Germany - FRAMaK case study

ICAO

Template for good practice examples of environmental assessment (Draft V1.0)

Note: The italicized text is for guidance only and merely indicates the kind of information that is likely to be of value for users of the ICAO assessment guidance. You do not need to cover all points if some are not applicable to your case study.

Organisation/Company*: (The name of the body that undertook or sponsored this assessment)*

Project Title: *(The title of the project being assessed)*	Date of Assessment:
Free Route Airspace Maastricht and Karlsruhe (FRAMaK), SESAR Live Trial and Demonstration Activity	31/07/2014 (Final Report Publication)

ASBU Module Code(s)[1]:	State's Action Plan[2]:
FRTO	-/-

Project Description: *(Briefly describe the project or proposed operational change to be assessed for its environmental implications; Please when possible, use schematics for illustration.)*

FRAMaK[3] (Free Route Airspace Maastricht and Karlsruhe, a joint project of DFS Deutsche Flugsicherung GmbH, Deutsche Lufthansa AG and EUROCONTROL Maastricht UAC, funded by the SESAR Joint Undertaking in the course of SESAR Live Trial and Demonstration Activities, JUNE 2012 – MAY 2014) demonstrated the benefits of Cross-Border Direct Routes (DCT) by means of RAD (Route Availability Document) App 4 published DCT routeing options publicly available for flight operations.

In Live Trials (62 revenue flights) the benefits and impacts of Free Route operations based on User Preferred Routeings were demonstrated.

Reason for the environmental assessment: *(Explain why the environmental assessment was undertaken and, if applicable, include any specific regulation, policy, or rule that requires the assessment to be undertaken)*

The assessment took place in the framework of a SESAR Live Trial and Demonstration Activity. Complementing the SESAR working programme these Live Trial and Demonstration shall pave the way for the deployment of advanced concepts and technologies in order to reach the SES Performance Targets. Since it has been an originary aim of the FRAMaK project to demonstrate (also environmental) benefits the assessment was intended from the very beginning.

Client or competent Authority: *(Explain which body the assessment will be submitted to for their approval or decision making. Was the assessment internal or public? What audience is it intended to inform?)*

The assessment has been internal (within the project).

The results were submitted as a Demonstration Report to the SESAR Joint Undertaking (SJU), reviewed and approved from the SJU.

Through communication activities interested ATM stakeholders (ANSPs, Airline Operators) have been and still are

[1] **APTA**-Approach procedures including vertical guidance; **WAKE**-Wake vortex; **RSEQ**-AMAN / DMAN; **SURF**-A-SMGCS, ASDE-X; **ACDM**-Airport CDM; **FICE**-Increased efficiency through ground - ground integration; **DAIM**-Digital AIM; **AMET**-Meteorological information supporting enhanced operational efficiency; **FRTO**-En route Flexible Use of Airspace and Flexible routes; **NOPS**-Air Traffic Flow Management; **ASUR**-ADS-B satellite based and ground based surveillance; **ASEP**-Air Traffic Situational awareness; **OPFL**-In-Trail procedures (ADS-B); **ACAS**-ACAS improvements; **SNET**-Ground based safety nets; **CDO**-Continuous Descent Operations, PBN STARs; **TBO**-Data link en-route; **CCO**-Continuous Climb Operations

[2] http://www.icao.int/environmental-protection/Pages/action-plan.aspx

[3]

Created by DFS Deutsche Flugsicherung GmbH, Deutsche Lufthansa AG and EUROCONTROL for the SESAR Joint Undertaking within the frame of the SESAR Programme co-financed by the EU and EUROCONTROL.

informed about the project's outcomes.

Assessment Approach: *(This section asks for a brief description of your application of the ICAO guidance for each main assessment step. If a step was not undertaken, give a brief explanation of why the step was omitted or is not applicable to this assessment example. Please complete each section individually. In this box you can explain why the ICAO approach to assessment was chosen. If you did not apply the ICAO methodology, please explain how your methodology differed from the ICAO approach.)*

In addition to the more generic ICAO approach the project was requested also to follow SESAR guidance for Performance Assessment (SESAR WP B.04.01) and Environmental Impact Assessment (SESAR WP 16). The EIA processes and steps of SESAR and ICAO are very similar. Both assessments were part of the demonstration activities outlined above.
In preparation of the demonstration the project elaborated a Demonstration Plan (as a contractual deliverable subject to review/assessment by the SESAR Joint Undertaking) and a Performance Assessment Plan which provided detailed information on Key Performance Areas (KPAs) addressed by the demonstration (here primarily [Horizontal] Flight Efficiency and Environmental Sustainability), the related Key Performance Indicators (KPIs), and the metrics representing these KPIs. Details were provided about the validation techniques applied in different phases of the demonstration as well as data collection and data processing needs and the statistical approach (methodology).

Preparatory Work: *(Briefly explain the relevant background activities that have been undertaken to prepare for the assessment. This may include decisions or processes such as, deciding that an environmental assessment is required, identifying the assessment client, gathering base data, deciding on years to be assessed, deciding on assessment methods or standards to be applied. There is no need to cover all possible information, simply provide a sufficient explanation of the reasons why the assessment steps and approach were selected. How did you establish which rules, regulations, or standards applied to the assessment?)*

As stated above as a SESAR Live Trial and Demonstration Activity it was the aim of the project to demonstrate the benefits of Free Route operations in terms of Flight Efficiency (route length, route length extension) and Environmental Sustainability (fuel burn and CO2); as such the environmental impact assessment has been an originary objective of the FRAMaK project.
Being a SESAR Live Trial and Demonstration Activity the project was requested to follow SESAR guidance for Performance Assessment (SESAR WP B.04.01) and Environmental Impact Assessment (SESAR WP 16). As far as available and applicable in the context of FRAMaK demonstrations the guidance has been followed respectively. If necessary minor modifications have been added; measurements not covered by SESAR Guidance were accomplished based on project partners' best practices.

Describe the proposed [operational] change, its purpose and alternatives: *(Explain what will change as a result of the proposal to be assessed – this may repeat the information in the earlier project description. Explain why this project is required and what purpose it serves, and what alternatives have been considered. Information on why these alternatives were rejected is useful but not essential)*

The overall objective of the project was to demonstrate that cross-border Free Route capabilities extending over multiple ANSP areas of responsibility (AoRs) with a very complex airspace structure comprising several major hubs and an extremely high traffic density can be realized and that these capabilities have positive impact on the KPAs Efficiency and Environmental Sustainability.

The project's aim was to develop and demonstrate solutions for Airline Operators' Flight Plan filing, airspace regulation publications, ANSP procedures, system adaptations, connection with sub- and adjacent fixed route systems etc. to achieve its goals in view of the short-term capabilities of involved stakeholders in the timeframe of the project. Furthermore, the solutions were to be suitable for a common and generic application, available to all types of GAT flights, and ready for expansion over other areas

In an iterative approach comprising Fast Time Simulations (FTS), Real Time Simulations (RTS), Flight Trials (FT) and in-depth route analyses by an Airspace User (DLH) the project was going to achieve an acceptable balance between Flight Efficiency and Capacity requirements, while maintaining or improving the current safety standard and without hampering Military Mission Effectiveness.

For Aircraft Operators, the project should allow for an increase in Efficiency and Environmental Sustainability of airline operations. Thus, positive cost effects with regard to fuel consumption, aircraft flight hours and with regard to the regulations of the European Union Emissions Trading Scheme (EU ETS) were expected.

From the ANSPs' perspective the project should contribute to the Efficiency targets of the overall network as well as to the Environmental Sustainability of the European ATM system. Furthermore, the stability of the overall network was to be improved which would reduce downstream disruptions. The general effects of the Free Route Airspace concept on capacity in high density areas should form a key investigation area.
The project aimed for cross-border route designs which foster adequate and reliable capacity planning. Clearly and especially within the process of route design development and its demonstration by means of flight trials, capacity degradations violating capacity demands were precluded. From the very beginning this constraint was taken into account in the initial demonstration plan.

In particular, the SESAR FRAMaK Project had the following goals:

- demonstrate that Free Route is feasible across national and ANSP boundaries in a complex and high traffic density environment,
- demonstrate that a user preferred trajectory is feasible across national and ANSP boundaries in a complex and high traffic density environment,
- determine conditions for a realistic and stepwise transition towards a large cross border Free Route Airspace,
- validate the benefits and impacts of the Free Route Airspace solution with the customers,
- provide a Free Route Concept and Route design ready for implementation
- As mentioned earlier the project aimed for gains in the Key Performance Areas Efficiency and Environmental Sustainability

while the effects on Capacity had to be carefully evaluated.

The project should elaborate solutions related to operational requirements allowing for direct routing/free routing and user preferred profiles within the airspace of Maastricht UAC (MUAC) and Karlsruhe UAC (KUAC). Initial steps should be accomplished for a Free Routing Airspace within which users can freely plan their routes between an entry point and an exit point with or without reference to the Air Traffic Services (ATS) route network.
Concerning the User Preferred Route flight trials, as a starting point defined waypoints within the Free Route Airspace were considered as still being used to enable flyable routings for the on-board Flight Management

Systems (FMS). The Airspace User was supposed to freely choose either a direct routing between an entry and exit point of choice or to use existing waypoints in between which allow for a routing as close as possible to the most efficient one. No restrictions regarding ATS routes or specific sequences of these waypoints were assumed to be necessary.

The project aim was not only to deal with areas or times with less dense traffic, but to also include busy areas like KUAC Centre or MUAC within higher traffic time periods. Therefore, it had to consider both ATM restrictions on the one side and airline operators' (AO) needs on the other.

Describe the scope and extent of the assessment: *(How was it decided that this assessment was needed – "screening". Describe the impacts to be assessed, for example, aircraft noise, CO_2 or NOx emissions, climate impacts or air quality impacts. Explain the decision making process that determined this scope and the level of detail to be used in the assessment – "scoping". Also describe any formal processes to consult upon or agree on the scope, for example, via a nominated competent authority if applicable. Explain, for example, if the scope was set using expert judgement or a pre-assessment checks or information gathering. Also describe how the decision to undertake a more detailed assessment, or not, was taken. How were the base-case and proposed case(s) determined, why were particular years chosen?)*

The demonstration should bring evidence that cross-border Free Route capabilities extending over multiple ANSP AoRs can be realised and that these capabilities lead to significant benefits for the Airspace Users, measurable in the Key Performance Areas Efficiency, and Environmental Sustainability.
The geographical scope of the project entailed the combined AoRs of Karlsruhe UAC and Maastricht UAC located in the Brussels UIR, Amsterdam FIR, Hannover UIR and Rhein UIR. Thus, the demonstration comprised a very complex airspace structure and a traffic density, which is under the highest of the world, serving major traffic streams and major European hubs.
In the course of this demonstration, solutions for AO Flight Plan filing, airspace regulation publications, ANSP procedures, system adaptations, connections with sub- and adjacent fixed route systems, etc. were to be developed. These items should be available for future operational usage also in terms of a common and generic application which is ready for expansion over other areas and applicable for all types of GAT flights.

Dealing with two innovative operational capabilities FR-CAP-01 (Cross-Border Direct Routings) and FR-CAP-02 (Cross-Border User Preferred Routings) for demonstrating the benefits and impacts associated with these capabilities the FRAMaK project envisaged two main demonstrations:

- Public Live Trials (EXE-0201-D001) demonstrating the benefits and impacts of Cross-Border DCT operations based on flights using publicly available DCT routing options published in RAD Appendix 4. The DCT routing options were elaborated in the course of 11 so-called "Route Design Workshops" which lead to the definition of implementation packages. Those packages have been published in successive AIRAC cycles, starting in October 2012 and ending in March 2014. In Table 16 below AIRAC 1211 (effective 18 OCT 2012) is considered to be the start date of the exercise execution.
- Flight Trials (EXE-0201-D006) demonstrating the benefits and impacts of Cross-Border UPR operations by execution of 62 revenue flights of DLH using a User Preferred Routing.

With regard to FR-CAP-01 additional demonstration activities have been executed in order to achieve complementary results:

- EXE-0201-D002 analysed the potential benefits of Cross-Border DCT routings based on SAAM Network Assessments. This type of analysis is the usual way in which Free Route Airspace projects and initiatives assess the benefits. Thus, in order to compare the outcome of FRAMaK with those of other projects this demonstration activity was foreseen.
- Cross-Border DCT routing options affecting the Karlsruhe UAC Core Area have not been made publicly available by publication in RAD Appendix 4 without prior analysis of operational feasibility by means of Real Time Simulations.
  To demonstrate the potential benefits and the operational feasibility two demonstration activities complemented the Public Live Trials with regard to the Karlsruhe UAC Core Area:
    - EXE-0201-D003 analysed the potential benefits and operational impacts of Cross-Border DCT routing options affecting the Karlsruhe UAC Core Area by means of Fast Time Simulations (SAAM

and AirTOp).
    - EXE-0201-D004 analysed the operational feasibility of Cross-Border DCT routing options affecting the Karlsruhe UAC Core Area by means of a Real Time Simulation. Additionally, specific simulation runs focussed on safety aspects.
- Similarly, Cross-Border DCT routing options affecting the Maastricht UAC Core Area have not been made publicly available by publication in RAD Appendix 4. In EXE-0201-D005 those DCT routing options have been analysed regarding their operational feasibility in a Real Time Simulation.

Describe the assessment itself: *(Describe any standards or mandatory requirements for the assessment to be undertaken together with the methodology, monitoring or model used to determine the extent of the environmental impacts for the proposal. Give an indication of the extent or time-horizons that were chosen (if not already described earlier). Was quality management applied? For example, was there a process to ensure that the input data for the environmental assessment was consistent with other parallel assessments? Were interdependencies encountered and how did you address any trade-off issues? Was the expertise for this assessment available from internal resources or procured externally?)*

Being a demonstration activity not starting from scratch but based on former Free Route activities like FRAM and FRAK there was no need for a solely sequential approach. Thus, the analyses subsequent to the route design and the network assessment, i.e. whether to accomplish a FTS, a RTS or a combination of both, was depending upon the operational conditions to be considered and investigated. Therefore, it was possible that if mature background knowledge was available from former activities FRAM and/or FRAK new FRAMaK DCTs were published without preceding FTS (in excess of mandatory SAAM route validations prior to RAD publication) or RTS. At KUAC side simulation-based analyses in particular dealt with the so-called Karlsruhe Central sectors which form the maximum density airspace covering southwest Germany.
The validation of the FRAMaK operational concept with regard to FR-CAP-01 and FR-CAP-02 comprised the following validation activities:

Activity	Objective
SAAM Network Assessment EXE-0201-D002	To study FRAMaK DCT routing proposals with regard to connectivity to adjacent/subjacent airspace, resulting traffic flows etc. and to analyse potential benefits.
KUAC Central FTS **SAAM/NEST Assessment** EXE-0201-D003	To study FRAMaK solutions for KUAC Central Sectors with regard to connectivity with adjacent westerly airspace in context of other FABEC activities (IP LUX, CBA Land/West); this FTS will be used as basis for the AirTOp FTS.
KUAC Central FTS **AirTOp** EXE-0201-D003	To study FRAMaK solutions for KUAC Central Sectors in specific sectors with regard to sector load at crossing points, workload; this FTS will be used as basis for the KUAC Central RTS.
KUAC Central RTS EXE-0201-D004	To study FRAMaK solutions for KUAC Central Sectors in a real time simulation.
MUAC RTS EXE-0201-D005	To study FRAMaK solutions in high density airspace of MUAC AoR.
Live Trials EXE-0201-D001	To study AEM scenario economy (distance, time, fuel burn, CO_2, NO_x), attractiveness of route options (change of traffic flows) in real life operations based on FPLs and track information.

EXE-0201-D006	To study operational impact on ANSP side.
	To study impact on flight efficiency based on real life flight planning data and a/c system data. To study operational impact on AO side (dispatch & flight crew).

With regard to EXE-0201-D001 data analyses has been accomplished based on flights within 4 measurement periods which were referenced against the respective period in the previous year. For measurement period 4 a second comparison has been accomplished with the respective period two years before which allows for a full comparison between the periods before and after FRAMaK DCT implementations.

Period	Time	Reference
MP1	2013, Week 12, 18/03-24/03/2013	2012, Week 12, 19/03-25/03/2012
MP2	2013, Week 26, 24/06-30/06/2013	2012, Week 26, 25/06-01/07/2012
MP3	2013, Week 44, 28/10-03/11/2013	2012, Week 44, 29/10-04/11/2012
MP4	2014, Week 12, 17/03-23/03/2014	2013, Week 12, 18/03-24/03/2013
MP4b	2014, Week 12, 17/03-23/03/2014	2012, Week 12, 19/03-25/03/2012

Within the measurement period and the reference period respectively comparisons have been accomplished for

- complete weeks (MON – SUN), and
- weekends (SAT + SUN).

FPL and track data (CPF) for data analysis were collected according to the following steps:

- Within each measurement period flights were identified which filed at least one FRAMaK DCT.
- Based on the collection of flights within the measurement period flights of the reference period were identified according to predefined matching criteria.

Doing so, the database for data analyses contained only flights operated during the measurement period and with a FPL comprising at least one FRAMaK DCT.
As a result the database comprised the number of flights shown hereafter:

Measurement Period		Flights in FRAMaK area	Flights filed DCT
		number	number
MP1	Complete Week	49,002	2,992
	Weekend	13,747	1,071
MP2	Complete Week	61,486	4,743
	Weekend	17,179	1,656
MP3	Complete Week	59,557	4,758
	Weekend	16,161	1,611
MP4	Complete Week	55,395	4,802
	Weekend	14,871	1,596
Total	Complete Week	225,440	17,295
	Weekend	61,958	5,934

For comparisons between measurement periods and reference periods flights were further filtered according to the aforementioned matching criteria.

EXE-0201-D006 had a focus on the Airline Operator's option of filing User Preferred Routes within the FRAMaK airspace (FR-CAP-02). In accordance with the FRAMaK Operational Procedure for Cross-Border User Preferred Routes Demonstrations and the FRAMaK - Cross-Border User Preferred Routes Demonstrations Test Plan Deutsche Lufthansa accomplished 62 UPR Test Flights on six citypairs Frankfurt – Stockholm, Frankfurt – Los Angeles, Frankfurt – Vancouver, and Munich – Manchester, Munich – Oslo, Munich – San Francisco.
The flight trials started in September 2013 and were completed in March 2014. From Dec 2013 an extended UPR Test Area, comprising parts of UK airspace as well as Danish, Norwegian and Swedish airspace could be used for the planning of User Preferred Routes.
Initially, UPR Flight Trials took place on weekends only. The usage of the NATS Scottish UIR airspace for UPR Flight Trials on transatlantic routes was limited to weekend only. In general, UPR Flight Trials within Europe and departing to USA and Canada, have comprised flights with STD not before 0900 UTC. The UPR Flight Trials within a month has been announced at least 7 days prior to each month by means of a monthly schedule. The schedule was sent by DLH to all affected parties. Based on the same samples, different analyses for other KPA than environment (safety, predictability, workload, capacity etc.) have been made. However, a weighting or a trade-off between them has not been made.

Describe the results and how they were communicated: *(Explain in general terms what the results of the assessment were, how this was used, for example to what extent it informed decision making or approval for the project. Was it produced as a draft for consultation or simply as a final report? Were the results validated or verified in any way – for example were the assessment processes or quality management processes independently audited? Did the results feed into a wider process, for example, a business case assessment?)*
Based on the analysis of FPL and track data of 17,295 flights within four measurement periods of each one week duration the results of the FRAMaK Cross-Border DCT Public Live Trials (EXE-0201-D001) provide evidence for the benefits of Cross-Border Direct routing options. Reductions of FPL route length (-6.8 NM per flight or -0.6%) and actual flown track length (-3.7 NM per flight or -0.3%) provide important contributions for the enhancement of ATM performance in terms of efficiency and environmental sustainability.

KPA	Success Criterion	Result of the demonstration
Efficiency (horizontal)	Reduction of FPL route length in Cross-Border DCT operations	Reduction by 6.8 NM per flight (-0.6%). For weekend traffic FPL routings have become shorter by 9.1 NM per flight (-0.8%).
Efficiency (horizontal)	Reduction of actual route length in Cross-Border DCT operations	Reduction by 3.7 NM (-0.3%) per flight. For weekend traffic actual flown routes per flight are 3.9 NM shorter (-0.3%).
Efficiency (horizontal)	Reduction of fuel burn in Cross-Border DCT operations	Based on FPL routings fuel burn decreased by 107.5 kg (-0.8%) per flight (weekend traffic: -145.1 kg / -1.1%). Based on actual flown routes fuel burn decreased by 56.4 kg (-0.4%) per flight (weekend: -95.3 kg / -0.7%).
Efficiency (horizontal)	Improvement of REDES (route efficiency regarding the directness towards the destination) in Cross-Border DCT operations	Based on FPL routings REDES was down to 1.035 by 0.4 percentage points (weekend: 1.037, -0.3 percentage points). REDES of actual flown routes decreased by 0.1 percentage points to 1.019 (weekend: 1.017 / -0.3 percentage points).

Efficiency (horizontal)	Improvement of RESTR (route efficiency regarding the directness towards the FRAMaK exit point) in Cross-Border DCT operations	Based on FPL routings RESTR was down to 1.018 by 0.6 percentage points (weekend: 1.016, -0.5 percentage points). RESTR of actual flown routes decreased by 0.2 percentage points to 1.007 (weekend: 1.006 / -0.2 percentage points).
Efficiency (vertical)	Reduction of fuel burn through use of DCTs offering optimized vertical profile	Reductions between 7 and 68 kg per flight.
Environmental Sustainability	Reduction of CO_2 emission in Cross-Border DCT operations	Based on FPL routings CO_2 emissions decreased by 339.8 kg (-0.8%) per flight (weekend traffic: -458.5 kg / -1.1%). Based on actual flown routes CO_2 emissions decreased by 178.1 kg (-0.4%) per flight (weekend: -301.0 kg / -0.7%).
Environmental Sustainability	Reduction of NO_x emission in Cross-Border DCT operations	Based on FPL routings NO_x emissions decreased by 2.9 kg (-1.3%) per flight (weekend traffic: -3.1 kg / -1.3%). Based on actual flown routes NO_x emissions decreased by 1.2 kg (-0.5%) per flight (weekend: -1.9 kg / -0.8%).
Predictability	Reduction of ENR variability in Cross-Border DCT operations	A reduction of ENR variability was not demonstrated. Other than to expected from improved route efficiency indicators REDES and RESTR ENR variability increased with many entry-exit pairs. This may be due to potential reductions of cruising speeds.
Predictability	Improvement of FPL adherence	An improvement of FPL adherence was not demonstrated.
Cost Effectiveness (Sectorization)	No adverse results regarding sector occupancy in Cross-Border DCT operations	No effect on route length per sector.
Cost Effectiveness (Sectorization)	No adverse results regarding sector occupancy in Cross-Border DCT operations	No effect on flight duration per sector.
Cost Effectiveness (Sectorization)	No adverse results regarding sector occupancy in Cross-Border DCT operations	No effect on number of sectors per flight.

Other – Operational Feasibility	Good eligibility of Cross-Border DCT routing options	Eligibility of flights for FRAMaK DCTs (based on shortest route option) is 15%, i.e. for 15% of flights in the FRAMaK area one or more FRAMaK DCTs have been available. In weekend traffic the eligibility is 10%.
Other – Operational Feasibility	Good acceptability of Cross-Border DCT routing options	8% of all flights in the FRAMaK files one or more FRAMaK DCTs (weekend: 10%). Based on the eligibility for FRAMaK DCTs 50% of flights made use of them. In weekend traffic more flights used a FRAMaK than technically eligible assuming the shortest route option.

These results were confirmed by EXE-0201-D002. The results of the SAAM Network Assessment show that – despite the high number of rather straight if not direct routing options already available prior to FRAMaK DCT demonstrations – the newly created FRAMaK Direct routing options provide a potential of more than 1.5 million NM route savings per year (4.2 NM per flight) corresponding to a potential reduction of fuel consumption of more than 9,000 tons (25 kg per flight) and a reduction of CO2 emission of more than 30,000 tons (83 kg per flight). Thus, if airline operators make use of the new FRAMaK Direct routing options they might save up to 7.5 million Euro per year which are the estimated direct cost savings caused by fuel consumption, not taking into account potential but individual indirect cost benefits due to less flight time affecting maintenance, staffing etc.

KPA	Success Criterion	Result of the demonstration
Efficiency (horizontal)	Reduction of FPL route length in Cross-Border DCT operations	Potential reduction by 1,512,163 NM per year (weekend: 665,096 NM per year). Average reduction of FPL route length by 4.15 NM (weekend: 5.48 NM) per flight. Potential reduction of route extension from 2.01% to 1.70% during summer week, from 1.96% to 1.67% during winter week.
Efficiency (horizontal)	Reduction of fuel burn in Cross-Border DCT operations	Potential reduction by 9,072,976 kg per year (weekend: 3,990,574 kg per year). Average reduction by 25 kg (33 kg) fuel per flight.
Environmental Sustainability	Reduction of CO_2 emission in Cross-Border DCT operations	Potential reduction by 30,243,252 kg CO_2 per year (weekend: 13,301,912 kg per year). Average reduction by 83 kg (weekend: 110 kg) CO_2 per flight.
Capacity	No degradation regarding number of flights in Cross-Border DCT operations	No negative effects
Capacity	No adverse results regarding ENR Throughput in Cross-Border DCT operations	No negative effects

Other – Operational Feasibility	Good eligibility of Cross-Border DCT routing options	Complete Week	Summer	22.5%
			Winter	21.4%
		Weekend	Summer	18.9%
			Winter	17.5%

The so-called Vertical Optimisation Directs, i.e. DCT routing options which were designed for improved vertical profiles by allowing for a late descent, have demonstrated an enormous potential for fuel burn savings. Especially if the new routing is not affected by flight level constraints potential savings reach up to 68 kg per flight. These promising results should lead to further investigations regarding connectivity between Upper Airspace (DCT or UPR) with aerodromes using optimised descent profiles which allow for a late descent.

Focussing on FR-CAP-02 "Cross-Border User Preferred Route" demonstrations in EXE-0201-D006 were accomplished on six citypairs under study (3 of them inner-European, 3 transatlantic). In total 62 flights have been executed following a User Preferred Routing.
With the short-haul flights route lengths reductions between 1 NM and 16 NM were achieved, corresponding to fuel savings between 6 kg and 87 kg; on average the fuel reduction for short-haul flights is 5.5 kg per NM saved. Route lengths of transatlantic flights were reduced by 12-25 NM, accounting for fuel savings between 280 kg and 618 kg; average fuel reduction is 23.6 kg per NM saved.

KPA	Success Criterion	Result of the demonstration	
Efficiency (horizontal)	Reduction of FPL route length in Cross-Border UPR operations	Short-haul:	1 NM … 16 NM
		Long-haul:	12-25 NM
Efficiency (horizontal)	Reduction of actual route length in Cross-Border UPR operations	Short-haul:	1 NM … 16 NM
		Long-haul:	12-25 NM
Efficiency (horizontal)	Reduction of fuel burn in Cross-Border UPR operations	Short-haul:	5.6 kg per NM saved
		Long-haul:	23.6 kg per NM saved
Efficiency (horizontal)	Improvement of REDES in Cross-Border UPR operations	Actual flown UPR tracks: 1.015 (improvement vs. FR-CAP-01)	
Efficiency (horizontal)	Improvement of RESTR in Cross-Border UPR operations	Actual flown UPR tracks: 1.007 (no improvement vs. FR-CAP-01)	
Environmental Sustainability	Reduction of CO_2 emission in Cross-Border UPR operations	Not measured but due to route length reduction a reduction of CO_2 emission is to be assumed.	
Safety	No increase of complexity in Cross-Border UPR operations	ATCOs reported higher complexity of work, especially for continental flights.	

Safety	No degradation of the perceived level of safety in Cross-Border UPR operations	Crews and Dispatchers reported no safety issues. 14% of ATCOs reported safety hazards linked to UPR flights.
Safety	No degradation of the perceived level of situation awareness in Cross-Border UPR operations	UPR routings had to be checked and monitored continuously in order to maintain situation awareness. A clear labelling of UPR flights would be required.
Capacity	No adverse results regarding number of flights in Cross-Border UPR operations	On a case-by-case basis no capacity degradations were demonstrated. ATCOs stated that a high number of UPR flights would reduce capacity.
Other - Workload	No increase in operator workload in Cross-Border UPR operations	Dispatchers reported an increase in workload, especially in route construction, manual flight planning and filing. ATCOs reported an increase in workload due to the need for continuous checks of routings and the instruction not to deviate the flight from the FPL route.
Other – Operational Feasibility	No adverse operator feedback regarding Cross-Border UPR operations respectively	Approx. 77% of flight crews reported no irregularities. The major irregularity was ATCO not informed (offered DCT's).

Lessons learned: (*Explain here what worked well, what could be improved, what you would do differently next time –If applicable please explain if you think the ICAO assessment guidance could be improved and in what way. If you did not use the ICAO methodology can you identify aspects of your methodology that could provide benefits to future iterations of the ICAO guidance? What aspects of the ICAO guidance would you apply to your own methodology for future assessments?)*

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Comments: *(Optional - Offer here any other advice or hints that may be of value to others using ICAO environmental assessment guidance.*)

The full FRAMaK report is available here:
http://www.sesarju.eu/sites/default/files/documents/concepts/D12_FRAMaK_Final_Report_00_02_03_withAnnex-red.pdf?issuusl=ignore

WG2 ASBU Case study

ICAO

Template for good practice examples of environmental assessment (Draft V1.0)

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Organisation/Company*: (The name of the body that undertook or sponsored this assessment)*
ICAO CAEP WG2 ASBU Task Group

Project Title: *(The title of the project being assessed)* **Aviation System Block Upgrade (ASBU) Analysis**	Date of Assessment: **Ongoing**

ASBU Module Code(s)[4]: CDO; APTA	State's Action Plan[5]:

Project Description: *(Briefly describe the project or proposed operational change to be assessed for its environmental implications; Please when possible, use schematics for illustration.)*

In 2013 the CAEP WG/2 ASBU Task Group undertook a high level analysis of the fuel saving benefits of ASBU Block 0. This analysis concerned reviewing the Block 0 Modules to first of all identify the operational improvements (OIs) of each Block 0 module. The subsequent step was to assess whether these OIs would potentially have an impact upon fuel burn / CO_2. Following these steps, a set of 'rules of thumb' were developed for a generic application of the OI(s)so that potential global fuel saving benefits could be estimated following the receipt of current and planned implementation data of the ASBU Block 0 modules.

Reason for the environmental assessment: *(Explain why the environmental assessment was undertaken and, if applicable, include any specific regulation, policy, or rule that requires the assessment to be undertaken)*

There were no specific regulative requirements for this analysis but it was planned to follow directly the environmental assessment methodology where relevant.

Client or competent Authority: *(Explain which body the assessment will be submitted to for their approval or decision making. Was the assessment internal or public? What audience is it intended to inform?)*

The study will be submitted to ICAO-CAEP Steering Group for approval and will likely be then released and published.

It is intended that the results of this analysis will inform will inform global ATM Stakeholders in particular those who may be unsure as to what environmental benefits may be possible following ASBU implementation or those where evidence needs to be gathered to justify an implementation business case.

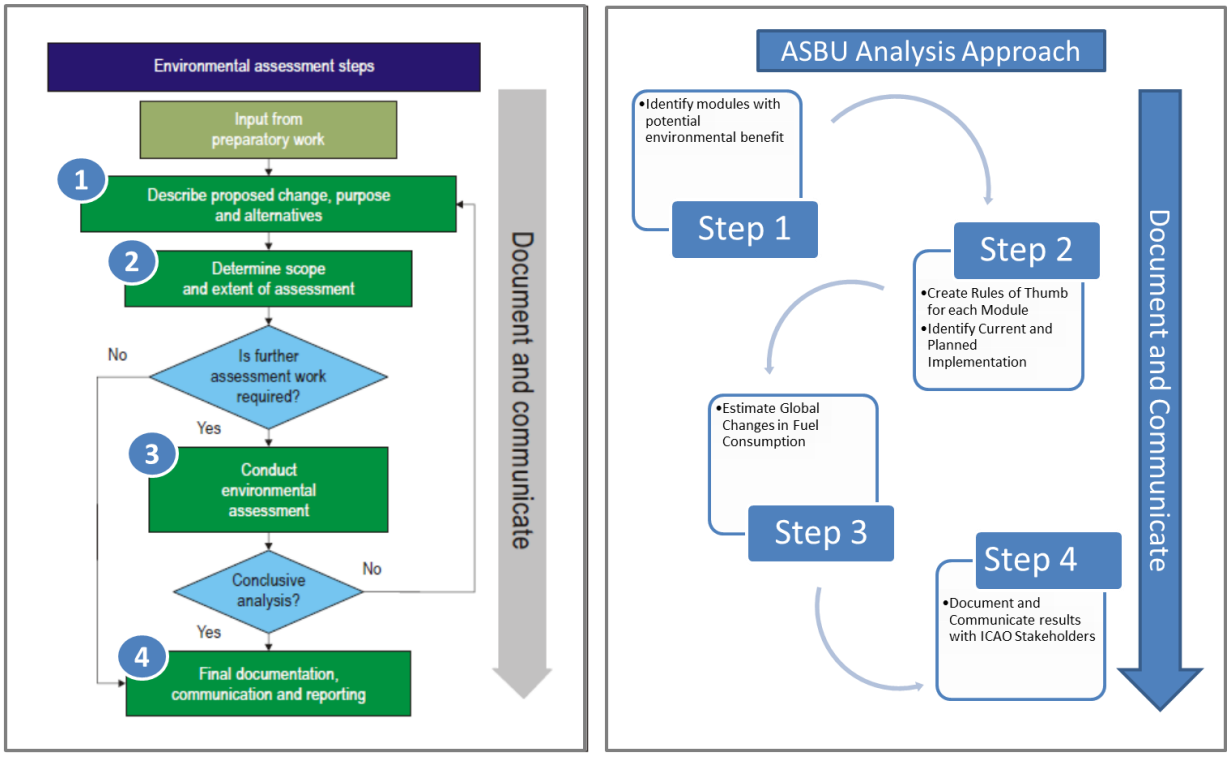
Assessment Approach: *(This section asks for a brief description of your application of the ICAO guidance for*

[4] **APTA**-Approach procedures including vertical guidance; **WAKE**-Wake vortex; **RSEQ**-AMAN / DMAN; **SURF**-A-SMGCS, ASDE-X; **ACDM**-Airport CDM; **FICE-**Increased efficiency through ground - ground integration; **DAIM-**Digital AIM; **AMET-**Meteorological information supporting enhanced operational efficiency; **FRTO-**En route Flexible Use of Airspace and Flexible routes; **NOPS-**Air Traffic Flow Management; **ASUR-**ADS-B satellite based and ground based surveillance; **ASEP-**Air Traffic Situational awareness; **OPFL-**In-Trail procedures (ADS-B); **ACAS-**ACAS improvements; **SNET-**Ground based safety nets; **CDO-**Continuous Descent Operations, PBN STARs; **TBO-**Data link en-route; **CCO-**Continuous Climb Operations

[5] http://www.icao.int/environmental-protection/Pages/action-plan.aspx

each main assessment step. If a step was not undertaken, give a brief explanation of why the step was omitted or is not applicable to this assessment example. Please complete each section individually. In this box you can explain why the ICAO approach to assessment was chosen. If you did not apply the ICAO methodology, please explain how your methodology differed from the ICAO approach.)

ASBU Block assessment process was aligned to generally follow the approach found in Figure 3-1 of ICAO Doc. 10031. Figure 1 below presents the ASBU Analysis approach alongside the Doc. 10031 Environmental Review Process.



Preparatory Work: *(Briefly explain the relevant background activities that have been undertaken to prepare for the assessment. This may include decisions or processes such as, deciding that an environmental assessment is required, identifying the assessment client, gathering base data, deciding on years to be assessed, deciding on assessment methods or standards to be applied. There is no need to cover all possible information, simply provide a sufficient explanation of the reasons why the assessment steps and approach were selected. How did you establish which rules, regulations, or standards applied to the assessment?)*

The CAEP Steering Group asked that a group be formed in CAEP to fully scope the requirements of assessing the environmental benefits from Aviation System Block Upgrade (ASBU) Block 0 in cooperation with the ASBU module experts. The group drafted a Terms of Reference document to present a proposed scope, schedule, and resource requirements for the consideration of the CAEP Steering Group for approval. The Terms of Reference document was developed by a team composed of experts in environmental analysis from CAEP, experts in the definition of the ASBU modules, experts in operations, and the ICAO Secretariat. Ultimately, the CAEP Steering Group approved the Terms of Reference as developed.

Describe the proposed [operational] change, its purpose and alternatives: *(Explain what will change as a result of the proposal to be assessed – this may repeat the information in the earlier project description. Explain why this project is required and what purpose it serves, and what alternatives have been considered. Information on why these alternatives were rejected is useful but not essential)*

The first part of the guidance was to describe the proposed change. The ASBU TG interpreted this as gaining understanding of the definitions of the Block 0 modules. To do this a review of each module was undertaken to identify the following:

- Module description
- Potential interdependencies with other modules
- Details of the information available
- Assumptions to be taken into consideration
- Implementation information
- References
- Any other pertinent information

To aid this process, a review template was developed to ensure that reviews of different modules followed the same format and contained all of the relevant information.

The objectives of this task was to ensure that all information regarding the operational impact and the changes that would take place following implementation could be shared with, and understood by, the task group.

There were no alternatives to be considered as an assessment of global fuel bur savings was required and the method undertaken was considered the only way that such an estimation could be realistically achieved.

Describe the scope and extent of the assessment: *(How was it decided that this assessment was needed – "screening". Describe the impacts to be assessed, for example, aircraft noise, CO_2 or NOx emissions, climate impacts or air quality impacts. Explain the decision making process that determined this scope and the level of detail to be used in the assessment – "scoping". Also describe any formal processes to consult upon or agree on the scope, for example, via a nominated competent authority if applicable. Explain, for example, if the scope was set using expert judgement or a pre-assessment checks or information gathering. Also describe how the decision to undertake a more detailed assessment, or not, was taken. How were the base-case and proposed case(s) determined, why were particular years chosen?)*

See Section "Reason for the environmental assessment" and "Preparatory Work"

The second step was to determine the scope and extent of assessment. In the context of the ASBU task, the ASBU TG interpreted this screening process as identifying which modules would have an operational improvement that could provide an environmental saving in terms of fuel burn. Fuel burn was the only environmental impact that was included in the terms of reference of this analysis so there was no need for such a prescriptive scoping process should be undertook. There were several other factors to take into consideration however. It had to be discussed whether not only could an environmental saving be identified but whether the benefit could be isolated from a system benefit that may include the benefits of multiple operational improvements. Furthermore, discussion also involved whether there was sufficient information available to identify a possible benefit and whether there would

be sufficient implementation data for an OI in the case that an environmental benefit be identified.
There was no official requirement for consultation because an actual assessment was not being undertaken however in order to ensure that all relevant stakeholders were involved in the review of the modules and the entire decision making processes, representatives from all the relevant stakeholder groups (i.e. pilots, ATC, airports and airlines) were encouraged to participate in the working group.
The analysis was principally undertaken based on a review and knowledge of actual information that was either in the public domain or available from existing studies or other from the TG members.

Therefore, the analysis was based upon an expert judgement process of existing material.

It should be highlighted that there was no plans for the ASBU to undertake an environmental assessment themselves but to follow the same methodology process to identify existing data, studies and information that could enable the identification of a realistic generic benefit of the module.

The baseline and future state were fixed at the start of the analysis.

Describe the assessment itself: *(Describe any standards or mandatory requirements for the assessment to be undertaken together with the methodology, monitoring or model used to determine the extent of the environmental impacts for the proposal. Give an indication of the extent or time-horizons that were chosen (if not already described earlier). Was quality management applied? For example, was there a process to ensure that the input data for the environmental assessment was consistent with other parallel assessments? Were interdependencies encountered and how did you address any trade-off issues? Was the expertise for this assessment available from internal resources or procured externally?)*

The assessment was undertaken as detailed above.

Quality management was applied by getting an ANSP group from CANSO to review the rules of thumb after being developed. The aim of this oversight was to ensure that there were no obvious errors in the analysis and that any information from ANSPs that could be pertinent to the analysis, was included.

Interdependencies were considered in the analysis and where identified, as far as possible, it was ensured that there would be no double counting of benefits. In addition, the general idea was to identify a conservative level of benefits to ensure that in the case of possible double counting, the overall benefits would not be overestimated.

All resources were from CAEP WG/2 or from colleagues / organisations of the WG/2 members.

Describe the results and how they were communicated: *(Explain in general terms what the results of the assessment were, how this was used, for example to what extent it informed decision making or approval for the project. Was it produced as a draft for consultation or simply as a final report? Were the results validated or verified in any way – for example were the assessment processes or quality management processes independently audited? Did the results feed into a wider process, for example, a business case assessment?)*

The results of the analysis were developed by individuals who were volunteers to lead the review for each module and these rules of thumb were discussed during teleconferences open for all WG/2 members. Any contentious issues were discussed on a one to one basis with the individuals concerned to ensure that there was consensus. The results were communicated, discussed and followed up with the work group and relevant bodies, in particular, the CAEP Modelling and Databases Group (MDG) who had the responsibility to model the benefits of the OIs by putting the rules of thumb into their models.

During the analysis, the ASBU Tasks leads from WG/2 were in frequent communication with MDG to ensure that the information that had been transferred to them had been interpreted correctly. Despite this,

there were still some little misunderstandings between some of the assumptions behind the rules of thumb and the interpretation of the estimated savings.

Following the initial study by MDG, there were a couple of verification checks undertaken. At the project level, a separate group undertook a verification check to ensure that the data had been calculated and interpreted correctly. At the system level, a reality check was undertaken to ensure the results of the analysis were in the correct 'ball park' by checking to see whether or not the estimated fuel savings fell within the range of total possible available fuel saving benefits that had been previously been estimated in a previous study.

It is expected that in the future, information gleaned from this study will be used to provide supporting data for business case analyses.

Lessons learned: (*Explain here what worked well, what could be improved, what you would do differently next time –If applicable please explain if you think the ICAO assessment guidance could be improved and in what way. If you did not use the ICAO methodology can you identify aspects of your methodology that could provide benefits to future iterations of the ICAO guidance? What aspects of the ICAO guidance would you apply to your own methodology for future assessments?)*

In general, the task leads consider that the work has been carried out to the highest degree possible taking into account the remit of the terms of reference, the information available, the timeframe and the resources available.

Two issues were identified:
1, The task was quite complex and involved detailed technical discussions in places. Therefore, it became apparent to the task leads that there was a general reluctance for new people to become involved in the task once it had been initiated as they felt it was too technical.

2, It would be more valuable to have a wider working group to be involved in the project particularly from additional States of regions.

3, Coordination with supporting and collaborating groups was important for the successful completion of the ASBU Analysis. This coordination was important to ensure that the analysis approach and schedule was agreed to and the results of the analysis present the consensus of each participating group.

Comments*:* *(Optional - Offer here any other advice or hints that may be of value to others using ICAO environmental assessment guidance.*)

A box in this document should be added for the 'document and communicate' process.

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(17 pages)