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NLR	*Stichting Nationaal Lucht- en Ruimtevaartlaboratorium*	*NL*
ONERA	*Office National d’Etudes et de Recherches Aerospatiales*	*F*
Eurocontrol	*European Organisation for the Safety of Air Navigation*	*INT*
DUT	*Delft University of Technology, Faculty of Aerospace Engineering*	*NL*
QinetiQ	*QinetiQ (formerly DERA)*	*UK*
RC-F	*Rockwell-Collins France*	*F*
SIA	*Smiths Industries Aerospace and Defence Systems*	*UK*
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Contributing Partners	Authors
Eurocontrol	A. Nuic, angela.nuic@eurocontrol.int

Contact Information
National Aerospace Laboratory, NLR
Attn. Mr. R.C.J. Ruigrok
Anthony Fokkerweg 2
1059 CM Amsterdam
The Netherlands
Tel.: +31-20-5113595
Fax: +31-20-5113210
e-mail: ruigrok@nlr.nl

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Partner	Distribution list
EC	J. Forsman, Jonas.FORSMAN@cec.eu.int
NLR	R.C.J. Ruigrok, ruigrok@nlr.nl , +31 20 511 3595 M.S.V. Valenti Clari, valenti@nlr.nl , +31 20 5113012 L.J.J. de Nijs, nijs@nlr.nl , +31 20 511 3737
ONERA	J.L. Farges, Jean-Loup.Farges@cert.fr N. Imbert, Nicole.Imbert@cert.fr
Eurocontrol	E. Hoffman, Eric.hoffman@eurocontrol.int A. Nuic, angela.nuic@eurocontrol.int C. Shaw, chris.shaw@eurocontrol.int M. Bouassida, mouna.bouassida@eurocontrol.int
DUT	H.G. Visser, h.g.visser@lr.tudelft.nl R. Wijnen, r.a.a.wijnen@lr.tudelft.nl
QinetiQ	P. Platt, phil.platt@atc.qinetiq.com B. Booth, bill.booth@atc.qinetiq.com A. Magill, adrian.magill@atc.qinetiq.com
RC-F	A. N'Diaye, andiaye@rockwellcollins.com C. Alber, calber@rockwellcollins.com S. Koczo, skoczo@rockwellcollins.com O.F. Bleeker, ofbleeke@rockwellcollins.com
SIA	J. Lomas, john@siaero.co.uk
AIRBUS FRANCE	D. Ferro, daniel.ferro@airbus.aeromatra.com
ECA / VNV	R.C. Brons, rcbrons@wxs.nl R. Hoogeboom, vtz@vnv-dalpa.nl
AEA / BA AEA / SAS AEA / KLM	A. Fisher, Alex.B.Ficher@British-Airways.com A. Shand, Andy.N.Shand@BritishAirways.com A. Ellis, andrew.d.ellis@britishairways.com B. Nilsson, bengt.nilsson@sas.se B. Berends, benb@klm.nl

Summary

This document contains an overview of the Free Routes Airspace Project (FRAP) as addendum to INTENT deliverable D1-1 “Project Scope and Relevant Results of otherProjects, Activities and Initiatives – D1-1”.

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1. Introduction

During the INTENT project, the Eurocontrol Free Routes Airspace Project (FRAP) was identified to be an interesting project to survey within INTENT WP1.2 “Survey of past and ongoing activities concerning traffic separation assurance”. Main reason for this was the change of the project scope in INTENT to include ground separation assurance concepts with both structured and unstructured airspace. Especially the ground separation assurance operational concept with unstructured airspace is very much in line with the Eurocontrol FRAP project.

2. Summary of FRAP project

2.1. Project overview

The Free Route Airspace Project is a pilot project between the Eight States and the EUROCONTROL Maastricht UAC. It considers the concept application in the airspace of the Eight States between FL295 and FL460. The project is supported from within the European Air Traffic Management Programme (EATMP) by both the Airspace Management, Navigation, Air Traffic Control and Data Processing Domains.

The civil and military Air Traffic Control organisations of the States of Belgium, Denmark, Finland, Germany, Luxembourg, The Netherlands, Norway and Sweden together with EUROCONTROL are examining the feasibility and practicalities of introducing the Free Route Airspace Concept in their airspace to enable users to plan and fly their preferred routes between entry and exit points. Access to and egress from this airspace, planned for flight levels above FL295 up to FL 460, would be by conventional means.

The Eight States and EUROCONTROL completed project planning in December 1998 with the approval of the project. Project development and feasibility is being conducted until 2001. Phase 1 analyses the feasibility of Free Route Airspace through simulation and prototyping and will produce an Implementation Plan. Safety and business cases will be developed in parallel to demonstrate the project's feasibility and support for its adoption by all participating States. Project implementation will be prepared from 2001 with the development of required framework instruments (Procedures, Documentation, Letters of Agreement, etc) leading to the implementation of Free Route Airspace Concept in the Upper Airspace of the participating States from 2003 pending a successful feasibility study. Monitoring and Development will start at implementation of Free Route Airspace. It will provide monitoring during the first year of operations and will conduct a review of the Free Route Airspace Concept in operation.

The EUROCONTROL Agency has the objective of further, progressive implementation across other ECAC States.

The specific objectives of Phase 1 include:

- Airspace and Procedures - Determine the airspace structure and procedures required for the support of free route operations;
- Capacity - Determine the extent to which the Free Route Airspace Concept (FRAC) will contribute to an increase in capacity in the Eight States Free Route Airspace to meet the expected forecast growth in traffic.
- Safety - Evaluate the effect on the level of safety resulting from free route operations including contingency arrangements and fallback
- Impact on Stakeholders - Examine the cost benefit of FRAC in both operational and financial terms
- Impact on Controllers - Determine the impact on Controllers, both civil and military, to adapt to free route operations
- Civil Military Co-operation - Evaluate the level of co-operation described in the Free Route Concept on military operations.

During the Feasibility Assessment several small scale simulations (with 9 controller working positions), 2 large scale simulation (with 24 controller working positions) and 20 Rapid Prototyping Sessions using the STASNS/SPICE Platform have been performed. These simulations provide, together with a number of other activities, the basis for the validation of the Free Routes Airspace Concept.

2.2. Document overview

Following documents have been used for this review:

1. FRAP SRT-1, EEC Note No. 22/99, 1st Small Scale Free Route Real-time Simulation
2. FRAP SRT-2, EEC Note No. 06/00, 2nd Small Scale Free Route Real-time Simulation
3. FRAP SRT-3, EEC Note No. 14/00, 3rd Small Scale Free Route Real-time Simulation
4. FRAP SRT-4, EEC Note No. 17/00, 4th Small Scale Free Route Real-time Simulation
5. EEC Report, Eight-states Free Route Airspace Project, Large Scale Real-Time Simulation; NORTH scenario
6. EEC Report, Eight-states Free Route Airspace Project, Large Scale Real-Time Simulation; SOUTH scenario

2.3. Detailed review of the project

2.3.1. Technological issues

2.3.1.1. CNS requirements

B-RNAV – is one of the enablers of the FRAP.
System Support - Enhancement for the purposes of flight planning, flight data display and exchange, co-ordination, conflict detection and resolution.

2.3.1.2. Decision Support Tools

<u>Conflict Detection Tool</u>

Conflicts are likely to be more random in nature and different in characteristic in Free Routing, which could result in problems of detection for the Controller. The regular conflict points that exist today will be dispersed and become less predictable. The use of Conflict Detection and Resolution tools is expected to provide significant support to Controllers in the execution of these tasks. The efficiency of some of these tools, for example Medium Term Conflict Detection (MTCD), is highly dependent on the availability of an accurate system trajectory for a given flight.

A relatively simple Medium Term Conflict Detection (MTCD) was provided to the controllers during FRAP Real Time simulations. In order to support distribution of task between the PLC and EXC, conflicts were divided into Planning Conflicts or Executive Conflicts

- Conflicts were classified as Planning Conflict if at least one of the flights involved in the conflict was still not under control of the sector.
- Conflicts were classified as Executive Conflict if at least one of the flights involved in the conflict was under control of the sector.
- Conflicts where one aircraft was controlled by the sector and the other aircraft was not under control by the sector was classified Planning Conflict and Executive Conflict.

The PLC received MTCD information about Planning Conflicts via a dedicated window, Conflict and Risk Display (CRD). In the CRD the PLC could select to see Planning Conflicts only, or to see all conflicts.

The EXC received MTCD information directly in the data label of the subject aircraft, in order to avoid windows covering parts of the EXC radar picture. EXC could call select the CRD to be presented.

Both controllers could call down additional information about conflicts via

- The Dynamic Flight Leg (DFL), where DFLs of conflicting aircraft would be shown with a colour coding of the portion of the trajectory where the aircraft were in conflict.
- The Vertical Aid Window, that provided a vertical presentation of the conflicting flights and other flights along the trajectory of the subject aircraft.

In the CRD the controllers could choose to see Conflicts and Risks, or Conflicts only.

A Risk is defined as two aircraft within a defined lateral distance, where there is an overlap of the level bands Actual Level/Exit Level/Cleared Level of the two aircraft. A Conflict is a Risk where the level bands Actual Level to Cleared Level of the two aircraft are overlapping.

MTCD look-ahead time was set to 15 minutes for Planning Conflicts and 5 Minutes for Executive Conflicts. Only conflicts where the predicted minimum distance between aircraft were 8 NM or less were presented to the controllers.

One of the objectives of the simulations was set up to answer the question whether MTCD is an enabler for FRA or not. Controller perception was that there was a need for system support to the controller to perform the monitoring tasks. This can be in the form of MTCD, Area Proximity Warning (APW) or Conformance Monitoring. In earlier simulations it was concluded that the need for system support to the monitoring task would arise at a lower traffic level in FRA than elsewhere.

Safety nets - Short Term Conflict Detection (STCA)

Short Term Conflict Alert (STCA) was defined within the radar coverage area, taking into consideration Cleared Flight Level. The look-ahead time was 2 minutes.

Human Machine Interface

In FRA the entry and exit of a sector or ACC are not via a fixed co-ordination point. The assimilation of an aircraft's route through the sector without any reference points may be difficult for Controllers to visualise. Therefore the HMI provided at the Controller Working Positions (CWPs) should be sufficient to support the display of the free route e.g. by graphical display.

Functionality and Human Machine Interface used in FRAP simulations are listed below:

1st Small Scale Free Route Real-time Simulation: The platform used was based on the functionality and Human Machine Interface presently in use within the Eight-States, and included features such as Paper Strips, Electronic Flight Lists, Short Term Conflict Alert, OLDI, and VHF- and telephone.

2nd Small Scale Free Route Real-time Simulation: The functionality and Human Machine Interface that is expected to be in operations in the two States within the next 3 years formed the basis for the platform used. This included OLDI/SYSCO and Short Term Conflict Alert. Medium Term Conflict Detection was not included. The HMI was a stripless, object based, colour coded concept very close to the HMI that will be included in the new systems in the two countries.

3rd Small Scale Free Route Real-time Simulation: Functionality and Human Machine Interface expected to be in operations in the eight States within the next 5 years formed the basis for the platform used. This included OLDI/SYSCO and Short Term Conflict Alert, Medium Term Conflict Detection and Area Proximity Warning. The HMI was a stripless, object based, colour coded concept very close to the proposed EATMP HMI.

4th Small Scale Free Route Real-time Simulation: Functionality and Human Machine Interface expected to be in operation in the military ACCs within the simulated area over the next five years formed the basis for the platform used. This included OLDI/SYSCO, System Supported Civil-military Co-ordination and Short Term Conflict Alert. The HMI was a stripless, object based, colour coded concept.

1st and 2nd Large Scale Free Route Real-time Simulation: Functionality and Human Machine Interface similar to the ones that are expected to be in operation in the ACCs within the simulated area before year 2005 formed the basis for the platform. This included OLDI/SYSCO, System Supported Civil-military Co-ordination, Medium Term Conflict Detection and Short Term Conflict Alert. The HMI used a stripless, object based, colour coded concept.

The Measured Sectors in FRAP simulations were all manned with two controllers, Executive Controller (EXC) and Planner Controller (PLC), each controller had a separate Controller Working Position (CWP). The CWP consisted of:

- Sony 29' square colour display, used to provide a multi-window working environment;
- Hewlett Packard processor (240/360/3000) and Metheus display driver;
- 3 Button Mouse;
- AUDIOLAN simulation telecommunication system with headset, foot switch and panel-mounted push-to-talk facility.

Each CWP included a subjective workload panel (Instantaneous Self-Assessment – ISA) used by the controller for periodic input (every 5 minutes) during measured exercises.

Executive Controller (EXC) and Planner Controller (PLC) each had radar windows with colour coding of the data label to indicate the Flight Plan Life State. The data label contained callsign, Mode-C, Entry level (EFL), Cleared level (CFL), Exit level (XFL) and Route elements. Additional information such as heading and speed instructions could be added to the data label.

Flight plan data was presented on a call-down basis for one flight at a time in a dedicated window and in Sector Entry Lists for flights about to enter the sector.

A graphical presentation of the flights planned trajectory was available on a call-down basis.

Input of instructions was performed directly via the data label.

Short Term Conflict Alert (STCA) was activated if two flights were predicted to be within 3,7 NM and 700' (1700' for non-RVSM equipped aircraft and above Fl 400) within 1 minute.

2.3.2. ATM Performance issues

2.3.2.1. Capacity

One of the objectives of the FRAP is to determine the extent to which the Free Route Airspace Concept (FRAC) will contribute to an increase in capacity in the Eight States Free Route Airspace to meet the expected forecast growth in traffic.

The controller workload is the main limitation of the sector capacity in present situation. By reducing the controller workload the increment in sector capacity could be achieved. During the small and large scale simulations controller workload has been accessed through the collection of different subjective and objective data. ISA technique has been used to access perceived controller workload. ISA stands for Instantaneous Self-Assessment. It is a technique originally developed by DRA Portsmouth Maritime Command and Control and used at the EEC for several years.

Each control position is equipped with a small box containing 5 buttons labelled:

- Very High
- High
- Fair
- Low
- Very Low

At five-minute intervals the controller is prompted by a flashing red light to the button which corresponds to his perceived workload during the previous five minutes. The light flashes for 30 seconds during which time the controller must respond. At each interval a record is written of the button selected and the delay in responding so that by the end of the exercise there is a history of the variation of each controller's perceived workload.

The main advantage of ISA is its simplicity. The procedure is very simple to explain and administer. The results are usually used to identify busy periods within a sector rather than as an absolute measure of workload.

The second of two planned large-scale simulations where the Free Routes concept was validated was also set up to be a comparison between Free Routes and the Fixed Route environment in terms of controller workload.

Some of findings from this simulation indicated that in the simulated airspace the EXC workload is higher in FRA (more tactical instructions have to be issued, frequency load is higher) and the PLC workload is higher in FRA (the effort required to maintain the mental picture of the traffic is higher, conflicts are more difficult to identify).

However, it shall be noted the findings in less dense traffic previous reports have pointed towards a reduction of controller workload. (FRAP SRT-1, EEC Note No. 22/99 and FRAP SRT-3, EEC Note No. 14/2000)
It seems that for airspace where a lot of strategic de-conflicting of traffic has taken place, or where traffic density is high, FRA is a disadvantage, elsewhere FRA is an advantage
A need to further develop tools to support the PLC identifying conflicts and support the EXC in the monitoring task has been emphasised once again. This tool should enable the PLC to assist the EXC and obtain a better task distribution on the sector. That could potentially increase sector capacity.

2.3.3. Human factors

The FRAP Human Performance Study was took part in the simulation, and performed a number of measurements related to human performances, such as eye movement tracking and heart beat rate. The study has been done by NLR, the results of this study are published in a separate report which has not been available for this review.

Other measures that were taken during the simulations are categorised in two groups and listed hereafter:

Subjective data

- Questionnaires. The controllers were asked to fill in questionnaires before and after the simulation.
- Instantaneous Self Assessment (ISA)
- Debriefings. Controller opinions were collected during the daily debriefings

Objective data

The following data-sets were recorded:

- The number of pilot inputs/controller tactical instructions (level, heading, direct)
- Radio usage (number of calls per aircraft, average length of calls)
- Average flying time per sector
- The percentage of flights cleared to cruise at the level requested in the flight plan

The analysis based on the collected data and discussions during the briefings resulted in following conclusion:

- The Free Routes Airspace Concept is easy to understand and is accepted by the participating controllers. From a controller point of view the concept could be implemented when the required system support is in place.
- FRA will change the controller's tasks
- FRA shifts workload towards the executive controller
- There is a need to further develop MTCD functionality and HMI to shift work back to the planning controller and reduce executive controller workload

2.3.4. Institutional Aspects

Free Route Airspace is an integral part of the overall airspace organisation, interfacing with adjoining airspace through the fixed route network. It will be a managed airspace within which RVSM and BRNAV will operate and procedures will exist to accommodate the removal of the route structure within its boundaries.

FRA will encompass the lateral extent of the FIRs of the Eight-States and vertically from a base level as yet to be determined to the highest operating level of managed airspace. It is intended to include airspace where ATS has been delegated from adjoining States. The use of this airspace as Free Route Airspace and further Delegation of Air Traffic Services will be subject to agreement and institutional arrangements with the adjoining States.

For the purposes of studies the division between the Fixed Route Network and FRA is FL285.

FRA sectors should be:

- Unrestrained by artificial boundaries. Cross-Border sectorisation would be subject to institutional arrangements.
- Capable of being reconfigured to meet demand. A structured methodology where sectors were taken from a library of designs already known to the internal and external systems is likely in areas where there are significant fluctuations to traffic flow orientation.
- Capable of operating in mixed mode (Route Network and Free Route Airspace) if needed. Within some areas of FRA it is expected that mixed mode operations will be employed.

A single Flight Level Orientation System will be applied across the whole FRA.

Flights entering and exiting FRA will normally do so via the fixed route network. Flights between ACCs will continue to be subject to rules, procedures and Letters of Agreement.

The automatic exchange of flight data between ACC's and between sectors will require that that systems are capable of identifying and transferring data at random points along an ACC or sector boundary, unlike today where co-ordination is mainly affected by using fixed co-ordination points (COPs).

ATC Procedures - Revised Letters of Agreement between the involved ACCs were developed, in order to allow the use of Free Routes.