk Road. While the potential route directions of the Silk Road routes had not been determined with any certainty, one possibility is the application of these 'PBN Highways' between Kunming, China and Frankfurt, Germany as close as possible to the great circle.

2.3 A comparison of an example flight from Bangkok, Thailand to Frankfurt, Germany that would normally operate south of the Himalayas through Indian, Pakistan and Afghanistan airspace on MTF AR-4 routes and the Silk Road concept via Kunming yielded some surprising results. The Silk Road 'contingency' route system at 4,999NM was determined to be approximately **139NM** or 18 minutes shorter than the traditional route system at 4,860NM (**Figure 1**).

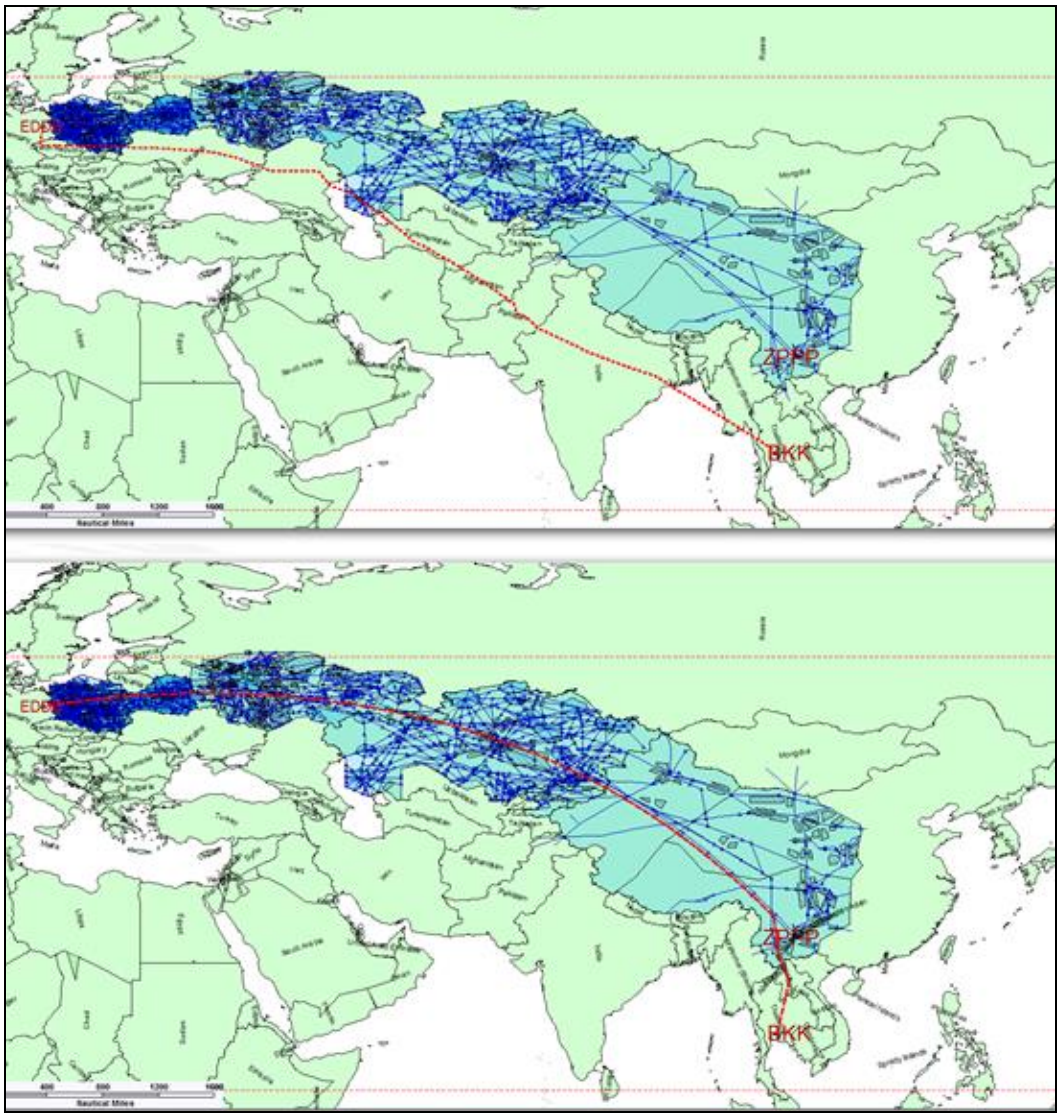


Figure 1: MTF AR-4 route compared with a possible Silk Road route north of the Himalayas

2.4 In utilising the IFSET tool for a contingency scenario with the Kabul FIR being unavailable, an assumption of 200 aircraft westbound was applied. Also, an assumption was made that the average aircraft would achieve a flight level of FL360 compared to FL340, due to the application of a more efficient longitudinal spacing (assumed 25NM versus 50NM), allowing aircraft to operate closer to their optimal level.

2.5 In making these assumptions, it is recognised that flights from Indo-China, Southern China, The Philippines, and Indonesia may achieve much greater savings than the Bangkok-Frankfurt example, while there may be a marginal difference from Malaysia and Singapore. The results are indicated in **Figure 2**.

Estimated Fuel Changes Report

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Scenario	Old Fuel Consumption (Kg)	New Fuel Consumption (Kg)	Savings (Kg)	Savings (%)
Silk Road	7933300	7596800	-336500	-4.2

Note - Results are rounded to the nearest 100 Kg.

Figure 2: IFSET Scenario Estimate

2.6 The greater savings from Southern China are demonstrated in a comparison of route length of a flight from Kunming to Frankfurt using the traditional route L888 (4,455NM) versus the Silk Road concept (4,210NM), the latter being shorter by 245NM (**Figure 3**).

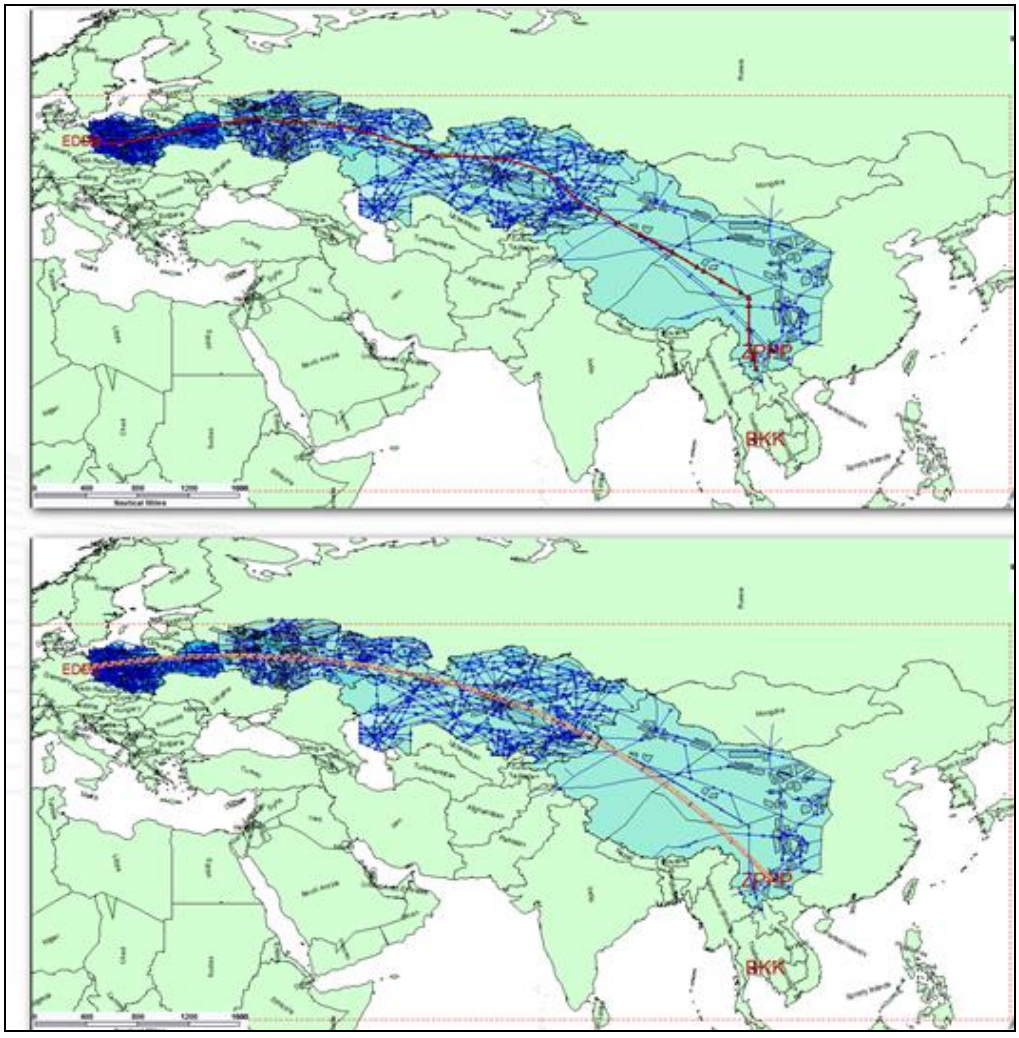

Figure 3: Kunming to Frankfurt comparison using L888 versus Silk Road

2.7 The IFSET results indicated a savings of approximately 1,682kg per aircraft, or 336,500kg per day. Given that eastbound aircraft can also benefit to the same degree, the total daily savings for 400 aircraft would be 673 tonnes of fuel, or 245,645 tonnes per annum.

2.8 Although the IFSET tool does not yet calculate the savings in terms of Carbon Dioxide (CO_2) or monetary values, these can be estimated manually.

2.9 For the CO2 savings, this would be equivalent to 776,238 tonnes per annum using an approximate multiplier of 3.16 from the fuel value.

2.10 Regarding the monetary savings in this scenario, if it is assumed that a barrel equivalent of kerosene (approximately 140kg) was USD125, then each aircraft would save 1,682 ÷ 140 = 12 barrels x 125 = USD1,500. The total daily and annual savings if we consider the whole operations of 400 aircraft/day would be USD600,000 and USD219 million respectively in this assumed scenario.

2.11 The IFSET calculations provide a powerful result for decision-makers in considering the relative costs and benefits of the Silk Road concept, and other ATM projects. In addition, the calculation from ATM improvement projects that become reality provide important indications of the work the aviation community is conducting to reduce the overall effect of aviation on the environment. This would inevitably assist in reducing pressure from external agencies for political solutions imposed unilaterally to reduce emissions.

IATA Peer Review

2.12 A peer review of the basic analysis provided in this paper was conducted by IATA, using the known assumptions provided by ICAO:

- distance saving (139NM);
- Total number of flights 200 in each direction, total 400 daily flights (eastbound + westbound).

2.13 The crosscheck using the IATA Infra Calculator resulted in the following (**Figure 4**):

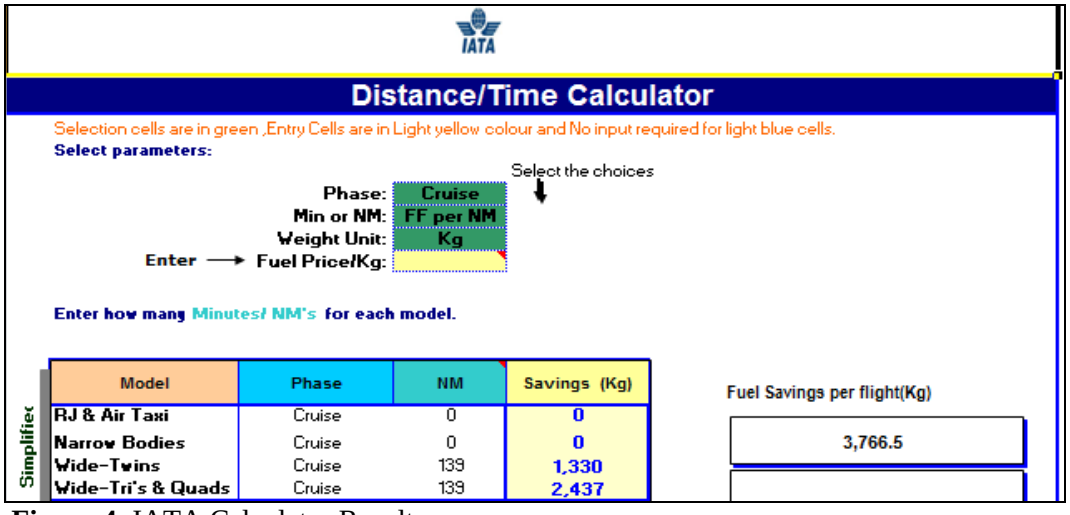

Figure 4: IATA Calculator Results

2.14 Assumption: Based on our observation, these are long haul flights and two thirds of the operations will be by Wide Twins, while one third will be by Wide Quads. Therefore, average fuel Savings with 139NM distance reduced = ((1330*(66%))+ (2437*(33%))= 1,682Kg.

2.15 The results indicated a savings of approximately 1,682kg (agreed) per aircraft, or 336,500kg per day (1682*200 = 336400 Kg, perhaps figure rounded to next thus 336,500Kg). Given that eastbound aircraft can also benefit to the same degree, the total daily savings for 400 aircraft would be 673 tonnes of fuel (1682*400 = 672, 800Kg, here also figures seems rounded up thus 673 Tones) or 245,645 tonnes per annum.

2.16 For the CO2 savings, this would be equivalent to 776,238 tonnes per annum using an approximate multiplier of 3.16 from the fuel value.

2.17 For ATF the conversion factor is 3.15 and not 3.16; estimated CO2 emissions savings = 245,645*3.15= 773,782 tonnes per annum.

2.18 Regarding the fuel price analysis contained within this paper, and noting the current analysis at (http://www.iata.org/publications/economics/fuel-monitor/Pages/price-analysis.aspx, the first row shows Jet Fuel price as 897.2 USD/MT, resulting in annual savings of 245,645 tonnes @ 897.2 = 220 Million USD.

IATA Conclusions

2.19 The following are IATA's conclusions for this scenario.

1. Based on the 139NM Distance Saving, IATA Infra Calculator estimates on An average 1,682Kg Fuel savings per flight.

2. Fuel Saving estimates based on 200 flights in each direction (Tot 400 daily flights) – I cannot get data for these flights at this point of time, but a rough estimate like from Key airports in Europe (LHR, FRA, CDG, AMS, MUC, MAN, Berlin, GVA, Say 10 European airports, and BKK, SIN, ZPPP, Philippines, Noibai, JKT, etc so say 10 airports in South Asia, means estimate of 400 daily flights.

3. These flights operates on "Wind analysis - Route Search flight planning". As per my experience, Probability of Westbound flights choosing North of Himalayas routes are more than that of South of Himalayas and vice versa for eastbound flights. Anyway, its wind component and detailed analysis is required to be carried out.

4. To begin with, there is possibility of 200 + flights daily may choose operating North of Himalayas, while the figure of 400 daily flights and 220 Mil USD Savings per year confirms potential of these routes and this potential cannot be denied.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper;

b) discuss the Silk Road example and any further uses of the IFSET tool; and

c) discuss any relevant matters as appropriate.

……